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*"E-Business Paradigms:
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Applying Fuzzy PERT in Cycle Time Management for Supply Chain System

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ABSTRACT

As the fast technology evolution and the globalization trend, the competition among businesses transform into supply chain network gradually. However, the operation performance of the supply chain network influenced by many uncertain factors. These uncertain influence factors include the demand of the customer, the response time of delivery, operation lead time, stock level and cost. Under foregoing conditions, enterprises cannot control the variations in actual environment precisely and satisfy customers' requirements. Therefore, the linguistic variables are used to express these uncertainties in this paper. First, this paper presents a procedure to transform the operation processes of the supply chain network into a diagram to indicate the activities among members of supply chain. Second, combining fuzzy set theory with the program evaluation and review technique (PERT) to estimate the cycle time of supply chain system. According to the fuzzy PERT model, we can calculate the cycle time and find out the critical path of a supply chain system. Furthermore, we can compute the possibility of the order fulfillment of a supply chain system. Finally, a numerical simulation is presented to illustrate the procedure of this proposed model.

Keywords: Supply chain system, Fuzzy numbers, Program evaluation and review technique (PERT), Fuzzy PERT.

1. Introduction

Today the enterprise faces many rigorous and challenges, including the globalization of competition and cooperation, a varieties of customer requirements and shortened product life cycles. The enterprise has to look for the effective methods to adjust strategic and manageable models and maintain operations and competitive advantages. For example, Material Requirement Planning (MRP), Manufacturing Resource Planning (MRPII) and Enterprise Resource Planning (ERP) [10, 21] are used to integrate the operation processes and resources for enterprises. The purpose of these tools is to reduce the response

time of the market demand and increase the customer satisfactions.

As the Internet and information technology grow rapidly, the industrial environment becomes more competitive for individual enterprise. Nowadays global marketplaces, no longer an individual enterprise competes as an independent entity but rather as an integral part of supply chain links [10]. In other words, each enterprise will depend on its management abilities to integrate and coordinate the complicated network of business relationships among supply chain members [5]. Therefore, supply chain management (SCM) has become one of the most important issues for enterprises.

A supply chain may be viewed as an integrated system that performs the procurement of raw material, its transformation to intermediate and end-products, distributor and promoting of the end-products to either retailers or customers [5, 21]. In recent years many researches are very interested in supply chain management problems and the concepts of SCM from different view points that were presented in [4, 5, 20, 27,28]. Unfortunately, there is no explicit description of supply chain management or its activities in the literature [30]. For example, New and Payne [23] described supply chain management as the chain linking each element of the manufacturing and supply processes from raw materials to the end user, encompassing several organizational boundaries. Jukka et al., [16] described supply chain management as a new way to provide goods and services to the end customer at the lowest cost and high service level, and the centric approach to manage the supply chain is no longer appropriate. SCM is an integrated approach to increase the effectiveness of the logistics chain by improving cooperation between members in the chain. Figure 1 shows the activities of a supply chain is comprised two fundamental procedures: (1) the Production layout and Inventory control process, and (2) the Distribution and Logistics process [1].

There is a growing interest in exploiting supply chain models in real applications and in developing decision support system to enhance supply chain management and control. Thus, a real supply chain operates in an uncertain environment. Different sources and types of uncertainty exist along the supply chain and make supply chain management

problems more complex [6, 7, 20, 24, 25, 26]. Facing the dynamic states of the supply chain market, a supply chain network system that its internal and each operation of links in fast supply chain express effectively, and responds and makes more accurate forecasting to the market demand in time, is the problem that we want the important concerns the topic.

Program Evaluation and Review Technique (PERT) [3, 11, 12] is the management technique of a kind of project scheme and makes use of the mode of the operation network, marking whole scheme in the correlation of each operation activity. Making use of mathematics function compute possible complete times that are the earliest start time, the latest start time, the earliest finish time, the latest finish time, float time and total float time. Therefore, PERT is suitable to compute the order completion time and forecast the order fulfillment ability in the supply chain network system.

However, in traditional program evaluation and review technique, various dynamic activity durations must be the crisp number or obedient to certain probability distribution. Under the real situation, the operation time of each activity is usually difficult to define and estimate. Therefore, in recent years there are many researchers combining the concepts of the fuzzy set theory with program evaluation and reviews technique in developing the fuzzy program evaluation and review technique (FPERT)[3, 9, 12, 14, 15, 19, 22, 29]. In FPERT, the duration time of each activity is expressed by a fuzzy numbers.

In this paper, FPERT is applied to deal with the cycle time management problem of supply chain system. First, we can calculate the fuzzy completion time of the supply chain system by Fuzzy PERT method. Second, we will indicate the critical path of the supply chain system. Finally, the possibility of promise delivery can be calculated.

2. Fuzzy sets and notations

Zadeh introduced a theory whose objects fuzzy sets are sets with boundaries that are not precise. The membership in a fuzzy set is not a matter of affirmation or denial, but rather a matter of a degree[31].

A fuzzy set can be defined mathematically by assigning to each possible individual in the universe of discourse a value representing its grade of membership in the fuzzy set. This grade corresponds to the degree to which that individual is similar or compatible with the concept represented by the fuzzy set. Thus, individuals may belong in the fuzzy set to a greater or lesser degree as indicated by a larger or smaller membership grade. As already mentioned, these membership grades are very often represented

by real number values ranging in the closed interval between 0 and 1[13].

2.1 Fuzzy Numbers

The fuzzy number \tilde{A} is a fuzzy set, its membership function $\mu_{\tilde{A}}(x)$, satisfies the following conditions [18]:

1. $\mu_{\tilde{A}}(x)$ is piecewise continuous.
2. $\mu_{\tilde{A}}(x)$ is convex fuzzy subset.
3. $\mu_{\tilde{A}}(x)$ is normality of a fuzzy subset, then the existence a real amount x_0 make $\mu_{\tilde{A}}(x_0) = 1$.

2.2 Triangular Fuzzy Number (TFN)

The triangle fuzzy number is a popular type of fuzzy number. A triangle fuzzy number can be expressed as $\tilde{T} = (l, m, u)$. When $l > 0$, then \tilde{T} is a positive triangle fuzzy number (PTFN)[8,32]. The membership function of positive triangle fuzzy number \tilde{T} is defined as (shown in Figure 2):

$$\mu_{\tilde{T}}(x) = \begin{cases} \frac{x-l}{m-l}, & l < x < m \\ \frac{u-x}{u-m}, & m < x < u \\ 0, & \text{otherwise} \end{cases} \quad (1)$$

where $l > 0$.

2.3 The operation of the fuzzy numbers

Given two positive triangle fuzzy numbers $\tilde{T}_1 = (l_1, m_1, u_1)$ and $\tilde{T}_2 = (l_2, m_2, u_2)$, then the additive operation between them can be expressed as follows [17]:

$$\tilde{T}_1 \oplus \tilde{T}_2 = (l_1 + l_2, m_1 + m_2, u_1 + u_2) \quad (2)$$

$$\tilde{T}_1 \ominus \tilde{T}_2 = (l_1 - u_2, m_1 - m_2, u_1 - l_2) \quad (3)$$

2.4 Ranking method of the fuzzy numbers

There are many ranking methods to transform fuzzy number into crisp value [2], Let $\tilde{T} = (l, m, u)$ be a triangle fuzzy number, then the defuzzified value is computed as [2]:

$$G(\tilde{T}) = \frac{l+m+u}{3} \quad (4)$$

Suppose \tilde{T}_1 and \tilde{T}_2 are two triangle fuzzy numbers, if $G(\tilde{T}_1) > G(\tilde{T}_2)$ then $\tilde{T}_1 > \tilde{T}_2$. If $G(\tilde{T}_1) = G(\tilde{T}_2)$ and $D(\tilde{T}_1) < D(\tilde{T}_2)$ then $\tilde{T}_1 > \tilde{T}_2$. If $G(\tilde{T}_1) = G(\tilde{T}_2)$ and $D(\tilde{T}_1) = D(\tilde{T}_2)$ then $\tilde{T}_1 \approx \tilde{T}_2$. Where $D(\tilde{T}_1) = u_1 - l_1$ and $D(\tilde{T}_2) = u_2 - l_2$.

2.5 The critical path method in fuzzy PERT

In this paper, we adopt an activity-on-node graph to represent a supply chain network. This graph includes two virtual tasks of null duration, start node and end node. For each task i the following notations will be used:

1. Succ(i)(respectively Pred(i)) refers to the set of tasks that immediately follow task i , while SUCC(i)(resp. PRED(i)) refers to the set of all the tasks that come after task i ;
2. \tilde{d}_i is the fuzzy duration of task i ;
3. \tilde{t}_i is the fuzzy earliest starting dates of task i ;
4. \tilde{T}_i is the fuzzy latest starting dates of task i ;
5. \tilde{m}_i is the fuzzy float time of task i .

These variables are restricted in following relations:

$$\tilde{t}_i = \max_{j \in \text{Pred}(i)} \tilde{t}_j \oplus \tilde{d}_j \quad (5)$$

$$\tilde{T}_i = \min_{j \in \text{Succ}(i)} \tilde{T}_j \ominus \tilde{d}_i \quad (6)$$

$$\tilde{m}_i = \tilde{T}_i \ominus \tilde{t}_i \quad (7)$$

If $G(\tilde{m}_i) = 0$, then task i is a critical activity. The critical path is a path which connected these critical activities from start node and end node.

3. Order Fulfillment Analysis model

Suppose that there are 2 suppliers, 3 manufacturers, 3 distributors and a final retailer the supply chain system. The duration time from receiving the order to deliver materials to manufacturer of suppliers S_i ($i=1, 2, \dots, m$) is denoted by $\tilde{T}_{S_i} = (S_{i1}, S_{i2}, S_{i3})$. The duration of the production of manufacturer M_k is denoted by $\tilde{T}_{M_i} = (M_{i1}, M_{i2}, M_{i3})$. The duration of the assembly

and distributor is denoted by $\tilde{T}_{D_i} = (D_{i1}, D_{i2}, D_{i3})$.

The duration of the final retail is denoted by $\tilde{T}_{R_i} = (R_{i1}, R_{i2}, R_{i3})$.

Two possible cases in supply chain system are discussed as follows:

- (1) The one supplier delivers materials to one manufacturer, one manufacturer products to one distributor, and the business sends the products to the final retail. In this case, the completion time of the supply chain system can be computed as:

$$\tilde{t} = \tilde{T}_{S_i} \oplus \tilde{T}_{M_i} \oplus \tilde{T}_{D_i} \oplus \tilde{T}_{R_i} \quad (8)$$

- (2) Several suppliers deliver materials to several manufacturer, several manufacturer delivers products to several distributor, and the business sends the products to the final retail. In this case, the completion time of the supply chain system can be computed as:

$$\tilde{t} = \max\{\tilde{T}_{S_i}, \tilde{T}_{S_j}\} \oplus \max\{\tilde{T}_{M_i}, \tilde{T}_{M_j}\} \oplus \max\{\tilde{T}_{D_i}, \tilde{T}_{D_j}\} \oplus \max\{\tilde{T}_{R_i}, \tilde{T}_{R_j}\} \quad (9)$$

Suppose the requirement due date of the customer is $RDD = \tilde{R} = (r_1, r_2, r_3)$, the completion time of supply chain system is denoted by $EF = \tilde{T}_{end} = (e_1, e_2, e_3)$, the promise delivery possibility (PDP) can be defined as (shown in Figure 3):

$$PDP = \begin{cases} 1 & , \quad r_1 - e_3 \geq 0 \\ \frac{\delta_1}{\delta_1 + \delta_2} & , \quad r_1 - e_3 \leq 0 \leq r_3 - e_1 \\ 0 & , \quad r_3 - e_1 \leq 0 \end{cases} \quad (10)$$

where

$$\delta_1 = \int_{x \geq 0} \mu_{\tilde{R} \ominus \tilde{T}_{end}}(x) dx, \quad \delta_2 = \int_{x \leq 0} \mu_{\tilde{R} \ominus \tilde{T}_{end}}(x) dx$$

In other words, when the value δ_1 is larger, it represents the order fulfillment ability of supply chain system is higher. Thus, the responds ability of supply chain system is stronger.

Therefore, the order fulfillment ability analysis of supply chain system is described as follows:

- (1) If $r_1 - e_3 \geq 0$, then the order fulfillment ability is 100%.
- (2) If $r_1 - e_3 < 0 < r_3 - e_1$, then the order fulfillment ability is denoted by PDP.
- (3) If $r_3 - e_1 \leq 0$, then the order fulfillment ability is

zero. In other words, the supply chain system can't delivery on time.

4. The results of simulation

In this paper, assumptions of supply chain processes considered are as follows:

1. The production facilities have unlimited capacities.
2. Customer demand is confined to a single product.
3. The raw material inventory is supplied from an external source.
4. External demand is fulfilled from the end-product inventory.

In order to implement the simulation analysis, we suppose the structure of the supply chain system as Figure 4. In Figure 4, S_1 and S_2 indicate the suppliers, M_1 , M_2 and M_3 indicate the manufacturers, D_1 , D_2 and D_3 indicates distributor, and the R_1 indicates the final retailer. Furthermore, the duration time of suppliers, manufacturers, distributor and the retailer are triangle fuzzy numbers and can be shown as Table 1. In Table 1, according to the LF- EF or LS- ES, we can compute the m value. According to the simple center method [2], we can compute the $G(\tilde{m}_i)$. If $G(\tilde{m}_i) = 0$, then task i is a critical activity. If completion time can't satisfy the customer requirement due date, we can adjust the duration time of activity on the critical path.

4.1 Requirement due date is crisp values

Suppose $RDD=(20,20,20)$ and $\tilde{T}_{end}=(13,18,25)$ then $\tilde{R}\Theta\tilde{T}_{end}=(-5,2,7)$. The PDP of supply chain network system can be computed as

$$PDP = \frac{\delta_1}{\delta_1 + \delta_2} = \frac{\frac{(25-13)*1}{2} - \frac{(25-20)*0.71}{2}}{\frac{(25-13)*1}{2}} = 0.70$$

Suppose $RDD=(15,15,15)$ and $\tilde{T}_{end}=(13,18,25)$ then $\tilde{R}\Theta\tilde{T}_{end}=(-10,-3,2)$. The PDP of supply chain network system can be computed as

$$PDP = \frac{\delta_1}{\delta_1 + \delta_2} = \frac{\frac{(15-13)*0.4}{2}}{\frac{(25-13)*1}{2}} = 0.07$$

When $\tilde{T}_{end}=(13,18,25)$ and RDD are different crisp values, the PDP of a supply chain system can be computed as above definition in this paper. In this case, if \tilde{T}_{end} is unchanged and RDD is smaller then the PDP of supply chain system is lower.

4.2 Requirement due date is fuzzy numbers

(1) Suppose $RDD=(12,20,23)$ and $\tilde{T}_{end}=(13,18,25)$ then $\tilde{R}\Theta\tilde{T}_{end}=(-13,2,10)$. The PDP of supply chain network system can be computed as

$$PDP = \frac{\delta_1}{\delta_1 + \delta_2} = \frac{\frac{(13+10)*1}{2} - \frac{(0-(-13))*0.86}{2}}{\frac{(13+10)*1}{2}} = 0.51$$

(2) Suppose $RDD=(10,15,21)$ and $\tilde{T}_{end}=(13,18,25)$ then $\tilde{R}\Theta\tilde{T}_{end}=(-15,-3,8)$. The PDP of supply chain network system can be computed as

$$PDP = \frac{\delta_1}{\delta_1 + \delta_2} = \frac{\frac{(0-(-8))*0.73}{2}}{\frac{(8+15)*1}{2}} = 0.25$$

(3) Suppose $RDD=(15,18,21)$ and $\tilde{T}_{end}=(13,18,25)$ then $\tilde{R}\Theta\tilde{T}_{end}=(-10,0,8)$. The PDP of supply chain network system can be computed as

$$PDP = \frac{\delta_1}{\delta_1 + \delta_2} = \frac{\frac{(0+8)*1}{2}}{\frac{(8+10)*1}{2}} = 0.44$$

When $\tilde{T}_{end}=(13,18,25)$ and RDD is a fuzzy number, the PDP of a supply chain system can be computed easily in this paper. According to the critical path, this method can indicate the critical activities and shorten their operation time to improve the PDP value. Therefore, the supply chain system can response the market requirement quickly and increase customers' satisfaction.

5. Conclusions

Along with the information technology growing fast, the competitions among enterprises have transformed into the competition between two supply chain systems. Thus, the robust management and operation model of supply chain system will increase

the competitiveness for the enterprise. Besides, the order fulfillment ability of supply chain system is the key factor for increasing their competitive advantages.

In this paper, the triangle fuzzy numbers are used to stand for the various uncertainty of duration time. According to the FPERT, we can find out the fuzzy earliest / latest final time and critical path in the supply chain network system quickly. In this paper the fuzzy model has proposed to analyze the order fulfillment ability of supply chain system for considering the uncertain duration time. According to the proposed model, we can immediately understand the status of each critical path of the supply chain system. If the completion time of critical path is not satisfy customer requirement due date, we can adjust the critical activities to raise PDP value and customer satisfaction. From the simulation results, it shows that if enterprise can hold duration time more precise, the order fulfillment ability of the supply chain network system more high.

This research is continued in two directions to further examine supply chain behavior in an uncertain environment.

- (1) To include additional sources of uncertainty into the fuzzy model, such as rush time or rush cost.
- (2) To examine the sensitivity of supply chain performances to various types of customer demand and fuzzy external supplier reliability.
- (3) In the future, we can to creative new better critical path method application in fuzzy program evaluation and review technique in supply chain network system.

6. Acknowledgements

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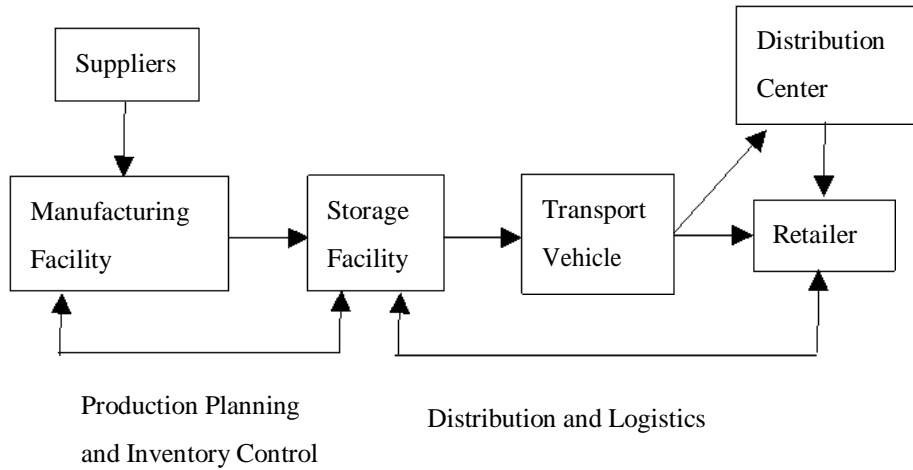


Figure 1. The supply chain process [1]

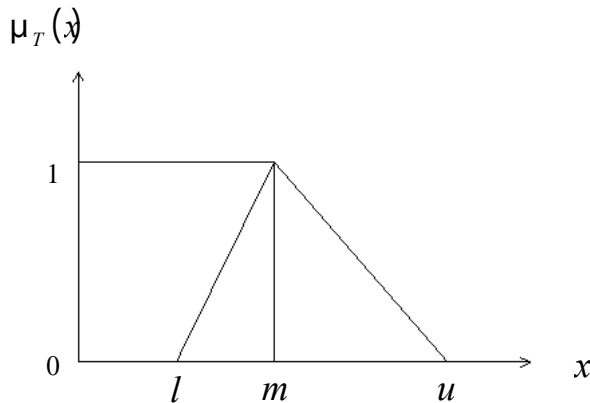


Figure 2. Positive triangle fuzzy number \tilde{T} .

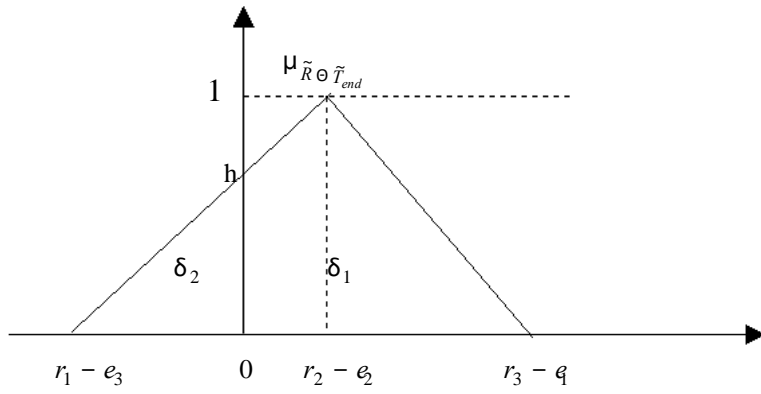


Figure 3. Membership function of $\mu_{R\Theta\tilde{T}_{end}}$.

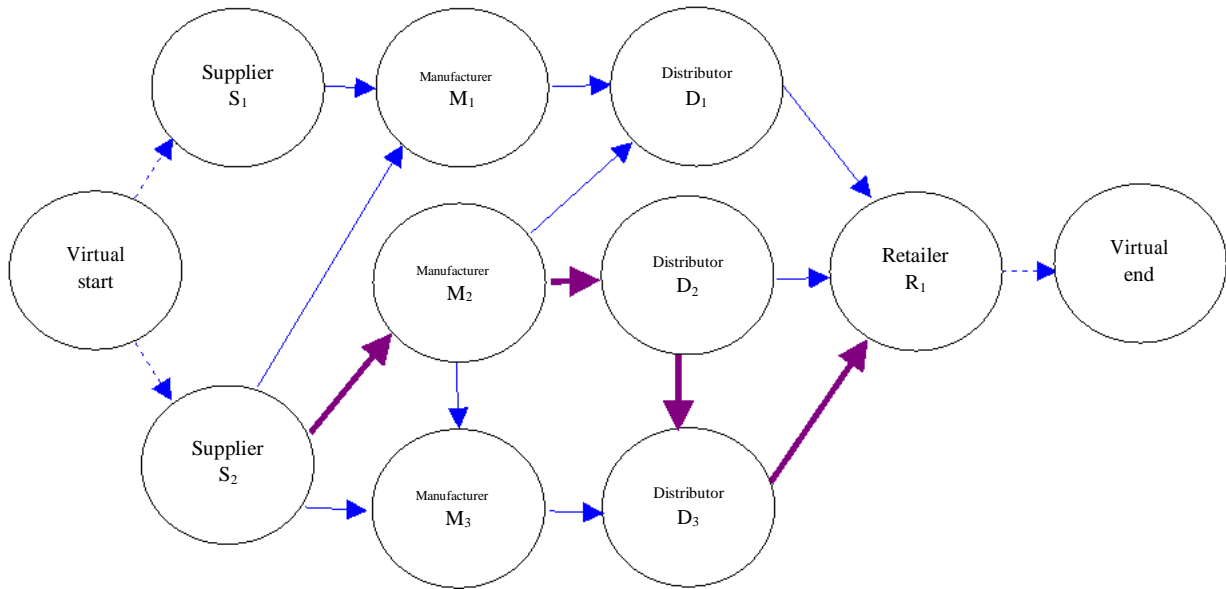


Figure 4. The graph of supply chain network.

Table 1 The stage duration time of supply chain system

node	Duration time	Earliest start time (ES)	Earliest finial time (EF)	Latest start time (LS)	Latest finial time (LF)	Float time (\tilde{m})	G(\tilde{m})
Supplier S ₁	(1,3,4)	(0,0,0)	(1,3,4)	(-5,7,19)	(-1,10,20)	(-5,7,19)	7
Supplier S ₂	(2,4,5)	(0,0,0)	(2,4,5)	(-12,0,12)	(-7,4,14)	(-12,0,12)	0*
Manufacturer M ₁	(2,3,6)	(2,4,5)	(4,7,11)	(-1,10,20)	(5,13,22)	(-3,6,15)	6
Manufacturer M ₂	(3,4,7)	(2,4,5)	(5,8,12)	(-7,4,14)	(0,8,17)	(-9,0,9)	0*
Manufacturer M ₃	(2,3,4)	(5,8,12)	(7,11,16)	(1,9,18)	(5,12,20)	(-4,1,6)	1
Distributor D ₁	(2,3,4)	(5,8,12)	(7,11,16)	(5,13,22)	(9,16,24)	(0,5,10)	5
Distributor D ₂	(3,4,5)	(5,8,12)	(8,12,17)	(0,8,17)	(5,12,20)	(-5,0,5)	0*
Distributor D ₃	(4,4,4)	(8,12,17)	(12,16,21)	(5,12,20)	(9,16,24)	(-3,0,3)	0*
Retailer R ₁	(1,2,4)	(12,16,21)	(13,18,25)	(9,16,24)	(13,18,25)	(-3,0,3)	0*

A User Preference Perception Model Using Data Mining on a Web-based environment

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Abstract

In a competitive environment, how to provide the information and products to meet the requirements of customers and improve the customer satisfaction will be the key criteria to measure a company's competitiveness. Customer Relationship Management (CRM) becomes an important issue in any business market gradually. Using information technology, businesses can achieve their requirements for one to one marketing more efficiently with lower cost, labor and time.

In this paper, we proposed a user preference perception model by using data mining technology on a web-based environment. First, the users' web browse records are aggregated. Second, fuzzy set theory and most sequential pattern mining algorithm are used to infer the users' preference changes in a period. After the test had processed, we use the on-line questionnaire to investigate the customer satisfaction degree from all participators. The results show that the degree of satisfaction was up to 72% for receiving the new information of participants whose preferences had been changed. It indicates that the proposed system can effectively perceive the change of preference for users on a web environment.

Keywords: Preference Perception, Data Mining, Fuzzy Set Theory, Most Sequential Pattern Mining Algorithm (MSPMA)

1. Introduction

Due to the information technology development and the World Wide Web (WWW) prevalence, the traditional business model has a tremendous revolution. As Customer Relationship Management (CRM) concept arises, more and more businesses pay much attention to the interaction between business and customers gradually. Every interaction and modification improves your ability to fit your product to this particular customer [26]. In a real business environment, it is a huge expense in time and labor to implement a one to one marketing solution in the past. Today, information technology can accelerate businesses to improve their interaction with customers more easily and efficiently.

Using the Internet to provide customers' personal products or services, it is an applicable solution to establish a low cost and high performance channel to accelerate interaction between businesses and customers

[7]. As the Internet users and information explosively grow, providing users' personal information or services actively that has become an important issue for those Website owners to retain customers' loyalty and satisfaction [31]. In the other hand, analyzing the users' personal searching or reading behavior that is also useful to accelerate businesses to understand the customers' requirements indeed. According to analytic data, the marketing salesman can provide customers one to one promotion activities.

Over these years, data mining and data warehouse become to power tools for businesses to sense the complicated market trend. Data mining and data warehouse retrieve useful knowledge or information from an enormous database, then integrate, accumulate and translate them into a part of the business wisdom [1]. In other words, data mining provides business managers an effective solution to retrieve valuable information from a variety of data sources.

As data mining and data warehouse grow, businesses can analyze customer's consumptive behavior and divide into several different kinds of groups or communities efficiently[30]. In this paper, we propose a user preference perception model using data mining and fuzzy set theory to detect user's preference trends or changes. It is applicable to accelerate businesses to understand what customers' preferences and their changes. Businesses can provide customers more fit and valuable information or services according to their preferences, and improve customer's satisfactions and achieve the aim of CRM.

The organization of this paper is as follows. First, we introduce some literatures include Data Mining, Knowledge Discovery in Database, Web Mining, Fuzzy Set Theory, and Mining Path Traversal Patterns. Second, we proposed a user preference perception model to calculate the degree of user's preferences and obtain the user's browsing patterns. Third, we built a website to demonstrate the feasibility and effectiveness of the proposed model. Finally, we make some conclusions at the end of this paper.

2. Literature Review

2.1. Data Mining and Knowledge Discovery

As information technology grows, businesses can aggregate and store mass data more easily and efficiently. But businesses expend a lot of space, money and labor in

maintaining those data and cannot acquire any additional benefit from them in the past. As the number of data and dimensions swift increases, analytic experts are harder to analyze and interpret data than the past. Therefore, Data Mining (DM) and Knowledge Discovery in Database (KDD) arose to support analyst and retrieve valuable information from mass data [14].

Data Mining is one of the most general approaches to reducing data in order to explore, analyze and understand it [15]. In the other views, scholars identify it is one method that can discover and extract implicit previously unknown and potentially valuable information, relationship and knowledge from previous data [4,10,15]. Knowledge discovery in Database (KDD) is the knowledge intensive processes of discovering knowledge that is implicit in large and diverse database [13,22,28]. It is an inherently iterative process of selecting data, preprocessing it, transforming it into a workable form, data mining over it, and interpreting the results [27]. According to the foregoing definition of DM and KDD, we identify the common aim of them is providing an efficient method to retrieve valuable information or knowledge from mass data. By these ways, businesses can acquire valuable information to make important decisions or strategies and enhance their competitiveness.

2.2. Web mining

The Internet has become one of the most popular information communication media in the world recently. It provides abundant, varied, and interactive information through the Web [4,11,18]. Although users can acquire amounts of information from Internet resources, they also face the serious information overload problem. Thus far, browsers and search engines cannot provide the information to meet users' requirements exactly and solve the information overload problem on the Internet effectively [7,20,21]. Web mining is one of effective tools to analyze users' browsing behavior and provide users the information meet their need respectively [18]. Web mining can be broadly defined as the discovery and analysis of useful information from the WWW [11,24]. Etzioni [12] divided Web mining into three parts as follows:

- (1) Resource discovery. Locating unfamiliar documents and services on the Web.
- (2) Information extraction. Extracting specific information from newly discovered Web resources automatically.
- (3) Generalization. Uncovering general patterns at individual Websites and across multiple sites.

Furthermore, there are three major categories in Web mining area as follows [2,5,11,18,20]:

- (1) Web content mining. The discovery of useful information from the Web.
- (2) Web structure mining. Trying to discover the model underlying the link structure of the Web.
- (3) Web usage mining. Trying to make sense of the data generated by the Web surfer's sessions or behaviors.

Web usage mining obtains logs file, user profiles, registration data, user sessions or transactions, cookies and any data as the results of interactions from web servers or proxy servers [18]. It mines those data to discover valuable information about user's intention. In this paper, we use Web usage mining to discovery the user's browsing patterns and perceive preference changes from his/her cookies.

2.3. Fuzzy Set Theory

A fuzzy set \tilde{A} in a universe of discourse X is characterized by a membership function $\mu_{\tilde{A}}(X)$ which associates with each element x in X a real number in the interval $[0,1]$. The function value $\mu_{\tilde{A}}(X)$ is termed the grade of membership of x in \tilde{A} [8,32].

Definition 2.1. A fuzzy set \tilde{A} of the universe if discourse of X is convex if and only if for all x_1, x_2 in X ,

$$\mu_{\tilde{A}}(\lambda x_1 + (1-\lambda)x_2) \geq \min(\mu_{\tilde{A}}(x_1), \mu_{\tilde{A}}(x_2)), \quad (1)$$

where $\lambda \in [0,1]$.

Definition 2.2. A fuzzy set \tilde{A} of the universe if discourse of X is called a normal fuzzy set implying that $\exists x_i \in X, \mu_{\tilde{A}}(x_i) = 1$.

A fuzzy number \tilde{n} is a fuzzy subset in the universe of discourse X whose membership function is both convex and normal (shown in Fig. 1).

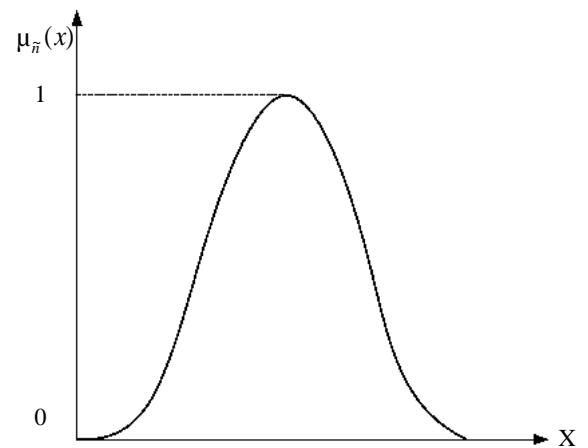


Fig. 1 A fuzzy number \tilde{n} .

Definition 2.3. The α -cut of a fuzzy number \tilde{n} is defined as

$$\tilde{n}^\alpha = \{x_i; \mu_{\tilde{n}}(x_i) \geq \alpha, x_i \in X\}, \quad (2)$$

where $\alpha \in [0,1]$.

\tilde{n}^α is a non-empty bounded closed interval contained in X and it can be denoted by $\tilde{n}^\alpha = [n_l^\alpha, n_u^\alpha]$, n_l^α and n_u^α are the lower and upper bounds of the closed interval, respectively. Fig. 2 shows a fuzzy number \tilde{n} with α -cut [17,33].

Up to now, the fuzzy set theory has applied in many areas such as fuzzy logic control [6], fuzzy decision-making [19], fuzzy expert system [16], and fuzzy information retrieve [23] etc. In this paper, we apply the membership function of fuzzy set theory to represent and calculate the degree of user's preferences. It can help us to deal with the relationship between user's browsing time and the length of web page content efficiently.

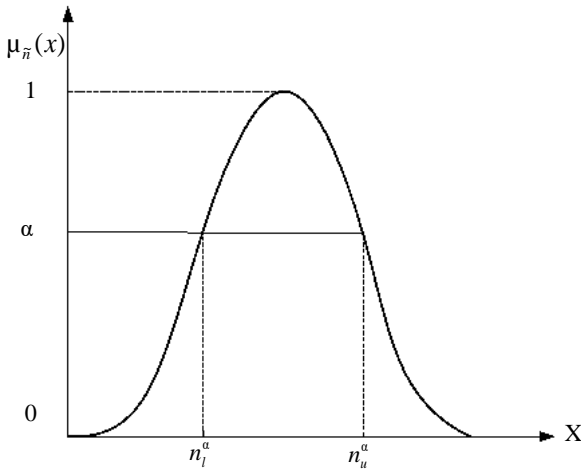


Fig. 2 A fuzzy number \tilde{n} with α -cut.

2.4. Mining Path Traversal Patterns

In a distributed information-providing environment where documents or objects are lined together, users are apt to traverse objects back and forth in accordance with the links and icons provided [10]. Therefore, extracting the patterns from user's log data in such environment is referred to as mining path traversal patterns. It facilitates web-site owners or managers to understand what access paths are users interested in and relationships between web pages. These information or relationships will be the important references for website owners or managers to improve the website structure or content. For the sake of extracting valuable user's access patterns from log data, there are several procedures as described as follows [9].

- (1) Determining maximal forward references from the original log data. Using algorithms to convert the original sequence of log data into a set of traversal subsequences. Each traversal subsequence represents a maximal forward reference from the starting point of a user access.
- (2) Determining the large reference sequences. Using algorithms to determine the frequent traversal patterns and the termed large reference sequences from the maximal forward references. A large reference will appear a sufficient number of times

in the database.

- (3) Determining the maximal reference sequences. After large reference sequences are determined, maximal reference sequences can then be obtained in straightforward manner. A maximal reference sequence is a large reference sequence that is not contained in any other maximal reference sequences.

3. User Preference Perception Model

In this paper, we analyze log data from web servers to obtain user's surfing tracks and browsing time. Then both of fuzzy set theory and maximal reference sequences are applied to perceive the changes of user's preference in our model.

3.1. Converting log data

Obtaining user's surfing paths from the log data of web servers and convert them into user's traversal subsequence sets by user's number respectively. The traversal subsequence is a set of web-page nodes and sorted by the time-stamp in a determinate period, e.g. $T_1 = \{Y, B, H, C, T, I, H, J\}$ and $T_2 = \{Y, H, P, T, I, K, H, J\}$.

3.2. Eliminating the uninterested nodes

Eliminating the node whose browsing time exceeds the maximum threshold value from the user traversal subsequence set. In this paper, the maximum threshold value is denoted by t_{\max} . When the number of users visit the web page, we can compute the average of browsing time (t_{avg}). If a visitor's browsing time exceeds the average of browsing time in this web page, the degree of the visitor's preference is regarded as 1. It means that this visitor shall interest in this web page completely. Contrary to the foregoing situation, a visitor's browsing time more short means the visitor has much less interests about this web page. Therefore, the degree of the visitor's preference that depends on the browsing time is represented by the membership function of fuzzy set theory (shown in Fig. 3). The degree of preference (P) is calculated as follows.

$$P_{ki} = \begin{cases} 0, & t_{\max} < t_{ki} \\ 1, & t_{\text{avg}} \leq t_{ki} \leq t_{\max} \\ \frac{t_{ki}}{t_{\text{avg}}}, & 0 \leq t_{ki} < t_{\text{avg}} \end{cases} \quad (3)$$

where, t_{ki} is the browsing time of the k th visitor in the i th web page, P_{ki} is the degree of the k th visitor's preference in the i th web page.

According to the membership function of the preference degree, α -cut is applied to divide the web pages into two categories as follows.

- (1) If $P_{ki} \geq \alpha$, we think that the k th visitor has

interests about the i th web page. We reserve this web page in database to analyze the preference of this visitor at the rest of procedures.

- (2) If $P_{ki} < \alpha$, we think that the k th visitor has no interests about the i th web page and eliminate this web page in our model.

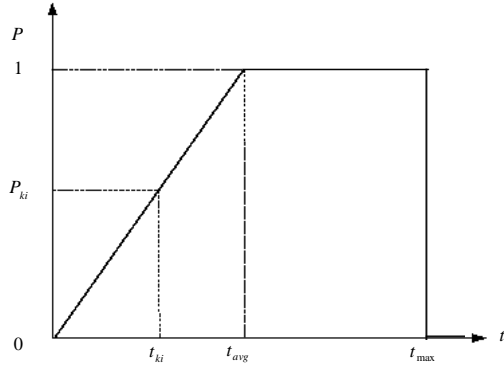


Fig. 3 The membership function of the preference degree.

3.3. Extracting browsing patterns

After the foregoing procedures, the interesting web pages of all users will be stored in database D_T . In this paper, each web page belongs to a category. Then, Full Scan (FS) algorithm, essentially utilizes the concept of DHP (Direct Hashing and Pruning), is applied to solve the discrepancy between traversal patterns and association rules [25].

For example, a user's traversal subsequence set is shown in Table 1. Recall that L_k represents the set of all large k -references and C_k is a set of candidate k -references. The procedures of the FS are described as follows.

- Step 1. Candidate 1-reference sequences and their support value (appearance frequency) are listed in G_1 (shown in Table 2).
- Step 2. After scanning through D_T , those k -references in C_k with count exceeding the threshold become L_k . Thus, FS gets L_1 and makes a hash table to count the number of occurrences of each 2-reference.
- Step 3. Starting with $k = 2$, FS generates C_k based on the hash table count obtained in the previous pass and determines the set of large k -references L_k , and makes a hash table to determine the candidate $(k + 1)$ -references. If L_k is nonempty, the iteration continues for the next pass (shown in Table 3 and 4).

In mining association rules, a set of candidate references C_k can be generated from joining L_{k-1} with itself, denoted by $L_{k-1} * L_{k-1}$. If we set the threshold equal to 3, the results of extracting browsing patterns are listed in Table 5.

Table 1 The original traversal sequences.

Traversal Sequences	Item Set
T_1	$\langle Y, B, H, C, T, I, H, J \rangle$
T_2	$\langle Y, H, P, T, I, K, H, L, J \rangle$
T_3	$\langle P, H, I, T, Y, J, H, P \rangle$

Table 2 G_1 To L_1

C_1		L_1	
Item Set	Support	Item Set	Support
$\langle T \rangle$	3	$\langle P \rangle$	3
$\langle B \rangle$	1	$\langle Y \rangle$	3
$\langle C \rangle$	1	$\langle J \rangle$	3
$\langle H \rangle$	6	$\langle I \rangle$	3
$\langle I \rangle$	3	$\langle H \rangle$	6
$\langle J \rangle$	3	$\langle T \rangle$	3
$\langle Y \rangle$	3		
$\langle P \rangle$	3		
$\langle K \rangle$	1		
$\langle L \rangle$	1		

Table 3 G_2 To L_2

C_2		L_2	
Item Set	Support	Item Set	Support
$\langle TH \rangle$	3	$\langle TH \rangle$	3
$\langle TI \rangle$	2	$\langle TJ \rangle$	3
$\langle TJ \rangle$	3	$\langle HT \rangle$	3
$\langle TY \rangle$	1	$\langle HI \rangle$	3
$\langle TP \rangle$	1	$\langle HJ \rangle$	5
$\langle HT \rangle$	3	$\langle HP \rangle$	3
$\langle HI \rangle$	3	$\langle IH \rangle$	3
$\langle HJ \rangle$	5	$\langle IJ \rangle$	3
$\langle HY \rangle$	1	$\langle YH \rangle$	5
$\langle HP \rangle$	3	$\langle YJ \rangle$	3
$\langle IT \rangle$	1	$\langle PH \rangle$	3
$\langle IH \rangle$	3		
$\langle IJ \rangle$	3		
$\langle IY \rangle$	1		
$\langle IP \rangle$	1		
$\langle JT \rangle$	0		
$\langle JH \rangle$	1		
$\langle JI \rangle$	0		
$\langle JY \rangle$	0		
$\langle JP \rangle$	1		
$\langle YT \rangle$	2		
$\langle YH \rangle$	5		
$\langle YI \rangle$	2		
$\langle YJ \rangle$	3		
$\langle YP \rangle$	2		
$\langle PT \rangle$	2		
$\langle PH \rangle$	3		
$\langle PI \rangle$	2		
$\langle PJ \rangle$	2		
$\langle PY \rangle$	1		

Table 4 C_3 To L_3

C_3		L_3	
Item Set	Support	Item Set	Support
<THT>	0	<HTJ>	3
<THI>	0	<HTH>	3
<THJ>	2	<HIH>	3
<THP>	1	<HIJ>	3
<HTH>	3	<YHJ>	4
<HTJ>	3		
<HIH>	3		
<HIJ>	3		
<HPH>	1		
<IHT>	0		
<IHI>	0		
<IHJ>	2		
<IHP>	1		
<YHT>	2		
<YHI>	2		
<YHJ>	4		
<YHP>	2		
<PHT>	1		
<PHI>	1		
<PHJ>	2		
<PHP>	2		

Table 5 User browsing patterns.

User Browsing Patterns	Support
<P,H>	3
<H,P>	3
<Y,H,J>	4
<Y,I,J>	3
<H,I,H>	3
<H,T,J>	3
<H,T,H>	3

3.4. Perceiving user's preferences

According to user browsing patterns and the degree of preference in each category, changes of a user's preferences will be perceived in the proposed model. In this study, each browsing pattern is regard as a document and its web pages that belong to the same category are regarded as a same term. The vector and the weighted value are applied to represent the degree of preference in different categories. The degree of preference in each category is calculated as follows.

$$P_i = (w_{i1} w_{i2} \dots w_{ik}) \quad (4)$$

where, the P_i is the i th user's preference degree in each category, w_{ij} is the i th user's preference degree in the j th category. ($j=1, 2, \dots, k$)

If a category appears in the almost of browsing patterns, it's the degree of importance should be less than the other categories appears in little patterns. Categories that are less important for browsing patterns should be assigned lower weights, whereas categories that are more important in a browsing pattern should be assigned higher

weights. According to this concept, we use TFIDF (Term Frequency – Inverse Document Frequency) [29] to adjust the degree of preference in each category from a browsing pattern. The formula is described as follows.

$$w_j^* = \sqrt{\frac{f_j}{n} \times \log \frac{p_n}{p_j} + 1} \quad (5)$$

where, w_j^* is the degree of preference in the j th category, f_j is the appearance frequency of the j th category, n is the total number of appearance frequency from each category in all browsing patterns, p_n is the total number of browsing patterns, p_j is the number of browsing patterns that contain the j th category.

For example, if the i th user's initial preferences are both of H and T categories, his/her preferences are denoted by $P_i = (w_H, w_P, w_Y, w_I, w_J, w_T) = (1, 0, 0, 0, 0, 1)$. After a determinate period, if the system gets user's browsing patterns are as same as table 5. The degree of preference in the H category is calculated as follows.

$$w_H^* = \sqrt{\frac{9}{19} \times \log \frac{7}{7} + 1} = 0.377$$

According to the results of preference measurement, user's preferences are denoted by $P_i = (0.377, 0.262, 0.212, 0.262, 0.726, 0.262)$. When the threshold of the degree of preference is 0.3, we filter out those preferences whose degree of preference are lower than the threshold and retain those preferences whose degree of preference are equal or higher than threshold. Thus, user's new preferences are denoted by $P_i = (w_H, w_P, w_Y, w_I, w_J, w_T) = (1, 0, 0, 0, 1, 0)$. Comparing the discrepancy between initial and new preferences, the change of user's preferences are perceived easily and obviously.

4. System design and experiments

In this paper, a website for providing personal news is built to demonstrate the feasibility and effectiveness of the proposed model. The system architecture and experiments are elaborated as follows.

4.1. System architecture and functions

In this study, a website for providing personal information is built in a personal computer with a Pentium 4 processor and Linux operation system. The architecture of this proposed system is shown in Fig. 4. The major components of this system and their functions are described as follows.

- (1) Web server log database. When a registered member logged in the website, all of his/her surfing paths and browsing time are recorded and stored in the server log database.
- (2) Converting log data. The system will convert log data into user's traversal subsequence sets by user's

registered number respectively.

- (3) Eliminating user uninterested nodes. In this stage, the system depends on threshold limit value of browsing time and α -cut to eliminate those web pages whose browsing time are excess long or the degree of preference are excess low.
- (4) Extracting browsing patterns. FS will extract applicable browsing patterns from user's traversal subsequence sets.
- (5) Perceiving user's preferences. After a determinate period, user's new preferences are perceived in this component. The system will provide user news according to his/her new preferences.
- (6) Providing general or personal news. User can select any ways that meet his/her requirements for providing news. If the function of general news providing is selected, website will provide all categories of news in news database by date. Otherwise, website will provide user personal news by his/her preferences in user profile database.
- (7) News search engine. users can search news that they needs manually; even both of date and the type of category are avail conditions in the news search proceeding.
- (8) User profile database. When a user registered in the web site, all of information, including name, password, email, initial preferences and the others data are stored in user profile database.
- (9) News database. The news from several news providers are stored and sorted by their category attribution. In periodical, the system will update

news database every four hours.

4.2. Experiments and results

In order to verify the feasibility and effectiveness of the preference perception model we proposed, a website is built and experiments are implemented at Da-Yeh University in Taiwan. The results of the experiment sufficient indicate this proposed model is effective in perceiving the change of user preferences.

4.2.1. Experimental procedure

In this experiment, the participants are students at Da-Yeh University. The topical categories are divided into "Stock and Security", "Society and Culture", "International", "Home and Living", "Mainland China", "Business and Economy", "Regional", "Government", "Entertainment", "Science and Computer", "Recreation and Sports". The experimental procedure is described as follows (shown in Fig.5).

- Step 1. Member registration. All participants filled out their profiles like name, password, email address and preferences in the registration form. (shown in Fig.6).
- Step 2. Providing member personal news. When a member login the website, he/she will see the personal news by category according to his/her preferences from user profile database (shown in Fig.7).

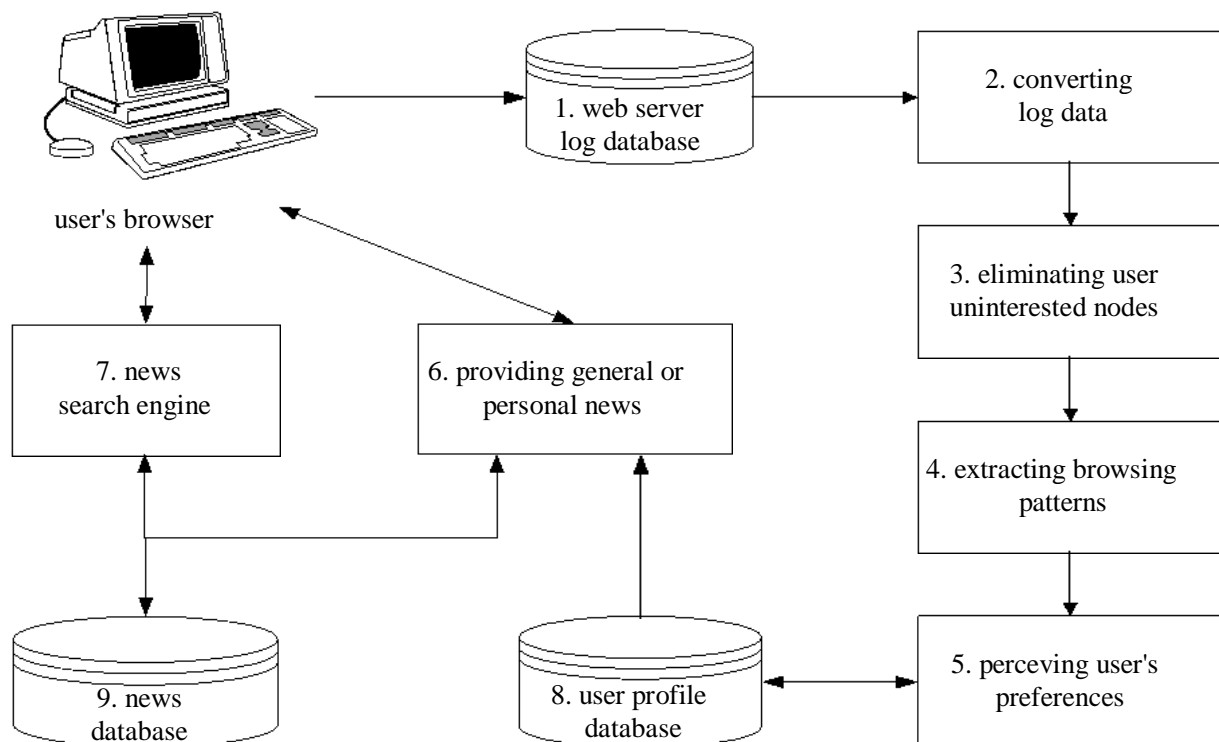


Fig. 4 The system architecture of the website.

- Step 3. Recording member's browsing behavior. The cookies in the member's browser are used to record all of surfing web pages, browsing time and timestamp. Till the member access the next web page, the cookies will be sent to the web server and stored in web server log database.
- Step 4. Perceiving member's preferences. According to the log data in three weeks, user's preferences are analyzed based on the user perception model we proposed. Due to the average of adult reading speed is 200 words per minute approximately [3], the average of reading time is applied to filter out those web pages that average of browsing time are excess long. In addition, the α is set 0.5 and threshold of traversal sequences is set 9. Thus, both of user browsing patterns and the degree of preference in each category are obtained from log data.
- Step 5. Providing member personal news. The website selects several news from those categories that meet user's preferences randomly. Members can see those selected news by category.
- Step 6. Satisfaction survey. In each bottom of news web page, members were asked to fill the questionnaire of satisfaction. The entire members and individual degree of satisfaction are calculated by the formula of satisfaction measurement.

4.2.2. Results analysis

During the experiment for the proposed preference perception model, there are 16176 pieces of news and 8087 log records are retrieved. Using the preference perception model, 576 avail maximal reference sequences and 314 browsing patterns are extracted and the changes of preference in 23 participants are perceived (shown in Table 6).

The results of the degree of satisfaction measurement for all participants are shown in Table 7. According to the results of satisfaction measurement, the average of the degree of satisfaction from member 3, 10 and 21 (their preferences had not changed) is 0.637. In the other side, the average of the degree of satisfaction from the other members (their preferences had changed) is 0.724. Thus, we can discover the degree of satisfaction for all members that preferences had been changed is higher than the others with no changes. In other words, the almost members can satisfy the results of the preference perception model we proposed.

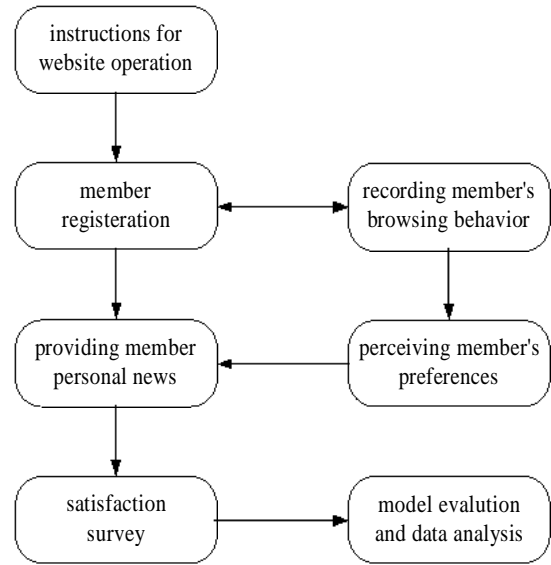


Fig. 5 A flowchart for experimental processes.

The screenshot shows a web interface for a 'Personal Intelligence' system. On the left is a sidebar with a tree view of categories. The main area is titled '新新聞目錄' (New News Directory) and contains a list of news items with checkboxes and radio buttons. Below this is a section for '個人資訊' (Personal Information) with fields for name, age, gender, etc. At the bottom, there are buttons for '新增新聞' (Add News), '刪除新聞' (Delete News), and '查詢新聞' (Search News).

Fig. 6 Fill out form of the member profile.

The screenshot shows a web interface for a 'Personal Intelligence' system. It displays a list of news items with their titles and categories. The interface includes a sidebar with a tree view of categories and a main area with a list of news items. Below the list, there are sections for '個人資訊' (Personal Information) and '新聞分類' (News Classification) with buttons for '新增新聞' (Add News), '刪除新聞' (Delete News), and '查詢新聞' (Search News).

Fig. 7 Personal news and category title.

5. Conclusions

In this paper, we proposed a user preference perception model using data mining on a web-based environment. After aggregating the user's web browse records, fuzzy set theory and most sequential pattern mining algorithm are applied to perceive the changes of user's preferences in a period. According to the user preference perception model, a web site for providing personal news is built to demonstrate the foregoing model we proposed. As the result of the degree of satisfaction survey from all participators, the degree of satisfaction are up to 72 % from the users whose preference had been changed in the test period.

Because of the convenience and prevalence the Internet provides, more and more businesses provide

information, service and product through it. If businesses can provide customer suitable service or products, they will improve not only competitiveness but also customer satisfaction and loyalty. The user preference perception model we proposed would accelerate businesses to provide more suitable information, services and products that meet the customer's requirements and make both of them enjoy the benefit through a web-based environment.

6. Acknowledgement

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Table 6 The results of perceiving user preference.

No.	The weight in each categories	Initial preferences	New preferences
1	4(0.516); 6(0.317); 9(0.256)	(00010100100)	(00010100100)
2	6(0.623); 11(0.299)	(00000111011)	(00000100001)
3	10(0.549)	(00000000010)	(00000000010)
4	10(0.549)	(01110000110)	(00000000010)
5	4(0.202); 9(0.444); 11(0.325)	(00111001111)	(00010000101)
6	2(0.303); 4(0.214); 7(0.214); 9(0.399); 11(0.358)	(00110000101)	(01010010101)
7	10(0.549);	(00000001110)	(00000000010)
8	4(0.400); 7(0.221); 9(0.355)	(01010000100)	(00010010100)
9	2(0.277); 4(0.283); 7(0.238); 9(0.184); 10(0.324)	(00010000011)	(01010010010)
10	9(0.367); 11(0.408)	(00000000101)	(00000000101)
11	2(0.364); 4(0.448); 9(0.364)	(01011010010)	(01010000100)
12	3(0.549)	(01111011110)	(00100000000)
13	4(0.362); 7(0.384); 9(0.265)	(00010010110)	(00010010100)
14	2(0.253); 3(0.263); 4(0.272); 7(0.358); 9(0.233)	(01100001111)	(01110010100)
15	9(0.549)	(01110011110)	(00000000100)
16	2(0.316); 4(0.255); 7(0.400)	(01111000010)	(01010010000)
17	2(0.139); 4(0.421); 9(0.328); 11(0.230)	(00000000001)	(00010000101)
18	9(0.549)	(11000000100)	(00000000100)
19	2(0.304); 4(0.219); 9(0.431)	(00000000100)	(01010000100)
20	7(0.321); 9(0.472)	(01010010110)	(00000010100)
21	4(0.398); 7(0.331); 9(0.241)	(00010010100)	(00010010100)
22	4(0.466); 9(0.289)	(10010100110)	(00010000100)
23	11(0.549)	(00000000101)	(00000000001)
24	2(0.214); 9(0.354); 10(0.153); 11(0.397)	(01000000011)	(01000000101)
25	4(0.309); 9(0.491)	(00010000000)	(00010000100)
26	2(0.374); 3(0.349); 6(0.272); 8(0.410); 9(0.167)	(00100101010)	(01100101000)

Table 7 The results of satisfaction measurement.

No.	The degree of satisfaction in each category	Average
1	6(0.867); 9(0.667); 4(0.8)	0.778
2	11(0.8); 6(0.6)	0.700
3	10(0.667)	0.667
4	10(0.933)	0.933
5	4(0.667); 9(0.6); 11(0.8)	0.689
6	9(0.8); 4(0.6); 2(0.533); 7(0.6); 11(0.8)	0.667
7	10(0.933)	0.933
8	4(0.667); 9(0.467); 7(0.6)	0.578
9	4(0.733); 10(0.933); 2(0.8); 7(0.733)	0.800
10	11(0.8); 9(0.667)	0.733
11	2(0.8); 9(0.733); 4(0.533)	0.689
12	3(0.733)	0.733
13	4(0.733); 9(0.6); 7(0.867)	0.733
14	2(0.6); 7(0.467); 9(0.8); 4(0.733); 3(0.2)	0.560
15	4(0.533); 9(0.667)	0.600
16	2(0.933); 7(0.8); 4(0.933)	0.889
17	9(0.533); 4(0.733); 11(0.867)	0.711
18	9(0.667)	0.667
19	4(0.6); 2(0.267); 9(0.533)	0.467
20	9(0.667); 7(0.933)	0.800
21	4(0.667); 7(0.4); 9(0.467)	0.511
22	9(0.6); 4(0.667)	0.633
23	11(0.6);	0.600
24	11(1); 9(1); 2(1)	1.000
25	4(0.733); 9(0.667)	0.700
26	6(0.667); 3(1); 2(0.6); 8(0.933)	0.800

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The Integrated Approach to E-Commerce Curriculum Success

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Abstract

The Internet has the potential to improve teaching and learning processes [1]. Learning and educational effectiveness of the integration of IT into the classroom has become a major issue. The purpose of this paper is to report on insights gained in integrating e-learning and classroom learning into my on-campus e-commerce courses over the last three years, and to explore planned and controlled approach to integrated model success for expected learning outcomes. A framework of the integrated model effectiveness is presented, which frames success dimensions, defines four dimensions of success, and addresses interrelated relationship. A survey study is used to demonstrate the analytic utility of the framework in the context of measurement of student learning experiences.

Keywords: Integrated Learning Model Success, Integrated Mode, Integrated Pedagogy, Student Satisfaction, Individual Impact and Evaluations.

1. Introduction

Recent years have witnessed the rapid expansion of online technology and its use in education and training. The Internet and web technologies are used for courses of study as small as self-paced tutorials and as large as entire degree programs [2]. Many educators intuitively feel that the integration of computing and communication technology into the classroom will enhance learning and the student ability to apply knowledge and skills to problem-solving situations. Despite this belief, pedagogic practice has not yet fully integrated information technology (IT) into the curriculum and classroom

activity, and computers remain greatly under-utilized in this context. [3]. The integration requires a fundamental change in the instructional mode, pedagogy design and learning process. The most critical challenge has been how to find effective approach to the integrated learning model success. The difficulty is to figure out how to perform the integrated strategies well.

Being an early adopter of the Internet in my traditional on-campus courses, I initiated a teaching research project for integrating Internet-based learning and classroom learning in E-Commerce course in 2000. I have reported an integrated learning model that has been used successfully in the course [4]. The objective of this study is to explore planned and controlled approach to integrated learning model success for expected learning outcomes. First, a framework of the integrated model effectiveness is presented, which frames success dimensions, defines four dimensions of success, and addresses interrelated relationship. Following that, a survey study is used to demonstrate the analytic utility of the framework in the context of measurement of student learning experiences. We expect the framework could be developed to serve as the conceptual basis for analysing and comparing education practice in integrating e-learning and classroom for enhancing education quality at university levels.

2. Background

A long practice in integrating e-learning and classroom learning in my traditional on-campus e-commerce courses has been developed since 2000. This year I published a paper to address the integrated mode of learning e-commerce. The integrated way is to create a supportive environment for learner centred learning process, which encompassing multimedia based

instruction teaching, Internet based learning, and teamwork. As Figure 1 illustrates, in each mode we design relevant methods for expected object of pedagogic practice. Grading consists of three portions that are commensurate with the activities existed in the learning process. A total of 930 students took the e-commerce course from 2000 to 2003, and 186 of them are graduate student. An analysis of students' feedback highlights strengths and features of such an approach. Statistical analysis revealed that successful use appears strongly related to the integration of the various course components based on IT, relevant methods fit for student satisfaction with a learning experience in the integrated environments, and the strategic instructional design for quality education.

Modes	Methods	Objects	Grading
Classroom	Multimedia instruction	Introducing foundation of e-commerce	Written examination: 40%
	Case teaching		
Internet-Based learning	Online virtual learning system	Providing a Individual learning in an asynchronou s mode	Experiment: 20%
	Online shopping	Providing an experience-oriented way to learn e-commerce from real world situation	
	Evaluation of Web sites		
	The virtual e-market operation		
Teamwork	Team project and presentation	Enhancing students' problem-solving skills and Collaborative ability	Project: 40%
	Building Web site		
	Business plans fore-commerce company		

Fig.1 The Integrated mode of learning E-Commerce

3. A Framework for Integrated Learning Model Success

The measurement of the integrated learning model success or effectiveness is critical to our understanding of the value and efficacy of new learning processes. We

attempt to synthesize our previous findings in the integrated mode of learning e-commerce into more coherent body of knowledge and to have an insight into the strategic design of such integration, which may be of benefit for universities with similar objectives. We proposal a taxonomy and an interactive model as framework for conceptualizing and operationalizing the integrated learning model success. The model consists of four interrelated dimensions of success: INTEGRATED MODE, INTEGRATED PEDAGOGY, STUDENT SATISFACTION AND INDIVIDUAL IMPACT.

The resultant integrated learning model success is produced in Figure 2.

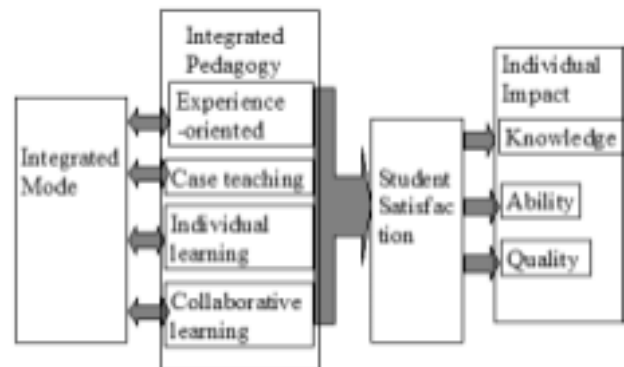


Fig.2 The Integrated learning model success

Four interrelated dimensions of success can be interpreted as follows:

Integrated Mode

It is related to adopted modes in an e-commerce curriculum, such as Classroom, Internet-Based and Teamwork. There are important considerations on what should and shouldn't be placed in Internet-based learning environment and which tools work best to reach instructional goals. Integrating the online and face-to-face mode for different subjects and different courses need a careful analysis and design.

Integrated Pedagogy

Effective use and integration of e-learning and classroom learning in on-campus courses requires development of

the integrated pedagogy for student-centered so that faculty can make correct decisions regarding methods fit for student satisfaction with a learning experience in the integrated environments, course content development and strategic design for each activity in the learning process and so on.

Our research shows four elements exist in integrated learning processes, which are Experience-Oriented learning, Case Teaching, Individual learning through on-line virtual teaching system and Collaborative learning. It is considered to provide appropriate integration of four elements into pedagogic design; effort will have significant impact on education practice. Our finding indicates that relevant method used in integrated learning mode is of critical importance and understanding the way individuals learn is the key to improving the pedagogic practice [4].

Student Satisfaction

The innovative feature of integrated learning model is to transform the learning process from the instructor-centered into student-centered. This learner centered approach are that it is experience-oriented and activity-based, and in the approach students can create their own ideas, both individually and collaboratively. Evaluations of the learning model success will centre on student satisfaction. So strategy design for measurement should systematically combine individual measures from the model success categories to create a comprehensive measurement instrument.

Individual Impact

Student satisfaction and individual impact are closely interrelated. Positive experience with student will lead to greater impact on student's knowledge, ability and quality in a causal sense.

Effective learning is a process of building and transforming mental models. Transformations entail changes in organization and structure of knowledge, development of problem-solving ability and critical thinking ability, and enhancing student quality.

Four interrelated dimensions of success imply a planned and controlled approach in identifying,

integrating and evaluating the different modes, methods and activities in student-centered learning process for the intended education purposes.

4. Data Analysis and Result

In the study, the effects of the integrated learning model was measured in terms of students' evaluation of their learning experience. The subjects in the study were the one-hundred-and-seven student who took the courses in the fall of 2002. There were forty-three undergraduate (42.1%) students and sixty-four graduate (57.9%) students, and sixty male (56.1%) and forty-seven female (43.9%) students in these classes. Students participated all learning activities in the integrated learning model including On-line shopping, the Virtual e-market operation, Case teaching and Team-project. The students may also access, Online Virtual Teaching System at any time and any place. It provides an online learning platform as a supplement to classroom learning. The students learn by themselves in an asynchronous mode. They can view teaching material and use source of e-commerce course at their convenience. This system is mainly made up with six modules: course teaching, case discussion, exercise option, experiment teaching, team activities and BBS.

The 11 items used to measure students' evaluation of their learning experience were included in the post-course questionnaire. Five-point likert-type scales were used to measure all items. The questionnaire also contained two multiple-choice questions eliciting the subjects' comments on learning modes and teaching methods that they liked or disliked.

Participants' final exam scores were also available. The exams consisted of two parts. One was on material covered in the course, a written examination, and another was oral presentation of team project at class. It was impossible to connect questionnaire responses with these test scores because the questionnaires were administered anonymously.

Subjects reported higher levels of satisfaction with the modes and methods in integrated learning process, which are in correspondence with four elements in integrated pedagogy dimensions shown in Fig.2:

Experience-Oriented Learning, Individual learning, Collaborative learning and Case teaching. Mean and Variance for four elements are reported in Table 1. Univariate analysis of variance for the evaluation of four elements in integrated learning model is presented in Table 2.

SUMMARY					
Elements	Variables	Count	Sum	Mean	Variance
Experience-oriented	On-line shopping	107	448	4.186916	0.511903
	The virtual e-market operation	107	430	4.018692	0.754364
Individual learning	On-line virtual teaching system	107	431	4.028037	1.178452
Collaborative	Team-project	107	417	3.897196	0.942162
Case teaching		107	431	4.028037	0.65015

Table 1. Summary: Mean and Variance for four elements of the integrated learning model

Indeed, the medians for all four elements are well above a rating of 3.89, indicating that students rated the integrated model on the positive side. In fact, as demonstrated by the three elements with medians of 4.0, the students found the experience-oriented learning, case teaching and individual learning particularly important and valuable.

Source	SS	df	MS	F	P-value	F crit
Between Groups	4.534579	4	1.133645	1.404058	0.231316	2.388752
Inside Group	427.9252	530	0.807406			
Total	432.4598	534				

Table 2. Univariate Analysis of Variance for the evaluation of four elements in Integrated Learning Model

Students' response to the open-ended question related to learning mode and method are reported in Table 3. This feedback provided further insight into the characteristic of each mode. It was highlighted that especially the Virtual E-Market operation was regarded as an exciting element of this integrated mode. Students

seem to be aware of the increasing importance of this experience-oriented approach. Besides the learning outcome regarding further understanding of real-world e-business process, the developed skills in making exchange and collaboration in the process was very much appreciated by the students. For Online Virtual Teaching system and Teamwork, It had a higher proportion of positive opinions than Classroom teaching, while Case teaching was very much appreciated by the students. The feedback corroborated that Case teaching is a good teaching method in traditional face-to-face learning mode, and students would prefer to be in the classroom with the professor for hands-on enlightening and teaching.

Question	Multiple-choice	Percentage
My most favourite learning mode in this course	Classroom teaching	11.2 %
	The Virtual E-Market operation	49.5%
	Teamwork	41.1%
	Online Virtual Teaching system	44.8%
Which method should be used in the e-commerce learning model	Instruction in basic e-commerce	61.6%
	Case teaching	75.7%
	The chapter exercises	28%
	The Virtual E-Market operation	78.5%
	Class discussion	42.9%
	Teamwork	71%

Table 3. Result of students' response to the open-ended question related to learning mode and method

Data analysis supported the utility of the framework, indicating that overall, students' affective reactions to the integrated learning model and pedagogy were powerful positive. That is, students have experienced integrated learning process in support of their knowledge construction, active learning, cooperation and learning via problem solving, and individual self-efficacy through On-line virtual teaching system.

5. Further Research and Conclusions

Based on previous research we develop a framework of the determinants of the integrated learning model effectiveness and report the results of a survey study to empirically test it. The framework for integrated learning model success seems to be flexible means that are amenable to the implementation of different learning modes, and to be planned and controlled approach to evaluate how learning model, pedagogy, and subject matter interact to produce desired learning outcomes.

These preliminary results have revealed possible topics of research. Our next step will be to improve our survey instrument to better isolate the effect of pedagogy used in right mode for subject satisfaction. It is important to attention to the possible interactions among the success dimensions and the effect of various independent variables on one or more of these dependent success dimensions. Four success dimensions that we identified in our framework also await systematic measurement in the context of empirical investigation.

With our efforts and practice in the project the framework could be developed to serve as the conceptual basis for analysing and comparing education practice in integrating e-learning and classroom for enhancing education quality at university levels.

Acknowledgement

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On Improving an Integrated Inventory Model for a Single Vendor and Multiple Buyers with Ordering Cost Reduction

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Abstract

In this paper, we propose a new model for improving lot size as obtained on applying the model given in “An integrated inventory model for a single vendor and multiple buyers with ordering cost reduction” (Int. J. Production Economics 73 203-215) proposed by Woo, Hsu, and Wu (2001) and our model provides a lower or equal joint total relevant cost as compared to Woo, Hsu, and Wu’s model. And a numerical study based on the example used by Woo, Hsu, and Wu is presented.

1. Introduction

Reducing inventory levels of raw materials, work-in-process, and finished items simultaneously in different stages has become the major focus for supply chain management. In recent years, there has been a growing trend in both research work and practical applications of VMI (vendor managed inventory) policy for various industries. Goyal (1977) [3] proposes a joint economic lot size (JELS) model where the objective is to minimize the total relevant costs for a single vendor, single buyer system. Banerjee (1986) [1] generalizes Goyal's model by incorporating a finite production rate for the vendor and gives the optimal joint production or order quantity. Goyal (1988) [4] extends Banerjee's model again by relaxing the lot-for-lot production assumption and argues that the economic production quantity will be an integral multiple of the buyer's purchase quantity and shows that its model provides a lower or equal joint total relevant cost as compared to Banerjee's model. Kohli and Park [5] investigate joint ordering policies as a method to reduce transaction costs between a single vendor and a homogeneous group of buyers. They present expressions for optimal joint order quantities assuming all products are ordered in each joint order. Lu [6] considers a one-vendor multi-buyer integrated inventory model and gives a heuristic approach for joint replenishment policy. Banerjee and Banerjee (1992) [2] consider an EDI-based vendor-managed inventory (VMI) system in which the vendor makes all replenishment decisions for his/her buyers to improve the joint inventory cost. Woo, Hsu, and Wu (2001) [7] extend the previous work to three level supply chain in which raw materials and EDI are considered. In the work, they considered that the

replenishment cycle is an integral multiple of the common replenishment cycle of the vendor and all buyers. The work also relaxes the lot-for-lot production assumption and performs a good effect since many optimal integer multiple used in the numerical example of Woo, Hsu, and Wu's paper are greater than 1, that is, the replenishment cycle of raw materials is no less than that of finished items. This may be true when ordering cost per raw material order for vendor is quite high, the inventory cost for raw materials is relatively low and the ordering cost for finished items is quite low etc. Otherwise, the replenishment cycle for raw materials may be less than that of finished items. So In this paper, we propose a new model for improving lot size as obtained on applying the model given in “An integrated inventory model for a single vendor and multiple buyers with ordering cost reduction”(Int. J. Production Economics 73 203-215) proposed by Woo, Hsu, and Wu (2001). And a numerical study based on the example used by Woo, Hsu, and Wu is presented.

2. Assumptions and Notations

2.1 Assumptions

1. Shortages are not allowed for the vendor.
2. The information of each buyer's replenishment decision parameters is available to the vendor.
3. The planned ordering cost for each buyer depends on the expenditure incurred per unit time to operate the new ordering system. This expenditure could be the leasing cost of equipment and the operating cost to keep the system working effectively.
4. The vendor purchases raw materials outside to produce finished items. The procurement cycle of raw materials is assumed to be an integral multiple of the common replenishment cycle for finished items or the common replenishment cycle for finished items is assumed to be an integral multiple of the procurement cycle of raw materials.

Assumptions 1-3 follow the assumptions of Woo, Hsu, and Wu (2001), and assumption 4 is a relaxation to that

of Woo, Hsu, and Wu (2001).

2.2 Notations

M	Number of buyers considered
$i=1,2,\dots,m$	Index of buyers
D_i	Demand rate for buyer i , which is a known constant
n	Integral number or fraction which denominator is an integer and numerator is one, which indicates the production batches per raw material procurement cycle and n is a decision variable
K	Expenditure per unit time to operate the planned ordering system between vendor and all buyers, which is a decision variable
C	Common cycle time for buyers, which is a decision variable
f_i	Fraction of backlogging time in a cycle for buyer i , which is a decision variable
M	Usage rate of raw materials for producing each finished item
A	Ordering cost per raw material order for vendor
S	Setup cost for production run for vendor
x	$x=0$ if $n \geq 1$ and $x=1$ if $n < 1$ which is a binary variable
T_{0i}	Original ordering cost per buyer i 's order
$T_i(K)$	Planned ordering cost per buyer i 's order, which is a strictly decreasing function of K with $T_i(0) = T_{0i}$ and $T_i(K_0) = 0$
H_{vm}	Carrying cost per unit of raw materials held per time for vendor
H_{vp}	Carrying cost per finished item held per unit time for vendor
H_{bi}	Carrying cost per unit held per unit time for buyer i
L_i	Backlogging cost per unit backlogged per unit time for buyer i
TC_{bi}	the buyer i 's total inventory cost for finished items per unit time
TC_{vp}	Vendor's total cost per unit time for finished items

TC_p	the inventory cost of finished items for all buyers and the vendor
HC_{vm}	Vendor's carrying cost per procurement cycle for raw materials when $n \geq 1$
TC_{vm}	Vendor's total cost per unit time for raw materials when $n \geq 1$
JTC	Joint total cost per unit time for vendor and all buyers
HC_{vm}'	Vendor's carrying cost per procurement cycle for raw materials when $n < 1$
TC_{vm}'	Vendor's total cost per unit time for raw materials when $n < 1$

3. Model

The behavior of inventory levels for the vendor and all buyers for finished items is illustrated in Fig.1 which is the same as that of Woo, Hsu and Wu's. Therefore, the buyer i 's total inventory cost for finished items per unit time is

$$TC_{bi} = \frac{T_i(K)}{C} + \frac{C}{2} [H_{bi}(1-f_i)^2 D_i + L_i f_i^2 D_i] \quad (1)$$

The vendor's inventory for finished items is

$$TC_{vp} = \frac{1}{C} [S + H_{vp} \sum_{i=1}^m \frac{D_i^2 C^2}{2P}] = \frac{S}{C} + \frac{CH_{vp}}{2P} \sum_{i=1}^m D_i^2 \quad (2)$$

Then the inventory cost of finished items for all buyers and the vendor is

$$TC_p = \sum_{i=1}^m \frac{T_i(K)}{C} + \frac{C}{2} \sum_{i=1}^m [H_{bi}(1-f_i)^2 D_i + L_i f_i^2 D_i] + \frac{S}{C} + \frac{CH_{vp}}{2P} \sum_{i=1}^m D_i^2. \quad (3)$$

The inventory levels for raw materials in the paper of Woo, Hsu and Wu (2001) is illustrated in Fig.2. The arrival of each raw material procurement will coincide with the start of a new production run. The procurement lot size of raw materials is equal to n multiple of the usage of each production batch and hence each procurement cycle equals nC time units. The stock of raw materials will be consumed continuously during each production run period $\sum_{i=1}^m D_i C/P$, and then be held until the next production run starts.

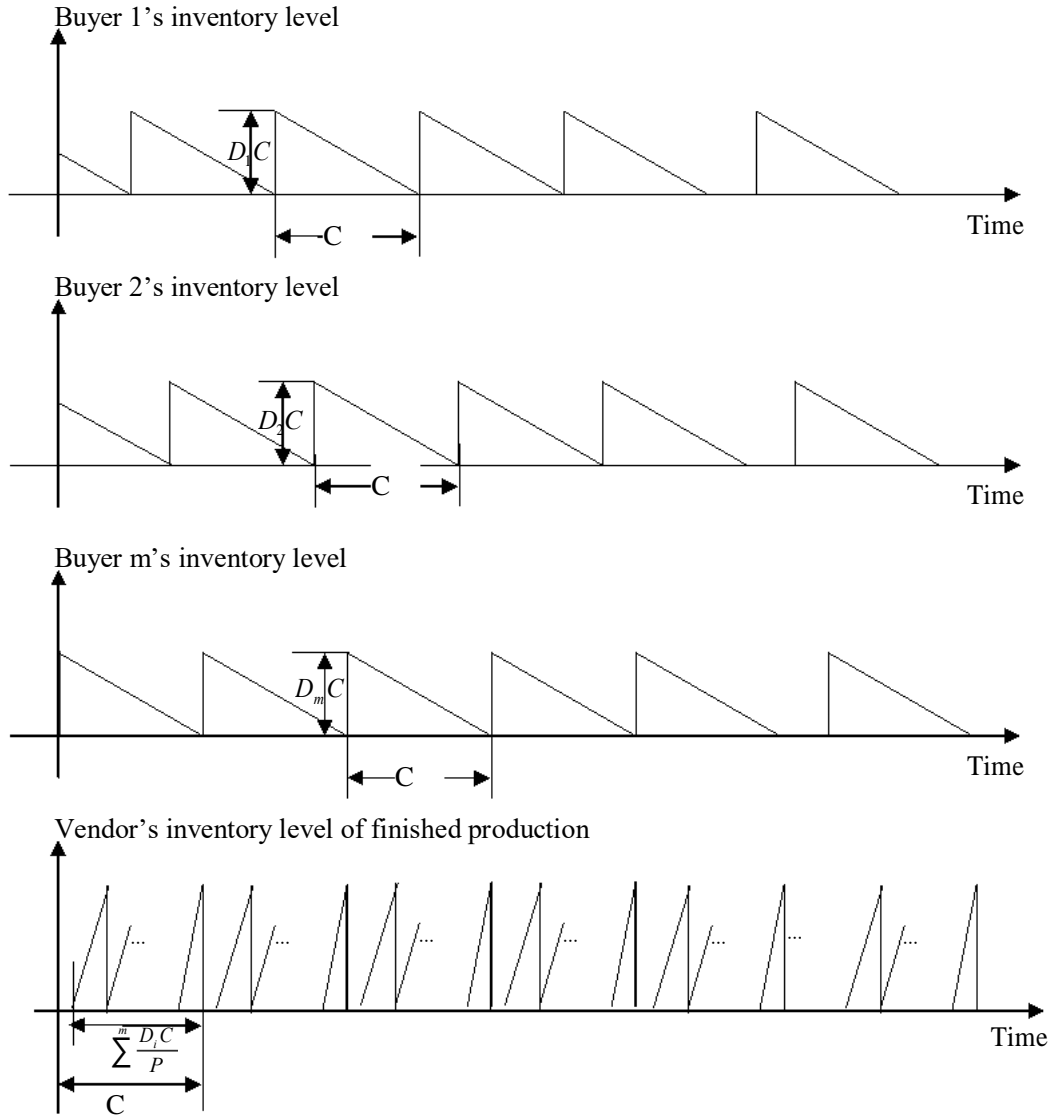


Fig. 1. The inventory level for finished items

Therefore, the vendor's raw materials stock per procurement cycle consists of n triangles and $(n-1)$ rectangles and the carrying cost for raw materials per cycle is

$$\begin{aligned}
 HC_{vm} &= H_{vm} \left[\frac{1}{2} (nM \sum_{i=1}^m D_i C) \left(\frac{\sum_{i=1}^m D_i C}{P} \right) \right. \\
 &+ \sum_{i=1}^{n-1} \left(\sum_{i=1}^m D_i C^2 \right) \left. \right] \\
 &= \frac{nMH_{vm}}{2P} \left(\sum_{i=1}^m D_i C \right)^2 + \frac{n(n-1)MH_{vm}}{2} \sum_{i=1}^m (D_i C^2). \quad (4)
 \end{aligned}$$

Thus, the vendor's total inventory cost for raw materials per unit time is

$$TC_{vm} = \frac{1}{nC} (A + HC_{vm}) = \frac{A}{nC} + \frac{CMH_{vm}}{2} \sum_{i=1}^m D_i (n-1)$$

$$+ \frac{\sum_{i=1}^m D_i}{P}. \quad (5)$$

From the inventory formulation of raw materials above, the least procurement cycle of raw materials is the common replenishment cycle, C . These may be true when the ordering cost per raw material order for the vendor is larger enough than setup cost per production run for the vendor. However, if the ordering cost per raw material order is small, for example, all raw materials being sent by all suppliers of the vendor or in JIT (just in time) setting), the procurement cycle of raw materials may be relatively short comparing with that of the common replenishment cycle for all buyers. In this setting we assume the usage of each production batch is an integral multiple of the procurement lot size of raw materials. That is, the procurement cycle of raw materials

is the fraction multiple of the production run of finished items. For the fraction (notified by n), the denominator is an integer and the numerator is one. By this policy, the

change of inventory levels of raw materials is shown in Fig. 3.

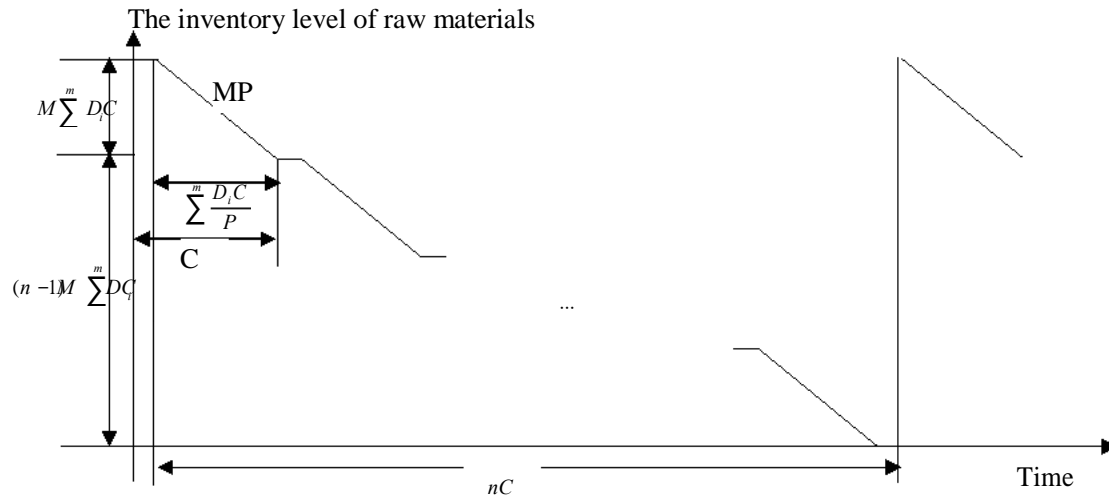


Fig. 2. One kind inventory level for raw materials

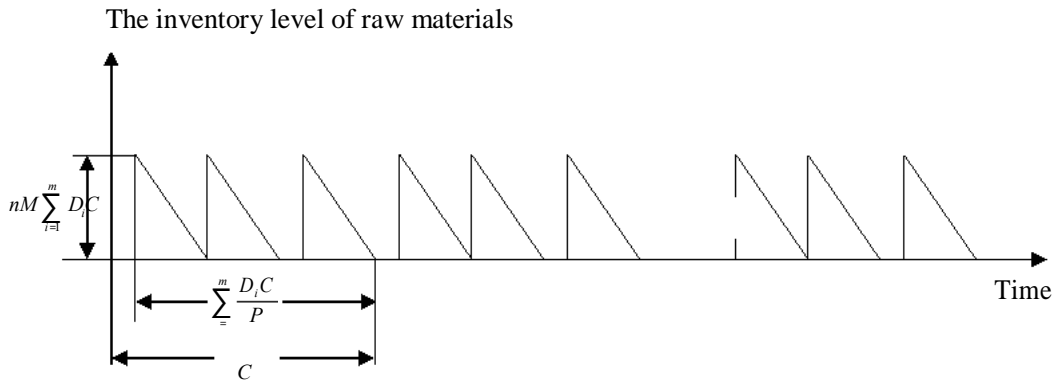


Fig. 3. Another kind inventory level for raw materials

The vendor's raw materials stock per procurement cycle consists of n triangles and the carrying cost of raw materials per cycle is

$$HC'_{vm} = \frac{nMH_{vm}}{2} \sum_{i=1}^m (D_i C) \left(\sum_{i=1}^m \frac{D_i C}{P} \right) \\ = \frac{nMC^2 H_{vm}}{2P} \left(\sum_{i=1}^m D_i \right)^2. \quad (6)$$

Thus, the vendor's total inventory cost for raw materials per unit time is

$$TC'_{vm} = \frac{1}{nC} (A + HC'_{vm}) = \frac{A}{nC} + \frac{nMCH_{vm}}{2P} \left(\sum_{i=1}^m D_i \right)^2. \quad (7)$$

Therefore, comparing with lot-for-lot policy and that of Woo, Hsu and Wu (2001) a more general model (notified by GM) is proposed here.

Model GM:

$$\min_{K, n, C, x, f_i} JTC = K + TC_p + (1-x)TC_{vm} + xTC'_{vm} \\ = K + \frac{1}{C} \left[\frac{A}{n} + S + \sum_{i=1}^m T_i(K) \right] + \frac{C}{2} \sum_{i=1}^m [H_{bi}(1-f_i)^2 D_i \\ + L_i f_i^2 D_i] + \frac{CH_{vp}}{2P} \sum_{i=1}^m D_i^2 + \frac{CMH_{vm}}{2} \left[(1 \right.$$

$$-x) \sum_{i=1}^m D_i (n-1 + \frac{\sum_{i=1}^m D_i}{P}) + x \frac{n(\sum_{i=1}^m D_i)^2}{P}, \quad (8)$$

subject to:

$$1 - n \leq x(\sum_{i=1}^m D_i C) \quad (9)$$

$$\sum_{i=1}^m D_i < P, \quad (10)$$

$$T_i(K) = T_{0i} e^{-rK}, \quad r > 0 \text{ and } i=1,2,\dots,m \quad (11)$$

where K , f and C are nonnegative variables; x is a binary

variable; and $n \in \{\frac{1}{\infty}, \dots, \frac{1}{2}, 1, 2, \dots, \infty\}$.

4. Analysis of the Model

Model GM gives an alternative for raw material procurement cycle; one is that the procurement cycle is integral times common cycle time and another is that the common cycle time of finished items is integral times the procurement cycle of raw materials. When $n > 1$ the model in this paper is the same as that of Woo, Hsu, and Wu (2001). From the paper of Woo, Hsu, and Wu (2001), the optimal result is derived as:

$$f_i^* = \frac{H_{bi}}{H_{bi} + L_i} \quad (12)$$

$$C^* = \sqrt{\frac{2[A/n + S + \sum_{i=1}^m T_i(K)]}{H \sum_{i=1}^m D_i}} \quad (13)$$

$$n^*(K) = \begin{cases} \frac{AG}{MH_{vm}(S + \sum_{i=1}^m T_i(K))} \leq n^*(n^*+1) & \text{if } G > 0, \\ 1 & \text{otherwise,} \end{cases} \quad (14)$$

$$K^* = \begin{cases} \frac{1}{r} \ln \frac{Hr^2 \sum_{i=1}^m D_i \sum_{i=1}^m T_{0i}}{1 + \sqrt{1 + 2Hr^2 \sum_{i=1}^m D_i ((A/n) + S)}} & \text{if } n > N, \\ 0 & \text{otherwise,} \end{cases} \quad (15)$$

where

$$H = MH_{vm} (n-1 + \frac{\sum_{i=1}^m D_i}{P}) + \frac{1}{\sum_{i=1}^m D_i} [\frac{H_{vp}}{P} \sum_{i=1}^m D_i^2 + \sum_{i=1}^m \frac{H_{bi} L_i D_i}{H_{bi} + L_i}], \quad (16)$$

$$G = \frac{1}{\sum_{i=1}^m D_i} [\frac{H_{vp}}{P} \sum_{i=1}^m D_i^2 + \sum_{i=1}^m \frac{H_{bi} L_i D_i}{H_{bi} + L_i} - MH_{vm} (1 - \frac{\sum_{i=1}^m D_i}{P})] \quad (17)$$

$$N = \frac{2(S + \sum_{i=1}^m T_{0i}) - Gr^2 \sum_{i=1}^m D_i (\sum_{i=1}^m T_{0i})^2}{2MH_{vm} r^2 \sum_{i=1}^m D_i (\sum_{i=1}^m T_{0i})^2} + \frac{\{[2(S + \sum_{i=1}^m T_{0i}) - Gr^2 \sum_{i=1}^m D_i (\sum_{i=1}^m T_{0i})^2]^2\}}{2MH_{vm} r^2 \sum_{i=1}^m D_i (\sum_{i=1}^m T_{0i})^2} + \frac{8AMH_{vm} r^2 \sum_{i=1}^m D_i (\sum_{i=1}^m T_{0i})^2}{2MH_{vm} r^2 \sum_{i=1}^m D_i (\sum_{i=1}^m T_{0i})^2} \quad (18)$$

We have $x = 1$ from Model GM when $n < 1$. Model GM can be rearranged as model RGM.

Model RGM:

$$\min_{K, n, C, x, f_i} JTC' = K + \frac{1}{C} [\frac{A}{n} + S + \sum_{i=1}^m T_i(K)] + \frac{C}{2} \sum_{i=1}^m [H_{bi} (1 - f_i)^2 D_i + L_i f_i^2 D_i] + \frac{CH_{vp}}{2P} \sum_{i=1}^m D_i^2 + \frac{nCMH_{vm} (\sum_{i=1}^m D_i)^2}{2P}, \quad (19)$$

subject to Equations (10) and (11).

From Equation (19), for any given C , K , and n , the optimal value of f_i can easily be obtained as

$$f_i^* = \frac{H_{bi}}{H_{bi} + L_i} \quad (20)$$

By substituting (20) into (19) and rearranging the result, we can have

$$JTC' = K + \frac{1}{C} [\frac{A}{n} + S + \sum_{i=1}^m T_i(K)] + \frac{C}{2} [\sum_{i=1}^m \frac{H_{bi} L_i D_i}{H_{bi} + L_i} + \frac{H_{vp}}{P} \sum_{i=1}^m D_i^2 + \frac{nMH_{vm} (\sum_{i=1}^m D_i)^2}{P}]. \quad (21)$$

From Equation (21), for any given K , and n , the optimal value of C can be obtained as

$$C^* = \sqrt{\frac{2[A/n + S + \sum_{i=1}^m T_i(K)]}{H \sum_{i=1}^m D_i}}, \quad (22)$$

where

$$H' = \frac{nMH_{vm} \sum_{i=1}^m D_i}{P} + \frac{1}{\sum_{i=1}^m D_i} \left[\frac{H_{vp}}{P} \sum_{i=1}^m D_i^2 + \sum_{i=1}^m \frac{H_{bi} L_i D_i}{H_{bi} + L_i} \right] \quad (23)$$

Substituting (22) into (21), the joint total cost for any given K and n becomes

$$JTC'(n, K) = K + \sqrt{2H' \sum_{i=1}^m D_i \left[\frac{A}{n} + S + \sum_{i=1}^m T_i(K) \right]} \quad (24)$$

Theorem 1 For any fixed K, the optimal value of n for (24) can be determined as

$$\frac{1}{n^{*2}}(1 - n^*) < \frac{MH_{vm} \sum_{i=1}^m D_i [S + \sum_{i=1}^m T_i(K)]}{PB} \leq \frac{1}{n^{*2}}(n^* + 1) \quad (25)$$

where

$$B = \frac{A}{\sum_{i=1}^m D_i} \left[\frac{H_{vp}}{P} \sum_{i=1}^m D_i^2 + \sum_{i=1}^m \frac{H_{bi} L_i D_i}{H_{bi} + L_i} \right] \quad (\text{see Appendix A for proof}).$$

for proof).

Lemma 1 With the increasing of K, n^* is decreasing and the minimal n^* is bounded by the case when K=0 (see Appendix B for proof).

Lemma 1 implies that the greater the expenditure in ordering cost reduces the shorter raw materials procurement cycle is. When $n^*=1$, JIT setting occur. It is intuitively appealing and also the main reason why the integrated inventory system is willing to invest to reduce the ordering cost.

Theorem 2 The optimal K can be determined by

$$K^* = \begin{cases} \frac{1}{r} \ln \frac{H' r^2 \sum_{i=1}^m D_i \sum_{i=1}^m T_{0i}}{1 + \sqrt{1 + 2H' r^2 \sum_{i=1}^m D_i ((A/n) + S)}} & \text{if } n > N', \\ 0 & \text{otherwise,} \end{cases} \quad (26)$$

where $N' =$

$$\frac{P(2(S + \sum_{i=1}^m T_{0i}) - Br^2(\sum_{i=1}^m T_{0i})^2) + \{8PAMH_{vm} r^2(\sum_{i=1}^m T_{0i})^2\}}{2MH_{vm} r^2(\sum_{i=1}^m T_{0i})^2}$$

$$+ \frac{[P(2(S + \sum_{i=1}^m T_{0i}) - Br^2(\sum_{i=1}^m T_{0i})^2)]^{1/2}}{2MH_{vm} r^2(\sum_{i=1}^m T_{0i})^2} \quad (27)$$

(see Appendix C for proof)

5. Algorithm Steps

Through the above analysis, we present an algorithm for solving Model GM by the following steps:
Step 1: Give the all solutions by Equations (14)-(15) which are given by the paper of Woo, Hsu, and Wu (2001). If $n > 1$, these solutions are considered as the optimal solutions of Model GM, set $n=0$ and go to Step 3; else, go to Step 2.

Step 2: For each $n \in \{n | n(K=0) \leq n \leq 1\}$, calculate the

corresponding optimal K by Equation (26), and give the optimal K and n. Then gives the other optimal solutions f and C by Equations (20) and (22), set $n=1$ and go to Step 3.

Step 3: substitute the optimal n, K, f and C into Equation (8), and get minimal JTC.

6. Numerical Analysis

This section presents numerical example to Model GM. Some of related input parameters which no change come from the paper of Woo, Hsu, and Wu (2001) are given in Table 1. The other parameters changed are shown in Table 2. These parameters are changed five times and the corresponding results are shown in Table 2 too for comparing with the policy of Woo, Hsu, and Wu (2001). The unit time is one year and the monetary unit is U.S. dollar.

Table 1 Values of input parameters

Parameters	Value	Parameters	Value
D_i ($i \in \{1, 2, 3\}$)	1000	P	60000
M	1	R	0.01
H_{bi} ($i \in \{1, 2, 3\}$)	8	L_i ($i \in \{1, 2, 3\}$)	20
H_{vm}	2	H_{vp}	4

Table 2 Five selected points and the corresponding results

Selected point	1	2	3	4	5
Parameters	A=20 S=1000 $T_{0i}=200$	A=20 S=300 $T_{0i}=200$	A=200 S=300 $T_{0i}=200$	A=200 S=200 $T_{0i}=100$	A=600 S=200 $T_{0i}=100$
Results 1*	$n^*=1$ $K^*=413$ $C^*=0.096$ $f_i^*=0.29$ $JTC^*=21767$	$n^*=1$ $K^*=471$ $C^*=0.054$ $f_i^*=0.29$ $JTC^*=12476$	$n^*=1$ $K^*=449$ $C^*=0.068$ $f_i^*=0.29$ $JTC^*=15429$	$n^*=2$ $K^*=417$ $C^*=0.047$ $f_i^*=0.29$ $JTC^*=13512$	$n^*=3$ $K^*=412$ $C^*=0.049$ $f_i^*=0.29$ $JTC^*=17039$
Results 2**	$n^*=1/3$ $K^*=406$ $C^*=0.10$ $x^*=1$ $f_i^*=0.29$ $JTC^*=21171$	$n^*=1/2$ $K^*=464$ $C^*=0.055$ $x^*=1$ $f_i^*=0.29$ $JTC^*=12412$	$n^*=1$ $K^*=449$ $C^*=0.068$ $x^*=0$ or 1 $f_i^*=0.29$ $JTC^*=15429$	$n^*=2$ $K^*=417$ $C^*=0.047$ $x^*=0$ $f_i^*=0.29$ $JTC^*=13512$	$n^*=3$ $K^*=412$ $C^*=0.060$ $x^*=0$ $f_i^*=0.29$ $JTC^*=17039$

*The results with the policy of Woo, Hsu, and Wu (2001). ** The results with Model GM

From Table 2, we have two interesting findings:

1. When $x^*=1$ the joint total cost with Model GM is less than that of Woo, Hsu, and Wu (2001), such as points 1 and 2. In these settings, $n^*=1$ with the policy of Woo, Hsu, and Wu (2001). However since in these points A is lower and S and T_{0i} are higher than those at point 3, the vendor prefers more ordering times in a common replenishment cycle C, and we have a lower joint total cost than the results with the policy of Woo, Hsu, and Wu (2001). For example, at point 3, $n^*=1$ and $JTC^*=\$21767$ in results 1, however $n^*=1/3$ and $JTC^*=\$21171$ in results 2. Model GM adopts the policy of ordering three times in one common replenishment cycle while lot-for-lot policy is implemented with the policy of Woo, Hsu, and Wu (2001) and the joint cost is reduced from $\$21767$ to $\$21171$ by $\$596$.
2. When $x^*=0, n>1$ the results with Model GM are the same as those with the policy of Woo, Hsu, and Wu (2001) where $n^*\geq 1$, such as at point 3, 4 and 5.

7. Conclusion

In this paper, a general model and the corresponding algorithm are proposed. From the last numerical example, it can be seen that Model GM provides a lower or equal joint total relevant cost as compared to that of Woo, Hsu, and Wu's model.

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Appendix A:

For any fixed K, the minimization of $JTC'(n, K)$ in

Equation (24) is equivalent to

$$\begin{aligned}
 \min_n \{ & \frac{nMH_{vm} \sum_{i=1}^m D_i}{P} + \frac{1}{\sum_{i=1}^m D_i} [\frac{H_{vp}}{P} \sum_{i=1}^m D_i^2 \\
 & + \sum_{i=1}^m \frac{H_{bi}L_iD_i}{H_{bi}+L_i}] [\frac{A}{n} + S + \sum_{i=1}^m T_i(K)] \\
 = & \min_n \frac{AMH_{vm} \sum_{i=1}^m D_i}{P} + n \frac{MH_{vm} \sum_{i=1}^m D_i [S + \sum_{i=1}^m T_i(K)]}{P} \\
 & + \frac{A}{n} \frac{1}{\sum_{i=1}^m D_i} [\frac{H_{vp}}{P} \sum_{i=1}^m D_i^2 + \sum_{i=1}^m \frac{H_{bi}L_iD_i}{H_{bi}+L_i}] \\
 & + \frac{1}{\sum_{i=1}^m D_i} [\frac{H_{vp}}{P} \sum_{i=1}^m D_i^2 + \sum_{i=1}^m \frac{H_{bi}L_iD_i}{H_{bi}+L_i}] [S + \sum_{i=1}^m T_i(K)]
 \end{aligned} \tag{A-1}$$

Thus $\min_n JTC'(n, K)$ is equivalent to

$$\min_n \{ n \frac{MH_{vm} \sum_{i=1}^m D_i [S + \sum_{i=1}^m T_i(K)]}{P}$$

$$+ \frac{A}{n} \frac{1}{\sum_{i=1}^m D_i} \left[\frac{H_{vp}}{P} \sum_{i=1}^m D_i^2 + \sum_{i=1}^m \frac{H_{bi} L_i D_i}{H_{bi} + L_i} \right] \quad (A-2)$$

And let

$$Y(n') = \left\{ \frac{MH_{vm} \sum_{i=1}^m D_i [S + \sum_{i=1}^m T_i(K)]}{n' P} \right.$$

$$\left. + \frac{n' A}{\sum_{i=1}^m D_i} \left[\frac{H_{vp}}{P} \sum_{i=1}^m D_i^2 + \sum_{i=1}^m \frac{H_{bi} L_i D_i}{H_{bi} + L_i} \right] \right\}$$

and $n' = \frac{1}{n}$, we have

$$Y(n' + 1) - Y(n') =$$

$$\begin{aligned} & - \frac{1}{n'(n' + 1)} \frac{MH_{vm} \sum_{i=1}^m D_i [S + \sum_{i=1}^m T_i(K)]}{P} \\ & + \frac{A}{\sum_{i=1}^m D_i} \left[\frac{H_{vp}}{P} \sum_{i=1}^m D_i^2 + \sum_{i=1}^m \frac{H_{bi} L_i D_i}{H_{bi} + L_i} \right] \end{aligned} \quad (A-3)$$

and

$$[Y(n' + 1) - Y(n')] - [Y(n') - Y(n' - 1)] =$$

$$\frac{2}{n'(n'^2 - 1)} \frac{MH_{vm} \sum_{i=1}^m D_i [S + \sum_{i=1}^m T_i(K)]}{P} > 0. \quad (A-4)$$

So $Y(n')$ is a strictly convex function and the

sufficient and necessary condition for $Y(n')$ to be minimal at n is therefore

$$Y(n' + 1) - Y(n') \geq 0 \quad \text{and} \quad Y(n' - 1) - Y(n') > 0.$$

That is,

$$n'(n' - 1) < \frac{MH_{vm} \sum_{i=1}^m D_i [S + \sum_{i=1}^m T_i(K)]}{PB} \leq n'(n' + 1)$$

Therefore,

$$\frac{1}{n^2} (1 - n) < \frac{MH_{vm} \sum_{i=1}^m D_i [S + \sum_{i=1}^m T_i(K)]}{PB} \leq \frac{1}{n^2} (n + 1).$$

Appendix B:

When $n < 1$,

$$\frac{\partial}{\partial n} \left[\frac{1}{n^2} (1 - n) \right] = \frac{n - 2}{n^3} < 0 \quad \text{and}$$

$$\frac{\partial}{\partial n} \left[\frac{1}{n^2} (1 + n) \right] = \frac{-n - 2}{n^3} < 0.$$

So we have the minimal n when

$$\frac{MH_{vm} \sum_{i=1}^m D_i [S + \sum_{i=1}^m T_i(K)]}{PB} \text{ get its maximum.}$$

Since

$$\frac{\partial}{\partial K} \left[\frac{MH_{vm} \sum_{i=1}^m D_i [S + \sum_{i=1}^m T_i(K)]}{PB} \right]$$

$$= \frac{MH_{vm} \sum_{i=1}^m D_i}{PB} \sum_{i=1}^m \frac{\partial T_i(K)}{\partial K}$$

$$= \frac{MH_{vm} \sum_{i=1}^m D_i}{PB} \sum_{i=1}^m \frac{\partial T_i(K)}{\partial K}$$

$$= - \frac{MH_{vm} \sum_{i=1}^m D_i}{PB} \sum_{i=1}^m T_{0i} r e^{-rK} < 0.$$

$$\frac{MH_{vm} \sum_{i=1}^m D_i [S + \sum_{i=1}^m T_i(K)]}{PB} \text{ is a decreasing function}$$

with respect to K .

So when $K=0$, n^* get its minimum.

That is,

$$n(K=0) \leq n \leq 1.$$

Appendix C:

From Lemma 1, we know that $n \in \{1, \frac{1}{2}, \frac{1}{3}, \dots$

$\dots, n^*(K=0)\}$ for any n . that is, n is numerical. So we can

calculate optimal K to minimize $JTC'(n, K)$ for any

fixed n . So for any fixed n , from

$$\frac{\partial}{\partial K} JTC'(n, K) =$$

$$1 + \sqrt{\frac{H' \sum_{i=1}^m D_i}{2[A/n + S + \sum_{i=1}^m T_i(K)]}} \sum_{i=1}^m \frac{\partial T_i(K)}{\partial K}$$

$$= 1 - \sqrt{\frac{H' \sum_{i=1}^m D_i}{2[A/n + S + \sum_{i=1}^m T_{0i} e^{-rK}]}} \sum_{i=1}^m T_{0i} r e^{-rK} = 0, \quad (C-1)$$

the solution of Equation (C-1), notified by K_1 can be obtained as

$$K_1 = \frac{1}{r} \ln \frac{H' r^2 \sum_{i=1}^m \sum_{j=1}^m T_{0i}}{1 + \sqrt{1 + 2H' r^2 \sum_{i=1}^m D_i ((A/n) + S)}}, \quad (C-2)$$

and

$$\sum_{i=1}^m \frac{\partial T_i(K_1)}{\partial K_1} = - \sqrt{\frac{2[A/n + S + \sum_{i=1}^m T_i(K_1)]}{H \sum_{i=1}^m D_i}}. \quad (C-3)$$

Since

$$\begin{aligned} \frac{\partial^2 JTC'(n, K)}{\partial K^2} &= \sqrt{\frac{H' \sum_{i=1}^m D_i}{2[A/n + S + \sum_{i=1}^m T_i(K)]}} \left\{ \sum_{i=1}^m \frac{\partial^2 T_i(K)}{\partial K^2} \right. \\ &\quad \left. - \frac{\sum_{i=1}^m (\partial T_i(K) / \partial K)^2}{2[A/n + S + \sum_{i=1}^m T_i(K)]} \right\} \end{aligned} \quad (C-4)$$

, substituting (C-3) to Equation (C-4), we have

$$\begin{aligned} \frac{\partial^2 JTC'(n, K_1)}{\partial K_1^2} &= \sqrt{\frac{H' \sum_{i=1}^m D_i}{2[A/n + S + \sum_{i=1}^m T_i(K_1)]}} \left\{ \sum_{i=1}^m \frac{d^2 T_i(K_1)}{dK_1^2} \right. \\ &\quad \left. - \frac{1}{H' \sum_{i=1}^m D_i} \right\}. \end{aligned} \quad (C-5)$$

Since

$$\begin{aligned} \sum_{i=1}^m \frac{d^2 T_i(K_1)}{dK_1^2} &= - \frac{1 + \sqrt{1 + 2H' r^2 \sum_{i=1}^m D_i (A/n + S)}}{H' \sum_{i=1}^m D_i} \\ &> \frac{1}{H' \sum_{i=1}^m D_i}, \end{aligned} \quad (C-6)$$

we have

$$\begin{aligned} &\times \left(n - \frac{P(2(S + \sum_{i=1}^m T_{0i}) - Br^2 (\sum_{i=1}^m T_{0i})^2) + \sqrt{8PAMH_{vm} r^2 (\sum_{i=1}^m T_{0i})^2 + [P(2(S + \sum_{i=1}^m T_{0i}) - Br^2 (\sum_{i=1}^m T_{0i})^2)]^2}}{2MH_{vm} r^2 (\sum_{i=1}^m T_{0i})^2} \right) \\ &\times \left(n - \frac{P(2(S + \sum_{i=1}^m T_{0i}) - Br^2 (\sum_{i=1}^m T_{0i})^2) - \sqrt{8PAMH_{vm} r^2 (\sum_{i=1}^m T_{0i})^2 + [P(2(S + \sum_{i=1}^m T_{0i}) - Br^2 (\sum_{i=1}^m T_{0i})^2)]^2}}{2MH_{vm} r^2 (\sum_{i=1}^m T_{0i})^2} \right) > 0. \end{aligned} \quad (C-11)$$

Therefore, $K_1 > 0$ if and only if

$n >$

$$\frac{P(2(S + \sum_{i=1}^m T_{0i}) - Br^2 (\sum_{i=1}^m T_{0i})^2) + \sqrt{8PAMH_{vm} r^2 (\sum_{i=1}^m T_{0i})^2 + [P(2(S + \sum_{i=1}^m T_{0i}) - Br^2 (\sum_{i=1}^m T_{0i})^2)]^2}}{2MH_{vm} r^2 (\sum_{i=1}^m T_{0i})^2}.$$

$$\frac{\partial^2 JTC'(n, K_1)}{\partial K_1^2} > 0. \quad (C-7)$$

That is, $JTC'(n, K_1)$ is a strictly convex function

and have only a unique solution in Equation (C-1).

So if $K_1 > 0$, the optimal K is K_1 .

Note that $K_1 > 0$ if and only if

$$\begin{aligned} &\frac{H' r^2 \sum_{i=1}^m \sum_{j=1}^m T_{0i}}{1 + \sqrt{1 + 2H' r^2 \sum_{i=1}^m D_i ((A/n) + S)}} > 1. \text{ That is,} \\ &H' r^2 \sum_{i=1}^m \sum_{j=1}^m T_{0i} \\ &> 1 + \sqrt{1 + 2H' r^2 \sum_{i=1}^m D_i ((A/n) + S)} \end{aligned} \quad (C-8)$$

By rearranging the inequality and taking square for both sides, we can have

$$\begin{aligned} &(H' r^2 \sum_{i=1}^m \sum_{j=1}^m T_{0i} - 1)^2 \\ &> 1 + 2H' r^2 \sum_{i=1}^m D_i ((A/n) + S) \end{aligned} \quad (C-9)$$

That is,

$$\begin{aligned} &((\frac{nMH_{vm} \sum_{i=1}^m D_i}{P} + B)r^2 \sum_{i=1}^m \sum_{j=1}^m T_{0i} - 1)^2 \\ &> 1 + 2(\frac{nMH_{vm} \sum_{i=1}^m D_i}{P} + B)r^2 \sum_{i=1}^m D_i ((A/n) + S) \\ &(n + \frac{BP}{H_{vm}M}) \{ MH_{vm} r^2 \sum_{i=1}^m D_i (\sum_{i=1}^m T_{0i})^2 n^2 - P(2(S \\ &+ \sum_{i=1}^m T_{0i}) - Br^2 (\sum_{i=1}^m T_{0i})^2) n - 2PA > 0 \} \end{aligned} \quad (C-10)$$

that is, $(n + \frac{BP}{H_{vm}M})$

Else, there is no solution in Equation (C-1). The optimal K is zero since $JTC'(n, +\infty) = +\infty$.

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The Environment Factors Analysis of Electronic Commerce Credit System in China

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Abstract

This essay raises that the problem of credit lacking is the major reason which hinders the development of electronic commerce in China through investigating the existing environment in our electronic commerce. The credit problem of electronic commerce is showed in three aspects: the reliability of information flow, security of currency payment and the reliability of service and commodity delivery. From the practical environment of the Chinese cultural moral tradition, the planned economy transferring to the market economy and the analysis of the electronic commerce in social environmental system in which the China's government changes its duty, there are six key system factors will influence the credit environments: technological standardization, laws and regulations, cultural morality, property right institution, government, and information delivery and open scheme. This essay Sets up two models of structure model and dynamic model for electrical commercial credit system analysis. The focus is to discuss the effect of this system factors' relationship among laws and regulations, credit cultural morality's influence on electronic commerce, property rights institution and the functions government takes a role in setting up the credit system.

Keywords: electronic commerce environment factors credit system analysis

1. Introduction

Modern market economy is the production and exchanging system of society and the professional division supported by credit.

2. Analysis model of Electronic Commerce Credit System

2.1 The Structure Model and Electronic

Commerce Credit System

Electronic commerce is the continuation of traditional commerce relationship and commerce activities. The traditional commerce relation needs a long period to be acknowledged and agreed in order to set up a trust. In the practice of electronic commerce, there is a strong virtuality in the net exchange. The biggest difference between net shopping and traditional shopping is that the buyers and sellers don't meet face to face. The effect of credit problem on the electronic is not only technology but all aspects of the social economy that is supporting the electronic commerce.

Comparing with the practical commerce activities, the basic factors of forming electronic commerce haven't been greatly changed^[1]. The credit scheme between buyers and sellers, the choosing scheme of products, the payment scheme of currency, the transferring scheme of goods and service all make up the foundation of electronic commerce activities. Thus, three aspects are the most important in investigating the growing environment of electronic commerce.

First, providing the net station of product information and choice as the trading activity place on net to set up a link of the customers' net space with the indefinite physical place without planning so that the circulation of commerce information realizes.

Second, electronic payment can make customers to pay for their buying or flowing fund through banks or credit cards on net anywhere they are.

Third, product allotment on net can send the products to customers efficiently at a low cost in order to realize the flowing of service and goods in the geographical space.

From the basic procedure of the electronic commerce, its credit system is showed in three aspects: the trustworthiness of information flow, security of currency payment and the reliability of service and

commodity delivery. From the establishment of the credit system, these three parts can be divided into one foundation, one motivation, and three supporting layers :one is the technological standardization, the other two are the lawful and cultural moral standardizations. Property right institution is the base of credit system existence. Information spread and its open scheme are the motive power of credit system .The technological standardization includes the technology of information security, electronic currency system , and the technology and management of the service and commodity delivery. The lawful standardization includes two kinds: limits of the principal part involving the electronic commerce and the government administrative behavior mainly focusing on the security, privacy , protection of knowledge property and the lawful efficiency of electronic contracts

ect. which involving the benefits of the right protection of the country and consumers, and supervision of the commercial activities. Cultural moral standardization shows the moral sense and human sense attached to the market economy, respecting the private right and cooperation spirit including the rights of survival, property, free choice and so on . It reflects the foundation of linking and developing the whole market economical social association. The key problem of the credit in our country is the institution. So the main contents of building credit system are that to build credit information network, to improve the basic construction of property right institution, to improve the host of credit government, form, and citizen., to improve the three support systems of law, technological standardization , and cultural moral standardizations(figure .1).

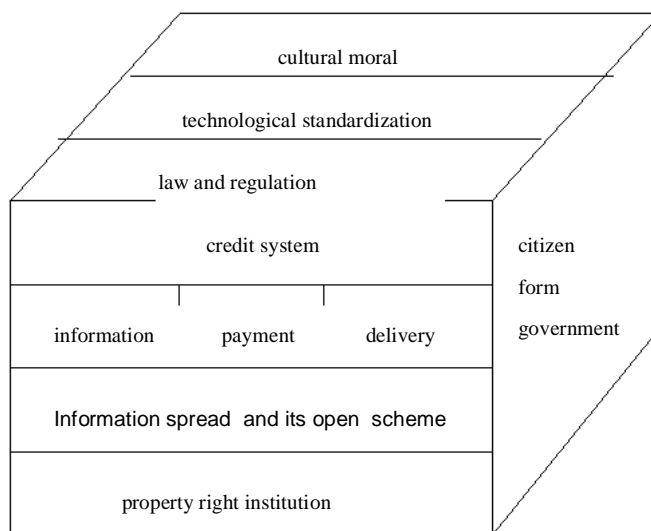


Figure.1 Structure model of the electronic commercial credit environment analysis

2.2 Dynamic Model of the Electronic Commercial Credit Environment Analysis

From the aspect of the credit environmental analysis of the electronic commerce, there are six key factors will influence the three aspects of environment: technological standardization, laws and regulations, cultural morality, government, property right institution, Information spread and its open scheme. The credit environments indicate the regulations in the activities of the market economy and a series of rules limiting the people's behaviors. Their formal form includes laws, regulations, property right institution, related procedures and technical requirements.

The informal forms include culture, customs and morality, etc. It's quite obvious and regular for the Technical regulation and laws and regulations to influence the electronic commercial credit problems (as illustrated in solid line) while the cultural morality, property right institution, and government's influence on the electronic commercial credit problems is indirect and indefinite (as illustrated in break line). Cultural morality, property right institution, and government will have an effect on the credit problems through technical choice and setting up the laws and regulations. The information spread and its open scheme gives the relation for all this factors,

delivery the effect for each other(show as solid line and break line in figure2). Their relations between them can

be illustrated as figure 2.

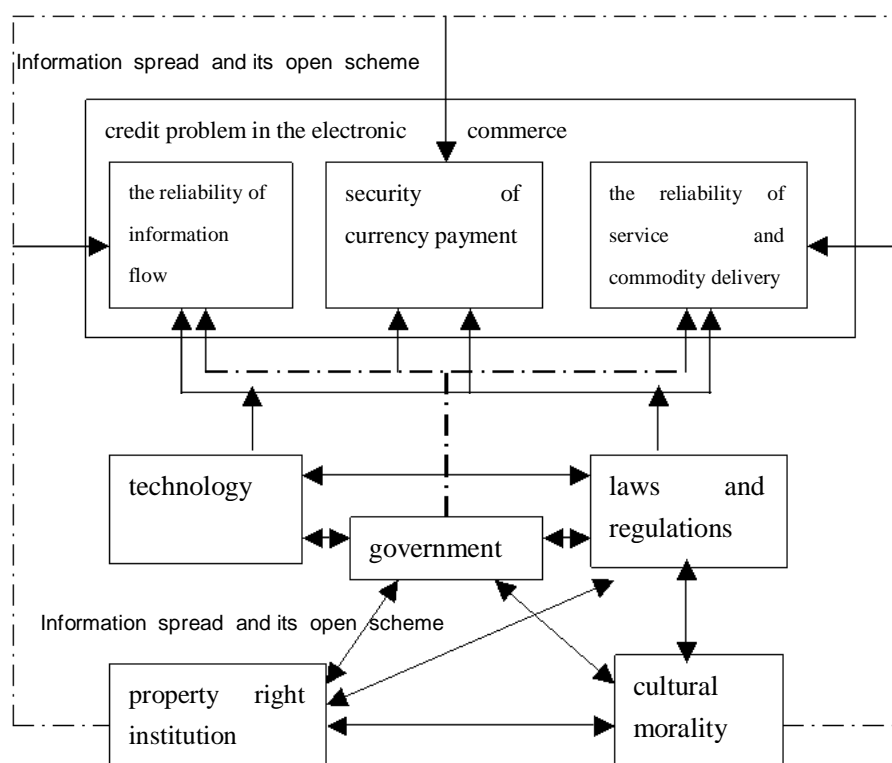


Figure.2 Dynamic model of the electronic commercial credit environment analysis

3. Analysis of the credit environment factors of electronic commerce

Credit problem is a question that every economic system should face. Individuals, society and government may all have the problems of credit losses. Serious credit problem widely exists in the economic lives and every field such as finance stock, contract, advertisement, medium, construction, statistics and so on. China has just its special situation of economic transfer. The credit problem of the electronic commerce should be paid more attention. Technology is always the major factor in its credit environment. Lots of economic issues and judicial cases involve the dependence on the technology for electronic commerce. Many theses have been deeply discussed in the aspect. Thus this essay will focus on the effect of the laws and regulations, cultural morality, property right institution, Information spread and its open scheme, and government on the electronic credit problem.

credit system evolution.

The law of the electronic commerce makes its credit perfect^[2]. Electronic commerce's happening must bring the innovation of the trade ways, business model and administrative management ways also with a series of law problems. The fixed ones of the electronic information media cause the characteristics of electronic commerce's legislation. The internet has got rid of the traditional physical limits of the countries, which communicates rapidly and easily while electronic contracts and documents can be revised, copied and deleted without any mark. As for the traditional commercial activities, the electronic commerce based on the new media brings a series of new policy problems, mainly focusing on the law efficiency of the security, privacy, knowledge property right protection, and electronic contracts. Meanwhile it requires new demands for the country's power, consumers' right and interest protection, surveillance to the commercial activities and statistics and

3.1 Law system is the necessary assurance of

etc.

Electronic commerce's legislation aims at setting up credit system, protecting property right institution, Information spread and its open scheme, credit morality, which can force all the social members follow. The premise and key rules of the designing the credit system are based on seeking for the own interest for all people legally. First of all, everyone is equal to have the right to ask for his or her legal interests. The idea of most important for the right and regulation from the market economy is the logical origin of electronic commerce's legislation.

3.2 Government credit is the core of the credit system evolution.

Government credit is the major factor of setting up the social credit environment that electronic commerce needs^[3]. The role of the government is great importance in the process of developing the credit environment construction of the electronic commerce. The largest challenge to the electronic commerce in China is not the problem of technology, but the arrangement of policy's consistence and institution frame. Electronic commerce is challenge with the traditional trading ways' laws and institutions in trade. The remains of the division of the administrative right lead to the policy frame which is hard to form an inter-department and consistence. The sense of lacking credit from institutions is the major factor damaging the existing environment of the electronic commerce.

It is not long for China to carry out the market economic institution while law system is not perfect. The enterprise as the "homo economicus" seeks for the largest revenue. It can hardly avoid hurting the social and public interests in order to obtain the revenue. Under such real social environment, the social credit should depend on the support of the administrative surveillance provided by the government. Without the government forcing management, the social credit will not set up. Without the government's support, the whole social credit system will degenerate and be destroyed.

Heightening the government's transparency is the effective method of ensuring government credit. The urgent thing to establish the credit system is setting up the

efficient surveillance and controlling system to the government behavior and building the policy credit of the government surveillance.

3.3 Moral environment is the support of credit system evolution

Credit culture and credit morality are the basic support of electronic commerce^[2]. For two thousand years, the moral theory in the society of China has been the theory of Confusion and Meng(孔孟学说), that is the basic of the Chinese moral instruction. The new moral instructions have been brought since the New China was founded. The communist morality is to think of others first, devote all to the society, and be unselfish; all these provide the moral rules for the effective social operation. As the transfer from the planned economy to the market economy gradually, the economical activities have surpassed people's relation of the traditional natural economy and planned economy, at the same time, the adaptable credit moral regulation falls behind clearly. The market economy requires the related support of the credit moral regulation, but the market economy itself cannot produce the adaptable credit moral regulation. According to the principle of economics, we can predict the establishment of the credit moral regulation is based on the Cost- Revenue Principle, which ensures the credit cost of breaking contracts higher than the revenue of breaking contracts during using the credit. Any reasonable people may compare the cost and revenue to make a sensitive choice between the short-term revenue of breaking contracts and long-term credit loses and limits their own behavior to keep promise for a very long time. If the credit devalue in social opinion occurs, and related laws and regulations are not established, the risk of the credit and cost is less than the revenue. Credit morality will develop as an evolution process of "bad money drives out good". Once the credit social value gets into process of devalue, it will encourage more and more people to destroy credit. It goes on and on, at last becomes the great increase of the trading cost and the social economy may be destroyed. The electronic commerce will also lose the base of existence.

The credit morality is the base to promote market resource allocation efficiency. The support of the law

relies on punishment while morality on criticism. It is the high cost to keep the social credit by laws, such as lawsuit, judicature and enforcing the law. It may cost a lot to ensure the fair judgment. But the judgment of morality is quite different. Its social cost is very low, to get the same result as the law punishment. Therefore, it is the most effective method to get the social total utility by the moral limit.

3.4 Property right institution is the base of credit system existence

The base of credit system evolution originates from the long-term expectation for the social members to the social economic developing environment. In the market economic activities^[4], the distinct property right is the motive force seeking for long-term benefits that makes people have a stable expectation for the future. Meanwhile it will make the once game behavior change into a repeated long-term game behavior. In Hayek's viewpoint, the market economy itself is an increasing expanding of the cooperation rules between people. The base of this rule regards property right as the core labor cooperation relationship. Credit will be followed only by seeking for long-term benefit. Distinct property right will ensure to form a scheme of keeping credit and protecting its own right to punish other's cheat for long-term benefit. Property right institution keeps a long-term expectation for every market agent to exist and grow in a transparent and expectable environment that protects the social credit system. The problems about credit in China are brought out because of imperfect property right institution, which causes short-term behavior and breaking credit to occur again and again.

3.5 Information spread and information open scheme are the motive power of credit system evolution.

The wide revelation of credit information is the necessary motivation of the credit system evolution. One important character of electronic commerce is the expanding of credit trading area to every way of the social lives. Under the closed natural economy, the people involving the trades come from relatively closed natural

areas. They can support and protect their credits by the relationship of religion, neighborhood and social public opinions. Therefore, they can't find who will make a trade with if lacking of the credit. In the open electronic commerce market, it is becoming more and more complicated about the trading objects, trading varieties, trading amounts, trading places and trading ways. The initial information communicating ways and moral binding of the two trading objects cannot meet the needs of the electronic commerce. Especially for China in the period of transferring market economy, the wide revelation of credit information is an effective binding force. The wholly open information helps to reduce the credit shortage caused by information non-symmetry. By the government credit and law authority, the supplies of low-cost increasing information through modern information spreading way will help to prompt social credit system evolution. The inter-department management under the government, including the credit information of banks, business management, public security, taxation, helps improve the condition of information non-symmetry so as to set up the confidence of electronic commerce. This will make a decisive affect on our present credit system construction.

4. Conclusion

In the world, the development of the electronic commerce is growing faster than the social culture, and establishment, revising and perfecting the government policies, standards, and laws. In China, although the electronic commerce lies in the very initial period of introduction, the credit problem is seriously obvious because of our traditional natural economy and planned economy and its related moral principles, imperfect laws and regulations and the vague location of the government's role in the process of the economic transfer. The provisions of the electronic commerce rely on the building and perfecting the whole social information infrastructure, the form of the credit culture and moral regulations, and the support and cooperation of the country's laws and regulations and etc. Government can take a great important role in the building process of the credit environment that the electronic commerce needs. The choice and innovation of the institution are the most

important factors involving the credit problems in China's electronic commerce.

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Internet-enabled e-Banking Systems and Customer Responses

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Abstract

This paper presents an empirical study of Internet-enabled e-banking systems and customer responses on the basis of structural equation modeling. The results suggest that perceived usefulness, ease of use, system security, quality services and convenience represent the major avenues affecting customer interactions with e-banking services. The findings provide commercial banks with meaningful information for developing commercially sustainable Internet-enabled e-banking systems.

1. Introduction

Many commercial banks implement Internet-enabled e-banking systems with an aim to provide an effective channel for the delivery of innovative banking services [17]. However, it seems very challenging to extend market penetration and achieve the expected value of Internet banking in competitive marketplace. As far as this is concerned, this paper explores various factors associated with Internet-enabled banking systems from the customer point of view. In particular, it empirically elucidates customer response in light of their experience from using the existing Internet banking services. The influences of individual variables are tested using confirmatory factor analysis and structural equation modeling. The empirical results are discussed in an analytical manner to examine the impacts of different variables on the issue concerned.

2. Research Model

Technology Acceptance Model (TAM) enables the explanation of user behavior across a broad range of end-user computing technologies and the acceptance of computer-based information systems [10]. It asserts that the influence of external variables upon user behavior is mediated through user beliefs and attitudes. Actually, TAM adapts the Theory of Reasoned Action (TRA), which is specifically tailored for modeling user acceptance of information systems [9]. Attitudes are related to individual affective feelings about performing a behavior. Both perceived usefulness and perceived ease of use are belief constructs. Perceived usefulness refers to the prospective user's subjective probability that using a specific system might enhance job performance within an organizational context [10]. It captures the extent to which a potential adopter views the innovation as offering value over alternative ways of performing a similar task [2]. On the

other hand, perceived ease of use refers to the degree to which the prospective user expects the use of a system to be free of effort [10]. A number of previous empirical studies have proved that both perceived usefulness and perceived ease of use affect the acceptance of information systems implemented within an organization [1] [3] [14].

In terms of technology-based self services, customers usually apply a compensatory process to evaluate multiple attributes and gradually form their expectations based on experience [11] [15]. The quality of services can be assessed using consumption-based perceptions [8]. The evaluation that individuals can rationally provide in such situations would be derived from their expectations. For instance, the expectations assigned to speed of delivery, ease of use, and reliability determine expected service quality, which might in turn affect the individual's intention to consume [12]. Internet-enabled e-banking is an innovative alternative of banking services. However, it is not an unfamiliar phenomenon at this stage because it has been implemented for several years. Therefore, it is meaningful to examine customer responses in terms of the actual use of the services beyond individual attitudes and intention to use. The evaluation of online banking systems should involve multiple considerations in addition to perceived usefulness and perceived ease of use. In this paper, a research model is developed to examine such constructs as perceived usefulness, perceived ease of use, systems security, service quality and convenience.

3. Research Methods

This project involves a survey of individual assessments of e-banking services provided by commercial banks. In terms of the design of a questionnaire for our survey, a complex construct should be rich in meaning and multi-dimensional. Multiple measures were employed to evaluate the constructs mentioned in the previous section. Respondents are requested to give their opinions regarding the perceived importance of each variable, on the basis of a seven-point Likert-scale, with which 1 represents "Not important at all" or "Strongly disagree," while 7 represents "Extremely important" or "Strongly agree." Our questionnaire was circulated to individuals in a random manner. Respondents were requested to access various attributes with respect to Internet banking currently provided by banks. They were also requested to tell to what extent they have actually used Internet banking services within a particular period of time. As a result, we

received the feedback from three hundred individuals who possess experience on Internet banking services. On the basis of the assumed causal relationships of different variables and their potential impacts on customer responses to e-banking services, we validate each set of measures in an egalitarian way through reliability test, exploratory factor analysis (EFA) and confirmatory factor analysis (CFA).

4. Results

The results show that factor loadings are greater than the cutoff value of 0.4 [13]. Hence, all items seem relevant to those major factors being examined. Firstly, the factor loadings of those items associated with “Usefulness” are 0.9302, 0.8788, and 0.6047, respectively, which are positively significant. These three items together explain 65.45% of the variance. Secondly, the factor loadings of five items in relation to “Ease of Use” are 0.8346, 0.8464, 0.8321, 0.8759 and 0.8424, respectively, explaining 70.52% of the variance. Thirdly, the factor loadings of four items in relation to “System Security” are 0.8803, 0.8807, 0.5057, and 0.7888, respectively, explaining 60.55% of the total variance. Moreover, the factor loadings of the two items associated with “Quality Services” are 0.8989 and 0.8989, explaining 80.42% of the total variance. These factor loadings considerably support the convergent validity and discriminant validity of factors. The values of Cronbach alpha resulted from reliability analysis prove the internal consistency of the sample data. The values of Cronbach alpha are 0.7606 (Usefulness), 0.8987 (Ease of Use), 0.8327 (System Security), and 0.7238 (Quality Services), respectively, further indicating that the items associated with each factor mentioned above are relatively consistent [13] [19].

The t values (estimated factor loadings divided by their standard errors) for the factor loadings of manifest variables are all above two (for example, 17.7048, 24.7869 and 21.3946 for the three items associated with “Usefulness”), supporting the statistical significance of the parameter estimations and indicate the unidimensionality of each exogenous latent variable and the convergent validity of our model. In addition, the relatively large squared multiple correlations (R^2) for each exogenous latent variable (minimum value of R^2 is 0.5250 in the present case) not only supports the assertion that items are reasonable measures of the constructs [6] [13], but also indicates that the items are well represented the exogenous variables.

The estimates of the path coefficients from β_1 to β_5 are calculated using Latent Variable Equation [6]. The results indicate that the path coefficients in the CFA model for perceived usefulness, perceived ease of use, system security, service quality and perceived convenience are 0.2939 ($p < 0.01$), 0.2747 ($p < 0.01$), 0.1219 ($p < 0.05$), 0.1372 ($p < 0.05$), and 0.0757 ($p < 0.1$), respectively.

Our analysis shows that the Goodness of Fit Index (GFI) [5] is 0.9125 and the GFI Adjusted for Degrees of Freedom (AGFI) is 0.8469. AGFI values higher than 0.80 suggest a good fit of the hypothesize model [4]. The Root Mean Square Residual (RMR) is 0.0521. The RMR value less than 0.1 is considered a good fit and a value less than 0.05 is considered a very good fit of the data to the research model. It also suggests that the model fits well. GFI is a measure of the relative amount of variances and covariances jointly accounted for the model [18], while RMR is a measure of the average of the residual variances and covariances [16]. Bentler and Bonett’s Non-normed Index is 0.9149, Bollen Non-normed Index is 0.9438 and Bentler’s Comparative Fit Index is 0.9433. The Chi-square statistic is 211.47 with d.f. = 52 which is a statistically significant validity of constructs within the model [7]. Finally, the test Statistics (e.g. GFI, AGFI, and RMR) suggest a good fit of the hypothesized model, which shows that 36.81% of the variation of the endogenous variable can be explained by the exogenous variables.

5. Discussion

This empirical investigation elucidates critical factors of Internet-enabled e-banking services from the customer point of view. In particular, the reliability analysis and exploratory factor analysis show that the individual items are relevant. The convergent validity of these items is strongly supported by the resulted factor loadings. Our hypothesized model is supported by the results presented in the previous section. The constructs within the model have also been validated, because the estimates of path coefficients indicate that perceived usefulness, ease of use, system security, service quality and convenience considerably influence individual customer responses to Internet-enabled e-banking.

In general, the use of e-banking services varies from looking for information to conducting transactions. Banks should pay attention to customer concerns because the e-banking platform ultimately is built for individuals. The improvement of Internet banking systems should focus on functionalities, user friendliness, system security and service quality. An Internet-enabled banking website should improve the usefulness of Internet banking services by allowing customers to interactively search the latest banking information, conduct real-time transactions, and make investment plans. Therefore, the design of Internet banking systems should focus on navigation, content and interactivity. Most online customers seek a sophisticated service. A desirable platform for e-banking should be aesthetically appealing and user-friendly. It should also possess practical functionalities to meet the need of individual customers. In addition, customers are usually concerned about such uncertainties as authorized access, confidentiality, transaction restrictions, and serious security procedure implemented. It is necessary to continuously enhance the security level of online banking systems by implementing the latest security systems and

instruments. Additional resources must be allocated in this direction even though the investment might be significant.

Convenience would be a great advantage of Internet banking, because it enables individuals to easily access accounts and execute transactions through e-banking systems anywhere. Customers are no longer constrained by physical access and opening hours of branches. Many appreciate the convenience of e-banking, because they do not have to queue up for routine banking services in brick-and-mortar branches. Today, quality service is a must in the competitive environments. Similar to face-to-face services at a bank branch, customers are also expected quality services with e-banking systems. It is practically difficult to effectively provide assistance to customers and ensure consistent service performance in the virtual environment. However, it would be desirable if banks could respond to service request and process transactions in a reliable manner. Therefore, it is necessary for commercial banks to continuously reengineer their business processes and implement the best practices in the industry.

6. Conclusion

This paper has contributed to the development of knowledge because the theoretical approach of TAM for evaluating the acceptance of information systems has been extended to assess Internet-enabled banking systems. In addition to perceived usefulness and ease of use, systems security and quality services should be emphasized, because these aspects also considerably explain individual interactions with the present Internet-enabled banking services. Finally, our findings based on customer feedback have practical implications, because commercial banks are provided with useful information to enhance e-banking systems and services. By continuously improving critical features and sophisticated functions, Internet-enabled e-banking is likely to achieve greater customer acceptance and market penetration.

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Electronic Business (EB) in the Context of Global Sourcing: A Proposed Framework

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Abstract

Global sourcing operates under the challenges and pressures of intensive global-wide competition. Global sourcing can benefit from the functionality of electronic business (EB) by exhibiting more flexible structures and added opportunities in communications and transactions with partners among worldwide supply chains/networks. This study aims to answer two research questions, “what are the relationships between global sourcing and EB?” and “how do EB applications and strategies help global sourcing lead to better performance?”

Our literature review addresses the relationships between global sourcing and EB from three perspectives: the applied theories, the covered business scope, and the changing roles of flows. In analyzing the potential benefits of EB to global sourcing, the enhancement on SC components and alignment effects are discussed. Finally, a framework is proposed to highlight how EB and global sourcing interact with each other, resulting in five major issues: the enhancement of SC components, the changing micro-environment, the effect of accelerating evolution of global sourcing, the integration of activities, and the significant improvement on outcomes.

1. Introduction

Global supply chain management (GSCM) is regarded as one of today's key business trends. Global sourcing can benefit from the functionality of electronic business (EB) by exhibiting more flexible structures and added opportunities in communications and transactions with partners among worldwide supply chains/networks. This study aims to answer two research questions, “what are the relationships between global sourcing and EB?” and “how do EB applications and strategies help global sourcing lead to better performance?”

The paper is organized along an extensive literature review section, the primary focus of which emphasizes foundations of global sourcing, key issues of EB, and the concept of alignment. Subsequently, a framework is developed in which the relationships between EB and global sourcing are analyzed, followed by conclusions.

2. Literature Review

2.1 Global Sourcing

2.1.1. Definitions of global sourcing

Because of the types, as well as the scope of global sourcing, the literature offers various definitions of global sourcing. Some definitions are mainly based upon specific features of a particular industry [39]; some are based upon corporate goals [12]; while still others are based on the specific format of sourcing activities [37]. In addition, there exists a clarification battle between international sourcing and global sourcing [26] [5] [1] [35]. However, in order to cover broader evolution stages and all possible types of global sourcing, this study adopts a broader definition of global sourcing, taken from Murray, Kotabe & Wildt [30]: “(global sourcing) involves setting up production operations in different countries to serve various markets, or buying and assembling components, parts or finished products worldwide.”

2.1.2. Key determinants of global sourcing

Five key issues in global sourcing are identified in the literature: financial issues, strategic issues, structural issues, culture issues, and evolution and classification issues. Each of these is discussed in turn.

^{3/4} Financial issues

In the context of global sourcing, financial issues are the ones most often mentioned in the literature. Issues such as production cost, transfer pricing, exchange rate, and switching cost abound. For instance, Kouvelis [17] provides an in-depth analysis of how to make global sourcing an operational hedging mechanism to respond to fluctuating exchange rates. The main theme of Kouvelis' evaluation model is to compare the tradeoff between switching cost and exchange rate fluctuation for a certain period, so as to help a corporation make orders to suppliers based on total cost minimization. Lowe, Wendell & Hu [21] take a similar perspective. By utilizing the value of historical data and scenario-based mechanisms, a two-phased approach is proposed to look into the tradeoff between switching cost and exchange rate fluctuation.

Transfer pricing is another important tax issue multinationals face [34]. Based on the setting of four

“vectors” (i.e., material flows, transfer prices, profit and loss, and proportions of transportation cost allocation), Vidal & Goetschalckx [41] establish a mathematical model for maximizing net income after tax of a global SC.

The studies mentioned above lack the support of empirical evidence or real cases. More and more studies hold the opinion that “financial factors are important to global sourcing while the financial-deterministic perspective is doubtful.” Examples can be found in [19] [32].

From a theoretical perspective, financial issues still hold. Theories being cited include transaction cost theory, opportunity theory, resource based theory, macroeconomic theory, and contingent claim theory [28] [17] [29] [11].

³/₄ Strategic issues

Strategic issues, in comparison with financial issues, cover a relatively wider scope. It at least includes issues of design, product maturity, the level of global sourcing, and relationship management, which are all cited as critical success factors of global sourcing.

Based on optimal control theory, Mallick & Mukhopadhyay [22] propose that different goals of corporations lead to different requirements on supply chain design patterns, and the determinants of “global versus local” design include: product variety, product life cycle, and sales response to design decisions.

When focusing on relationship management, Samli, Browning & Busbia [37] provide a good reference for examining the relationship between global sourcing and corporate strategies. In this study, the authors not only validate the correlation between the intensity of international sourcing and a “strategic versus opportunistic” dichotomy, but also suggest that global sourcing should be regarded as a strategic tool rather than a goal of a strategy. Sheth & Sharma [38] hold similar opinions, which suggests that global sourcing is expected to be a strategic advantage and a key driver. Moreover, Bozarth et.al. [5] explore the relationships between sourcing decisions, sourcing strategies, and prior supplier performance. They conclude that global sourcing in early stages will tend to adopt the strategies of multiple sourcing and formal contractual relationships, while those in more mature stages of global sourcing will tend to focus on partnership or supplier relationship.

Overall, in contrast to the prediction by transaction cost analysis, studies that highlight the importance of strategic issues on global sourcing postulate that the adoption of intensive strategic alliance-based global sourcing for components will be the key for success, which is in line with Murray’s [29] propositions.

³/₄ Structural issues

In order to find the optimal structure for the global sourcing organization, two dimensions are highlighted [1]: the level of internationalization, and the level of centralization. Arnold suggests that the global sourcing organization model should take three types of fit into

consideration: intra-strategy fit, intra-structure fit, and structure-strategy fit. Further, when determining the degree or level of internationalization and centralization, both should be measured by company-layer and procurement-layer. By analyzing nine cases, three ideal types for the global sourcing organization were identified: central purchasing model, coordination model, and outsourcing model.

When flexibility is taken into consideration, Kouvelis [17] concludes that either having a flexible contract or adding more suppliers to the global sourcing structure will help solve the fluctuating exchange rate problems, at least in the short run.

In addition to the traditional structural change of global sourcing, a new business unit named international procurement office (IPO) is introduced [12], providing more autonomy and flexibility for companies, and regarded as another way of structural change or adjustment for the fit of global sourcing.

Kotabe, Murray and their colleagues did a series of research on the theme of global sourcing. From these studies, global sourcing activities can be categorized into eight types, based on three dichotomy dimensions: inter-firm (outsourcing) versus intra-firm, domestic versus foreign (abroad), and component versus assembly. This classification framework indeed helps to highlight the possible alternative structures of global sourced oriented companies, and then further identifies the interactions between structure and global sourcing behaviors [30] [31] [28].

Finally, Petersen, Frayer & Scamell [35] suggest, based on empirical study, that sourcing structure and processes, and sourcing capacity, are regarded as the keys for achieving effective global sourcing.

³/₄ Cultural issues

Culture plays an important role in explaining why organizations react and operate differently. The most well-known examples in the field of global sourcing are those comparing US firms and Japanese firms, such as [16] [11]. Furthermore, more and more studies argue the generalizability of the findings made by the US-based survey, because of the consideration of culture difference [12] [36].

When extending the global activities of a SC upstream and downstream, Ettlie & Sethuraman [11] found that culture will result in different patterns of global sourcing. For instance, Japanese corporations tend to more adopt a local supply source.

Hult [14] focuses on the sustainable competitive advantages of global sourcing. Hult finds that culture factors indeed affect the long term success of global sourcing for US companies. However, surprisingly, these cultural factors do not necessary impact performance independently.

Kotabe [16] compares the patterns of US companies and Japanese companies. Kotabe concludes that US companies, relatively speaking, stress cost efficiency (while compromised in the long run), while Japanese companies emphasize non-cost factors or effectiveness

(which will be improved in the long term). This study also implies how different cultures affect the outcome of global sourcing.

Rexha & Miyamoto [36] examine global sourcing issues on Australian subsidiaries of multinational corporations (MNCs), and conclude that intra-firm trade will play a different level of importance among different countries and areas. Besides, the drivers of global sourcing also differ from place to place.

$\frac{3}{4}$ Evolution and classification issues

Undoubtedly, the purposes and strategies of global sourcing evolve with time. Thus, not surprisingly, many frameworks for either vertical (evolution) or horizontal (classification) classifications of global sourcing are proposed in literature.

On the one hand, with regard to the evolution progress, Monczka & Trent [25] [26] [27] may have provided the most complete typology of global sourcing to date. According to Monczka & Trent, there are four phases in the evolution of global sourcing: domestic purchasing only (phase 1), foreign buying based on need (phase 2), foreign buying as part of a procurement strategy (phase 3), and integration of a global procurement strategy (phase 4) [5] [36] [35].

On the other hand, from the perspective on classification, Li, Murray & Scott [20] provide an interesting framework. Generally speaking, they divide the country-of-origin (COO) into three sub-categories: COO of design (e.g., designed in Japan), COO of assembly (e.g., assembled in Mexico), and COO of corporation (e.g., IBM known as a US firm). Besides, from the perspective on sourcing targets, Murray [28] proposes that firms make sourcing decisions on two phases: production-component sourcing and assembly sourcing, combining the concerns of “domestic versus foreign sourcing (i.e., location aspect)” and “internal versus external sourcing (ownership aspect).”

2.2 Electronic Business

2.2.1 Definitions and formats of electronic business

The Internet has become increasingly important to organizations for certain aspects of electronic business (EB) [4]. It helps to redefine how back-end operations are conducted, and in the process alters the roles and relationships of various parties. Hence, it is believed to have an even more profound impact on B2B interactions. Various terms, such as e-catalog, e-procurement, and B2B EC, that are relevant to EB, are all cited as enablers to efficient business operations. Even though different definitions abound in the literature, this study takes on Lee & Whang's [18] definition of EB, “the planning and execution of the front-end and back-end operations in the supply chain using the Internet.”

2.2.2 Perspectives on examining the effects of electronic business on SCM

The transition or evolution of buyer-seller relationships, in general, is from open market negotiation, through

cooperation and coordination, to collaboration [40]. This trend can be approached from three perspectives (i.e., from transaction-oriented, through information flow-based, to relationship-focused), when mapping global sourcing evolution. In the following, literature relevant to EB on SCM is reviewed and categorized into one of these three perspectives.

$\frac{3}{4}$ Transaction-cost-based perspective

In general, with regard to citing the benefits of applying IT into business, cost and efficiency are always regarded as key benefits and drivers. It is no exception for EB-based applications. For instance, Baron et.al. [3] propose that the major benefits of e-catalogs for both suppliers and retailers include drastically reduced production costs, expanded markets, and reduced processing costs.

In addition to the concern of the key components of eMarket hypotheses (i.e., search cost and coordination cost) [23]; Barua, Ravindran & Whinston [4] suggest the framework to be extended by an evaluation cost when deploying supplier-selection strategies and global sourcing activities. They develop an analytical model that allows a buyer to maximize the payoff from the selection process. In this model, three related but identical dimensions are stressed: medium of transaction (manual versus electronic), product type (standard versus unique), and types of costs (search, communication and evaluation), where costs are taken as a function of the nature of the product and the type of medium.

Essig & Arnold [10] enrich the economic impact of the eMarketplace from a theoretical perspective. Based on information economics theory, an analytical model with 6 steps is proposed. Step 1 analyzes the consequences of improved information and communication technology on a macro level. Step 2 takes a closer look at the transaction frame as a combination of macro- and micro-analysis. Step 3 and 4 take a closer look at the consequence for various purchasing situations and transactions based on information economics and transaction analysis. Step 5 provides general recommendations for their applications based on its e-procurement matrix, which is a combination analysis of information qualities and transaction analysis. Finally, Step 6 shows the consequences for e-marketplaces in bringing together suppliers and customers.

Markus [24] argues whether the phenomenon of EB activities can be fully explained by economic-centered theories. By taking a phenomenon-based approach, Markus investigates four famous and successful e-marketplaces (i.e., Global Sources, PartMiner, Converge, and Ecnnet), which represent those with different natures, founder background and major objectives. Markus finds various behavior patterns and operating philosophies, and concludes: (1) successful e-marketplaces do very different things; (2) they are highly dynamic in form and function; (3) they do not all increase price transparency; (4) there is no simple relationship between ownership/seller power; and (5) e-marketplaces have different IT implementations of the same functionality. In

other words, it is obvious that economic-based theories cannot fully explain the phenomenon of eMarketplaces in the real world, which is in line with [8].

$\frac{3}{4}$ Information-flow-based perspective

With regard to the impacts of EB on SC integration from an information-flow-based perspective, there are at least three issues or benefits being mentioned in the literature: negotiation mechanism, coordinated workflow, and information integration.

Negotiation and collaboration often work together to find appropriate supplying companies or solutions for supplier replacement processes. Besides, a backup mechanism can also be implemented by these activities. Ito & Salleh [15], hence, employ the idea of the open tender concept with intelligent agents and a blackboard-based negotiation mechanism to develop a collaborative SC system. It is then applied in a parts/material supply system in Japan in an effort to find alternative suppliers when origin suppliers have problems in time delivery.

Lee & Whang [18] regard coordinated workflow as one of the critical dimensions of SC integration. They suggest that workflow coordination helps to deal with three tasks: efficient procurement and automated services, facilitating order processing and financial flows, and procurement coordination (by supplier selection, order quote generation, and the integration of purchasing decisions).

Moreover, information integration, considered the foundation of SC integration, is also important in this regard. One common approach is the use of Internet information hubs. It is a node in the data network where multiple organizations interact in pursuit of SC integration. Besides, it has the capabilities of data storage, information processing, and push/pull publishing, which can be analogized to what “cross-docking” accomplishes in the physical logistics world [18].

$\frac{3}{4}$ Relationship-based perspective

Recently, relationship management and strategic issues are cited as key for those companies that want to implement EB applications successfully. This is because the implementation of EB in the SC is not only the realization of a technology change, but also a process of organizational change. More specifically, different implementation phases reflect different levels of complexity in terms of technical implementation, process changes and trading partner relationships [33].

Nguyen & Harrison [33] explore the roles of EB in maintaining different types of supplier-buyer relationships. They propose a two-dimensional framework that can be used in assessing the relationship of SC to EB: the means of communication (different types of electronic business applications) and the type of information being exchanged (operational or strategic approach). Besides, this framework also suggests three possible alternatives for developing and maintaining supplier/buyer relationships when integrating EB into business processes: step-by-step formulation, quick build up, and adaptation.

Dai & Kauffman [8] argue that, in addition to cost reduction, other benefits such as maintaining established long-term relationships with preferred suppliers should be highlighted as well. These mechanisms are taken as the reasons for the existence of private hub and public market mechanisms. In other words, private aggregating and negotiating mechanisms are being adopted for large quantity business supply purchases, while public market mechanisms are more often adopted when firms face uncertain and high variance demand.

Besides, previous research reports that buyers prefer to transact with just a handful of suppliers (rather than having a larger supplier base) so that suppliers have incentives to make specific investments in systems that enable and support buyer-supplier coordination [2]. Dai & Kauffman [8] conclude that private aggregating and matching networks are not predicted by the theory of electronic markets, which again highlights the importance of relationship management. Besides, online B2B markets are also found to be a driver in promoting expertise sharing and collaboration among multiple players.

Lee & Whang [18] propose that, due to the establishment of new buyer-seller relationships, new business models will emerge in the context of SC integration. The first model comprises “virtual resources,” which can be pooled to create a secondary market of virtual resources. Secondly, SC will restructure for gaining efficiencies, especially in the substitution and separation of information flows, financial flows, and physical flows.

2.2.3 Future trends of electronic business with regard to SCM

With the spread of digitalization, one could argue that EB has taken on many of the characteristics of financial trading: from simple to complex transactions, from middlemen to speculators, from transactions to solutions, and from buyer-seller exchange transactions to seller side asset swaps.

Deloitte Consulting, and Deloitte & Touche [9] propose six possible trends of B2B: (1) the formation of X2X networks, which will help to seek new business models to leverage core competencies; (2) the proliferation of niche exchanges; (3) the development of industry-wide standards; (4) the rise of private vertical hub and co-investment with existing partners; (5) companies take a portfolio approach to effectively leverage value chain capabilities by utilizing the means mentioned above; and (6) re-optimization of Internet processes to leverage the new environment and its dynamics.

2.3 Strategic Alignment

A well-known framework for analyzing the impacts of IT on organizations and business networks is the strategic alignment model [13]. In this model, the authors distinguish between the business domain (business strategy and business architecture) and the technology domain (information strategy and IT architecture) in an

organization. The two domains can influence each other in two ways. They distinguish two main perspectives on how the alignment between the domains can take place. In the first perspective (alignment) the business strategy is the driving force for business architecture or information strategy, ultimately affecting the IT architecture. In the second perspective (impact) the IT strategy is the driving force for IT architecture or business strategy, ultimately affecting business architecture. Furthermore, when analyzing the enabler or the inhibitors to alignment, Henderson & Venkatraman [13] proposed four strategic perspectives, namely strategic execution, technology potential, competitive potential, and service level.

3. Framework for E-Business and Global Sourcing

The study aims at summarizing the relationships between EB and global sourcing, as well as the (potential) benefits that EB might contribute to global sourcing. The relationships between EB and global sourcing are analyzed from two angles, namely from a theoretical basis (i.e., what theories are applied), and covered business scope; based on an extensive literature review. Benefits that EB can contribute to global sourcing will be discussed at two levels: SC components and alignment. Finally, a framework providing insights in global sourcing and EB is developed.

3.1 Analysis on the Relationship between EB and global sourcing

3.1.1 Theoretical aspect

From the perspective of the theoretical foundations of EB and global sourcing, both fields take economic oriented theories as their foundation. Amongst these theories, cost driven issues are cited most often, particularly when emphasizing the development stage. As a result of significant differences between the nature and implied assumptions of EB and global sourcing, not all economic theories are equally applied in both fields. In other words, studies of EB rely less on economic disciplines in comparison to global sourcing. For instance, the core theory in EB is the e-market hypothesis [23], which is derived from transaction cost theory. On the contrary, global sourcing applies more economic theories. Generally speaking, the major differences lie in the assumption of the world-view. EB assumes that the whole business is positioned within a theoretical (or virtual and perfect) world, which implies that there is no significant difference between global reach and local reach. Consequently, some practical issues such as transfer price, tax and exchange rate fluctuation are not considered in most EB applications. On the contrary, global sourcing, which is an extension of regional operations aiming for efficient operations across the world, stresses the practical concerns that are relevant to sourcing structure, locations, and stability; hence, it

regards such financial topics as practical means for improvement.

3.1.2 Applied aspect

The breadth of covered business scope, generally speaking, can be measured on two dimensions: vertical (i.e., the number of functions), and horizontal (i.e., the variety of the support of sourcing business with various focuses and locations).

On one hand, with respect to the vertical dimension, global sourcing creates close linkage with overall operations via adopting new strategies or changing the physical settings; whereas EB deploys a new infrastructure for integrating all relevant tasks without changing the existing structure. In other words, due to the mechanisms offered, EB enables the possibility of integrating or bundling the forward and downward activities of global sourcing more tightly (such as supplier selection, performance evaluation, and contracting), which in turn, streamline the overall global sourcing operations without requiring much extra effort.

On the other hand, for the horizontal dimension, according to the evolution stages of buyer-seller relationships of global sourcing [37], and that of EB [40], both take similar transformation patterns. Because various EB applications weigh players, founders and concerns (such as public versus private) differently, they can satisfy different requirements of global sourcing in different stages. For instance, the public hub offers the mechanism for cost efficient operations such as lowering switching cost, coordination cost, and ordering cost; while the private hub helps to strengthen the relationship by information sharing and coordination.

3.1.3 Flow perspectives

When talking about the roles of flows (i.e., information flow, physical flow, and financial flow), global sourcing and EB have different focuses. Global sourcing focuses more on financial flows and physical flows, and bundles all the flows tightly with the existing structure. On the contrary, EB stresses mainly information flows, and assumes that there is no further need to change organization structures or to be concerned about physical flows. Hence, different investment strategies and integration paradigms arise. More specifically, EB tends to synchronize flows and structure by investing in information infrastructures, while global sourcing prefers to invest in physical / business infrastructures so as to streamline all flows and structures.

3.1.4 In Summary

The evolution stages and reference theories of global sourcing are similar to that of EB. Global sourcing is a kind of strategy for improving the performance, while EB is a type of application or mechanism for satisfying new requirements. As a consequence, EB can be regarded as a means for solving the requirements of global

sourcing.

Moreover, the literature suggests a contingency perspective due to the variety of contexts in global sourcing [29]. This argument is consistent with what is observed from the linkage between EB and global sourcing, which might imply that lots of opportunities exist for utilizing the EB mechanisms for supporting various types of global sourcing in different contexts.

3.2 How does EB benefit global sourcing?

In this section, benefits of EB to global sourcing are discussed at two levels: Supply Chain components and alignment issues.

3.2.1 Supply Chain components

Structure, control, and optimization are regarded as three main components of a SC [6] [7], all within the context of globalization. These four components are elaborated on below.

$\frac{3}{4}$ Structural aspect

When analyzing the effects of global sourcing structure, EB helps to deal with at least six issues: (a) extend the possible set of global supplier base (i.e., extending to those suppliers are in foreign countries with external format); (b) substitute physical IPOs by virtual EB applications; (c) create complete competition markets and eliminate the effects of (supplier) switching costs; (d) separate but ensure the synchronization of the flows and the structure (which will result in better management policies and higher flexibility of structure adjustment); (e) offer the possibility of global reach by using public hubs; and (f) transform partnerships by using the private hubs and replace the means of conventional vertical and horizontal integration.

$\frac{3}{4}$ Control aspect

By integrating the functions of information hubs, agent-based coordination mechanisms, and blackboard-based negotiation systems, real time monitoring and collaboration will help to speed up response to those situations in emergency (e.g., an order cannot be delivered on time or on schedule). In short, a backup mechanism of global sourcing (especially for standardized materials) is thus established.

Meanwhile, in regard to non-standardized parts, EB applications are also helpful in transforming some non-standardized parts (i.e., e-hierarchical oriented products) into standardized types (i.e., e-market based products). It implies that not only intensive knowledge sharing and information exchange will be established, but EB also assists in examining the quality of suppliers and keeping those with good quality as long-term partners.

From a market perspective, a public hub is also beneficial for competitors to source collectively and globally (i.e., achieving the goal of “co-competition” for non-core parts). Besides, reverse auction can be efficiently executed for those parts with excess sourcing

[24]. Hence, under existing control mechanisms and bargaining power structure, buyers might have more choices and means to face the sourcing issues, with the help of EB applications.

Finally, with regard to financial control, EB is able to help real time decisions such as negotiation for the appropriate transfer price and identification of the formulation and formalization of a sourcing contract. However, unfortunately, EB cannot contribute much in this area up till now; but it is expected to provide better solutions or mechanisms (such as real time clearance and flexible contracting) in the near future by creating new EB business models and functions.

To sum up, because of information sharing and coordination mechanisms, global sourcing becomes more easy to control, and in turn, raises the possibility of stronger partner relationships.

$\frac{3}{4}$ Optimization aspect

The optimization aspect reflects how global sourcing is optimally designed for, hence EB cannot directly enhance the outcome or operations.

$\frac{3}{4}$ Micro-environment aspect

It is believed that if EB is taken in the context of global sourcing, it will evoke the changes of the existing corporate culture, (the speed of) product maturity and popularity, SC maturity, and the stages of global sourcing. It might even result in the transformation of existing corporate paradigms, and the next wave of revolutions in global sourcing and SC operations.

3.2.2 Alignment aspect

Conceptually, if global sourcing is regarded as a managerial / strategic issue, with proper business architecture and strategy, whereas EB is regarded as an IT issue, with proper IT architecture and strategy as well, different alignment strategies can be taken. In general, when integrating EB and global sourcing, two alignment strategies can be found: “strategic execution” and “technology potential”. The most significant examples include the stories of eMarketplaces such as PartMiner, Converge, and Cnet [24].

To sum up, due to the features of EB and its variety of functionalities, it may propel global sourcing towards improved performance. However, as mentioned earlier, EB cannot ensure the stability of physical flows and financial flows for global sourcing, unless potential partners are involved in this system.

3.3 An insight in EB and global sourcing: A proposed framework

In this section, two research questions will be addressed:

$\frac{3}{4}$ “what are the relationships between global sourcing and EB?”

$\frac{3}{4}$ “how do EB applications and strategies help global sourcing lead to better performance?”

“What are the relationships between global sourcing and EB?”

can be answered from three aspects. In the first place, from the theoretical perspective, both EB and global sourcing are mainly based on economic-oriented theories, and include the concerns of strategic relationship management. In terms of business scope, EB helps to speed up the evolution of global sourcing stages. Beyond that, integrating and extending relevant activities into global sourcing (such as supplier selection and evaluation, and afterwards reverse sourcing) can be achieved without huge investment. Moreover, with regard to the flows, because EB and global sourcing have different focuses (i.e., information flows versus physical flows plus organizational structures), integrating both fields might lead to better control and coordination for all flows (but still having limited benefits on financial flows).

“How do EB applications and strategies help global sourcing lead to better performance?” can be explained as follows. Firstly, EB helps to enrich SC components in structure elements (such as more players and more alternatives for location expansion) and control mechanisms (such as sense response more quickly, and more tightly monitoring and communications). Meanwhile, the micro-environment will also be influenced either directly or indirectly by the adoption of EB. Secondly, from the alignment perspective, with the help of EB, global sourcing has the potential for evoking alignment strategies such as “strategic execution” and “technology potential,” and thus creating better outcomes (such as better performance, improved partnership, and new business models).

As such, a framework is proposed to illustrate how EB and global sourcing interact, and is illustrated in Figure 1.

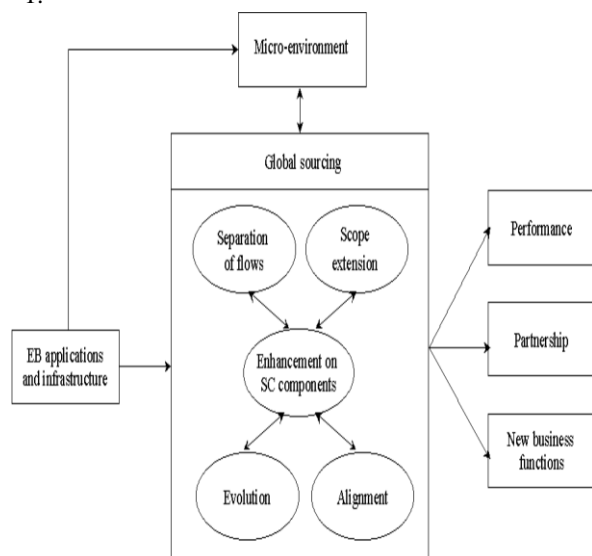


Figure 1 : A proposed framework of how EB and global sourcing interact

4. Conclusions

Global sourcing can benefit from the functionality of electronic business (EB) by exhibiting more flexible structures and added opportunities in communications and transactions with partners among worldwide supply chains/networks. This study aims to answer two research questions, “what are the relationships between global sourcing and EB?” and “how do EB applications and strategies help global sourcing lead to better performance?”

Our literature review addresses the relationships between global sourcing and EB from three perspectives: the applied theories, the covered business scope, and the changing roles of flows. In analyzing the potential benefits of EB to global sourcing, the enhancement on SC components (i.e., structure, control, and optimization), and alignment effects are discussed. Finally, a framework is proposed to highlight how EB and global sourcing interact with each other, resulting in five major issues: the enhancement of SC components, the changing micro-environment, the effect of accelerating evolution of global sourcing, the integration of activities, and the significant improvement on outcomes (i.e., better performance, improved partnership, and new business models). This framework sets the stage for future empirical validation in creating an operational framework and roadmap for improved global sourcing.

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An Empirical Examination of the Use of Mobile Technology – A Social Pressure Perspective

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Abstract

Mobile technology has been predicted to create new challenges and competitions to organizations. To business decision makers, the understanding of mobile technology would then become critical in helping organizations to better manage relevant technological issues. The theoretical analysis and empirical examination of mobile phenomenon, however, remain scarce. In addition, conventional wisdom tends to emphasize the economic aspect of information technology. Such emphasis, nonetheless, lacks the explanatory power to understand social factors of the use of technologies. Social aspects of technologies could significantly influence the success of adoption. Derived from institutional theory, which emphasizes the influence of social pressures on collective members' isomorphic behavior, the paper proposes how three different social pressures—coercive, mimetic, and normative pressures would positively influence a group member's use of mobile technology. Our findings suggest that the influence of social pressures on the use of mobile technology might be contingent upon the types of technologies. While normative pressure is positively related to the use of cellular phones, coercive and mimetic pressures are significant to the use of laptops. Business decision makers might thus employ various strategies to create certain social pressure and in turn promote the use of corresponding mobile technologies.

1. Introduction

The need of studying mobile technology appears to be increasingly critical as its exponential development would be likely to present tremendous challenges and opportunities to individuals and organizations. As amazon.com CEO Jeff Bezos once asserted, "If you look five to ten years out, almost all of e-commerce will be on mobile devices" [19, p.74]. In line with his view, practitioners have predicted that the transaction of mobile hardware is expected to exceed 3.9 billion by 2006 [2]. In addition, the US market would have 171.1 million mobile Internet users by 2005 with 111 million consumers accessing mobile Web on a monthly basis [5]. Cell phones, for example, would become a 'retail outlet' in a customer's packet [9] [18] and would be the second highest potential advertising medium next to television [26]. More importantly, mobile technology would significantly change firms' business model [19] and

information technology (IT) strategy [7] [13] [15] [25].

However, the current understanding of mobile technology remains mostly at the conceptual level [e.g., 8, 20, 21, 23, 24]. Empirical studies that help to understand and manage mobile phenomenon appear inadequate. With rapid changes and competitions in the business world, such insufficient understanding of the mobile phenomenon might cause organizational and managerial inability to respond to, let alone to manage its technological impacts. It is thus critical to be more actively examining the mobile phenomena. In addition, traditional IT literature tends to investigate emerging technologies through the economic perspective [17]. While this perspective such as transaction cost economics helps explain the cost efficiency of technological adoption, it lacks the power to disclose social factors that drive IT usage behavior. Guided by institutional theory, the paper thus seeks to shed light on how social factors promote the use of mobile technologies. Specifically, we investigate the relationship between social pressures and the usage behavior of two mobile technologies—cell phone and laptop. The findings could help us better understand the rationale of IT usage behavior and further provide insights to business decision makers on the importance of considering social factors when marketing and managing mobile technologies.

2. Social Pressures and Mobile Technology

Institutional theorists argue that the rationale behind an actor's action is, not to increase cost benefits or efficiency, but to gain legitimacy [11]. To survive in a collective field, actors have to first obtain social recognition. Such social recognition could be gained through acting to accommodate collective expectations, regardless of efficiency or cost benefits [16]. In modern society, organizations often adopt similar structures because of the isomorphic pressures they face [12]. Hiring a Nobel Prize winner in a university, for example, does not justify the immediate cost effectiveness; investing in an expensive yet inefficient technology, similarly, might cause financial loss. Organizations, however, could tend to undertake such actions because they perceive the need to gain social recognition or legitimacy. Such a need is normally resulting from the fear to be different or to be left behind [1].

Abrahamson [1] argues that in the context of adoption of innovation, actors often imitate a fashion setter or an

“opinion leader” [14] because fashion setters possess certain power to inspire others to “trust their choices of technologies and to imitate them.” [p.596]. Consequently, actors would imitate other actors’ choice of an innovation “when it obtains from these adopters’ knowledge that reduces ambiguity about the innovation” [1, p.597]. In so doing, the actor would appear more legitimate as it confirms to “emergent norms that sanction these innovations” [1, p.597]. Such an action sometimes is derived from “bandwagon pressures”—“pressures to adopt an innovation that increase according to the number of other organizations that have already adopted it” [1, p. 597].

The pressures that drive an actor to imitate or follow other actors have been well articulated by DiMaggio and Powell [4]. They explain that actors would often move toward the same direction as others because of coercive, mimetic and normative pressures. Coercive pressure is a strong force implying an action that actors must undertake. Failing to undertake such an action could result in fatal failures. At the organizational level, such urgency is often created by governmental regulation, industrial standard [10] or the dominance of powerful organization [22]. At the individual or group level, coercive pressure emerges when individual actors fear to be left behind [1] or being excluded from a social group. In the context of individual use of mobile technology, it is likely that individual actors would sense the need to use mobile technology to ensure that they could compete with their peers and/or be embraced by a social group. As such, we hypothesize:

H1: Coercive pressures will positively correlate with the use of mobile technology

Mimetic pressure, on the other hand, is mainly derived from environmental and technological uncertainty. While facing such uncertainty, actors tend to model themselves after those who have been well established and recognized as a legitimate player in the group [4]. In line with this view, Rogers [14] indicates that opinion leaders often influence later adopters who possess less knowledge or information about an innovation. Abrahamson [1] further suggests that while facing uncertainty, actors often fear to be different. Therefore, they would simply follow the fashion setters or group leaders when adopting an innovation. Considering the emerging nature of mobile technology, individual actors would inevitably face the technological uncertainty. As such, mimetic pressure would emerge and drive individuals to model themselves after those who have regularly used mobile technology. In the context of college education where students often engage in social groups, it is very likely that their use of mobile technology would be influenced by opinion leaders in the group. As such, we hypothesize:

H2: Mimetic pressures will positively correlate with the use of mobile technology

Finally, normative pressure is associated with

professionalization—the process through which actors respond to the pressures that are caused by the exchange of information in a group [4]. The professionalization reveals the information regarding each individual’s action and in turn creates an inevitable comparison among group members. Such a comparison would create certain normative pressure to encourage individual actors to remain competitive by demonstrating similar capabilities as others’. In the context of mobile technology, an actor would then tend to adopt a mobile technology due to normative pressures generated through professionalization among group members. As such, we hypothesize:

H3: Normative pressures will positively correlate with the use of mobile technology

3. Methodology

A survey questionnaire was used for data collection and exploratory factor analysis and multiple regression analysis were used for data analysis. Multiple regression analysis suited our research purpose because it was appropriate for prediction and explanation with a single dependent variable and multiple independent variables [6]. The data was collected from six technology-related classes in the College of Technology at an urban university. Among 250 questionnaires distributed, a total number of 129 useful questionnaire responses were used for the analysis. The dependent variable, ‘the use of mobile technology’, was measured by ‘the frequency of usage’, which was the most widely used measure in the IT literature [3]. Specifically, students were asked to rate their frequency of usage from “do not use at all” to ‘use it several times a day’.

3.1 Factor analysis

To ensure construct validity, the initial 18 items of social pressures were selected through a two-step process suggested by Davis [3]. First, the items were derived from conceptual definitions of DiMaggio and Powell [4], and second, the items developed were then consulted with seven colleagues. Factor analysis with varimax rotation extracted four principle components whose eigenvalues were above 1.00. The scree test further confirmed the appropriateness of this extraction. A factor loading value of .50 was chosen as the criterion for selecting significant items [6]. The scale reliability with the item-total statistics helps finalize three remaining factors, which correspond to coercive, normative and mimetic pressures, respectively (see Table 1).

4. Results

While Table 2 and Table 3 demonstrate the descriptive statistics, Table 4 and Table 5 illustrate the three-step hierarchical regression analysis for the frequency of use of cell phones and laptops, respectively. The results indicate that only normative pressure is

significant at the level of 0.10 for the use of cell phones (Table 4) and that only coercive and mimetic pressures demonstrate significant relationships with the frequency of laptop usage (Table 5). As such, for the use of cell phones, only hypothesis 3 is supported while for the use of laptops, only hypothesis 1 and hypothesis 2 are supported.

Table 1: Results of factor analysis of social pressures

Variables	Factor Loadings After Varimax Rotation		
	Coercive Pressures	Normative Pressures	Mimetic Pressures
CP1	0.84	0.00	0.16
CP2	0.76	0.33	0.00
CP3	0.74	0.33	0.18
CP4	0.72	0.42	0.18
CP5	0.69	0.34	0.25
CP6	0.62	0.33	0.43
CP7	0.61	0.27	0.42
NP1	0.23	0.88	0.13
NP2	0.28	0.87	0.20
NP3	0.30	0.87	0.24
NP4	0.34	0.81	0.28
MP1	0.21	0.21	0.88
MP2	0.20	0.22	0.89
Eigenvalues	7.4	1.4	1.2
% of Variance	57.0	10.5	9.3
Cumulative % of Variance	57.0	67.5	76.8
Internal Consistency	0.91	0.95	0.89

5. Discussion and conclusion

Hypotheses argue that social pressures in general and coercive, normative and mimetic pressures in particular would influence the use of mobile technology. The findings indicate that the influences of these pressures on the use of mobile technology might be contingent upon the types of mobile technologies. While normative pressures are significant to the use of cell phone, coercive and mimetic pressures provide better explanation for the use of laptop. One reasonable explanation for the difference is the fact that cell phone is widely adopted among college students. The device itself is relatively less expensive compared to a laptop. Furthermore, since its features and functions are constantly evolving¹, users are more likely to perceive cell phones as fashionable devices. Normative pressures that mainly concerned the social fashion resulting from information exchanged among social groups, thus, would be more likely to influence students' use of cell phones.

¹ For example, many manufactures recently launched new types of cell phone that allow not just the Internet connection but also the function of a digital camera.

Laptops, in contrast, are not as popular as cell phones among college students². Unlike cell phones, which could be shown in front of group members almost all the time, the laptop is not as portable and its functions and features do not change as frequently. As such, the influence of fashion and social norms (normative pressures) could then be less significant. Furthermore, the laptop is substantially more costly than the cell phone. Users might then perceive it to be more work oriented with higher risk involved. They might adopt the laptop only when necessary. Those who possess a laptop might thus be perceived as being in an elite group. Owning a laptop thus could denote certain symbolic group memberships; in other words, lacking a laptop means the possibility of being excluded by such a group. Coercive pressures, thus, could emerge to promote the use of a laptop for obtaining social recognition in such an elite group. Finally, since the laptop's features are more static, its usage might be based more on individual needs than on social fashion. If someone perceives a high degree of mimetic pressures in the use of laptops, they might be less knowledgeable about the technology in general. Less knowledgeable people would then tend to consider there to be less need for using a laptop because it is more costly with higher risk. The lower the needs for using a laptop, the less likely they will be to adopt it. This might help explain the negative relationship between mimetic pressures and the use of laptops.

The findings suggest the practical relevance of stimulating different types of social pressures when designing and marketing various mobile technologies. For low cost, highly portable devices (e.g., cell phones), a marketing strategy that aims for the influence of social fashion might be more effective. In contrast, for task oriented, high cost equipments (e.g., laptops), a strategy that focuses on easing technological uncertainty and creating an elite image might be more practical.

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² As shown in Table 2 and Table 3, the sample size for each of mobile technology decreases from 408 for cell phones to 335 for laptops.

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Table 2: Descriptive statistics for cell phone usage

Variable	Means	s.d.	1	2	3	4
1. Frequency of cell phone usage	5.34	1.31				
2. Purpose of cell phone usage	2.71	0.48	0.40***			
3. Coercive pressures	1.99	1.20	-0.00	0.03*		
4. Normative pressures	2.57	1.69	-0.02	-0.09	0.64***	
5. Mimetic pressures	2.41	1.42	-0.06	-0.03	0.55***	0.49***

Note. N = 408. *** p < 0.001, **p < 0.01, *p < .05. †p < 0.10.

Table 3: Descriptive statistics for laptop usage

Variable	Means	s.d.	1	2	3	4
1. Frequency of laptop usage	3.77	2.04				
2. Purpose of laptop usage	2.35	0.83	0.26***			
3. Coercive pressures	1.77	1.29	0.08†	0.08†		
4. Normative pressures	2.66	1.60	0.08†	0.12*	0.72***	
5. Mimetic pressures	2.03	1.41	-0.04	0.04	0.73***	0.63***

Note. N = 335. *** p < 0.001, **p < 0.01, *p < .05. †p < 0.10.

Table 4: Results of hierarchical regression analysis for frequency of cell phone usage

Variable	Step 1	Step 2	Step 3
Step 1			
School year	0.08	0.16**	0.19***
Marital status	-0.15**	-0.07	-0.04
With/without children	0.07	0.07	0.04
Number of teenage children	-0.22*	-0.24**	-0.24**
Region of nationality	0.10†	0.00	0.01
Work hours	0.12*	0.07	0.05
Traveling hours	0.11*	0.13**	0.12*
Step 2			
Purpose of cell phone usage		0.41***	0.43***
Step 3			
Coercive pressures			-0.02
Normative pressures			0.12 †
Mimetic pressures			-0.09
R ²	0.09***	0.23***	0.24***
Adjusted R ²	0.07***	0.21***	0.22***
Δ R ²	0.09***	0.14***	0.01

Note. N = 408. Entries are standardized betas. † p < .1. * p < .05. ** p < .01. *** p < .001.

Table 5: Results of hierarchical regression analysis for frequency of laptop usage

Variable	Step 1	Step 2	Step 3
Step 1			
School year	0.04	0.04	0.07
Marital status	-0.06	-0.04	-0.04
With/without children	0.01	0.06	0.03
Number of teenage children	0.12	0.16†	0.17†
Region of nationality	0.15**	0.13*	0.11†
Work hours	-0.05	-0.05	-0.04
Traveling hours	0.01	0.04	-0.01
Step 2			
Purpose of laptop usage		0.30***	0.28***
Step 3			
Coercive pressures			0.19*
Normative pressures			0.03
Mimetic pressures			-0.21*
R ²	0.04†	0.12***	0.14***
Adjusted R ²	0.02†	0.10***	0.11***
Δ R ²	0.04†	0.08***	0.02†

Note. N = 335. Entries are standardized betas. † p < .1. * p < .05. ** p < .01. *** p < .001.

Investment Strategy Analysis using Support Vector Machines

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Abstract

Investment strategy is the key point of investors who can make profits or otherwise. Investors always focus on their viewpoints subjectively, which may make them fall into the logic puzzle. The purpose of this paper is to integrate the technical analysis of financial markets with an emerging neural network model, Support Vector Machine (SVM), to solve the problem of investment strategy in Taiwan Futures Market (TAIFEX). The evaluation of investment strategy is the most essential task of investment analysis. However, the evaluation is usually time-consuming and laborious for investment experts. An effective and efficient decision support tool could significantly alleviate his/her burden and improve decision quality. The experimental results from a real-case study demonstrate its salient features of generalization and usability compared with original technical analysis.

Keywords: Investment strategy, technical analysis, three-level prices analysis, support vector machines, neural networks

1. Introduction

While investors distribute their assets among various investments, factors such as individual goals, risk tolerance and horizon will be considered. That is the so-called investment strategy. A successful investment strategy improves investors' chances of profit. However, due to the lack of objectivity, investors usually need indicators to help them adjust investment strategy and determine a sensible planning. Technical analysis (TAs) [12] is one of them, which analyzes price and volume data with charts and graphs to predict future market trends. Most TAs, e.g. MACD, KD, are too complicated and sometimes uncertain, which leads to confusion of investment analyzers, so three-level prices analysis is introduced in this paper. Three-level prices analysis is the extension of candlestick charts, and inspired by Elliott's Wave Theory [6] and Fibonacci Numbers [12]. Meanwhile, neural network techniques are introduced to enhance the performance of three-level prices analysis.

Recently, support vector machines (SVM) have been shown another novel approach to improve the generalization property of neural networks [3], [4]. Since its emergence, SVM has been widely applied to many kinds of field in the past few years, such as text

categorization, handwritten digit recognition and face detection. Most of them are with the engineering and science fields. The major advantages of SVM over other neural network models are better generalization performance, smaller number of parameters setting and capability of handling higher dimension data set.

The remaining sections of this paper are organized as follows. Section 2 describes the problem nature of technical analysis. Section 3 introduces the concept of SVM in solving classification problems. Section 4 exhibits the experiments with SVMs, parameters setting. Section 5 concludes this paper.

2. Technical Analysis

It is well understood that the ultimate purpose of investment is to make profits, so the technical analysis focuses on its profitability. Depending on different approaches used in analyzing the financial trading data, different sets of factors are considered. Technical analysts keep devoting to finding out the knowledge of stock price's movement and many famous theories were appeared, like Elliott Wave Theory, Dow Theory or technical indicators.

Many past research have devoted in data mining for the stock trading strategy, but many of them lack a usefulness knowledge presentation or took they effort to increase the accuracy [15].

Therefore, the investors not only need to understand the forecast solution but also need to realize the knowledge of the decision solution. The greatest contribution of the research which devoted to increase accuracy is focus on how to keep the expert's knowledge into the system. If the case appear again in the future, the system can response the solution very quickly.

2.1. Three-Level Prices Analysis

Three-Level Prices Analysis is one of the technical analyses, which is inspired by Elliott's Wave Theory [6] and Fibonacci Numbers [12]. It consists of three basic indicators, i.e. upper price (UP), middle price (MP), and lower price (LP). Table 1 details these three indicators and other notation conventions of 3-Level Price Analysis.

Table 1. Notation conventions of 3-level prices

UP	upper price $UP(t+1) = L(t) + (H(t) - L(t)) \times 1.382$
MP	middle price $MP(t+1) = (H(t) + L(t)) / 2$
LP	lower price $LP(t+1) = H(t) - (H(t) - L(t)) \times 1.382$
O	opening price of candlestick chart
H	highest price of candlestick chart
L	lowest price of candlestick chart
C	closing price of candlestick chart

The basic definition of three-level prices analysis is shown in table 2.

Table 2. Basic definition of three-level prices analysis

Rule 1	If today's close price is higher than UP then tomorrow's price movement range will be between UP and MP. The highest price do not to predict, and the LP will not be appeared.
Rule 2	If the today's close price is between UP and MP, then tomorrow's price movement range will be between UP and MP, and the LP has low probability appear.
Rule 3	If the today's close price is between LP and MP, then tomorrow's price movement range will be between MP and LP, and the UP has low probability appear.
Rule 4	If the today's close price is lower than UP then tomorrow's price movement range will be between LP and MP. The lowest price does not be predict, and the LP will not be appeared.

Rule1 and Rule2 are generalized to be RuleA; Rule3 and Rule4 are generalized to be RuleB.

Table 3. Generalized definition of three-level prices analysis

RuleA	If today's close price is higher MP then tomorrow's close price will be higher than MP.
Rule B	If today's close price is lower MP then tomorrow's close price will be higher than MP.

3. Theory of SVM

Support Vector Machine, pioneered by Vapnik in 1995, is the state-of-the-art neural network technology based on statistical learning [17], [16]. In recent years, it has drawn over-whelming attentions from diverse research communities thanks to its outstanding performance in solving classification problems. SVMs were originally designed for binary classification, whose objective is to construct an optimal hyperplane that the margin of separation between the negative and positive data set will be maximized. However, in practice, the data set of

interest is usually linear nonseparable. In order to enhance the feasibility of linear separation, one can usually perform a non-linear transformation to the data set into a higher dimensional space, the so-called feature space. Unfortunately, the curse of dimensionality makes the non-linear mapping too difficult to solve. One of feasible approaches is the mechanism of inner-product kernel. The ideas of optimal hyperplane and the kernel-product feature space establish the fundamentals of SVM and will be discussed in the following two sub-sections.

3.1. The Optimal Hyperplane

In order to describe the SVM mechanism clearly, we simplify a general classification problem to be binary and separable. Figure 1 exhibits the basic concept of SVM. There exist uncountable decision functions, i.e. hyperplanes, which can separate the negative and positive data set well, but of which only one has the maximal margin. This indicates that the distance from the closest positive samples to a hyperplane and the distance from the closest negative samples to it will be maximized. The hyperplane with maximal margin is the optimal hyperplane, as shown in Figure 1. The data points located on the dash-lines are support vectors, which satisfy the condition with the equality sign, defined in Eq. (3).

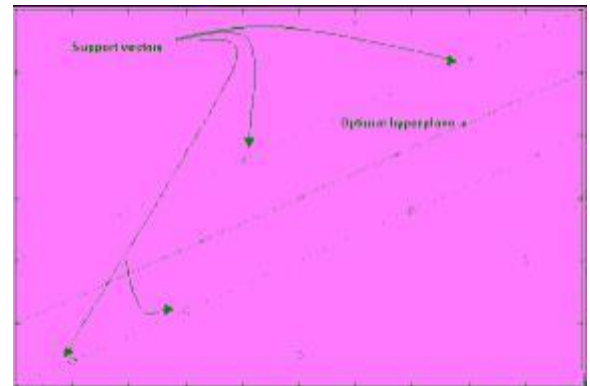


Figure 1. The basis of the support vector machines

Assuming the training data set \mathfrak{I} is in this form

$$\mathbf{x}_i \in \mathfrak{R}^n, y_i \in \{-1, 1\} \quad (1)$$

$$\mathfrak{I} = \{(\mathbf{x}_i, y_i)\}_{i=1}^n$$

There are n training examples, where \mathbf{x}_i is n -dimensional input space over \mathfrak{R} and y_i is the corresponding output. The decision boundary is defined by the following equation

$$\sum_{i=1}^n x_i w_i + b = 0, \text{ or} \quad (2)$$

$$\mathbf{x} \cdot \mathbf{w} + b = 0$$

Let \mathbf{w} and b be the weight vector and bias of the SVM, respectively. A specific pair (\mathbf{w}, b) represents the one hyperplane. The goal of training a SVM is to find a pair of (\mathbf{w}, b) with the largest margin, subject to the following constraint:

$$y_i(\mathbf{x}_i \cdot \mathbf{w} + b) \geq 1 \text{ for } i=1,2,\dots,K, \quad (3)$$

The margin of separation between two classes is $2/\|\mathbf{w}\|$ [7], therefore, the optimization problem is equivalent to minimizing the Euclidean norm of the weight vector \mathbf{w} . The constrained optimization problem, also called the primal problem [3], can be stated as follows:

$$\begin{aligned} \text{minimize } \Phi(\mathbf{w}) &= \frac{1}{2} \mathbf{w} \cdot \mathbf{w} \\ \text{subject to } y_i(\mathbf{x}_i \cdot \mathbf{w} + b) &\geq 1 \text{ } i=1,2,\dots,K, \end{aligned} \quad (4)$$

The cost function $\Phi(\mathbf{w})$ is a convex function of \mathbf{w} and the constraints are linear in \mathbf{w} . Based on the context, we exploit the characteristics of Lagrange multipliers [1] to solve the constrained optimization problem, which could be stated as:

$$\begin{aligned} \text{maximize } Q(\alpha) &= \sum_{i=1}^K \alpha_i - \frac{1}{2} \sum_{i=1}^K \sum_{j=1}^K \alpha_i \alpha_j y_i y_j \mathbf{x}_i \cdot \mathbf{x}_j \\ \text{subject to } \sum_{i=1}^K \alpha_i y_i &= 0 \text{ and } \alpha_i \geq 0, \text{ } i=1,2,\dots,K, \end{aligned} \quad (5)$$

where the aiding nonnegative variables α_i are the Lagrange multipliers, then the weight vector could be stated as

$$\mathbf{w} = \sum_{i=1}^K \alpha_i y_i \mathbf{x}_i \quad (6)$$

which only consists of the training data, as well as the objective function $Q(\alpha)$.

Nevertheless, most of classification problems are linear nonseparable, i.e. it is impossible to construct a linear hyperplane without misclassification. The so-called slack variables ξ_i are thus introduced to Eq. (3) in order to be tolerant of classification error. In this way, Eq. (3) is redefined as

$$y_i(\mathbf{x}_i \cdot \mathbf{w} + b) \geq 1 - \xi_i \text{ for } i=1,2,\dots,K, \quad (7)$$

That is, the goal of optimization becomes to find out the hyperplane with maximal margin and minimize the probability of classification error.

$$\Phi(\mathbf{w}) = \frac{1}{2} \mathbf{w} \cdot \mathbf{w} + C \sum_{i=1}^K \xi_i \quad (8)$$

where C is a user-specified parameter which controls the trade-off between complexity of the model and the number of misclassification points.

3.2. Kernel-Induced Feature Space

The introduction of the feature space is to allow the mapping of the input space onto a higher-dimensional space via a nonlinear transformation, which is capable of separating the data set easier.

$$\begin{aligned} j: \mathcal{S} &\rightarrow \mathcal{S}' \\ \mathbf{x}_i &\rightarrow j(\mathbf{x}_i) \end{aligned}$$

where \mathcal{S} is the input space, ϕ is a non-linear transformation and $\phi(\mathbf{x}_i)$ is the value of \mathbf{x}_i projected to the feature space \mathcal{S}' . Therefore, the cost function of Eq. (5) can be transferred to:

$$\sum_{i=1}^K \alpha_i - \frac{1}{2} \sum_{i=1}^K \sum_{j=1}^K \alpha_i \alpha_j y_i y_j j(\mathbf{x}_i) \cdot j(\mathbf{x}_j) \quad (9)$$

In order to separate the training data set linearly, one usually projects the input space into an higher-dimensional feature space, which results in the complexity of mapping and the curse of dimensionality. Based on this, the concept of inner-product kernel is introduced as follows.

$$K(\mathbf{x}_i, \mathbf{x}_j) = j(\mathbf{x}_i) \cdot j(\mathbf{x}_j) \quad (10)$$

Instead of calculating the exact value of $\phi(\mathbf{x}_i)$, only the inner-product of $\phi(\mathbf{x}_i)\phi(\mathbf{x}_j)$ is concerned, which is easier to implement. Referred to Eq.(2), Eq.(6) and Eq.(10), the decision boundary is redefined now in the following,

$$\begin{aligned} \sum_{i=1}^K \alpha_i y_i j(\mathbf{x}_i) \cdot j(\mathbf{x}) &= 0 \\ \Rightarrow \sum_{i=1}^K \alpha_i y_i K(\mathbf{x}_i, \mathbf{x}) &= 0 \end{aligned} \quad (11)$$

The kernel function, ϕ , can be any function which satisfies Mercer's theorem [10], where the radial-basis function is one of the most popular one:

$$K(\mathbf{x}_i, \mathbf{x}_j) = \exp\left(-\frac{\|\mathbf{x}_i - \mathbf{x}_j\|^2}{2s^2}\right) \quad (12)$$

Besides, the kernel function can be also polynomial learning networks or two-layer perceptron networks. The determination of appropriate kernel functions is usually case-dependent.

4. Experiments and Evaluation

In this section, we discuss a real case study of applying SVM to evaluating Futures trading strategy in Taiwan.

4.1. Collection of empirical data set

Our experiment data was collected from Taiwan stock exchange, the collected period was between 1991 to 2002, 12 years daily data. Each record includes the Open Price, Highest Price, Lower Price and the Close Price.

The original data is composed of daily candlestick charts; each candlestick chart consists of the opening price, closing price, highest price, and lowest price. Given the candlestick chart one day, the information of the trend next day, especially the closing price will help investors determine your investment strategy. However, the information provided by candlestick chart is limited, so three-level prices analysis is introduced here in order to enhance the consequence. The original data plus three-level prices analysis indicators are like this:

Table 4. Experimental data

Output	O	H	L	C	UP	MP	LP
1	9853	9988	9789	9862	0162	9819	9475
1	9862	9939	9752	9927	0064	9888	9713
0	9927	10053	9879	9964	0011	9846	9581
M				M			

Because of the nature of SVMs, we try to turn the prediction issue into a simple binary classification problem. The output y of each row is determined by the following equation:

$$y(t) = \text{sgn}(C(t+1) - MP(t+1))$$

$$\text{sgn}(x) = \begin{cases} 1 & \text{if } x \geq 0 \\ 0 & \text{otherwise} \end{cases} \quad (13)$$

Output value of 1 means the closing price next day will be higher than the MP generated by current data, and value of 0 means the closing price will be lower. The main purpose of the classification problem is that given a pattern composed of O, H, L, C, UP, MP, and LP, the classifier would determine its corresponding output.

4.2. SVM Simulations

The experiments are conducted by implementing a SVM simulator using OSU SVM Classifier Matlab Toolbox [5] built upon LIBSVM [8], which is capable of selecting parameters of model automatically based on the cross validation accuracy, implements the fast training SMO algorithm [14], and provides a cache memory management mechanism to enhance the operation of the algorithm. The simulation environment is Solaris 7 on SUN Ultra80 with 1GB memory. The Radial-basis function, referred to Eq. (12), is used as the kernel function in order to solve the non-linear classification effectively and the one-against-one algorithm is used to deal with the multi-classification problem, which has been proved to achieve better performance [8], [18].

In order to reduce the bias of simulation, the 5-fold cross validation is conducted. That is the raw data set is randomly permute into five folds; of which fold is used as the validation set and the rest is as the training set. The overall generalization is the averaged generalization on the evaluation set over five runs. The parameter C is determined empirically, which obtains the best performance in generalization. Besides, in order to prove the outstanding performance of SVMs, the experiment is also implemented by radial basis function networks [9]. Radial basis function networks (RBFNs), introduced by Broomhead and Lowe [2], also known as networks with locally-tuned overlapping receptive fields [11], have attracted interest for engineering applications due to their advantages over traditional multiplayer perceptrons in the past decades. Table 4 illustrates the comparison of SVMs with RBFNs and original three-level prices analysis. It is shown that SVM outperforms RBFN.

Table 5. The comparison of SVM and RBFN

	Generalization accuracy	Setting
SVM	67.1836 %	$C = 100, \sigma = 0.001$
RBFN	63.96 %	
3level prices	62.5%	

Table 5 details the accuracy by confusion matrix. The accuracy of targeting class 0, RBFN performs as well as SVM. As to class 1, SVM has a bit higher accuracy.

Table 6. Confusion matrix of SVM and RBFN

Desired \ Computed	0	1
0	66.27%	33.73%
1	35.48%	64.52%

SVM

Desired \ Computed	0	1
0	66.27%	33.73%
1	36.77%	63.23%

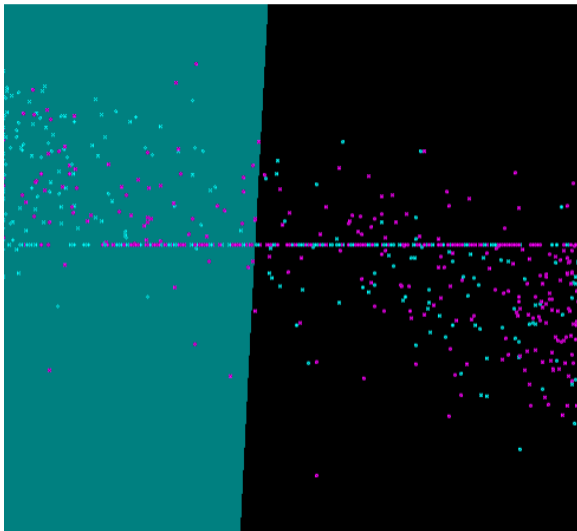
RBFN

Our outcome 67.1836% was calculated by real trading result, we want to know if the accuracy is the limited by the original three-level prices trading strategy or limited by SVM. So we compare the outcomes, we find the SVM is good algorithm, it learned the original very well, the consistency is about 90%. This compare result prove the 67.1836% accuracy is not limited by SVM.

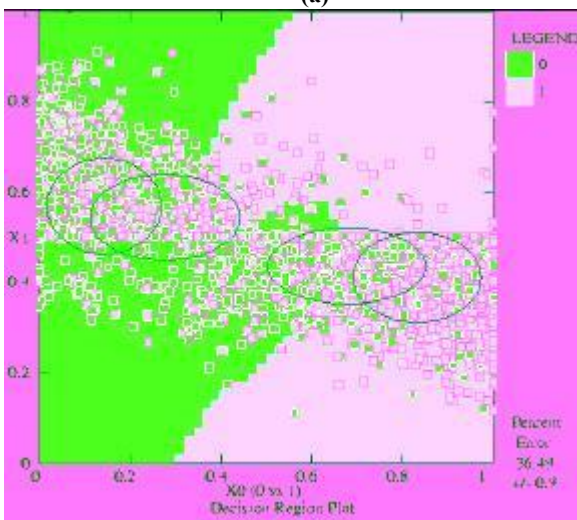
In order to visualize the decision boundary generated by SVM and RBFN, the input space is reduced from 7 indicators to only 2 indicators, C and MP . The visualization is demonstrated in Figure 2.

5. Conclusions

The SVMs has been proved to outperform most other artificial intelligent algorithms in solving classification problem, that's why it becomes so attractive in recent years. This paper is devoted to applying SVMs to investment strategy in which three-level prices analysis introduced. The outstanding performance of SVMs, exhibited in the experimental results, reveals that the SVMs is capable of generalizing well, i.e. avoid overfitting. On the other hand, we also find out that while the training data is chaotic, i.e., the structure in the training data are declared improperly, it will usually lead to lower prediction accuracy. There are rooms for future work. Not only three-level prices analysis, but also various kinds of financial analysis technique could take advantage of the characteristics of SVMs to enhance their performance.



(a)



(b)

Figure 2. The distribution of decision outcomes by (a) SVM and (b) RBFN

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Understanding Issues in Regulating Privatized State-owned enterprises

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Abstract

In the recent decades, the privatizations of state-owned enterprises have becoming a global trend. There are many nations privatized their infrastructure and services, such as gas, electricity, water, railway, sewerage... etc. However, the privatized monopoly enterprises have achieved the fruit of super-profit; the general public began to question the effectiveness of the privatization towards to the newly created monopoly enterprises. So the regulations of the public utilities required immediate attentions from government.

The main objective of this research is to review on literature on the privatization of the monopoly enterprises through its procedures and investigate whether the government required to apply necessary regulations onto it. As a result, the governments of the developed nations are relying on the effective control to create more economic benefits.

At last, this research would combine all the regulating models used in the developed nations and may use as a reference to any government or who else required such relevant findings towards to privatization in their nations.

1.1 Motivation

In the recent decades, the privatizations of state-owned enterprises have becoming a global trend. There are more and more nations privatized their infrastructure and services after UK made a lead, such as gas, electricity, water, railway, sewerage... etc. However, the privatized enterprises are not simply transferring the ownership from public owned to private enterprises but required governmental regulation onto it. Each nation was expecting better economic performance from the private ownership and effective governmental regulation.

However the public started to question the super profit from the privatized enterprises (so called "privatized monopoly enterprises") achieved, and doubts the effectiveness on the regulation of the privatized enterprises. In the recent years, UK government has raised over £ 5,000 million of 'windfall tax' from the privatized enterprises and its shareholders. Due to the public discontent, the labor government has set up an inter-departmental committee to launch investigations to study this phenomenon. The key point of this research is to study whether regulatory office may stop the

privatized monopoly enterprises from huge profits and make sure the service quality are maintained.

State-owned-enterprises (shorten as S.O.E. hereafter) are commonly monopolized characteristics due to its network economics of scale and scope. If competitors would like to enter the industry, they must rebuild the whole distribution network repeatedly. The result from that would be a great waste and increase the costs and lowering the general public's interests and the economic efficiency. (Chanter, 1993) Based on this factor, most nations controlled the monopolized industries directly or nationalized to solve the monopoly issues. However, the operation performances of S.O.E. have shown some severe flaws on: governmental direct control and the ownerships of the S.O.E. There are also some flaws on S.O.E. over the years: 1) lack of sufficient profit motivation; 2) lack of own decision-making power; 3) politics intervention operational decisions to cause the increase of costs and capital wastage. (Aharoni, 1986)

Thus, privatization is an important scheme to solve the flaw of the public asset ownerships. However, it may affect the consumers' rights inevitably in the post-privatization era. Thus, the general public believed the intervention of the governmental regulations onto the private monopoly enterprises is highly necessary. In theory, the effective governmental regulation shall establish a virtual near competition environment. Thus the effective regulation can lower the costs of public services, increase the efficiency, and maintain the near market competition standards. (Shapiro & Willig, 1990) In another word, the goal of the effective government regulation is to replace the market competition, and the general public will be benefits from total market competition efficiency. (Burton, 1997) The privatization and appropriate governmental regulation are the two key actions to expect to solve the monopoly and the issues derives from the public ownerships. This paper will review on the nature of the privatization regulation in the post-1984 era and explore the experiences from the other developed nations. It is highly beneficial to some nations, which have not initiated the privatization, or as a reference towards to their privatization legalization.

2. Paper Review

The remarkable case of privatization in UK is the British Telecom (hereafter named: BT) in 1984. Prior 1984, the privatization in UK remained small and unnoticeable. Post-1984 is a great move towards the privatization era. During the privatization of BT in UK, government also established the Office of Telecommunication, which shortens as Oftel, as a regulatory office for the new privatized monopolized industry. It regulated the licenses for new telecommunication industry, call charges, wholesale rates. The Oftel model was also adopted in the privatization of the other large-scale state-owned-enterprises in UK. Thus, the industry, which regulated by the office, would be termed as “regulated enterprises”.

During 1984-1991, the ruling party, conservative party, overturned the trend of the nationalized the state-owned-enterprises since WWII. The government began to privatize the infrastructure of a nation, such as telecommunication, gas, water, waste-sewerage, electricity. After that, the follow on governments also privatized the British railway while it was in government. The UK Government appointed one industry regulatory office to regulate the operation of the privatized monopoly industry after privatized one infrastructure. The UK regulatory office is operating different from the US governmental regulation commission. On the contrary, the regulation office was lead by a single administrator in the office. The office was empowered with high independence and jurisdiction even though it is a governmental office. The administrator is not entitling as public servant and the budget of the office is collecting from its regulated enterprises.

Because of that, the regulatory office is being defined as “independent” office. However the operation of the office is never independent and not empowered with necessary power. The totally “independence” literally means its zero liability to the public, because the office only report to parliament via the minister while the members of parliament have to liable to the general public. Thus, the administrators have to publish its annual operation report to define its progress on regulation in the assigned industry. The office also needs to make public hearing requested by its not parliament commission and/or auditing department. However, the UK government was not entitled to overturn or amend the established rules and the behaviors of the administrator/regulation office. The undoubtedly fact is the parliament does have certain influence towards to regulation office and the ministers do have the actual power to intervene by exercising his/her entitlement. Until now, there was no obvious evidence to prove that any ministers ever intervene the regulation offices’ decision and its behaviors.

Apart from the independence in the politics, the regulation office shall be a highly specialized

organization in its field. Each regulation offices are consists of many specialized experts, such as economists, accountants, and lawyers. The UK government was trying its best efforts to maintain the independence of the regulation office, but the office shall consult the public to maximize the coverage in its policy. For instance: the consumer councils of each monopolized enterprises shall raise some reference opinions on behalf of the consumers’ benefits. Thus, the regulation system in UK does not represent any parties, but playing a totally independent, fair role to legislate the regulation rules to the general public. It may not be an easy task to maintain with these two key factors, but it has been achieved in UK. It is due to both the regulators and ministers to obeying the rules strictly to maintain such equilibrium. This may not be an easy task in some nations where politics are severely involved with all legislations and operations throughout the government system.

In the UK, the authority of the regulation office was empowered from the legislation of the privatization and the Competition and Services (Utilities) Act, 1992. In this Act, it forces the public utilities to follow the regulation on its service quality and the supplying. The UK laws request the regulation office to complete two basic targets:

1. To ensure that public services/utilities can meet all the reasonable demands from public.
2. To ensure that all regulated enterprises to maintain the sufficient financial operation to supply high quality public utilities/services.

Generally speaking, the regulation criteria are varying from industry to industry. For instance in the gas industry (Gas Act, 1995), the first priority is to intensify the competition, while this is second priority in other industries.

In UK, the legislation of the regulation rules does not just empower the regulation office to enforce the regulation rules, but to leave more space for regulation office to operate with norm. (Colmon, 1997; Parker, 1997) In most privatization legislation, it is commonly seen the similar clause such as: *“the minister and regulator were empowered to exercise their duty... and take the relevant necessary action...”*. According this clause, we can foresee that all the regulation bodies would take different approaches and subject to the terms of regulation administrator. For instance, the current Gas Supply industry regulator has different measure in their term in office with their former regulators, although the regulations were all based on the Section 42(b) of 1986 Gas Acts. Thus it can be seen that the regulators are empowered with huge power to exercise. However, in many countries, it is difficult to accept that an authorized single regulator with huge authority to exercise. While the US model would be a more acceptable model, and the regulation offices were consisted of many committee

members to operate according to their prior legislations.

Apart from the relevant regulations, each regulated enterprises must obtain the licenses from the ministers or its regulation office. It must state the terms and conditions of operation in full details on the license, such as pricing, the wholesale rate, the rate of distribution network to other competitors. In another words, the licenses are generally over hundred pages and have all details within. However, the regulator remained power to define or amend the terms and conditions if necessary.

Key difference between UK & US models

When UK government began to privatization, they have studied the long established regulation system in US. But the UK regulation system is varying in four basic structures than US system:

1. UK system centralized its authority to a single administrator rather authority-shared committee system.
2. The UK government established one regulation office for each individual industry; while one US regulation commission is generally controls over number of industries.
3. The level of juridical authority. The UK system offers less likelihood of legal appeal for its regulated industry than US model.
4. The profit regulation of pricing capping.

The reason why the UK parliament adopted the single administrator model rather than US model? There are three main reasons:

1. At the time UK government establishing regulation commission, there were not many regulation experts available at the time. Thus, the UK government has to assign the regulation experts more precisely due to the human resource scarcity.
2. The single administrator model can adopt into the regulated industry faster and enable an effective regulation.
3. The ease of the accountability: it is relatively easy to measure the performance of the administrator. The UK model is the appropriate model for those nations without prior-privatization-experiences. In contrast, the advantages of the US model enable the inter-industries regulations commission to transfer its effective regulations experiences to other industries. While US model can also build a systematic regulations across the industry.

Why the UK parliament adopted the model, which assigned a single regulator per industry, rather than US model? There are three major factors:

1. At the time, UK established the regulation office for the privatization; there were not too many regulation experts available. Thus, the UK government has to assign precisely and thrifty due to the experts scarcity.
2. Single regulator can adopted into the characteristics of the industry much faster and perform the regulation more effectively.
3. Ease of measures the performance: it is relatively easy to measure the performance of the regulator. The UK model is appropriate to those countries, which never have privatization experiences. In adversely, the advantage of the US model is the possibility to transfer their effective experience to other industries via the inter-industries regulation commission. The US model can also build a more systematic regulation for other industries.

Until now, the UK government has no signs of showing to abandon the single administrator model, but there were some initiations to make amendments. For instance, the business of the Ofel has expanded to across all telecommunication categories and likely to combined all as one. The gas regulation office and electricity regulation offices may combine as one energy regulation office in the nearest future. In the fact, the reality has forced the UK government to make some amendments to combine its regulation system. For instance, the traditional telecommunication enterprises were challenged by the new emerging telecommunication enterprises. The multi-faceted UK gas corporation has initiated its business in its power generation business while some electricity companies on the market began to offer gas supply service. From these two cases, it has illustrated the UK regulations model would shift towards to US model in the future.

According to the US government regulation, all parties include the regulated enterprises, consumer groups, and other interest groups shall report in the regulation public hearing. According to the Federal Administration Act 1984, the US regulation model had developed in a model with more juridical contents.(Sappington, 1986) In adversely in UK, the juridical department played a minor role in the regulation system. It is almost impossible to challenge the regulation office's decisions. The Law can only offer the legal advises towards to the regulation decision procedure, such as obvious illegal and/or unreasonable policy making procedure rather than the comments on its decisions. Until now, it is rarely seen any juridical investigation towards to the regulation procedure.

Since the legal procedure can not offer any appeal opportunities to their regulated enterprises, thus the MMC. (Monopoly and Merging Commission, shorted as MMC) has become the important organization to

investigate any comments from the regulated enterprises. However, the MMC would involve to arbitrate only when the regulated enterprises conflicts with their regulated office in the license amendments. Since 1992, the MMC has involved in 6 pricing amendments and dissolutions between the regulator and the regulated enterprises. The MMC would only focus on any disciplines, which may obviously against public interests. If any of regulators' operations may against the public interests, then MMC would request regulator to amend the existing policy and/or take necessary actions to recover the loss to the public interests. However the MMC would not accept any appeals other than license operation conditions. The less effective appealing has turned down the regulated enterprises to take any actions to against its regulation office, regardless from legally nor administratively. Furthermore, the regulated enterprises are reluctant to solve any issues via MMC, because it normally makes the share prices fluctuate once the news disclosed to public. The regulated enterprises also concerned that the excess internal information may disclose to the public during the investigation. Thus, it is rarely seen any enterprises willing to appeal for a solution with its regulator via the MMC. Therefore the UK has limited results to appeal via the administration and legal methods. Since UK does not have appropriate formal law to regulate the regulator, thus there were many experts concerned that the UK regulators have been over-powered.

Veljoneski (1991, p.16) criticized the regulation office is a monster in the Constitution because the incompliance to its principles of control, audit, balance rule in the tradition democratic government system. This criticism is based on the viewpoints from the democratic regulation and the public liability. Thus, some researchers of the same viewpoints emphasized that all regulation office shall account for the public liability and accept the certain democratic procedures such as the formal governmental norms, assignment procedure, and public hearings. This statement may seem reasonable but may mislead to the general public.

Common regulation models

At the moment, the common democratic supervising procedures may not be appropriate to apply to the regulation office. In the contrast, the substantive model could be more appropriate than democratic supervising procedures. The legitimate of the substantive model shall acknowledge to the consistency of the government's policy, the specialization in problem solving, public interests, exact regulation goals, and clearly defined power. However, all these goals would be hard to achieve under the direct political controls. (Majone, 1996,1997) The UK regulation model is classified as this substantive model. The first goal the regulation is the effective regulation, which enhances the specialization in its practice, and maintains the independence in regulation. In adversely, the US public utility regulation model is a hybrid model of the

democratic model and substantive model. Thus, the specialization and independence of regulation have to subject to the outcomes from the public hearings and legal investigations.

We must admit that: the substantive model would be more appropriate than democratic model to reach the goal of "Economic efficiency" and "Pareto Optimum". However, it is more appropriate to adopt the democratic model if some social goals wish to be achieved, such as equilibrium between the wealth and incomes. Certainly, the regulation may result some resources re-distribution inevitably during the regulation, such as employment opportunities and the wealth. Thus, it may not be easy to distinguish the social goals of the "economic efficiency" and "re-distribution" strictly. Even though, the UK model can still view as a standard and substantive regulation model. Until now, we can understand that why UK regulators did not involved with any "social engineering" and the UK researchers' rejections to expand the regulation coverage to any social issues. (Foster, 1992, Ch.9) If there were too many social issues involved in the regulations, it means more political, society democratic issues would take into account of the regulation model. However, it may not be an easy task to seek an equilibrium state between the specialization independence and public liability. From the routine operation of the regulation office, it may highly likely that any political interventions may involve while political frequently over power of its operation in some nations.

In some nations, the society is difficult to accept any over-power economic forces, it would be necessary to induce some appropriate models to regulate. Therefore the appropriate model would suggest per: replaced the single administrator with panel of committee members, addition of the public hearings, judicial procedure, more intensify parliamentary supervision.

In UK, the most of the public enterprises had turned nationalize since 1945. The main motivation for such move was: the S.O.E. would perform better and fairer services because S.O.E. may not pursuit maximized profit as a goal. To fulfill this goal, the UK government established the board of directors to all S.O.E.. The purpose of establishing board of directors is to minimize the excess interventions from government. However, in reality, there were large numbers of political interventions remained existed and did not change even with the existence board of directors. Till late 1970s, the S.O.E. had a very low morale internally regardless of the level of positions. Furthermore, there were huge numbers of evidence and data has proved that the S.O.E. did not even meet the expected goals in its costs, capital investment ratio, and productivity. (Victors and Yarrow, 1988, p.151)

The Conservative party ruling government was blamed for the failure of the public ownerships in 1979.

General public are now viewing the privatization as a wonder solution towards the poorly performed S.O.E. but may not necessarily lead to an improvement of the economic performance. (Martin & Parker, 1997) For instance, the Jaguar automotives had privatized in July 1984 but remained in poor economic status till the transferring of ownership to Ford in 1989. In reality, the S.O.E. would generally improving in its operation performance due to the newly entered competitors.

4. Discussions and Suggestions

Discussion

Generally, government is less likely to introduce too much competition from its S.O.E., because excess competition may influence the profits to yield to the government and may cause bankruptcy or requirement of restructure to the S.O.E.. If any of these situations happened, the government must accountable for extreme liabilities and pressure. All these facts are understandable while the UK's experience in privatization also proved that it is rarely seen totally fair and effective competition for any S.O.E. in their industries. It is because the government may offer S.O.E. with some subsidies and other aids from government while the private competitors hardly receive any. For instance, UK began to liberate the market competition in the gas industry since 1982/3; however the real competition did not come into the game until the whole industry privatized. The privatization of the telecommunication, gas and electricity had speed up the pace of the competition in those industries for the two major factors: 1. Privatization; 2. the effective regulation. Under the efforts from the UK regulatory office, they have intensified the competition in one industry. UK gas has lowered its market share to 45% and the competition from its competitors remained growing. The whole gas market was liberated in 1998. In the electricity industry, the electricity generation has entered the era of competition as beginning; while the electricity distributions industry was fully liberalized after 1999. The competition in the telecommunication is never calm if compared to other infrastructure industries in UK. By the year of 1996, the telecommunication regulation office has issued 1,260 licenses, which included 3 public service licenses, 44 international call licenses and 18 international call resell licenses. (Oftel, 1997, p.96)

4.1 Suggestions

At the end, the performance measure of a regulated enterprises can be conducted from its productivity, profitability, price, service quality and numbers of staff employed. To summarize the available regulation models of the developed countries, it is found that all government expecting to create better economic benefits via its effective governmental regulation. As a result of that, the research is highly valuable for those developing countries or any government who are willing to conduct privatization in its nation as a reference.

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The Management of Debris Flow in Disaster Prevention using an Ontology-based Knowledge Management System *

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Abstract

In recently years, the government, academia and business have applied different information technologies to disaster prevention and diverse web sites have been developed. Although these web sites provide a large number of data about disaster-prevention, they are knowledge poor in nature. Furthermore, disaster-prevention is a knowledge-intensive task and a potential knowledge management system can overcome the shortcoming of knowledge poor. On the other hand, ontology design plays the key role toward designing a successful knowledge management system. In this paper, we introduce a three-stage life cycle for ontology design for supporting the service of disaster prevention of debris flow and propose a framework of an ontology-based knowledge management system with the KAON API environment. In addition, by appealing to the technology of component reuse, the system is developed at lower cost thus knowledge workers can focus on the design of ontology and knowledge objects. The objectives of the proposed system is to facilitate knowledge accumulation, knowledge reuse and dissemination for the management of disaster prevention. This work is expected to enable the promotion of the traditional disaster management of debris flow towards the so-called knowledge-driven decision support services.

Keywords: knowledge management system, ontology, disaster prevention of debris flow, ontology, component reuse

1. Introduction

In the information overloading age, one has to not only concern the way of how to collect information, but also needs to focus how to utilize the existing information. In recently years, many experts and researchers have devoted to the disaster prevention. They collected large numbers of data such as weather and geology which are related to disaster factors. In order to reduce the occurrence of debris flow and to protect people's life and property, the government, academia and business have applied diverse information technologies for disaster prevention. A number of information systems including decision support

systems and expert systems have been developed in addition to different kinds of web sites. Although these web sites provide large data about disaster prevention but they are usually knowledge poor. Moreover, they lack of the ability of transforming disaster-prevention data into resource of decision support strategically.

Knowledge is an important factor in the application of disaster prevention, which is a knowledge intensive task. Decision makers usually need to analyze changes of the environment, to ignite the alarm and to plan rescue work and procedure. It is obvious that one who can contribute to disaster prevention should own the essential knowledge for disaster prevention. It will be greatly helpful if the essential knowledge of disaster prevention can be retained and enhanced by successors or the community. This is the time which knowledge management can contribute to. Therefore, in the data rich disaster-prevention environment, it is important for moving the focus from data to knowledge management for disaster prevention.

In the knowledge management the most important issues is knowledge integration [2, 4], which focuses on the issue of the integration of different databases and different forms of knowledge representation [5]. In disaster prevention, there are two reasons that we should apply knowledge management. First, data format is adherent to uniformity. For example, many researchers collected data and then tried to explore the reason causing the occurrence of disaster. However, the data sets under investigation did not follow the standard format, therefore, the reusability of data is hindered. Secondly, documents of disaster prevention are usually semi-structured or non-structured so that reusing the knowledge and data existing in the documents is difficult as well. There are different approaches to define knowledge representation [7, 8], however, if one wants to achieve an objective of semantic search in a knowledge base and to suit in the open communication environment, ontology should come in to play. Ontology defines shared vocabulary of knowledge management systems to facilitate knowledge communication, search and knowledge representation [6]. It can help data integration and avoid data inconsistency. In terms of knowledge sharing and reusing, it also can reduce developing cost of knowledge management systems. Ontology has played a key role toward a

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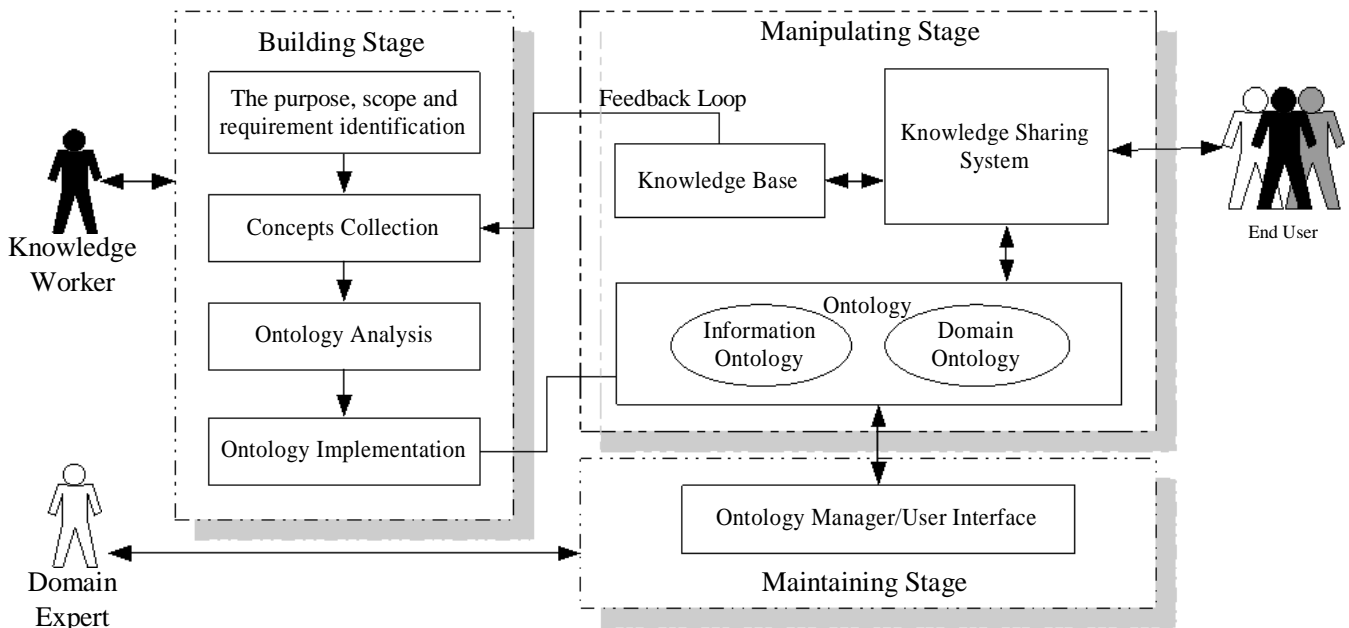


Figure 1. The framework of ontology-based knowledge management system

successful knowledge reuse in many projects [3].

In [1], we proposed a framework of a knowledge management system for the disaster prevention and designed a web-based knowledge management system for supporting disaster management of debris flow. In this paper, we focus on the discussion of system design and aim at knowledge sharing and knowledge dissemination. We propose a framework of the an ontology-based knowledge management system. The system can provide a semantic searching and facilitate knowledge sharing in the disaster prevention of debris flow.

This paper is organized as follows. Section 2 gives brief background knowledge for knowledge management and ontology. The ontology-based knowledge management system is presented in Section 3. Experiments conducted in disaster prevention of debris flow are demonstrated in Section 4. Section 5 concludes the paper.

2. Knowledge Management and Ontology

The basic activities of knowledge management are knowledge acquisition, creation, sharing/diffusion, and utilization. There also exist different knowledge management systems (KMS) that facilitate the activities of knowledge management [2, 9, 10]. In 1990s, the knowledge reuse and sharing already became the major issue in knowledge engineering [11]. In order to achieve the goal of knowledge reuse, the concept of object orientation has been introduced to knowledge management systems. In the sense a knowledge entity can be treated as a knowledge object (KO). KOs can be numerical data, text streams, validated models, meta-models, movie clips, or animation sequences [7], how to integrate and share KOs among different KMS is of great necessity and is a crucial challenge. In the literature, metadata has been widely used in the

integration of existed knowledge bases [12] whereas the ontology has been considered as a meta-level description of knowledge presentation [13]. Thus using ontology could made knowledge generalization and promoted knowledge sharing quickly.

Ontology is to play the important role of knowledge representation and represent knowledge domain hierarchy. Ontology could promote sharing and commonness and push knowledge sharing more quickly. The ontology can be divided into information ontology and domain ontology [14]. The information ontology is a meta model that describes knowledge objects and contains generic concepts and attributes of all information about knowledge objects, such as the title, authors, date, keywords, and other related information. The domain ontology consists of the concepts, attributes, and instances of domain.

In [14], a three-level architecture for intelligent decision support has been proposed. It contains application level, description level, and object level. The object level comprises various information and knowledge sources, the so-called KOs. Ontologies are in the description level, which enable users in the application level to intelligently access object-level sources. Ontologies are metadata that provide the search engine with the functionality of a semantic match. It is different from traditional search engines that directly search for the contents of data. From the viewpoint of ontology, XML is not suited to describe the interrelationships of resources in the Internet [15].

KAON, Ontoprise, and Ontopia [16] provide a complete set of ontology tool suites for building, maintaining and utilizing ontologies. In particular, KAON and Ontopia these tool suites can be deployed onto Java J2EE [17] architecture, a distributed component-based architecture, which makes the ontology-based system

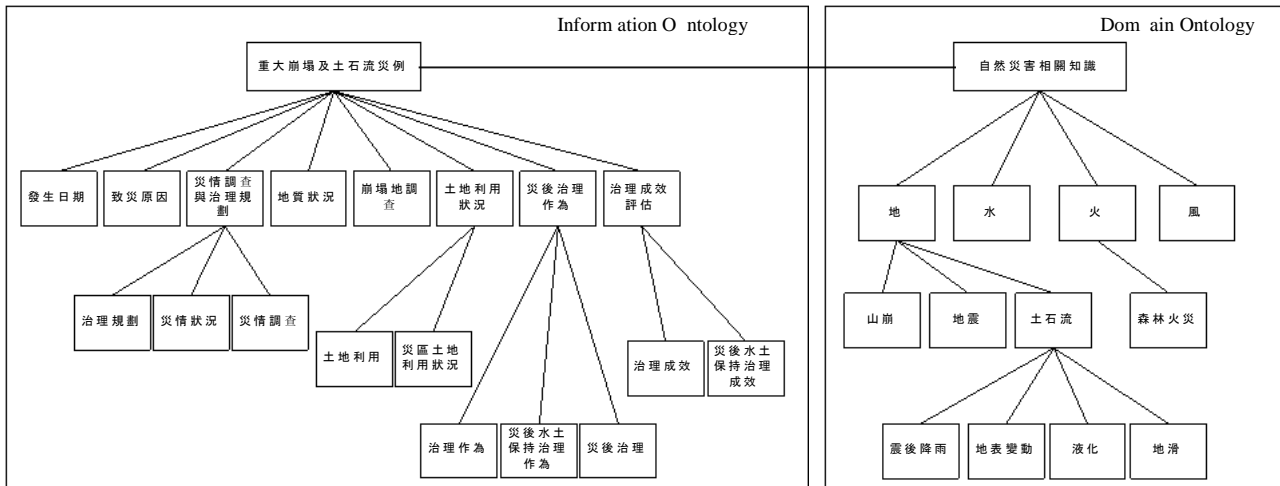


Figure 2. Disaster prevention of debris flow ontology

more flexible and robust. For this reason and the consideration of open source, KAON is chosen as the ontology development platform in this study.

In the past years, many information systems have been developed for different purposes. However today we should emphasize that the important of component reuse. The advantages of reusing components are faster developing time, better quality, and cheaper costs [21]. In this paper, we hold on the view of component reuse and reuse the system components that we developed an ontology-based knowledge management system for the metal industry to help develop this system [20].

3. Ontology-Based Knowledge Management System

This section describes how ontology can be built and interacted with a knowledge management system. We propose a framework of ontology-based knowledge system for disaster prevention of debris flow that exhibit in Figure 1. According to the literature [18], the life cycle of ontology design can be divide into three stages: building, manipulating and maintaining. In the building stage, we identify the purpose, scope and requirement of ontology. When we identified all requirements clearly, then we could begin to collect data and information about concepts of disaster prevention of debris. Next, we analyze the collected data and information. In the ontology implementation step, the ontology can be classified information ontology and domain ontology [19]. The information ontology is a meta model that describes knowledge objects and contains generic concepts and attributes of all information about knowledge objects, such as the title, authors, date, keywords, and other related information. The domain ontology consists of the concepts, attributes, and instances of disaster prevention of debris flow. In our research, we discussed with domain expert and defined the ontology display in Figure 2. The purpose of domain ontology is to achieve the objective of semantic match when searching for knowledge objects. In

the manipulating stage, the ontology is deployed to knowledge management system and supports the knowledge management tasks and searching when an end-user accesses the knowledge base. There is a feedback loop between knowledge base and ontology through both ontology analysis and implementation. With more and more various types of knowledge objects in knowledge base, the feedback loop provides the capability of expanding information ontology. In the maintaining stage, domain experts can add, update, and remove ontology via a user interface.

The architecture of the proposed system is composed of three layers: knowledge description layer, application layer and integration and presentation layer. We briefly describe the functionality of each layer as follows and more details can be found in [20].

(1) Data layer

All knowledge objects are stored in knowledge description layer. It contains several databases: system database, user database, personal knowledge base, common knowledge base, information ontology base, and domain ontology base.

(2) Business Logic layer

The proposed knowledge management system is built upon the Java J2EE environment, a distributed component-based platform. The J2EE server is deployed in application layer. It contains three major components: basic components, knowledge management components, and ontology management components.

(3) Presentation layer

The integration and presentation layer contains several JSP pages and Java servlets (lightweight Java applications in the server side). The major components are News, Forum, System Manager, Personal Knowledge Manager, and Knowledge Search Engine. All information in the forum can be treated as a part of information ontology.

4. Experiment

In our research, we apply knowledge management and information technology to disaster prevention of debris flow and propose a framework of the knowledge management system. The technologies of web and software component are used in designing the system. For knowledge management, it can reduce cost of development and maintenance, and one is supported by the functionality of searching related information quickly but also making right decision at the right time. The snapshots of system demonstration are shown in Figures 3, 4, 5 and 6.



Figure 3. The entry of knowledge management system

Figure 3 is the entry point of the system. The user has to login the system first and then start to engage in the activities of knowledge management, including creating, editing, browsing, and searching knowledge objects.



Figure 4. Information ontology Editor

The creation of knowledge object with information ontology is shown in Figure 4. The domain ontology editor is shown in Figure 5. Information and domain ontology have to be established by the system administrator that follow Dublin Core. The left side in the Figure 5 is the hierarchical classification of metal

ontology, and the right side is the viewer of concept.

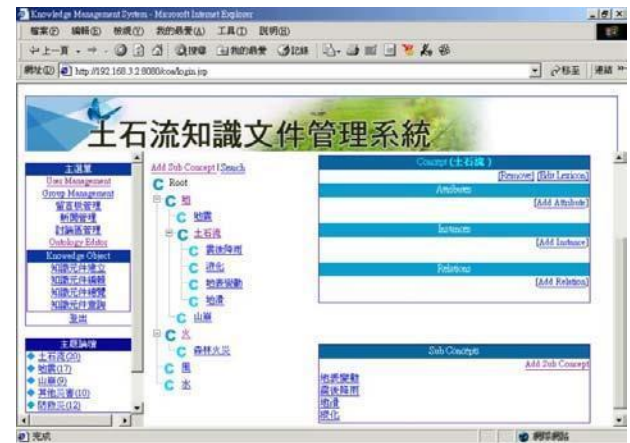


Figure 5. Domain Ontology Editor

When users want to search knowledge objects, they only need to fill out parts of Dublin Core then the knowledge search engine retrieves the matched objects from Information Ontology database as shown in Figure 6. In our system, we used semantic search, for example when we want to search something about typhoon, our system can retrieve information in disaster prevention of debris flow domain. And if we defined ontology include Chinese and English when we use Chinese to search information then we will find Chinese and English information both.

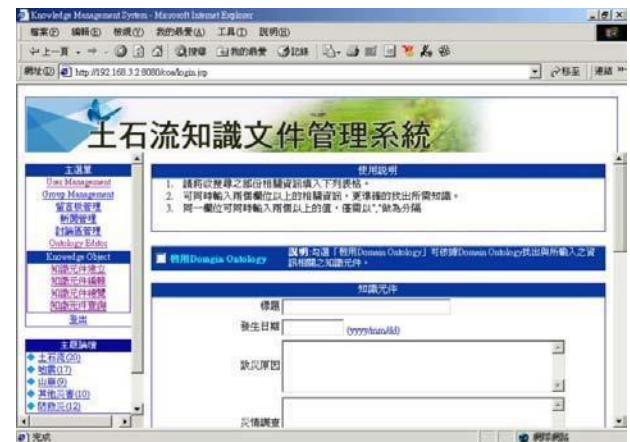


Figure 6. Search Knowledge object

5. Conclusions

For knowledge management, knowledge reuse and sharing already became the most important issue. In this paper, we proposed a framework of ontology-based knowledge management system and reused a prototype that we developed for supporting knowledge management in the metal industry in Taiwan previously. The system was built upon Java J2EE architecture for the sake of flexibility and robustness, and it utilized KAON API to communicate with KAON service for maintaining information ontology and domain ontology. This major advantage of the proposed system results from the salient features of component reuse so that researchers can focus on the design of knowledge objects and ontology without

the overhead of developing a new system.

In this study, we introduced knowledge management into the disaster prevention of debris flow and developed a pioneering prototype of ontology-based knowledge management system. Users can search relevant information and knowledge with the ability of semantic match. The system focuses on the issue of knowledge sharing and provides a simple way for knowledge searching. It is the objective of this study to accumulate knowledge about disaster prevention and to make people can get knowledge more easily. In such way, the traditional disaster management of debris flow can be prompted towards the so-called knowledge-driven decision support services.

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Legal Protection for the E-Commerce in Indonesia: A Study on the Development and the Future of Cyberlaw in Indonesian Legal System

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Abstract

In this new economy, electronic commerce has paved its way for every business stakeholders, be it merchants, investors, distributors and consumers. Putting their contribution this way, they are understandably eager to see the road they are taking is safely guaranteed to deliver the aimed result. Due to this, efforts and strategies are being assessed, planned, undertaken and evaluated to mitigate and manage the risks associated with e-commerce, most notably from legal and regulatory approaches.

The thrust of this paper is to analyze current situation of e-commerce in Indonesia from the legal point of view. It will examine the problems that have accrued so far in the lacuna of a comprehensive cyberlaw in the country based on local incidents and cases. Special analysis will be given on main provisions of the Electronic Information and Transaction Bill to see how much protection it would give to the e-commerce activities in Indonesia and which parts should be better improved. At the end, the paper tries to summarize overall development and future of cyberlaw and its prospect of facilitating the growth of e-commerce in Indonesia.

This study serves to compliment as comparison for other assessments of the growth of e-commerce globally and regionally. Looking at the fact that Indonesia is just another crucial market power in this region, the study of its legal system in the e-commerce is both imminent and unavoidable.

1. Introduction

In this new economy, electronic commerce has paved its way to become another 'new kid on the block' where more investors are putting their shares and more players are taking their parts. Not only this phenomenon is imminent in the developed economies, but also it is witnessed in the developing countries. It is the consequence of this intensified situation that more stakeholders want to see the road they are taking is safely guaranteed to deliver the aimed result. Due to this, more efforts are now undertaken to mitigate and manage the

risks associated with e-commerce, most notably from legal and regulatory approaches.

Nevertheless, before moving further to defining the nature that the e-commerce has, and the risks it comes along, one would need to take a look back on how this new dimension of economy manages to get its place in most of the countries on this globe. In as much as the e-commerce begins to reshape the developed country's economy, it also takes its way in the developing countries.

E-commerce has certainly allured developing countries mainly due to several characteristics it has to offer. First, as Minges [11] indicates, it certainly increases the sales and thus generates hard currency. In other word, subject to different level of success indifferent places and situations, the e-commerce proves to be workable. This fact will in turn boost employment and welfare, and apparently has some effect on reducing brain drain and urbanization alike.

What attracts business players most is the unprecedented level of transparency and efficiency that is offered by e-commerce, especially in the infant democracies such as found in the developing countries. These factors of transparency and efficiency have apparently rejuvenated business players in conducting their course of business. Taken together, all these factors provide explanation on the emerging role given to the e-commerce sector in reshaping the new economy in many developing countries.

2. E-commerce in Indonesia

2.1 Facts and Figures

Indonesia is the largest archipelago country in the world with more than 16,700 islands, spreading across 5,000 km of equatorial line. With a population of more than 210 million (Source: Indonesia Bureau of Statistics at www.bps.go.id), Indonesia is the 4th most populous country in the world. Although the country covers a large area, the population is concentrated in the islands of Java, Bali and Sumatra.

Like many other countries in Asian region, Indonesia also felt the effects of the economic crisis, which prevailed globally since 1997. That crisis hit Indonesian economy very badly. Data show that since 1997, GDP (gross domestic product) and income per capita have been decreasing [17]. But those numbers were improved in 1999 onwards because of the Indonesian economy recovery program under the new government.

Indonesia's demographic and geographic situation would appear to make it an ideal location for e-commerce. There is a large market spread over many islands. However, the current reality does not really reflect the expected impact. Indonesian 'e-readiness' – shorthand for the extent to which a country's business environment is conducive to Internet-based commercial opportunities— trails behind other developing countries in the region. The e-readiness ranking in 2002 placed Indonesia 52nd; trailing behind Singapore (11th), Malaysia (32nd), Thailand (46th) and the Philippines (49th), and only ahead of Vietnam (56th) [16].

The Indonesian Association of Internet Service Providers (APJII) [1] stipulates that the number of Internet users in Indonesia is 4.5 million in year 2002 (2.14% of the population), and at the end of 2003 is estimated at 7.550 million (about 3.5%). Refreshingly, until March 2003, the number of ISP that has been issued license reached 186 (See Table 1).

Table 1: Internet and e-commerce indicators in Indonesia. Source: Association of Internet Service Providers Indonesia (www.apjii.or.id)

	1999	2003 (till 1st quarter)
Internet Users	1,000,000	7,550,000
Internet Subscribers	256,000	800,000
Internet Service Providers	50	186
Country top level domain (.id)	3627	16,257

A survey performed by US-based Boston Consulting Group (BCG) of 14 Asian countries found that Indonesia's per-capita online spending was \$0.01 in 1999 (or a total of \$2m), leaving it behind India (\$0.03), Thailand (\$0.02) and Malaysia (\$0.05). BCG said 80% of the online transactions in Indonesia came via travel-related websites [3].

By volume, the accumulated value of e-commerce in Indonesia has been estimated at under US\$ 100 million in 2000, or less than 0.1 per cent of GDP [8] and only represents 0.026% of the total world transaction value that reached USD 390 billion in the same period [17].

Despite those discouraging figures, the future of e-business is still shining in Indonesia, provided that the existing barrier can be handled well. The hope can well emerge from the fact that Indonesia appears to be the freest Internet market in Indonesia. This is a direct impact of an unprecedented liberalization and freedom to speech unleashed by the current open political environment [8]. There are at present no limits on the number of Internet providers nor is content restricted in anyway.

According to recent statistics of Indonesian Association of Internet Service Providers (ISP), there is significant growth in all Internet-related figures: number of Internet users, Internet subscribers, Country Top Level Domain (CTLD), and number of ISP's in the last five years [1].

International Data Corp, a US research firm, estimated that the number of Indonesians who buy goods via the Internet would swell to 600,000 by 2003 (from 70,000 in 2000). It counted 3,544 websites managed by Indonesian companies, with upwards of 50 being Internet service providers [3].

2.2 E-commerce Barrier

Given the ideal expectation for the e-commerce in Indonesia, question may now be posed as to why e-commerce does not make a real big jump in Indonesia. This is purportedly due to existence of several barriers to e-commerce development, including lack of infrastructure (of both technological and regulatory), awareness, security, etc.

This paper foresees that legal, regulatory and policy frameworks count as among the major force to facilitate e-commerce development. For this reason also, this aspect has been made integral to the concept of e-readiness.

It is this importance that has been emphasized by the government of Indonesia when developing and formulating the national information system or called SISFONAS [15]. By virtue of this platform, the government of Indonesia shares the vision that there shall be an '*i before e*', or, infrastructure before going electronic. And this infrastructure includes regulation.

Looking at this fact, the fate of e-business certainly hinges on the adequacy of legal and regulatory frameworks that should serve as rule of the game. Inadequacy and lack of enforcement thus serve as detrimental barrier for the development of e-commerce.

The issues such as consumer protection, formation and delivery of contract, payment method, transaction security and data confidentiality have become a main menu when consumers consider e-business transaction.

The questions remains are to what extent all the stakeholders, mainly the authorities, have anticipated the legal and regulatory aspect of e-commerce.

3. Legal Protection for E-commerce in Indonesia

3.1 Current State of E-Business Law in Indonesia

In Indonesia, demand to upgrade the protection of laws for e-commerce environment is arising [5]. Steps have been initiated but considered very slow. While other countries in the region have had some pieces of legislation in place, there is no single act comprehensively addresses the issues of cyberlaw.

The main law currently deals with telecommunications sector is the Telecommunication Law No. 36/1999 [8]. However, this law mainly deals with the broad telecommunication sector, licenses, operation, network provision, and other procedural matters. It does not touch issues of content and other aspects of cyberlaws.

Despite the absence of a comprehensive cyberlaw, some redresses have been attempted from the existing traditional laws such as in online credit card fraud cases. But in many occasions it is proved that these laws are just not sufficient enough to accommodate special nature and challenges of e-commerce age. The penalties stipulated for cyber crime offenders often do not sufficiently bring about the deterrent effect, and existing punishment does not necessarily remedy the loss that may accrue.

Currently, Indonesia's Central Bank (Bank Indonesia or BI) is taking initiative to prepare draft law on fund transfer act. The law among other things will touch the issue of electronic transfer of fund between financial and banking institutions [2]. However, it submitted that the process that this draft will take to become law will still be long.

At administrative level, there is however a good signal from the Government when recently Presidential Decree No. 3/2003 was issued namely 'National Policy and Strategy on E-Government' in June 2003 [1]. The decree basically urges all sectors of government agencies in central and provincial levels to prepare and accommodate infrastructures, methods, procedures and human resources for the implementation of e-government. With this decree, the government is apparently ready to embark further with online environment of governance including official e-procurements.

To this extent, it can be summed up that the current state of e-business law in Indonesia is in its initial stage. Some scattered and conventional laws are still in use for cyberspace medium with limitations, while the government has taken some administrative measures to

embark themselves into online environment through the implementation of e-government.

On the top of this, it is worthy to note that this lacuna would be answered quite soon by the initiative to legislate a comprehensive cyberlaw legislation to be elaborated later in this paper. But first we would need to see some legal challenges that have been faced by e-business in Indonesia.

3.2 Challenges to Indonesia's E-business Law

The initial process of e-commerce in Indonesia that is discussed earlier may account partly for the present rudimentary state of Indonesian laws on electronic commerce. This condition, however, can also be seen as a reflection of the current state of the development of Indonesian business laws in general [6].

It is true in the sense that Indonesia still relies heavily on laws and regulations that are issued during the Dutch colonial rule to regulate such fundamental matters as contracts and evidence. This situation requires reform, which cannot accomplish overnight.

The urgency for legal reform in e-business area is furthermore warranted by rampant cases of infringement and violation of laws that relate to the e-commerce activities. Among those incidences are described in the following passages.

3.2.1 Online Copyright Infringement

The Ministry of Justice is responsible for Intellectual Property Rights. As far as copyright law is concerned, Indonesia has a copyright law and is a signatory to the Berne Convention. In general, foreign copyrights receive automatic protection in Indonesia but there is lack of resources for enforcement.

Indonesia has been cited as having the third highest software piracy in the world, 89 per cent in 2000 that results in a loss of US\$ 70 million [8].

Certainly, poor level of protection for the intellectual property rights is not a good signal for potential investors and consumers to come into Indonesian market. The government had just recently enforced the new copyright law (Copyright Law 19/2002) that comes with effect of more severe penalty for the copyright infringement.

The law has also accommodated what it needs to meet the e-commerce challenges. It expressly includes the Internet as one of the publication medium in which a copyrighted material may also be infringed. The law has made equal protection for the copyright in the online media, and thus clearing the way for e-business to operate safely.

For effective enforcement, the law gives more power to the law enforcers in order to conduct search and seizure of suspected infringement. This law has given a blow to online piracy movement in Indonesia; nevertheless, the effective enforcement of it still remains for us to see.

3.2.2 Internet Credit Card Fraud

Internet fraud is fast becoming a common factor in online retailing as e-commerce transactions rise and fraudsters develop more sophisticated methods. According to Gartner G2 research, the risk of Internet payment fraud is at least 12 times higher than it is for face-to-face transactions.

Unfortunately, this online credit card fraud (widely labeled 'carding') has been so much associated with Indonesia. In year 2002 an international online fraud survey by *ClearCommerce* listed the country in the two top twelve countries from where the most online credit card fraud originates, only second to Ukraine (see www.ocalasmostwanted.com). It was suggested that about 20% of credit card transaction from Indonesia was suspected to be illegal.

In year 2002 alone, there were 218 cases of credit card fraud reported to the Police [9]. Meanwhile, there have been 23 cases reported in 2003 (until August). Out of these incidences, only a handful cases have been successfully handled by the Police.

The victim of this scam is worldwide. In 2002, most of the victims were American (84 cases), and following the US are mainly victims from developed countries in the Canada, Europe, Australia, and East Asia.

This rampant incidence costs Indonesian e-commerce at inconvenience. According to *Gatra Magazine* [8], online transaction requests that originate from Indonesia's IP addresses have been rejected and blocked.

In dealing with these cases, law enforcers have encountered certain legal obstacles. This is mainly the result of absence of a comprehensive cyberlaw that would otherwise anticipate cases like these. It was reported that the Police in this instance seek remedy from the conventional Penal Code with so many limitations, especially in defining the constitution of commission of crime and defining evidentiary issues.

As said earlier, these rampant abuses of the e-commerce activities in Indonesia have warranted the urgency of enacting a comprehensive cyberlaw in order to ensure reliability of e-business, as well as the confidence of consumers, merchants and investors to embark in the new venture.

4. Assessment of Indonesia's Cyberlaw Bill: Electronic Information and Transaction Bill

The current Electronic Information and Transaction Bill ('the Bill') [12] is considered the first initiative of the country to enact a comprehensive legislation on cyberlaw. There were initially two government's agencies that came out with two different bill drafts at the same time. This fact reserves some comment in the later part of this paper.

The Ministry of Industry and Trade initiated the draft of Electronic Information and Electronic Transaction Bill. On the other hand, the Department of Tourism, Post and Telecommunication under the Ministry of Transport also came out with the draft of Information Technology Bill. This double initiative was uncoordinated creating prolonged, unfocused and unnecessary debates among academics and IT professionals.

Nevertheless, the debates were deemed to have brought constructive ideas as well. It is noteworthy that the two drafts took different approach in formulating cyberlaw into legislation. While the Electronic Information and Electronic Transaction Bill was concentrated on e-commerce law and related aspects taking into account the requirements under UNCITRAL model law on e-commerce, the IT Bill was a general law (some called 'umbrella law') dealing with so many issues on general terms.

After some years of debates, the government acted wisely to coordinate and merge the efforts together. The coordinating agency is now Ministry of Communications and Information, and the consolidated draft is now called Electronic Information and Transaction Bill.

The approach is somehow a hybrid of the two original drafts; it does cover quite extensive subject matters from e-contract to e-signature, from privacy and personal data to cyber squatting and intellectual property rights, and from cyber crimes to consumer protection. However, the Bill does not go lengthy enough in subject matters other than cyber crime, e-contract and related aspects. For other subject matters, the Bill provides that they will be governed by subsidiary regulations.

At present, the draft Bill had been finalized by relevant agencies after it was consulted to public for comment. It was reported in June this year that the Ministry has processed the Bill to be signed by the President and ready to be tabled to Parliament [14]. It is presumed that the Bill will be enacted not later than the first quarter of year 2004.

Since this draft bill is the first to accommodate cyberlaw requirements, once enacted the law will certainly provide basis for the reform or revision of other areas of laws including electronic fund transfer, e-

government, capital market, online taxation, and online banking.

4.1 Legal Position of Electronic Message & Admissibility of Electronic Evidence

The Bill acknowledges in section 4 that electronic information shall have legal effect as evidence. This proposition includes the print-out form generated from the electronic message. However, for its legal effect, the electronic message is required to have generated from electronic system that is reliable. Furthermore it also stipulates that the electronic information system must fulfill requirements of integrity, reliability, and accessibility. It also has to be able to retrieve the message it is required. Having said this, however, the Bill stipulates that there are some exceptions in certain matters where written document is still necessary & essential including the marriage contract and land matter.

4.2. Consumer Protection

It is stipulated in the Bill that everyone has the right to obtain accurate and complete information with respect to contract requirements, manufacturer, and product that is offered electronically section 10(1). For this purpose there can be reliability certification body to be jointly worked out by government and members of public.

In respect with dispute resolution methods, consumers are given variety of legal redresses by the Bill. In case there is found *any use of IT* by certain party that creates harm for society, a class action can be taken by virtue of section 37. Arguably, this '*use of IT*' is wide enough to cover many areas and issues to the favor of consumers.

Besides, civil action can also be brought to commercial court in the event there is a use of IT that causes commercial loss to the consumers. In certain circumstances where there is a threat to certain important aspect of public life, the government may instead take action to protect public interest.

Other than litigation, consumers are also given option to settle their e-commerce disputes by employing alternative dispute resolution (ADR) including arbitration as provided in section 42, and the decision resulting from such process shall be final and binding upon the disputing parties.

4.3 Electronic Contract

The principle of freedom of contract is strongly upheld by the Bill when it stipulates the freedom of contracting parties as to which law to govern, and in which forum to hear the disputes. In this respect, alternative dispute resolution is also available for the contracting parties to opt.

More than expected, the Bill does not only recognize the legal effect of an electronic contract and parties to it, but also places the e-contract inline with the requirements of international civil law. This international civil law would be the reference in the event where contracting parties do not specifically stipulate which law would govern their agreement. This stipulation in section 20 (3) is especially important in the event dispute arises and the parties did not specify which law is to be the governing law.

The constitution of e-contract still depends on the offer and acceptance of the offer; nevertheless the principles are being adjusted to the online environment. Furthermore, by virtue of section 23(3) the use of electronic agent for a contract can also be held binding as far as the electronic agent is functioning properly in the ordinary course of business. This provision accommodates among other things the widely used Automatic Teller Machines (ATM) by banking industries. Other kinds of payment methods that involve automatic arrangement e.g. through computers are also covered under this provision.

Given the relatively new and ever-developing circumstances of the information technology, the Bill does anticipate its limitation in governing the e-contract activities. As a result, the Bill also provides in section 25 that any business customs and commercial practice those are alive today and not in contravention with the provisions of the Bill shall remain applicable.

4.4 Writing & Signature Requirements

Electronic message can be held original and shall fulfill the requirement of 'writing' provided that its integrity, reliability, accessibility, and retrievability are guaranteed.

Electronic signature has a valid legal effect under section 11, and the requirements are set in section 13. The word used is 'electronic' and not 'digital'. Meaning, it is technology neutral. And interestingly, it does not ever touch the technology of public key infrastructure. Meanwhile, the certification authority is not made compulsory; instead it was made optional ('*dapat*') in section 15(1).

4.5 Cyber Squatting

Some aspects of domain name registration and related issues are touched in section 26 of the Bill. It recognizes any registration of domain names on first come first serve basis. However, this domain name shall not be registered under bad faith, should not trespass fair competition law, and should not infringe rights of others on the name.

If the latter occurs, the infringed party may take civil action for damages. While international system of registration is recognized, further procedure of names

registration would be regulated by subsidiary regulation. Arguably, this stipulation gives legal effect to the international arbitration procedures, e.g. those under WIPO, UDRP, etc.

4.6 Intellectual Property Rights

The Bill in section 27 recognizes and protects every intellectual property rights as the result of electronic information work, and same protection is given for Internet website design and any IP-righted materials it contains. This provision is very short and simple, purposely because there is already a comprehensive law deals with IP issues. Apparently the Bill tries to avoid overlapping with those IP legislations.

For instance, Indonesia's new copyright law No. 19/2002 does anticipate the information technology and what it may affect the copyrighted works. It already sufficiently provides that the same principles of copyright are applicable in the cyberspace medium.

4.7 Personal Data Protection

Personal data protection (PDP) has been among the most contentious issue in the cyberlaw discourse. This is due to many reasons, mainly its significance to two seemingly-contradictive things: human rights that demands maximum protection of privacy in one hand, and international trade that requires extensive personal data transfer on the other. This background leads to various international attempts to come with regulatory measures on PDP.

However, possibly to the surprise of many, the Bill only provides one section (section 28) to deal with PDP, and no subsidiary regulation is mandated by the draft.

It only stipulates that data subjects must give 'consent' before the 'use' of any information containing personal data and privacy rights of that party, except in relation to public information that are no longer confidential.

Questions arise as to whether there is similar protection in the event of collection, storage, or deletion of the same personal data? Also, what kind of 'consent' required? Is it an opt-in or opt-out model? Given the width of the issue, why very limited provisions in the Bill? And why no mandate is provided for any secondary legislation such as in other parts of the Bill?

4.8 Offences of Cyber Crime

The offences under proposed bill are among the most contentious issues. The first sight on Bill's provision suggests wide and extensive coverage of computer misuse types and categories.

First of all, it is Interesting to note that 'hacking' or a mere unauthorized access to a computer or electronic

system is not made an offence, in an opposite stand to the law in other major countries such as UK, Malaysia and Singapore. This is believed to be crucial since Indonesia has been known for its rampant cases on cyber crime involving hacking, web-defacing and credit card fraud.

Hacking is an offence only when, first, it is committed with the purpose of obtaining or altering information contained in that system. Secondly, it is committed with the intention to secure information classified as confidential, or that are detrimental for national security and international relations. It is argued that this provision on international relations and nation's critical information infrastructure would provide redress for the issues of cyber-terrorism.

Hacking is also an offence when it is committed against the electronic system of financial and banking industries, with the purpose of misusing it or gaining undue advantage out of it.

The Bill also criminalizes any action that posed harms to the proper functioning of nation's protected electronic system (e.g. those system under national critical infrastructures). 'Protected computer' is elaborated by the Bill's elucidation of section 34; to fall into two categories: first, special and exclusive computers that belong to the government's financial institutions, and secondly, the computers that are used by the state to communicate and trade with parties from other countries.

In other provision, the Bill makes it an offence for the wrongful communication of password, access code, or other means of access (section 35).

Credit card fraud is addressed in section 33, where it provides that, any way of unauthorized use or access of other people's credit card to gain benefit from e-commerce is an offence under the Bill. It is hoped that this provision may curb the existing problem and thus eliminate the notorious credit card fraud in Indonesia.

4.9 Summary

In this summary on our assessment on the Bill, there are some other aspects worth noting, including both advantages and weaknesses.

First appreciation worth to note is that draft has aptly acknowledged the nature of technology of the Internet and ICT that is ever changing, ever developing and very dynamic. Ready to face this nature, the draft expressly stipulates (in section 2) that the law to be enacted must be based on neutral technology basis.

This provision will enable the law to accommodate various and dynamic developments of the information and communication technology. All kinds of technology will be acknowledged and given legal effect as long as

the requirements of system integrity, reliability, and accessibility can be assured.

Since the cyberlaw is a '*lex specialis*' or special legislation, the drafts provides in section 3 another important provision, that any other existing laws that have some extent of ICT use and employment, will be deemed applicable. Thus, rather than repealing effect, the cyberlaws have instead acted as complimentary to other existing laws and regulation. This provision is very important to affect solid and comprehensive national legal system.

The Bill, however, reserves some considerations for improvement. The biggest limitation it posed may be associated to its wide but not-deep coverage, especially in the area of privacy and personal data protection.

Simple and short approach taken by the draft in dealing with other issues may also cause another inefficiencies of the law. The current draft Bill requires about eight regulations. Normally these regulations will take another time and process to achieve.

It appears that the civil procedures in the commercial court as provided by the Bill open room for delay of litigation. And this may create another factor of ineffectiveness of the law. By virtue of section 39, the court is given a maximum of 90 days from the date an action is registered to deliver judgment. An extension of 30 days is provided with the permission of Supreme Court. It submitted that a total of 120 days for the delivery of judgment is too a long period and may necessarily prejudice the action due to the nature of evidence that may be gone vary fast.

5. Final Remarks

The cyberlaw bill certainly is among the most long awaited legislation by anybody engaged in businesses in Indonesia. With e-commerce in Indonesia grows from time to time, legal and regulatory issues get more imminent and prevalent. It is very important that the current on-going process of the Bill's enactment be widely informed to all these business stakeholders.

While enacting the law is one remarkable achievement, attempts will need to be initiated to anticipate effective enforcement of the law itself. With the cyber crime cases getting more serious and rampant in Indonesia, the law once passed should be enforced as soon as possible.

To achieve maximum enforcement, at least three sectors need to be addressed. First, international and worldwide cooperation needs to be secured. This is due to the nature of cyber crime which is trans-border and extra-territorial. Certain kinds of collaboration needs to be initiated at region level first, and then to the global level.

Secondly, the Indonesian Government needs to ensure there are effective administrative measures, policies and strategies in executing the requirements of cyberlaw and e-government. The question such as which ministry or agency to take a lead will need to be answered to avoid overlapping tasks like what happened with the double draft bill on cyberlaw.

Last but not least, educational factor is urgent. Not only to create more Internet-literate society, but also to achieve most effective and efficient utilization of the ICT. It is foreseen that the problem of digital divide in the country is still an uphill task to solve. This is in anyway also to create more balanced and fairer digital society in the region.

With all these policies and strategies, the enactment of cyberlaw will serve its purpose especially in giving maximum protection for the future of e-commerce activities in Indonesia and the region.

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The Subjective Value of Information: Trading expertise vs. content, copies vs. originals in E-Business

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Abstract

What is the subjective value assigned to information? Is the subjective value of information similar to the realistic or normative value, or are there deviations introduced by human processing, the framing of the information source, or the external qualities of packaging and ownership of the information? Do people assess information as having the same value when offered the chance to sell it (Willingness to Accept, WTA) as when facing the need to buy it (Willingness to Purchase, WTP)? This is an empirical, experimental investigation of the effects of expertise vs. content, and copy vs. exclusive original packaging of information on the WTA/WTP ratio. In an animated computer simulation of a business game players maximize their profits by making choices regarding inventory and prices. Participants were also offered the chance to bid in trade (buy or sell) information regarding the weather that may affect demand. We find, as hypothesized, that the subjective value of information does indeed follow the predictions of Endowment Effect theory. Participants revealed a ratio of Willingness to Accept to Willingness to Purchase (WTA/WTP) that resembles the ratio common in the case of private goods. In the decisions, choices and performance recorded for the 294 subjects, we also found support for the hypothesis that the WTA/WTP diverges from unity more often and in a more pronounced manner for information traded in the "original" form rather than as a copy of the original, although even for copies the WTA/WTP ratio is still double. Results yield a value of about three for the WTA/WTP ratio for original information regardless of whether the source is content or expertise. Valuations of content and expertise did not diverge. However, the source of information can be manipulated by system design to become more salient. Copy information received a subjective value which was significantly different (lower) than original information. Implications for both online trading and online sharing of information are discussed.

1. Introduction

One of the central subjects of trading in e-business is information itself. E-business thrives on both the availability and the exchange of information in various forms. Every commercial transaction involves transfer of information. Commercial transactions usually involve not just the item being traded (books, CDs, antiques etc.) but accompanying information as well. Information is a unique good since use and access rights are often transferred by copying without the transfer of exclusive ownership rights. Similarly, expertise is transferred by copying since it does not leave the expert's mind. An exception may be when an expert provides exclusive advice and will not share or sell it again. Information and expertise can be transferred both by sharing (advice giving) and by trading. Since information exchange has become an integral part of e-business, the value of information must be part of the total transaction value estimate. Lack of sufficient information creates uncertainty which in turn leads to under trading of the goods traded. Hence, information is a catalyst to economic activity.

So far information was discussed in the general sense of the word. Some definitions are in order before proceeding. Three closely-related concepts are defined: Data, information, knowledge. Different definitions can be found in the literature for these terms from an information systems perspective [1, 2] or from an economic perspective [3-5]. The definitions used here were adopted from the knowledge management literature [6]. While more complex and detailed definitions are available (for example, [7]), the following definitions have been selected because they are fairly simple and parsimonious and enable operationalization. Data are discrete, objective facts about events. Information is analyzed and/or contextualized data. Information carries a message and makes a difference as perceived by the receiver. Knowledge or expertise is a human quality that builds on data and information together with experience, values, and insight. In this study we focus on two

instantiations of information: information as content and information as expertise. Content is the more tangible of the two.

The value of information is enigmatic. Information is neither a private nor a public good. It is an experience good. The main focus of this paper is to offer a way to assess the value of information as content and expertise.

The present research proposes to investigate the subjective value of information and expertise by combining economic and psychological theory with information systems research. We use an experimental/simulation approach to suggest possible approaches to evaluating the intangible, subjective value of information.

2. The Value of Information

Several unique characteristics render information difficult to value. Information is an unusual good in many aspects - production, distribution, cost, and consumption. Information is both an end-product and an input into the production of other goods, decisions, or information. It often accompanies market goods as an integral part. For example, an increasing portion of all consumer goods are accompanied by user manuals. Our purchasing decision may also be based on the availability of expert advice and recommendation.

Information is expensive to produce and cheap to reproduce [3, 4]. In fact, distribution is accomplished mainly by reproduction or copying. The same content can be distributed by different media, and the price is often derived from the medium rather than from the value delivered by the content itself. In point of fact, people consume information both by sharing and by purchasing, while most other goods are consumed mostly by purchasing. The cost of information can be either direct or indirect. The quest for the value of information is further complicated by the fact that information is an experience good, meaning that its value is revealed only after consumption [4, 8].

The value of information can influence the value of objects of commerce, therefore, we set out to investigate the value of information and expertise as a first step of a broader question relating to the influence of the availability of information on trading market goods.

Theoretically, there are three ways to assess the value of information [1, 9]: Normative, realistic, and subjective. While user utility should be the base for calculating the price of information, utility varies by person and circumstance. Realistic methods are *ex post* and consequently inappropriate for evaluating information content (also referred to as the “inspection paradox”) [8]. We therefore focus on the subjective value of information.

The tradition of studying decision-making under uncertainty has addressed patterns of information use and the value assigned to information. This literature sets the

backdrop for understanding information business trends. The heuristics experiments [10] as well as later studies [11] demonstrated that people tend to ignore available information such as prior probabilities, sample size and the like. Instead, decisions are based on other subjective methods such as representativeness, availability, and adjustment and anchoring (also known collectively as heuristics). Earlier experiments have also shown that people tend to be conservative and undervalue information available for the revision of a prior opinion [12]. A recent study [13] tested the pursuit of information for daily decisions. Participants preferred to seek information and to base their choices on (objectively) noninstrumental information. In other words, people assigned positive subjective value to objectively worthless information. Theory also suggests that people seek information because it seems the right thing to do [14], implying over-demand for information and a high subjective value. People tend to accumulate information “just in case” they may need it in the future, again leading to excessive demand [8]. The theoretical tension is, therefore, between studies indicating that information is under-valued and research showing that information to be over-valued.

2.1 The Endowment Effect

Subjective value has been studied experimentally for many types of market goods (also called private goods) and nonmarket goods (also called public goods). One very interesting finding of experimental research on subjective value is the discovery of a disparity between the highest amount one is willing to pay (WTP) for a good and the lowest amount one is willing to accept (WTA) as compensation for giving up the same good. This disparity was coined as the Endowment Effect (EE) [15, 16]. Traditional economic assumptions imply that, when income effects are eliminated, the difference between WTP and WTA should be negligible (the difference should amount to the decreasing marginal utility). However, experiments with various types of goods have shown that WTA is significantly greater than WTP. By definition, WTA and WTP values are neither normative nor realistic. Instead, they are subjective values, since they represent an individual’s personal perception of an object’s worth for him or herself. The EE methodology itself is designed with the purpose of eliciting submissions of private values and is described in section 3.2 below. We apply the WTA/WTP methodology as used for various types of goods in order to investigate the subjective value of information with a view to determining what characterizes information as a good.

2.2 The WTA/WTP Disparity

The consistent, unexpectedly large and uni-directional difference between WTA and WTP observed in relation to traditional goods and services has generated much research interest. Attempts were made to explore whether the discrepancy can be explained by economic theory or

whether the difference belongs to the realm of less than- or bounded- rational choice and is rooted in psychological origins. We will summarize some of the pertinent literature on the WTA/WTP disparity and the explanations offered by economists and psychologists highlighting the common denominators of these two approaches.

Commonly, bidding is employed as the general experimental approach for researching the values of WTA and WTP. Participants in experiments are offered the opportunity to bid for the purchase of an item, or to state a reserve price for the sale of an item. There are many bidding mechanisms and there is no specific experimental design common to all the experiments described below. A comprehensive methodological review detailing the types of bids used in different papers can be found in [17]. Using the various bidding mechanisms, researchers have demonstrated a significant disparity to exist between the values of WTA and WTP for common market goods such as chocolates, pens, and mugs [18, 19], and a much larger disparity with regard to nonmarket goods such as health [15, 20]. Trading induced-value tickets, or tokens of known value, have not shown a WTA/WTP disparity [18, 21, 22]. Induced value tickets or tokens are characterized by having only pure monetary value. In this case, of “induced value” items, the expected number of trades took place, the expected number of trades being half of all possible trades. Herein lies one of the important implications of the disparity, namely that the existence of a significant difference between WTA and WTP leads to a reluctance to trade and results in undertrading. This was further confirmed by trading induced-value tickets of unknown value [21, 22] as well as lottery tickets [23, 24], which resulted in a WTA/WTP disparity and undertrading. Interestingly, uncertainty was not the cause for the disparity observed in the mugs experiment [18], since the bids were made on mugs marked with clearly visible price labels.

The studies mentioned here as well as dozens of others [17] reveal a continuum ranging from induced (known) value tickets, where WTA is found to equal WTP, through market goods, where the disparity exists, and on to nonmarket goods where the disparity is largest. The WTA/WTP ratio approaches unity for induced value items, being usually about 3 for market goods, while for nonmarket goods that ratio is very large, usually about 10.

2.2.1 Theoretical Foundation of the WTA/WTP Disparity

The main psychological explanations of the WTA/WTP disparity are loss aversion [18, 19, 25] which is based on Prospect Theory [26], and the degrees of similarity and uncertainty in the cases of induced value tokens and lottery tickets [23, 24]. The main economic explanations are the substitution effect [20, 27], the tradeoff between the price of information and the expected payoff [28] and intrinsic value [29].

The Prospect Theory approach received experimental economic substantiation [30]. Similarity observed in psychological experiments [31] is equivalent to economists’ explanations of the substitution effect. Psychologists also acknowledged that lack of commensurability is necessary for the EE to manifest itself [18], again a hint for the substitution effect. The immunity of induced value tickets to the Endowment Effect also supports the substitution effect explanation as such tickets have perfect substitutes when their values are known. The degree of uncertainty or the amount of information provided have also been researched both by psychologists and by economists. The results in all cases show similar trends. Psychological theory proposed in order to explain the WTA/WTP disparity is based on observations of human behavior. This is in line with economic models, which in this area of research are inductive and based on experimental markets rather than on traditional economic assumptions. Overall it can be said that economic and psychological research are moving in the same direction, thus lending support to each other. The main underlying causes of the EE seem to be loss aversion and the substitution effect with their respective outgrowths. Variables that influence the EE are the type of good traded (induced-value, market, nonmarket) and the existence and availability of substitutes, which imply the availability of information on the market.

2.3 Implications for the Subjective Value of Information

A choice to pursue information for decision making is a result of the desire to reduce the uncertainty that characterizes certain decisions. Information in this sense is not a regular consumer good; it is more like a raw material consumed in the production of other goods down the value chain. The decisions as to what kind of information will aid in reducing the uncertainty, where to look for information, and what is the information worth are in themselves made under uncertainty. One rarely knows in advance what kind of information one will find, what will be the quality of that information, and to what extent will it actually reduce uncertainty. All this stems from the fact that information is an experience good, the value of which is revealed only after consumption and from a lack of access to meta-information. Research that would shed light on the value of information prior to consumption or what influences value formation will be of importance to information consumers, content providers, decision makers, and information system designers.

The result of the WTA/WTP disparity, or of the EE, is that it creates undertrading. Fewer trades take place than should have occurred under standard economic assumptions. As cited earlier, lack of information contributes to an increase in the WTA/WTP divergence and hence leads to undertrading. Conversely, abundance of information suggests an accelerated pace of trade. Information is an economic catalyst. Increasing its

perceived value and the demand for it should be the objective of any market-oriented organization in wishing to increase the number of trades. Since information is often a crucial component of market goods, enhancing the value of that information would enhance the overall value of the goods and diminish undertrading.

Substitution effect theory should predict a large WTA/WTP disparity for information. This is due to its inherent nature as an experience good, each item of content being unique. On the other hand, the abundance of free information on the Internet and searchers' inclination to seek free content suggest a low subjective value for information producing parity between WTA and WTP. In light of this contradiction we have chosen to begin our investigation with a fundamental question about the WTA and the WTP for information in order to form a basis for further research on factors influencing these values and other issues of importance.

Our research questions are: Where is information found on the WTA/WTP disparity continuum? Where is expertise found on this continuum? What is the effect of originality? In other words, are people sensitive to originals versus copy in their valuation of information. Our hypotheses are: H1: The WTA/WTP ratio for information (content or expertise) is greater than unity and is similar to that of private goods. H2: The WTA/WTP ratio for content is larger than the WTA/WTP ratio for expertise. H3: The WTA/WTP ratio for original information (content or expertise) is larger than for copy information. H4: There will be an interaction between the source of information (content or expertise) and its originality (original or copy).

3. Methodology

3.1 Research Instrument

A Java-based animated computer simulation of an easy-to-understand business game called "The Lemonade Stand" was used as the experimental instrument. In this simulation the player owns a lemonade stand and must operate it so as to maximize his/her profits by selling to passers-by. Information about expected weather and assumptions about its effect on demand may affect choices regarding inventory and prices. Participants are offered the chance to trade (buy or sell) this information, in addition to making decisions about inventory and prices. A detailed description of the simulation game can be found in previous manuscripts [32-34].

3.2 Procedure

The experiment was launched by a detailed in-class presentation of the simulation along with handouts that consisted of the instructions and sample screenshots. A prize was offered to the player who would achieve highest profits. Participants were told that profits could be made in two ways: 1. By trying to optimize the inventory, lemonade quality, and price per cup depending on the

weather data (if available). 2. By trading information (selling generates direct income, while buying information can generate indirect payoffs if played wisely).

A full description of the experimental session can be found elsewhere [32, 34, 35]. Market prices of the information trades were built into the simulation but were not known or revealed to the players. They were only told that market prices were to be determined randomly and that trades would be executed at market prices if the bids they offered were acceptable. This was done to ensure incentive compatibility according to the Becker-DeGroot-Marschak principle [36], known in the literature as the BDM method. In BDM, trade takes place only if bids are compatible with current market prices. BDM is therefore a useful method in eliciting private values and is a popular tool in studies of the Endowment Effect.

Participants: Two hundred and ninety four students in two groups of, respectively, one hundred and fifty and one hundred and forty four participated in the experiment as part of a class requirement. One group was presented with information as content, the other group was presented with information introduced as expertise. Participants were told, variably, about the origin of the information as being either a document or a human expert. Within each group the order of presentation of bids changed according to a Latin Square so that some participants received the buying scenario first while others received the selling scenario first. Each participant had four opportunities to bid: Buy original, sell original, buy copy, sell copy. The experimental design was, therefore 2X2X2: Buy vs. Sell; Original vs. Copy and Content vs. Expertise.

The players were seated in a computer lab with an individual computer for each player. They were not allowed to interact with each other but were allowed to ask the experimenter for clarifications. The experiment yielded one value for each type of bid for the weather information for each participant. The entire experiment lasted an hour and a half, which included the presentation, the warm-up games, and the four games with bidding.

A brief introduction to the game, a Powerpoint presentation, and a link to the game itself are available at: <http://gsb.haifa.ac.il/~draban/lemonade/>

4. Results

This section details the results received in the EE experiments. These results reflect data collected from two hundred and ninety four (294) students who provided their private value bids for buying and selling information as described in section 3.2. The data from the four groups of each of the two levels of the independent variable 'source' (content and expertise) have been combined for the analysis that follows. This analysis has been performed in order to test hypotheses H1-H4 listed in Section 2.3.

Explanation of acronyms used in the tables that follow:
WTP – Willingness to pay for original weather

information

WTA– Willingness to accept payment for original weather information

WTPC – Willingness to pay for a copy of weather information

WTAC – Willingness to pay for a copy of weather information

WTA/WTP – EE ratio for original information

WTAC/WTPC –EE ratio for copy information

H1: The WTA/WTP ratio for information (content or expertise) is greater than unity and is similar to that of private goods.

To test this hypothesis one sample t-tests were performed to compare the mean ratios of content and expertise with the values of one and three. Table 1 summarizes the findings of these tests for original and copy content and expertise.

Table 1: Results for one-sample t-tests comparing the means of the ratios for original and copy content and expertise to values of 1 and of 3.

	Mean Ratio	Std. Dev.	Test Value=1		Test Value=3	
			t	Sig.	t	Sig.
Orig. Cont.	2.79	3.45	6.37	0.00	-0.73	0.46
Orig. Expt.	2.74	3.01	6.95	0.00	-1.03	0.31
Copy Cont.	2.04	2.76	4.60	0.00	-4.27	0.00
Copy Expt.	1.85	2.27	4.53	0.00	-6.07	0.00

Table 1 clearly shows that the mean ratios for original content and expertise are significantly different than unity. The mean ratios for original content and expertise are not significantly different from three while the same ratios for copy of content or expertise are significantly different (lower) than 3. Additional analysis revealed that the ratios for copy content and expertise are not significantly different from a value of two.

H2: The WTA/WTP ratio for content is larger than the WTA/WTP ratio for expertise.

To test this hypothesis independent samples t-tests were performed to compare the mean ratios of content and expertise. Table 2 summarizes the findings of these tests for original and copy content and expertise.

Table 2: Results for independent samples t-tests comparing the means of the ratios for original and copy content and expertise.

	Mean Ratio	Std. Dev.	t	Significance
Original Content	2.79	3.45	-1.33	0.89
Original Expertise	2.74	3.01		
Copy Content	2.04	2.76	-0.62	0.54
Copy Expertise	1.85	2.27		

Table 2 shows that the mean ratios for original and copy content and expertise do not significantly differ, meaning that participants did not assign different values to different sources of information.

H3: The WTA/WTP ratio for original information (content or expertise) is larger than for copy information.

To test this hypothesis a paired samples t-test was performed to compare the mean ratios of original content and expertise and copy content and expertise. Table 3 summarizes the findings of the test of the independent variable 'originality'

Table 3: Results for a paired samples t-test comparing the means of the ratios for original and copy content and expertise.

	Mean Ratio	Std. Dev.	t	Sig.
Original Content and Expertise	2.77	3.24	3.64	0.00
Copy Content and Expertise	1.95	2.53		

Table 3 reveals that original information is valued significantly higher than copy information.

H4: There will be an interaction between the source of information (content or expertise) and its originality (original or copy).

To test this hypothesis a univariate ANOVA was performed to compare the variances of original content and expertise ratios and copy content and expertise ratios and to test for interaction effects between the independent variables, source and originality. Table 4 summarizes the findings of the test of the independent variable 'originality'

Table 4: Results for a univariate ANOVA comparing the variances of the ratios for original and copy content and expertise and the interactions between them.

Independent Variable	F	Sig.
Originality	11.74	.00
Source	.24	.63
Originality*Source	.08	.78

Table 4 shows that while different levels of originality bear a significant influence on private values, there is no significant difference attributed to the source of information. This is in agreement with findings shown in Table 2. In addition, Table 4 shows there is no interaction effect between the two independent variables, originality and source. Originality is significant regardless of the source. The value attributed to a specific source does not change with different levels of originality.

3. Discussion

Based on performance in a simulated business management task we have found, as hypothesized, that the subjective value of information does indeed follow the predictions of Endowment Effect theory. Participants revealed a ratio of Willingness to Accept to Willingness to Purchase (WTA/WTP) that resembles the ratio common in the case of private goods. It should be emphasized that this ratio should (analytically) approach unity. However, the empirically revealed preference here places this ratio elsewhere. Of the 294 subjects, we also found support for the hypothesis that the WTA/WTP diverges from unity more often and in a more pronounced manner for information traded in the “original” form rather than as a copy of the original, although even for copies the WTA/WTP ratio is still double. In other words, the realization that information is owned exclusively attenuates the Endowment Effect.

Another way to examine the same result is to state that exclusive access to information, that is enforceable by information systems (such as information security, encoding, etc.) might strengthen the endowment effect on subjective valuation of information.

The high variance of the ratios for copy information occurred in part as a result of a large number of people submitting bids which resulted in ratios smaller than one. This is an interesting observation because it means that participants realized that they could make a quick profit from selling information which they could later still use for themselves. This indicates a very good understanding of the game rules. Further statistical analysis of the initial data confirmed our findings. When comparing the ratio components, WTA for expertise with WTA for content, as well as WTP for expertise and for content no significant differences are observed although values for expertise were always higher than for content. WTAC for expertise

and content have been found to have a statistically significant difference ($t=2.68$; $p<.01$) and so have WTPC for expertise and content ($t=2.38$; $p<.02$). This confirms the previous finding relating to the higher value assigned to original than to copy information.

The trend toward higher value for expertise without statistical significance raises some thoughts. It shows the flattening effect of the computer where the typical e-business decision maker has to imagine an expert or a document based on text displayed on a screen. In addition, the large bidding scale in this experimental setup induced variance. Participants could place bids between 0 and 100 dollars for either buying or selling. The scale is even larger considering that decimals were allowed. Research in social science usually involves using a smaller scale such as seven-point Likert scales. The scale was not defined by any anchors which provide meaning to specific choices. Again, scales used in social sciences often have anchors such as “agree” and “disagree”. In our scale there was no ‘right’ or ‘correct’ answer. Our scale in effect is a one item measure, in contrast to psychological measures where several items are used to quantify specific traits or constructs.

The high variance is in accord with the high uncertainty associated with buying and selling experience goods. The value of experience goods is not known a priori and there is no indication for it. Perhaps smaller variance will be achieved if a ‘preview’ is made available for the weather forecast in our game. Examples of ‘previews’ for other information experience goods include abstracts of articles and film previews.

If we look at the same issue from a different angle, in electronic commerce bidding is always a one item measure. This characteristic can be manipulated. For example, a wide scale without anchors may induce higher bids which are in the interest of auction sites.

The value assigned to specific information by a certain person can vary according to external circumstances. This implies that subjective value is inherently unstable. Social science usually aims to identify stable or generalizable phenomena. Here instability is inherent. External circumstances include parameters such as timeliness, form, and content[9]. These parameters change per person and between people and are perceived differently especially when there is uncertainty about information.

While the first and third hypotheses were held up by our data, we found no support for the hypothesis regarding differences in valuation due to the source of information. Attributing the information to expertise or to a document had no significant impact on the WTA/WTP ratio. In other words, the subjective value of information is not variously affected in these results by the nature of the information. This result is surprising as we intuitively assumed a difference and because previous research has identified a difference [37]. The difference originally reported in the literature was attributed to ownership. Expertise was perceived to be privately owned rather than owned by the

organization. Information as product, a computer program, was perceived to be more organizationally owned. Sharing an organizationally owned information product was found to be mediated by prosocial transformation, people weighed the social good more than their personal benefits. In other words, according to this research when it comes to tacit knowledge, personal ownership supported sharing more than organizational ownership. This finding runs contrary to the general consensus in the knowledge management literature, which stresses the main difficulty as sharing tacit knowledge [6]. Thus, the findings of the present study align better with the knowledge management literature than with our specific hypothesis H2. In a later study [38] a product, a computer program, was perceived to be organizationally-owned and led to less sharing than privately-owned expertise. Both studies cited here were concerned with sharing information while the present focus is on trading information. It seems that people may behave differently when sharing information than when they are faced with the choices of buying and selling information.

To summarize, when trading information, as opposed to sharing it, people are sensitive to originality but not to the source. When access to some information is limited to a privileged few sets of eyeballs, that information is accorded or assigned a high value. When the information, content or expertise, becomes commonplace, its value decreases. Is it possible that the well-known economic concept of 'scarcity' governs our trading behavior as it does for other market goods? Is scarce information valued higher than widely-available information? This would mean that either behaviorally or cognitively people have not yet absorbed the concept of 'network economy', that information is distributed mostly by copying and its value does not necessarily decrease because of that. On the contrary, in a network economy value sometimes increases with wider distribution. The value of software is one such example – end-user software is often more valuable as more people use it and become dependent on it for communicating with other users.

Although our findings do not support the distinction between content and expertise and the ownership status implied by these forms of information cited in previous studies, we did find an ownership effect that resonates with the studies on information sharing and studies on EE in other market goods. First, an EE was observed and was statistically significant. EE is attributed to ownership status in the literature [18, 39]. Secondly, the fact that originality played a significant effect in the results shows that ownership matters. If everyone has access then value does drop, but if only one person has exclusive access/ownership value increases. Of course, ownership itself and perceptions of it can be affected and manipulated via system design.

A possible explanation for the surprising lack of significance of the source variable may perhaps be explained by the experimental manipulation. Both sources were explained to the participants textually on screen.

This uniformity of presentation provided experimental control. However, it may be argued that a computer can be used to present different forms of information differently. Perhaps our 'bare bones' controlled design created a flattening effect where any kind of information looks and feels the same. Graphics, sounds, and more elaborate texts could have contributed to stronger differentiation between both forms of information. This would be difficult to operationalize while keeping experimental control. Another way to examine perceptions of types of information is to experiment with stronger contrasts. Information in our experiment was important for estimating market demand for lemonade but perhaps it was not perceived as critical information. Experimenting with more critical information may elicit a difference between sources. For example, if a life-or-death situation is described as expertise, say a doctor's advice, it would be valued more than content, say an article taken from an encyclopedia. Another topic which is not a life-death question but could carry strong implications is investment information. Is analyst advice valued more than an information flier distributed by a bank? Another example may be related to professional decisions. Would we value an article we read in a work situation more than seeking an expert's advice? It would be interesting to see if a larger gap between EE ratios is revealed with further research, running the simulation game varying the criticality of the information. Of course the most obvious path for further research is to expand work on sharing information. What are the equivalent dimensions to WTA/WTP when sharing rather than trading is at stake?

Our research shows a value of about three for the WTA/WTP ratio for original information regardless of whether the source is content or expertise. The similarity between content and expertise may be attributed to some extent to the trading scenario and to some extent to the flattening effect of our simulation. However, some of our results indicate that source may become significant depending on the degree of criticality, or, in other words, source can be manipulated by system design to become more salient. Copy information received a subjective value which was significantly different (lower) than original information. This observation invites further research into information system users' perceptions of the information economy. Information systems can be used to enhance understanding of network economy and they can be used to manipulate prevailing perceptions. Finally, since the 'source' variable did not display statistical significance, it came as no surprise that no interaction with the 'originality' variable was observed. In summary, studying the subjective value of information by using a computerized simulation of a simple business game as an experimental setting where EE methodology was applied proved to be a very productive research line which should be further elaborated by future work. The nature of information which is transferred by sharing, not just by trading, also invites research which would use a similar platform to assess the interplay or interdependence between trading and sharing content and expertise.

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Success Factors for Implementation of Electronic Commerce by Small and Medium Enterprises

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ABSTRACT

Electronic commerce becomes an essential part of business processes for many business firms. Electronic commerce has a particularly important implication for small-to-medium-sized enterprises (SME's) because the form of competition and business process has dramatically changed in the recent years due to the internet and on-line business activities.

This paper investigates various issues about implementation of electronic commerce by surveying a group of Korean SME's as a sample. This study focuses on finding out the critical factors for successful implementation of electronic commerce by SME's. Our research model is more comprehensive than the ones used in the previous research by including moderating variables in the context.

1. INTRODUCTION

Electronic commerce (EC) is rapidly becoming an essential part of business processes for many business firms. It has a particularly important implications for small to medium-sized enterprises (SME's) because the form of competition and business process has dramatically changed in the recent years due to the internet and on-line business opportunities.

Previous research on e-commerce has mostly focused on finding out the determinants of adoption and diffusion of e-commerce. [1] [4] [5] [7] Now that the engaging in e-commerce (EC) becomes a norm for most business firms, it is necessary to decide what type of EC would be most effective for a certain situation.

This paper investigates various issues about implementation of electronic commerce by SME's. Our study has two distinctive aspects compared to the previous research. Firstly, we focus on small to medium-sized business firms because they are different from large enterprises [2] [3], and comprise a large portion of national economy in the developing countries. Secondly, we use a more comprehensive research model than the previous research by including moderating factors in the model (Figure 1.).

2. RESEARCH METHODOLOGY

2.1 Research Model and Hypotheses

While previous studies focused on the adoption issues [1] [4], this paper is to investigate a more comprehensive relationship among the factors that affect the adoption, implementation, and performance of the EC by small and medium enterprises as shown in the research model (Figure 1). For each part of the relationship indicated as H1, H2 and H3, twelve hypotheses are constructed and tested. Table 1 contains the explanations of the factors, and 36 hypotheses in total are tested as shown in Tables 2 to 4.

Figure 1. Research model for E-Commerce.

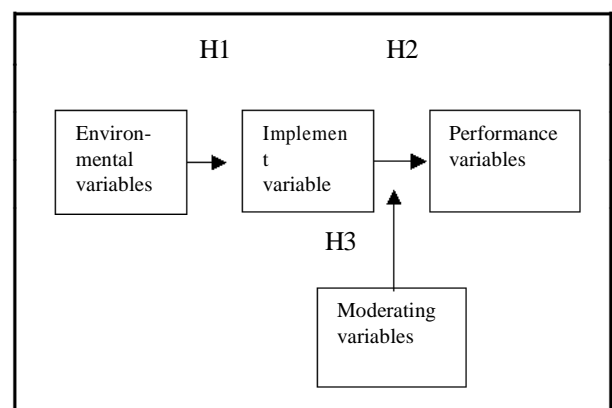


Table 1. Explanation of the variables.

Variables	Contents
Environmental variables	- Type of industry - Age of the firm - Environmental uncertainty
Implementation variables	- Type of EC (B2B, B2C, B2G) - Scope of EC - EC strategy - Characteristic of EC
Moderating variables	These are the general condition of a firm's information system (IS) measured by IS maturity.
Performance variables	These are the firm's performance measured by - Utilization of EC - Satisfaction from EC implementation - Usefulness of EC

H1: Hypotheses on firm environment and EC implementation:

The firm's decision on what type of EC to implement is

affected by the environment in which the firm operates. The external environment affects a firm's decision on EC implementation in such areas as the types, scope, strategy, and characteristics of EC. Twelve hypotheses are tested and the details are listed in Table 2.

H2: Hypotheses on EC implementation and firm performance:

The performance of a firm is affected by the type of EC which the firm implements. A firm's performance is generally improved by implementation of electronic commerce. The magnitude of improvement, however, would be different by the type of EC system implemented by a firm. The details of the hypotheses are listed in Table 3.

H3: Hypotheses on moderating effect:

The impact of the EC implementation on the firm's performance would be affected by the moderating variables that show the general condition of the firm's information system such as IS maturity. The details of the hypotheses are listed in Table 4.

Table 2. Hypotheses on firm environment and EC implementation.

Number	Hypothesis content
Hypothesis 1	Type of industry determines the type of EC that a firm implements.
Hypothesis 2	Type of industry determines the scope of EC that a firm implements.
Hypothesis 3	Type of industry determines the strategy of EC that a firm implements.
Hypothesis 4	Type of industry determines the characteristics of EC that a firm implements.
Hypothesis 5	Age of the firm affects the type of EC that a firm implements.
Hypothesis 6	Age of the firm affects the scope of EC that a firm implements.
Hypothesis 7	Age of the firm affects the strategy of EC that a firm implements.
Hypothesis 8	Age of the firm affects the characteristics of EC that a firm implements.
Hypothesis 9	Environmental uncertainty affects the type of EC that a firm implements.
Hypothesis 10	Environmental uncertainty affects the scope of EC that a firm implements.

Hypothesis 11	Environmental uncertainty affects the strategy of EC that a firm implements.
Hypothesis 12	Environmental uncertainty affects the characteristics of EC that a firm implements.

Table 3. Hypotheses on EC implementation and firm performance.

Number	Hypothesis content
Hypothesis 13	EC utilization is affected by the type of EC implemented.
Hypothesis 14	EC satisfaction is affected by the type of EC implemented.
Hypothesis 15	EC usefulness is affected by the type of EC implemented.
Hypothesis 16	EC utilization is affected by the scope of EC implemented.
Hypothesis 17	EC satisfaction is affected by the scope of EC implemented.
Hypothesis 18	EC usefulness is affected by the scope of EC implemented.
Hypothesis 19	EC utilization is affected by the strategy of EC implemented.
Hypothesis 20	EC satisfaction is affected by the strategy of EC implemented.
Hypothesis 21	EC usefulness is affected by the strategy of EC implemented.
Hypothesis 22	EC utilization is affected by the characteristics of EC implemented.
Hypothesis 23	EC satisfaction is affected by the characteristics of EC implemented.
Hypothesis 24	EC usefulness is affected by the characteristics of EC implemented.

Table 4. Hypotheses on moderating effect.

Number	Hypothesis content
Hypothesis 25	The impact of EC type on EC utilizat

	ion is affected by IS maturity.
Hypothesis 26	The impact of EC type on EC satisfaction is affected by IS maturity.
Hypothesis 27	The impact of EC type on EC usefulness is affected by IS maturity.
Hypothesis 28	The impact of EC scope on EC utilization is affected by IS maturity.
Hypothesis 29	The impact of EC scope on EC satisfaction is affected by IS maturity.
Hypothesis 30	The impact of EC scope on EC usefulness is affected by IS maturity.
Hypothesis 31	The impact of EC strategy on EC utilization is affected by IS maturity.
Hypothesis 32	The impact of EC strategy on EC satisfaction is affected by IS maturity.
Hypothesis 33	The impact of EC strategy on EC usefulness is affected by IS maturity.
Hypothesis 34	The impact of EC characteristics on EC utilization is affected by IS maturity.
Hypothesis 35	The impact of EC characteristics on EC satisfaction is affected by IS maturity.
Hypothesis 36	The impact of EC characteristics on EC usefulness is affected by IS maturity.

2.2 Data Collection and Analysis

We have circulated survey questionnaires to collect data from the SME's in Korea. A total of 74 firms returned the questionnaires, and 51 of these were used for analysis after excluding those with missing data and non-SME's. The profile of the respondents are as follows (Table 5). Statistical tests are used to analyze the data and to find out the answers for the hypotheses presented in the above.

Table 5. Profile of respondent firms.

Type of industry	Number of firms	Proportion
Manufacturing	25	49%
Sales/Distribution	6	11.8%
Service/IT/Technology	14	27.5%
Others	6	11.8%
Total	51	100%

3. ANALYSES AND RESULTS

Tables 6 through 8 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.

3.1 Business Environment and EC Implementation

The hypotheses about the effect of the business environment on the firm's decision on EC implementation are tested. Three variables are selected to define the firm's business environment: type of industry, age of the firm, and environmental uncertainty. Four dimensions of the firm's decisions are analyzed: the types of EC, the scope of EC implementation, EC strategy, and EC characteristics. The types of EC for firm's selection include Business-to-Business (B2B), Business-to-Customer (B2C), and Business-to-Government (B2G).

The results in Table 6 show that among the three environmental variables only the industry type affected two aspects, EC type and EC scope, of a firm's implementation decision. The other two environmental variables are found to have no effect on the firm's decision on the various EC implementation issues such as type, scope, strategy, and characteristics of electronic commerce.

Table 6. Impact of business environment on EC implementation.

Environmental variable	Implementation variable	Test	Result (p-value)
Type of industry	EC type	X ² test (Cross tabulation)	accept (0.025)
	EC scope	ANOVA	accept (0.028)
	EC strategy	X ² test (Cross tabulation)	reject (0.119)
	EC characteristics	X ² test (Cross tabulation)	reject (0.554)
Age of the firm	EC type	X ² test (Cross tabulation)	reject (0.310)
	EC scope	ANOVA	reject (0.438)
	EC strategy	X ² test (Cross tabulation)	reject (0.410)
	EC characteristics	X ² test (Cross tabulation)	reject (0.406)
Environmental uncertainty	EC type	X ² test (Cross tabulation)	reject (0.731)
	EC scope	ANOVA	reject (0.826)
	EC strategy	X ² test (Cross tabulation)	reject (0.256)
	EC characteristics	X ² test (Cross tabulation)	reject (0.164)

* Results indicate whether the hypothesis is accepted at the significance level of $\alpha = 0.05$.

3.2 EC Implementation and EC Performance

We tested the relationship between the four EC implementation variables discussed above, EC type, EC scope, EC strategy and EC characteristics, and the EC performance experienced by the firm measured in utilization, satisfaction and usefulness. The average

performance is compared between the groups of firms implementing the same type of EC and with the same degree of scope, etc..

Among the hypotheses tested, three turned out to have significant results as shown in Table 7. EC scope is found to have significant effect on EC utilization and on EC usefulness. That is, those firms that use EC on a wide range of business activities show a higher level of EC utilization and usefulness. Also, EC strategy has significant effect on EC utilization. Firms that adopt differentiation strategy, i.e., using EC for differentiating themselves from the competitors, show a higher EC utilization than the other two groups adopting either cost-leadership or niche-market strategies.

Table 7. Impact of EC implementation on EC performance.

Implement- ation variable	Performance variable	Test	Result (p-value)
EC type	EC utilization	ANOVA	reject (0.207)
	EC satisfaction	ANOVA	reject (0.743)
	EC usefulness	ANOVA	reject (0.924)
EC scope	EC utilization	Correlation test	accept (0.001)
	EC satisfaction	Correlation test	reject (0.359)
	EC usefulness	Correlation test	accept (0.041)
EC strategy	EC utilization	ANOVA	accept (0.051)
	EC satisfaction	ANOVA	reject (0.584)
	EC usefulness	ANOVA	reject (0.471)
EC characteris- tics	EC utilization	t-test	reject (0.406)
	EC satisfaction	t-test	reject (0.117)
	EC usefulness	t-test	reject (0.192)

* Results indicate whether the hypothesis is accepted at the significance level of $\alpha = 0.05$.

3.3 Moderating Effect of IS Maturity

From the preliminary tests, we found that only information system (IS) maturity has a sizable impact among the three moderating variables, IS maturity, IS intensity and organizational capability. The IS maturity of a firm is measured by the firm's knowledge and attention for the EC system. The moderating effect of IS maturity on the relationship between EC implementation and EC performance is examined.

As shown in Table 8, IS maturity is found to have a significant impact on the some aspects of the relationship between EC implementation and EC performance. Firstly, IS maturity has affected the relationship between EC scope

and EC utilization in that the effect of EC scope on EC utilization increases as the IS maturity gets higher. Secondly, firms tend to show significant difference in satisfaction from the EC implementation depending on what EC strategy they adopt when their IS maturity level is low. However, when the IS maturity level is high, EC strategy does not cause difference in satisfaction among the firms. They tend to experience same level of satisfaction from the EC implementation regardless of the EC strategy adopted.

Table 8. Moderating effect of IS maturity on the relationship between EC implementation and EC performance.

Implement- ation variable	Perform- ance variable	IS maturity	Test	Result (p-value)
EC type	EC utilization	High	ANOVA	reject (0.695)
		Med	ANOVA	reject (0.516)
		Low	ANOVA	reject (0.258)
	EC satisfaction	H	ANOVA	reject (0.890)
		M	ANOVA	reject (0.417)
		L	ANOVA	reject (0.177)
	EC usefulness	H	ANOVA	reject (0.522)
		M	ANOVA	reject (0.593)
		L	ANOVA	reject (0.592)
EC type	EC utilization	H	Correlatio n test	reject (0.858)
		M	Correlatio n test	accept (0.007)* **
		L	Correlatio n test	reject (0.071)*
	EC satisfaction	H	Correlatio n test	reject (0.874)
		M	Correlatio n test	reject (0.868)
		L	Correlatio n test	reject (0.376)
	EC usefulness	H	Correlatio n test	reject (0.416)
		M	Correlatio n test	reject (0.100)*
		L	Correlatio n test	reject (0.293)
EC strategy	EC utilization	H	ANOVA	reject (0.175)
		M	ANOVA	reject (0.656)
		L	ANOVA	reject (0.468)
	EC satisfaction	H	ANOVA	accept (0.016)* *
		M	ANOVA	reject (0.083)*
		L	ANOVA	reject (0.656)

EC characteristics	EC usefulness	H	ANOVA	accept (0.020)*
		M	ANOVA	reject (0.756)
		L	ANOVA	reject (0.677)
	EC utilization	H	t-test	reject (0.473)
		M	t-test	reject (0.535)
		L	t-test	accept (0.038)*
	EC satisfaction	H	t-test	reject (0.450)
		M	t-test	reject (0.259)
		L	t-test	reject (0.077)*
	EC usefulness	H	t-test	reject (0.492)
		M	t-test	reject (0.196)
		L	t-test	accept (0.024)*

Note: Results indicate whether the hypothesis is accepted at the significance level of $\alpha = 0.05$.

*: $p < 0.1$; **: $p < 0.05$; ***: $p < 0.01$

4. CONCLUSION

We have found several factors important for successful implementation of electronic commerce (EC). They are the type of industry for environmental factor, the scope of EC and the EC strategy that firms adopt for implementation factors. Lastly, IS maturity is found to be important as moderating factor for certain combinations of implementation and performance variables.

From the results, we could find that EC becomes more effective when firms use it for a longer period of time and for a wider range of business activities. In other words, the longer and larger the investment in EC, the better result a firm can expect. Electronic commerce are said to help small-and-medium enterprises (SME's) compete against large firms on a more level ground by moving the competition from the physical market place to cyber market space and thus reducing the marketing and distribution cost. It seems, however, that firms need a substantial and sustained investment in EC to enjoy the benefits from its use. SME's need to understand that EC is not a cheap solution to increase its competitive power as it seems.

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The Impact of Strategy on Corporate Success in Electronic Business

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Abstract

While the necessity for taking a strategic approach at the Internet and electronic commerce has often been stressed, there is a lack of broad empirical evidence for the resulting benefits. Existing work is either conceptual or, if empirical, rather specific, e.g. based on case studies.

We contribute to closing this research gap, providing empirical evidence from a numerical base of 443 general cases. Based on existing theory, we investigate the business value of having a dedicated Internet strategy and of pursuing each of the three competitive strategies according to Porter's typization, namely cost leadership, differentiation, and customer focus. With a simple path model, we test the impact of these four factors on corporate success in electronic business for different subsets of the numerical base.

We find that in general and for B2C companies, a dedicated Internet strategy as well as the pursuit of the cost leadership or customer focus strategy are success factors, whereas for B2B companies, only a dedicated Internet strategy and the pursuit of the cost leadership strategy prove to be effective. The general findings are independent of company size and of companies' experience on the Web. If the companies are divided into three groups according to the fraction of revenues they generate from online sales, only one distinct success factor remains for every group.

1. Introduction

Particularly since the burst of the dot-com bubble and the failure of many Internet ventures, which had been launched by start-ups as well as by traditional companies, the importance of taking a sound strategic approach on the Internet and in electronic commerce has often been stressed, yet the realization in practice seems to be far behind. As Porter complains in his 2001 article [17], "many of the pioneers of the Internet business [...] have competed in ways that violate nearly every precept of good strategy", leading to the consequence that "price has been defined as the primary if not the sole competitive variable". This may in part be due to a lack of insight from existing research in the area, which covers issues including:

- how the Internet impacts and transforms industries and markets, i.e. the environment in which companies operate and position themselves with their strategies, e.g. [6] [17],
- the process of designing and implementing a strategy for the Internet, e.g. [11] [19] [18], or [20], and
- how the Internet as an extra communications, sales, and distribution channel can be used and integrated with existing channels, [5] [10] [14] or [4], especially with respect to the pricing of goods and services offered online, [9] [2], or [8].

Yet, most of the existing contributions focus on a particular industry (e.g. the financial industry), business model (such as retailing, [6]), or customer segment (such as B2C, [18]). Plus, many of them are conceptual analyses. However, there has been only little work showing empirical evidence how, and if at all, the strategic use of the Internet and the pursuit of competitive strategies in electronic commerce contribute to the overall success which companies achieve with their Internet activities, e.g. [3] [13], whereas a rich body of literature studies the effect of corporate strategy on business performance in conventional companies, e.g. [12]. Due to this lack of general empirical evidence, the business benefit or business value from implementing a dedicated Internet strategy remains unclear, especially to corporate decision makers. For the same reason, executives are still unsure about what they can expect from the different options of competitive strategy in electronic commerce. We therefore posit the following research questions:

1. Is a dedicated Internet strategy a driver for success in electronic business?
2. Which competitive strategy is a success factor in electronic business? Is there any competitive strategy that works best or that doesn't work and why?
3. How (and why) does the role of the above factors vary depending on:
 - a. control variables, such as company size and online experience,
 - b. the main customer segment (i.e. if it is a B2B or a B2C-company), or

- c. the fraction of revenues generated online (i.e. degree of “digitization”)?

In order to investigate these research questions, we develop a research model which is then tested against empirical data collected in a large-scale survey with 443 cases in the German-speaking market, which is one of the key international E-Business markets.

The remainder of this article is structured as follows: The research model is developed in the next section, where we first give a concise definition of a dedicated Internet strategy and formalize different strategic options in electronic commerce. Then, we develop the model structure and explain our research approach. In the third section, the survey, the statistical analysis, and its results are presented. In the fourth section, we interpret and discuss the major findings, contributions and shortcomings of our research. Finally, we discuss the implications of our work for further research and for practice.

2. Research Model

2.1 Theoretical Background

In a general, we define the term “strategy” as “the manner in which a firm decides to compete, which encompasses the pursuit, achievement, and maintenance of competitive advantage” [12], “the creation of a unique and valuable position, involving a different set of activities”, “making trade-offs in competing”, and “creating fit among a company’s activities” [16]. A strategy should be a fundamental, long-term, and sustainable guideline for a company. Accordingly, we term a strategy that specifically targets Internet issues, i.e. the use of the Internet to support, transform, conduct, or extend a firm’s business activities, a dedicated Internet strategy. Further, we employ Porter’s 1980 typization [15] to review different options of competitive strategy, which we apply to electronic commerce:

1. Cost leadership, being the competitor with the lowest costs and cheapest prices.
2. Differentiation, realizing price premiums by distinguishing one’s product and service offering from competitors’ offerings with unique features.
3. Customer focus, concentrating on specific market segments and pursuing either the “cost leadership” or “differentiation” strategy within these segments.

There has been much dispute about which of these strategic options prove viable in electronic commerce. E.g., Sinha argues that the Internet greatly threatens the “differentiation” strategy, because it lowers buyers’ search costs and eventually leads to cost transparency [21], leading to competition mainly driven by costs. Clemons et al., on the other hand, propose that due to the abundance of available information, as “transparency goes both ways” companies have a larger knowledge about their customers than ever before. Therefore, through highly differentiated product and service offerings, they can charge prices nearly independent of actual costs, but largely depending on customers’ valuation [7]. Finally, Baker et al. contend that based on this level of customer knowledge, companies can segment their markets with high-resolution and precision (ideally target customers individually) and, through segment-specific pricing, particularly profit from skimming the high customer valuations [2].

2.2 Derivation of Hypotheses and Model Development

Based on the above discussion, we translate our research questions in order to formulate our model hypotheses. As the dependent construct for our analysis, we employ the construct of corporate success in electronic business, thus simplifying the consequential chain of causes and effects (implementation of a strategy determines the way a company acts on the market, which translates into reactions from the market, and, ultimately, contributes to the success or failure of a company) to the top-level outcome. We thereby assume an integrated perspective and choose the corporate level as the level of analysis as well as the whole company as the object under study. We obtain:

- H1: Having a dedicated Internet strategy increases companies’ success in electronic business.
- H2: Pursuing the ‘cost leadership’ strategy in electronic commerce increases companies’ success in electronic business.
- H3: Pursuing the ‘differentiation’ strategy in electronic commerce increases companies’ success in electronic business.
- H4: Pursuing the ‘customer focus’ strategy in electronic commerce increases companies’ success in electronic business.

Further, we neglect the impact which other factors not linked to strategy have on corporate success in electronic business. Our research model is displayed in Figure 1:

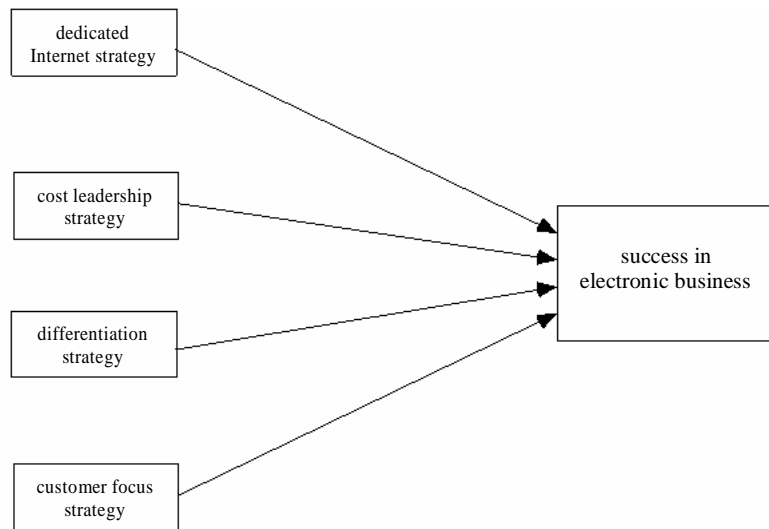


Figure 1: Research model

3. Method

3.1 The Survey

The numerical data used in the statistical analysis of this model has been collected in a large survey that was conducted from May to June 2000. The questionnaire and a comprehensive descriptive analysis of the results have been published as the “e-reality 2000” study in September 2000 [22]. Among other issues, such as readiness for electronic business or adoption of the Internet and electronic business concepts, the purpose of this survey was to measure companies’ strategic approach towards the Internet and electronic business on a corporate-level, and, especially, the success or failure so far achieved in electronic business.

To gather data, market research professionals conducted personal interviews with upper- to top-level executives in 1308 companies in the German-speaking area (Germany, Austria, and Switzerland), who were in charge of their companies’ electronic business activities. The sample of companies for conducting the interviews was drawn from a data base of companies, such as to render the survey representative with respect to geographic region, company size in terms of employees, and industry. In case that an interview could not be conducted as planned, a replacement was determined from the same superset in order to maintain the representativity of the sample.

3.2 Aggregation and Preprocessing of the Survey Data

Prior to the statistical analysis, the gathered raw data is reduced and condensed to an essential subset as follows: At first, we concentrate on companies who had a Web page online at the time of the survey, reducing the original data set of 1308 cases to 730 cases (or 55.8%). (Another 171 companies, or 13.0%, were still planning to

launch their site within the next 12 months.) In a second step, we focus on companies who specified that they had yet gained sufficient online experience such as to provide information on the success of their company’s electronic business activities, diminishing the number of cases to 469. Then, in a third step, we eliminated those cases exhibiting excessive missing values in the 13 question items (i.e. more than 6 items, corresponding to more than 50% of the items left unanswered) covering the success of their company’s electronic business activities, leaving a total of 443 valid cases for the numerical analysis.

3.3 Descriptive Analysis

Same as in the original survey, the remaining 443 cases constitute a heterogeneous selection of companies from all industry backgrounds, company sizes, and business models, even if the original claim to be a representative selection for the German-speaking market must be relaxed. The size of 136 companies (corresponding to a fraction of 30.8%) ranges between 1 and 19 employees, that of another 190 companies (42.8%) between 20 and 49 employees, and 95 companies (21.5%) have 50 or more employees.¹ Concerning companies’ experience on the Web, 211 (47.7%) have had a Web presence for up to 2 years, while 229 (51.8%) have owned one for 2 years or more.

A group of 210 companies (or 47.3%) specify consumers as their main customer segment, 205 companies (or 46.3%) state that they mainly serve businesses. Another 15 (or 3.4%) mainly serve administrations, thus consider themselves as B2A-companies. A number of 61 of the businesses (or 13.9%) generate none of their revenue from electronic commerce and can thus be considered traditional “bricks-and-mortar” businesses. Another 106 businesses (23.9%)

¹ In this section, the numbers (fractions) of cases short of the total of 443 (100%) are due to missing values in the question items covering company structure.

generate between 1 and 9% of their revenues from electronic commerce. This group of businesses can be viewed as being in the process of digitizing its processes and, therefore as “clicks-and-mortar” businesses. Further, 73 businesses (16.5%) generate 10 or more percent of their revenues from electronic commerce, suggesting that their electronic commerce activities have reached a stage of maturity, which is why they can be regarded as “true E-Businesses” [1]. Only 8 companies (or 1.7%) generate 50 or more percent of their revenues from electronic commerce.

3.4 Operationalization and Encoding of Variables

In the survey, single indicator variables are used for recording to what extent companies employ a dedicated Internet strategy or each of the three options for the competitive strategy in electronic commerce. The indicator variables constitute metric variables implemented on an equidistant interval (or Likert-like-) scale, ranging from “1” (worded “does not apply at all”, representing strong dissent) to “5” (worded “fully applies”, representing strong agreement). The wording of the indicator variables is as follows:

1. “Does the statement ‘we have defined a strategy which specifically targets Internet issues’ apply to your company?”
2. “Please specify to what extent you pursue each of the competitive strategies listed in electronic commerce, again employing the scale [between 1 and 5].”
 - a. “Cost leadership (cheapest prices within an industry or a segment).”
 - b. “Differentiation (separation from competition through uniqueness with respect to quality, innovative offerings, processing time, etc.).”
 - c. “Customer Focus (competitive advantage through individualization of customer relationships, concentration on smallest customer segments, mass customizing).”

3.5 Measuring Corporate Success in Electronic Business

We limit our view on the concept of corporate success in electronic business to the shareholders’ perspective. The concept is conceptualized such as to accommodate for the major theories on competitive advantage, value creation and firm performance [1]. It is operationalized as a score value obtained from an unweighted addition of the values of 13 indicator variables. Same as for the four items above, each of the 13 indicator variables is implemented as a metric variable on an equidistant

interval (or Likert-like-) scale, ranging from “1” to “5”. They are preceded by the question: “To what extent have the goals from this list actually been accomplished due to your Internet activities?”, and their wording is as follows:

1. “improved corporate image”
2. “increased market share”
3. “increased customer retention”
4. “reduced marketing costs”
5. “reduced sales costs”
6. “purchased more cheaply”
7. “developed new markets”
8. “increased revenues”
9. “offered new services”
10. “increased customer satisfaction”
11. “increased customer loyalty”
12. “increased overall corporate earnings”
13. “increased corporate value”

3.6 Statistical Analysis and Hypothesis Testing with Path Modeling

For testing the hypotheses in our research model, we employ the path analysis method. This method allows us to model correlations between independent constructs (in contrast to the multivariate regression method, e.g.), while we can employ constructs that are measured “directly”, i.e. via a single indicator variable (as opposed to covariance structure models, e.g., for which complex constructs should be employed).

The structure of the research model immediately translates into the path model for the numerical analyses. The correlations between the independent model variables are included in the path model, rendering it a saturated model (i.e. with zero degrees of freedom). Thus, model coefficients need not be estimated and can be calculated directly and without error from the correlation matrix, which is calculated from the numerical base employing the method of pair wise deletion of missing values. As perfect fit is achieved, fit measures such as GFI, AGFI, NFI, or the RMR assume extreme values.

In a first step, we perform an overall analysis employing the data from all 443 companies. In a second step, we perform a series of estimations each in order to control for company size and experience on the Web, employing the grouping of cases as introduced above. In a subsequent step, we perform two more series of estimations, separating companies according to their main customer segment (B2B or B2C) and according to the fraction of revenues they generate from electronic commerce. Based on the sample correlations, variances, and number of cases for each variable from the data set, the model coefficients are estimated using the unweighted least squares (ULS-) method. Significance values have been obtained from repeated bootstrap analyses (200 samples).

Table 1: Model parameters for the general case and depending upon different company sizes as well as experience on the web

	description of path or variable	general case	company size			experience on the web	
			small	medium	large	< 2 yrs.	≥ 2 yrs.
path coefficients	dedicated Internet strategy → success in e-business	0.197 0.292*** 0.381	0.259 0.381*** 0.513	0.022 0.165** 0.316	0.146 0.363** 0.538	0.052 0.191** 0.338	0.233 0.345*** 0.48
	cost leadership → success in e-business	0.177 0.267*** 0.356	0.11 0.247*** 0.392	0.119 0.284*** 0.436	0.004 0.2* 0.371	0.225 0.342*** 0.462	0.108 0.225*** 0.354
	differentiation → success in e-business	-0.131 -0.028 0.069	-0.266 -0.129 0.025	-0.257 -0.05 0.111	-0.164 0.048 0.22	-0.186 -0.027 0.112	-0.209 -0.061 0.086
	customer focus → success in e-business	0.131 0.222*** 0.324	0.206 0.374*** 0.552	-0.038 0.142 0.375	0.032 0.215** 0.459	0 0.152** 0.312	0.127 0.27*** 0.425
expl. var.	corporate success in electronic business	0.194 0.247*** 0.33	0.3 0.409*** 0.563	0.066 0.127*** 0.279	0.21 0.307*** 0.506	0.164 0.233*** 0.382	0.178 0.239*** 0.358

Table 2: Model parameters for the general case and depending upon different main customer segment as well as fraction of revenues from online sales.

	description of path or variable	general case	main customer segment		fraction of revenue generated through online sales		
			B2B	B2C	0%	1-9%	≥10%
path coefficients	dedicated Internet strategy → success in e-business	0.197 0.292*** 0.381	0.15 0.274*** 0.41	0.152 0.259*** 0.396	0.321 0.556*** 0.731	-0.089 0.082 0.227	-0.29 -0.059 0.196
	cost leadership → success in e-business	0.177 0.267*** 0.356	0.14 0.272*** 0.41	0.134 0.271*** 0.396	-0.07 0.214 0.497	0.28 0.443*** 0.605	-0.061 0.219* 0.486
	differentiation → success in e-business	-0.131 -0.028 0.069	-0.04 0.104 0.252	-0.216 -0.074 0.052	-0.319 -0.029 0.25	-0.138 0.092 0.236	-0.766 -0.556*** -0.356
	customer focus → success in e-business	0.131 0.222*** 0.324	-0.069 0.086 0.269	0.207 0.349*** 0.496	-0.273 -0.034 0.214	-0.085 0.093 0.36	0.083 0.272** 0.488
expl. var.	corporate success in electronic business	0.194 0.247*** 0.33	0.143 0.215*** 0.363	0.231 0.303*** 0.445	0.185 0.337*** 0.58	0.141 0.254*** 0.441	0.177 0.293*** 0.499

Note: Path coefficients between constructs and selected fractions of explained variance (bold figures in the middle of each cell) and 95% confidence intervals (figure on top and bottom of each cell). Significance levels for the path coefficients are indicated as follows: ***= significant at the 1% level, **= significant at the 5% level, and *= significant at the 10% level.

3.7 Numerical Results and Findings

The resulting model parameters for the three steps of our numerical analysis are displayed in Tables 1 and 2. The findings from the numerical results can be summarized as follows:

In general, having a dedicated Internet strategy is a driver for success in electronic business. Similarly, the competitive strategies “cost leadership” and “customer focus” are also success factors. However, no empirical evidence can be found that pursuing the competitive strategy “differentiation” in electronic commerce has a positive impact on corporate success. Instead, the results for the specific group of “true e-businesses” suggests the opposite, i.e. that pursuing this strategic option may rather have a detrimental effect.

With just very few exceptions, these findings for the general case do not vary with company size or experience on the Web. The findings for different main customer segments and with varying fraction of revenues generated from online sales, however, vary considerably:

On the one hand, the path coefficients between each a dedicated Internet strategy and the competitive strategy “cost leadership” and corporate success in electronic business are almost the same for B2B and B2C companies. On the other hand, the “customer focus” strategy seems to be totally ineffective for B2B companies, while it appears to be a strong additional success factor for B2C companies.

Further, depending on the developmental stage of the company (i.e. “digitization” of the business in terms of the fraction of revenues generated online), the effectiveness of a dedicated Internet strategy and the three options of competitive strategy as success factors varies greatly:

- a. A dedicated Internet strategy is the only one success factor for pure “bricks-and-mortar” enterprises.
- b. Conversely, for “clicks-and-mortar” enterprises, pursuing the competitive strategy “cost leadership” is the key success factor.
- c. Finally, “true e-businesses” succeed only through applying the competitive strategy “customer focus”. For them, the strategic option “differentiation” clearly is a success inhibitor.

Finally, the influential factors in our path model account for 24.7% of the variance of the dependent construct of corporate success in electronic business in the general case (although this fraction varies for specific groups of companies).

4. Discussion

4.1 Interpretation of Selected Findings

The difference in the findings for B2B and B2C companies with respect to the effectiveness of the “customer focus” strategy can be attributed to the different nature of these customer segments. A typical

customer in the B2B segment (a B2B customer) is a professional buyer, often within an organization, for which (s)he purchases according to a set of rules, in which finding a good or service with a favorable cost-performance ratio usually has a high priority. His or her emotional involvement with the purchased good or service as well as with the process of purchasing is generally low. Thus, the buying process is conducted very rationally. Plus, for purchasing a certain group of good or services, there are usually several buyers in the same organization who, depending upon their location and position within that organization’s hierarchy, may constitute a rather heterogeneous group. Yet, B2B suppliers are normally expected to make the same product and service offerings (especially with respect to the pricing) to everybody inside the customer businesses or organizations. For all of these reasons, focusing on an individual buyer or small customer segment in B2B, personalizing product, services, and prices, and generating economic benefit from that may be very difficult, if not impossible.

On the other hand, a B2C customer usually is a private individual shopping in his or her personal interest. Overall, the typical shopping process and purchase decisions in B2C are conducted less rationally than in B2B and subject to a diverse and complex set of determinants: Generally, B2C customers’ emotional involvement with the purchased good or service and with the process of purchasing is much higher. E.g., they may shop for enjoyment and entertainment, make spontaneous purchases while surfing the Web or buy something because of its brand. Thus, B2C customers are a lot more susceptible for individualized product and service offerings.

Very interestingly, companies’ choice of the “customer focus” strategy in electronic commerce is just about the same for B2B and B2C companies: It is pursued by 84 (40.8%) of the B2B companies and 83 (39.5%) of the B2C companies. Also, the fact that this strategy is a success factor with medium effectiveness for all companies reflects that its strong effectiveness for the group of B2C companies has been “diluted” (or mitigated) by its lacking effectiveness for the group of B2B companies.

Another issue deserving further discussion is the lack of evidence for the effectiveness of the “differentiation” strategy in electronic commerce. This effect cannot be attributed to the reason that a comparatively large fraction of companies employ the “differentiation” strategy, since firstly, the surveyed companies come from diverse industry backgrounds and, thus, do not compete in the same market or market segment, and secondly, even if all surveyed companies were competitors, every single company could attain a unique competitive position through its specific “differentiation” approach. (The latter would not be possible if some or all companies pursued the “cost leadership” strategy in the same market, because, strictly speaking, there can only be one “cost leader” in every market or market segment.)

Table 3: Fractions of companies employing a dedicated Internet strategy or a certain competitive strategy as well as fractions of B2B and B2C companies (all in %). These fractions comprise those cases where the interviewee responded with a “4” or a “5” to the respective question item.

fraction of revenues generated through online sales	dedicated Internet strategy	cost leadership	differentiation	customer focus	B2B	B2C
0%	14.7	1.6	41.0	4.9	61.0	31.1
1-9%	22.6	12.0	47.5	37.5	47.9	48.6
≥10%	39.6	14.6	76.9	49.3	41.1	53.6
0-100%	32.0	12.2	58.9	39.8	46.3	47.3

Maybe the missing effectiveness of the “differentiation” strategy can be attributed to people’s buying behavior on the Internet at the time of the survey. Maybe most customers really focus on low prices, as Porter complains, and are therefore not willing to pay price premiums on the Internet. This speculation is backed by the fact that the “differentiation” strategy proves to be a factor ensuring failure especially for the group of “true e-businesses” (i.e. the group which most depends on online sales). Interestingly, an astounding figure of 76.9% of them pursues this strategic option, as shown in Table 3:

The change in relevance of a dedicated Internet strategy and the three options of competitive strategy depending on the degree of “digitization” of the business can also be explained with the information provided in Table 3. It shows that the use of a dedicated Internet strategy and of the other competitive strategies becomes more widespread with increasing level of “digitization”. Further, with the exception of the “differentiation” strategy, “bricks-and-mortar” businesses hardly employ any dedicated Internet strategy or competitive strategies in electronic commerce. This is not surprising, since, by definition, they do not generate any (noteworthy) revenues from online sales. Among the large majority of companies who do not employ a dedicated Internet strategy, those few companies who do are at a distinct competitive advantage.

Moreover, the figures for the group of “true e-businesses” suggest that a considerable fraction of them is pursuing more than one strategic option from Porter’s typology at the same time, e.g. a hybrid strategy. As companies become mature players on the Internet (and as their market environment also matures), they may increasingly need to implement hybrid strategies in order to maintain or improve their competitive standing.

Also, as the last two columns of Table 3 show, the effectiveness of the “customer focus” strategy for the group of “true e-businesses” cannot be attributed to the fact that they are mostly B2C companies. (Neither can the effectiveness of the “customer focus” strategy for B2C

companies be justified with the fact that a high fraction of them are “true e-businesses”, since only 18.7% of the B2C companies are “true e-businesses”, which is very close to the 16.5% in the general case). We conclude that – as far as we have been able to control in our analysis – the effectiveness of the “customer focus” strategy for the “true e-businesses” should be seen as a separate characteristic for this stage of “digitization”. Analogously, we propose that the effectiveness of the “cost leadership” strategy is a characteristic for the group of “clicks-and-mortar” businesses.

4.2 Limitations and Weaknesses of the Research

The core shortcoming of our research is that we chose single indicator variables (items), and not complex constructs, as the empirical instruments for recording the presence of a dedicated Internet strategy or the pursuit of any of the three competitive strategies in electronic commerce. Although the advantages of our approach are that the respective part of the survey is easy and quick to administer and that statistical modeling is straightforward and requires only a small number of cases, we might have made some measurements with higher resolution, reliability, and validity by operationalizing the concepts as complex constructs with several indicator variables.

The relatively high fractions of explained variance in the dependent variable for “corporate success in electronic business” in our model must also be reviewed critically. It is important to note that it is not *exclusively* accounted for by the exogenous variables in our model, but that (parts of) the same variance can also be explained by other influential factors, for which we did not control (cf. above).

5. Conclusion

5.1 Suggestions for further Research

Weighing the contributions of our study against its limitations and shortcomings, it is clear that our contribution must be viewed as a first-level analysis, as a

“snapshot”. It leaves a number of issues open for future empirical research. Some suggestions are:

The survey should be repeated in a similar manner in order to assess how the identified interrelations change with time – especially as electronic commerce slowly matures – and vary in different markets. Further, as a next step, the effectiveness of the strategies could be investigated with higher resolution to show differences between industries or industry segments.

Also, future research should also investigate how companies’ choice of strategic options might be interrelated, i.e. if companies pursue several strategic options of Porter’s typology at the same time and, if yes, which combinations these are. This leads immediately to the effectiveness of hybrid strategies (e.g. mass customization), an issue which should be investigated in future.

Moreover, in future surveys, the strategic concepts should possibly all be implemented as multi-item measures. Then, more advanced numerical techniques, such as covariance structure modeling, could be employed. Finally, the strategic options examined in this paper should be researched in combination with other instruments designed to support the strategic orientation of a company (e.g. integrated E-Business concepts such as ECCRM or one-to-one-marketing).

5.2 Managerial Implications

In general, a dedicated Internet strategy should be designed and implemented. Although the resulting competitive advantage may dwindle in the future as more and more companies adopt a dedicated Internet strategy, it seems feasible that it becomes a “must have”, meaning that not having a dedicated Internet strategy will put a company at a competitive disadvantage.

Further, managers must keep in mind that the following recommendations reflect the characteristics of the German-speaking area in spring 2000 and that they are based on findings for an average company. Therefore, decision makers should also strongly consider the market environment and the specific case of their own company in order to assess the applicability of the following recommendations.

In general, it seems advisable to pursue either of the competitive strategies of “cost leadership” or “customer focus” in electronic commerce. Companies concentrating on the B2C segment should also consider the “customer focus” strategy. With respect to the “cost leadership” strategy, decision makers should remember that there can be only one “cost leader” in every market or market segment. If this certain strategic option becomes too popular, competition in the respective market (segment) increases, and the strategic option may no longer be a success factor, but – in extreme cases – rather a performance inhibitor.

Managers should be very skeptical towards the “differentiation” strategy in electronic commerce. Our results indicate that the buyers in most markets or market segments may not be willing to pay price premiums on

the Internet to a sufficient extent such as to make the “differentiation” strategy a viable option. Instead, managers should fear that price still is “the primary if not the sole competitive variable”, as Porter formulated.

During the transition from being a traditional “bricks-and-mortar” company, via becoming a “clicks-and-mortar” company and, finally, a “true e-business”, decision makers should shift their strategic focus. They should begin with the implementation of a dedicated Internet strategy, then consider the “cost leadership” strategy, and finally the “customer focus” strategy. Finally, especially if their company has already matured to the stage of being a “true e-business”, managers might also want to consider hybrid strategies in electronic commerce, i.e. the combination of some of the three options of competitive strategy discussed above.

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The Adoption of E-Procurement and Its Impact on Corporate Success in Electronic Business

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Abstract

E-procurement encompasses a spectrum of buying applications, from simple Web-shopping on suppliers' online interfaces or storefronts, participating in or organizing auctions to participating in or even actively operating buyside marketplaces, which can all be summarized as the "use of the Internet for purchasing and procurement". The benefits from e-procurement, especially the potential savings, are often emphasized, and companies spend large sums on implementations.

However, there is a lack of research providing broad empirical evidence on the effectiveness or business value of e-procurement at the corporate level. Based on a comprehensive theory background, we develop a research model for the adoption of e-procurement and its effect on corporate success in electronic business. Employing covariance structure analysis, we test our model against empirical data comprising 425 cases collected in a large-scale survey in the German-speaking market.

We find that the perceived benefits are a driver for adoption, whereas the perceived effort is an inhibitor. Contrary to expectations, the perceived effort has a positive impact on the perceived benefits. While our results suggest that adoption rises with companies' experience on the Web, no support can be found that adoption increases with company size. We also find that the adoption of e-procurement has a positive, but small impact on corporate success in electronic business.

1. Introduction

E-procurement encompasses a spectrum of buying applications, from simple Web-shopping on suppliers' online interfaces or storefronts, participating in or organizing auctions to participating in or even actively operating buyside marketplaces [24], [5]. For this paper we will employ a generic and comprehensive definition viewing e-procurement as the "use of the Internet for purchasing and procurement".

Due to the breadth of different applications it encompasses, e-procurement is – at least in parts – affordable for many more companies than its precursor EDI used to be. Yet, although a substantial amount of

research has been dedicated to EDI, only few works investigate the adoption of e-procurement and its organizational impact. The main shortcomings of existing research can be summarized as follows:

- Many studies on the business value of e-procurement are either conceptual analyses or based on case studies, e.g. [26]. There is still a lack of broad empirical evidence.
- Often, savings or process-oriented measures are used to analyze the organizational impact of e-procurement, such as in [11]. Top-level constructs, such as corporate success in electronic business, are seldomly employed.
- Also, due to the different characteristics of EDI and as research on EDI adoption often includes suppliers (e.g. [16]), the results are not readily transferable to e-procurement.

In order to address this research gap, we develop a research model which is then tested against empirical data collected in a large-scale survey comprising 425 cases from the German-speaking market, which is one of the key international E-Business markets.

The remainder of this article is structured as follows: The research model is developed in the next section, where we present an overview of prior research relevant for our work. Then, we derive the research hypotheses, develop the model structure, and explain our research approach. In the third section, the survey, the statistical analysis, and its results are presented. In the fourth section, we interpret and discuss the major findings, contributions and shortcomings of our research. Finally, we discuss the implications of our work for further research and for practice.

2. Research Model

2.1 Theoretical Background and Literature Review

The adoption or implementation of e-procurement can be considered as a specific case of information system/ information technology (IS/ IT) adoption or implementation. Analogously, its impact on corporate success in electronic business is linked to the issue of IS/ IT success and business value. As there is a rich body of literature available on these subjects, we will, in the following overview, discuss a selection of previous works from traits of research in the IS/ IT discipline relevant for building our research model and deriving our research hypotheses:

IS/ IT adoption

In their recent meta-analysis [18], Mahmood et al. aggregate the factors affecting the adoption or use of IT investigated in previous studies to a single model. They propose that the use of IT is determined by the following four dimensions of factors: the perceived benefits which an end user expects from using a particular IS, the individual characteristics of an end user, the IT maturity of the organization in which a particular IS is employed, and the characteristics of that organization (such as size and the degree of support for IS usage). They find that the perceived benefits which an end user expects is the key determinant for the usage of a particular IS. This dimension of factor has been introduced by Davis (cf. [9], [10]) as a part of the Technology Acceptance Model (TAM), proposing that the perceived ease of use of an IS influences the perceived usefulness and, in turn, that both of these factors determine an end user's usage decision. Davis' study has since been the subject of a multitude of replication studies for many different IS. Particularly companies' adoption behavior in dependence upon their size has been the subject of many studies suggesting that due to a different endowment with resources and a more long-term strategic orientation, large companies exhibit different adoption behavior from SMEs (e.g. [22], also see below).

The link between adoption of IS/ IT and corporate success

DeLone and McLean (cf. [12]) develop a taxonomy of different stages of IS success, covering system quality, information quality, use, user satisfaction, individual impact, and organizational impact. They derive this broad spectrum ranging from system- to top-level constructs from a "series of influence events" occurring "at the receiving end of an information system", thus establishing the conceptual link between these stages of IS success. For every stage, they review a number of previous studies employing IS success measures from the respective stage. They conclude that "not enough MIS field study research attempts to measure the influence of the MIS effort on organizational performance". Recently (cf. [13]), DeLone and McLean have reviewed past works based on their model and made some extensions to it, e.g.

service quality or the application to electronic commerce. They introduce net benefits as the new top-level construct to substitute individual and organizational impact, again strengthening the importance of this stage of measures.

The business value of IT

The issue of the business value of IT addresses the last stage of IS success in the DeLone and McLean model. Many studies have been undertaken to find empirical evidence for the business value of IT, yet their results have been inconsistent. The results of several works even suggest that IT might have a negative impact on business performance, leading to the so-called productivity paradox [3]. In an attempt to resolve this paradox, Hitt and Brynjolfsson separate the organizational impact of IT into three dimensions: productivity, consumer value, and business productivity [4]. While they find evidence that IT spendings increase productivity and consumer value, their results do not support the hypothesis that IT spendings drive business productivity. For a more recent and comprehensive discussion of related literature see the discussion e.g. in [7].

EDI – the precursor of e-procurement

Before the advent of the Internet as a universal open standard, companies could conduct electronic business transactions with other companies only if they participated in Electronic Data Interchange (EDI) mostly operated on specialized or proprietary systems and networks [15]. EDI can thus be regarded as an early stage of e-procurement and has already been widely investigated.

Based on a review of prior studies, Chwelos et al. develop and test a three-factor model to explain companies' intent to adopt EDI [8]. They find that all three factors, namely external pressure, readiness, and the perceived benefits (in that order), have a significant impact. However, their research is subject to some limitations severely impacting the generalizability of their results, including the facts that they do not measure actual adoption itself and that the subjects of their study are Canadian SMEs who have not yet implemented EDI.

Due to the high costs, EDI has first been implemented by large companies and been unaffordable for many SMEs. It is mainly due the diffusion of the Internet that EDI/ e-procurement has become available also for SMEs. Likewise, research has first concentrated on EDI/ e-procurement adoption in large companies and only recently shifted its attention to SMEs. Findings confirm that SMEs exhibit an adoption behavior different from large companies and are generally more reluctant [16], [6]. Similarly, research on the business value of EDI has also been conducted separately for large companies [20], [17] and SMEs [23], suggesting that the drivers for EDI success differ for large companies and SMEs.

Unique characteristics of E-Procurement

The main difference between e-procurement and EDI is that the former comprises a broader spectrum of buying applications with varying degree of complexity and

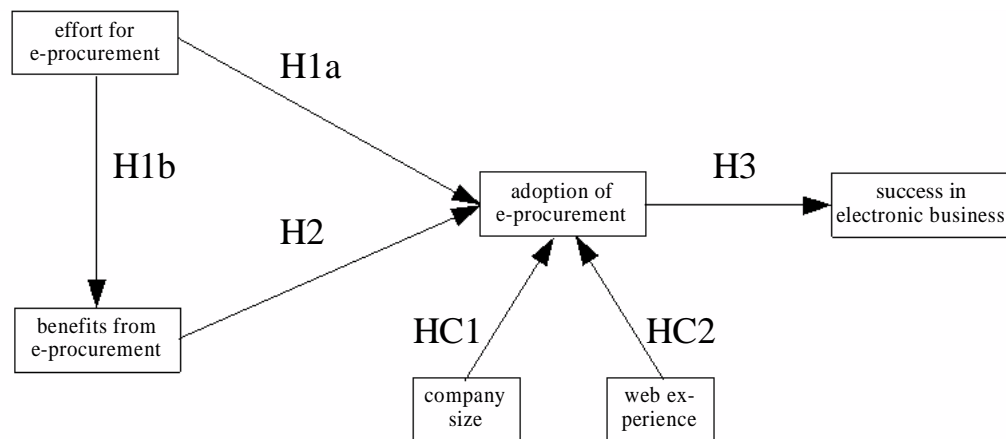


Figure 1. Research Model.

integration and (mostly) based on Internet technology [11]. Therefore, as adoption costs can be substantially lower, Web-based e-procurement can be implemented by SMEs who can rarely afford to participate in traditional EDI. Thereby, Web-based e-procurement can supplement traditional EDI. By operating traditional EDI with their bigger suppliers and Web-based e-procurement with their SME suppliers in parallel, large buying organizations, e.g., can conduct their purchasing 100% electronically [19].

2.2 Model Development and Derivation of Hypotheses

In order to pursue the research questions, we assume companies' perspective towards the adoption and success of e-procurement, choosing the corporate level as the level of analysis and the whole company as the object under study. We combine the insights gained from previous research on IS/ IT adoption and success to construct our two-stage research model:

In the first stage, we investigate the factors leading to the adoption of e-procurement. As we assume the *corporate* perspective, we drop the factors characterizing the *individual* user from the model proposed by Mahmood et al. For the same reason, we also omit intermediate stages from the TAM such as the attitude towards adoption or the intention to adopt. Further, in a simplified approach, we leave external factors related to competition, market pressure, or supply-chain relationships out of the model. We transfer the dimension of perceived benefits to the corporate level, yielding the two central factors perceived benefits of e-procurement and the perceived effort (which is a mere inversion of the ease of use construct). Thus, these factors measure the perceptions of decision makers or high-level representatives who judge e-procurement from the perspective of their company. According to Davis, we then postulate:

H1a: The higher the perceived effort, the less likely are companies to adopt e-procurement.

H1b: The higher the perceived effort, the less are the perceived benefits from e-procurement.

H2: The higher the perceived benefits, the more likely are companies to adopt e-procurement.

In order to account for companies' organizational characteristics and their IT maturity, as suggested by Mahmood et al., we further introduce two control variables to our model:

HC1: With increasing company size, companies are more likely to adopt e-procurement.

HC2: With increasing experience on the Web, companies are more likely to adopt e-procurement.

In the second stage of our research model, we simplify the causal chain between system characteristics and organizational impact in the DeLone and McLean taxonomy and directly test the impact of e-procurement on corporate success in electronic business:

H3: The adoption of e-procurement increases companies' success in electronic business.

The resulting research model is displayed in Figure 1.

3. Method

3.1 The Survey

The numerical data used in the statistical analysis of this model has been collected in a large survey that was conducted from May to June 2000. The questionnaire and a comprehensive descriptive analysis of the results have been published as the "e-reality 2000" study in September 2000 [25]. Among other issues, such as companies' readiness for electronic business or organizational and strategic measures, the purpose of this

survey was to measure companies' adoption of the Internet and electronic business concepts on a corporate-level, especially their adoption of electronic procurement. In particular, the survey recorded the success or failure companies had achieved in electronic business so far.

To gather data, market research professionals conducted personal interviews with upper- to top-level executives in 1308 companies in the German-speaking area (Germany, Austria, and Switzerland), who were in charge of their companies' electronic business activities. The sample of companies for conducting the interviews was drawn from a data base of companies, such as to render the survey representative with respect to geographic region, company size in terms of employees, and industry. In case that an interview could not be conducted as planned, a replacement was determined from the same superset in order to maintain the representativity of the sample.

3.2 Aggregation and Preprocessing of the Survey Data

Prior to the statistical analysis, the gathered raw data is reduced and condensed to an essential subset as follows: At first, we concentrate on companies who had a Web page online at the time of the survey, reducing the original data set of 1308 cases to 730 cases (or 55.8%). (Another 171 companies, or 13.0%, were still planning to launch their site within the next 12 months.) In a second step, we focus on companies who specified that they had yet gained sufficient online experience such as to provide information on the success of their company's electronic business activities, diminishing the number of cases to 469. Then, in a third step, we eliminated those cases exhibiting excessive missing values (i.e. more than 50% of the items left unanswered) in the 13 question items covering the success of their company's electronic business activities or in the items recording the perceived characteristics of e-procurement, leaving a total of 425 valid cases for the numerical analysis. Missing values in all of these items are each substituted by a value generated by linear interpolation and subsequent rounding to the nearest integer value on the measurement scale.

3.3 Descriptive Analysis

Same as in the original survey, the remaining 425 cases constitute a heterogeneous selection of companies from all industry backgrounds, company sizes, and business models, even if the original claim to be a representative selection for the German-speaking market must be relaxed. Among the surveyed companies 97 (or 22.9%) belong to the manufacturing sector, 42 (or 9.8%) to the construction industries, and 27 (or 6.2%) to the group of transportation, communications, and utilities. A fraction of 74 companies (or 17.3 %) are in the retail trade industry, whereas 41 (or 9.6 %) are wholesale trade businesses. Finally, 50 companies (or 11.7%) belong to the finance, insurance, and real estate sector, 81 (or

19.1%) to the service industries, and 3 companies (or 0.7%) to the public administration.

The size of 135 companies (corresponding to a fraction of 31.8%) ranges between 1 and 19 employees, that of another 182 companies (43.0%) between 20 and 49 employees, and 86 companies (20.3%) have 50 or more employees.¹ A group of 198 companies (or 46.5%) specify consumers as their main customer segment, 199 companies (or 46.9%) state that they mainly serve businesses. Another 15 (or 3.5%) mainly serve administrations, thus consider themselves as B2A-companies.

Concerning companies' experience on the Web, 204 (48.1%) have had a Web presence for up to 2 years, while 218 (51.3%) have owned one for 2 years or more. Finally, 256 (or 60.3%) already use e-procurement and another 61 (or 14.3%) plan to do so in the next 12 months.

3.4 Operationalization and Encoding of Variables

In the survey, indicator variables have mostly been operationalized as metric variables implemented on an equidistant interval (or Likert-like-) scale ranging from "1" (worded "does not apply at all", representing strong dissent) to "5" (worded "fully applies", representing strong agreement). The wordings for these indicator variables can be found in Table 1.

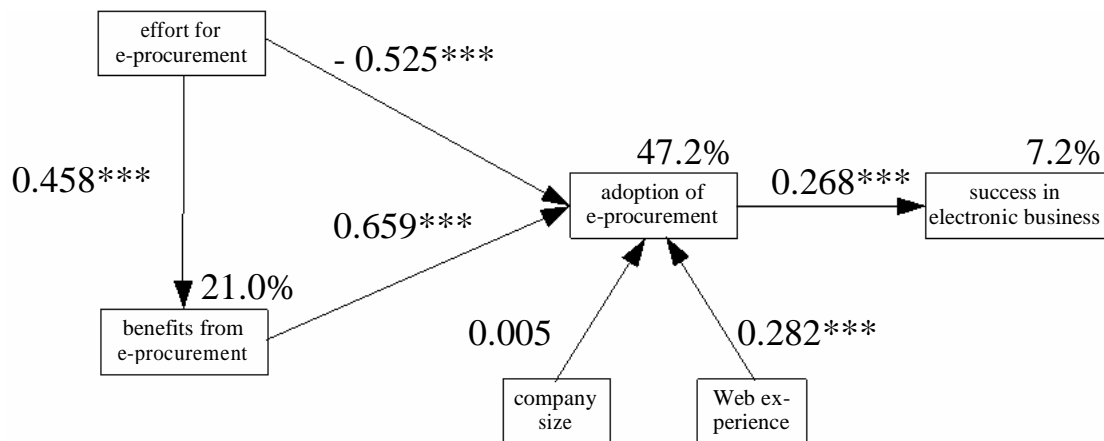
As an exception, the indicator variable for measuring companies' e-procurement adoption has been measured on a nominal scale with a choice of 3 items ("no usage and not planned, either", "no usage yet, but planned for the next 12 months", and "currently in use"). For the numerical analysis it has then been aggregated to a binary variable ("0" representing "not in use" and "5" representing "in use").² Similarly, company size and experience on the Web have also been recorded on a nominal scale with 9 or 7 items, respectively, which have then been projected on an equidistant interval scale.

3.5 Conceptualization and Operationalization of Corporate Success in Electronic Business

We limit our view on the concept of corporate success in electronic business to the shareholders' perspective. The concept is implemented as a construct comprising several subdimensions such as to accommodate for the major theories on competitive advantage, value creation and firm performance [1]. With the exception of the last, every subdimension consists of a score obtained from the unweighted addition of the values of two or three

¹ In this section, the numbers (fractions) of cases short of the total of 443 (100%) are due to missing values in the question items covering company structure.

² The scale items "0" and "5" have been chosen in order to match the scale of the remaining items, since the ULS estimation method employed for the numerical analysis (cf. below) is not scale free, i.e. the resulting path coefficients and even the identification of the model varies with the measurement scale of the underlying manifest variables.



Fit Measures:

GFI: 0.926, AGFI: 0.910, NFI: 0.841, RFI: 0.826, parsimony ratio: 0.912, PGFI: 0.764, PNFI: 0.768

Significance levels for the path coefficients are indicated as follows: *= significant at the 1% level, **= significant at the 5% level, and *= significant at the 10% level.**

Figure 2: Results of the numerical analysis: path coefficients between constructs and selected fractions of explained variance (percentage values) in the (partially) endogenous constructs.

underlying indicator variables for a total of 13 indicator variables:

- “Hard factors”, reflecting economic performance „increased market share”, “increased revenues”, and “increased overall corporate earnings”.
- “Soft factors”, accounting for a company’s achievements in the relation to- or perception by its customers „improved corporate image”, “increased customer retention”, “increased customer satisfaction”, and “increased customer loyalty”.
- “Cost reduction”, indicating a company’s improvements in process efficiency as well as procurement conditions, therefore covering firm performance from a transaction-cost economical perspective „reduced marketing costs”, “reduced sales costs”, and “purchased more cheaply”.
- “Innovation”, recording to what extent a company has strengthened its competitive position from the perspective of Schumpeterian theory, i.e. by being innovative „developed new markets” and “offered new services”.
- “Corporate value”, reflecting companies’ valuation and perception by third parties such as investors, therefore being the broadest subdimension and most susceptible to external influential factors „increased corporate value”.

Same as for the four items above, each of the 13 indicator variables is implemented as a metric variable on an equidistant interval (or Likert-like-) scale, ranging from “1” to “5”. They are preceded by the question „To

what extent have the goals from this list actually been accomplished through your Internet activities?”

3.6 Statistical Analysis and Hypothesis Testing with Structural Equation Modeling and Covariance Structure Analysis

For testing our model hypotheses, the research model is implemented as a structural equation model, which is displayed in Figure 2. Covariance structure analysis is employed as the numerical method. It allows us to make use of complex constructs for operationalizing our model constructs. Also, we can analyze the impact which several independent, yet interrelated constructs have on the dependent construct at the same time.

Based on the sample variances, covariances, and mean values from the data set, the model coefficients have been estimated using the unweighted least squares (ULS) method. Significance values have been obtained from repeated bootstrap analyses (1000 samples).

Further, in order to avoid “capitalizing on chance”, i.e. obtaining a model structure which happens to fit our data set very well, yet has little or no general validity, the coefficients for the model structure are not only estimated based on the data set as a whole. Instead, a variation of the cross-validation technique is employed: The model coefficients are estimated simultaneously for the full data set as well as two subsets with the constraint that the path coefficients within the complex constructs are fixed to the same value. The subsets (213 and 212 cases, respectively) have been generated by randomly dividing the data set in half.

Table 1. Constructs, indicator variables, and reliability measures.

construct	wording of the indicator variable or name of the subconstruct	standard. regr. weights	indicator reliabilities (≥ 0.4 ?)	factor reliability (≥ 0.6 ?)	avg. fraction of rec. variance (≥ 0.5 ?)	Cronbach's Alpha (≥ 0.7 ?)
effort for e-procurement	"e-procurement requires reengineering the whole purchasing process"	0.710 [†]	0.504	0.592	0.335	0.599
	"e-procurement necessitates expenses for training affected employees"	0.563	0.317			
	"e-procurement holds considerable problems in the integration with the company's existing IT/ IS"	0.429	0.184			
benefits from e-procurement (2 nd order construct)	"impact on processes" (1 st order construct)	0.867	0.752	0.910	0.772	(not computed)
	"impact on the supply chain" (1 st order construct)	0.871	0.759			
	"savings from e-procurement" (1 st order construct)	0.897 [†]	0.805			
impact on processes	"e-procurement reduces need for IT/ IS compared to prior systems, e.g. EDI"	0.517	0.267	0.540	0.374	0.526
	"e-procurement allows for delegating purchase decisions to the business units in charge while maintaining stronger centralized control"	0.694 [†]	0.482			
impact on the supply chain	"e-procurement leads to a re-evaluation of existing suppliers"	0.455	0.207	0.489	0.332	0.470
	"e-procurement leads to better purchasing conditions for us"	0.676 [†]	0.457			
savings from e-procurement	"e-procurement leads to shorter procurement cycles"	0.688 [†]	0.473	0.873	0.580	0.871
	"e-procurement leads to lower administrative costs"	0.812	0.659			
	"e-procurement allows for better data acquisition and automatic reporting"	0.720	0.518			
	"e-procurement leads to reduced stock-keeping"	0.792	0.627			
	"e-procurement causes purchasing managers to focus more on strategic tasks"	0.789	0.623			
corporate success in electronic business	"hard factors"	0.797	0.635	0.861	0.556	0.845
	"soft factors"	0.805	0.648			
	"cost reduction"	0.753	0.567			
	"innovation"	0.729	0.531			
	"company value"	0.631 [†]	0.398			

[†] indicates that the respective unstandardized path coefficient has been set to 1 for the numerical estimation.

3.7 Global Model Fit

Overall, the fit measures included in Figure 2 indicate a decent fit of our structural model with the sample covariances in the data set [2]. While the GFI and AGF values exceed the recommended value of 0.9, the NFI and RFI remain somewhat below. Similarly, the parsimony-adjusted PGFI and PNFI are close to the recommended value of 0.8. Part of this seemingly weak fit between the estimated model structure and the sample covariances should be attributed to the fact that the model structure was simultaneously fitted against the full data set as well as two subsets and that the global fit parameters reflect the discrepancy between the model structure and all three of these data sets.

3.8 Construct Quality

An overview of the constructs, wording of the indicator variables, resulting indicator loadings, and quality measures for the constructs is displayed in Table 1. The model construct “benefits from e-procurement” has been implemented as a second-order construct consisting of 3 first-order constructs. The quality measures indicate that the constructs largely meet the usually required minimum values [14], [21]. Yet, there are overall three indicator variables (the items “e-procurement holds considerable problems in the integration with the company’s existing IT/ IS”, “e-integration with the company’s existing IT/ IS”, “e-procurement reduces need for IT/ IS compared to prior systems, e.g. EDI”, and “e-procurement leads to a re-evaluation of existing suppliers”) with low loadings, implying poor indicator reliabilities, thus degrading the quality measures of the respective constructs. Typically, these three indicator variables would be deleted in a next step of model development, but, mainly for theoretical breadth, we have decided not to exclude this factor from the model at this stage.

3.9 Numerical Results and Findings

The resulting model parameters for our numerical analysis are displayed in Figure 2. With one exception, all path coefficients are found to be strongly significant. The findings from the numerical results can be summarized as follows:

The adoption of e-procurement can be explained by two main factors which account for almost half (47.2%) of the variance: the perceived effort for and benefits from e-procurement. While the perceived effort strongly deters companies from using e-procurement (i.e. acts as an adoption inhibitor, supporting **H1a**), the prospective benefits lead companies to employ it (i.e. act as an adoption facilitator, supporting **H2**). Interestingly, the perceived effort also has a strong positive impact on the prospective benefits constructs (explaining 21.0% of its variance, contradicting **H1b**). Further, no evidence can be found that the adoption of e-procurement depends on company size (**H3**) – on the contrary, the latter seems to have no impact at all. However, there is evidence that

adoption seems to increase with the time which companies have been on the Web (supporting **H2**).

The adoption of e-procurement, in turn, has a clear positive impact on companies’ success in electronic business (supporting **H3**). Yet, it only explains a small fraction (7.2%) of the variance in the latter construct.

4. Discussion

4.1 Interpretation of Selected Findings

While we have found empirical support for most of our research hypotheses, a few issues arising from the numerical results demand further clarification:

First, why does the perceived effort for e-procurement have a strong positive impact on the perceived benefits? From Davis’ results (cf. [9] [10]), one would expect that the perceived effort for e-procurement, being the opposite of the perceived ease of use, has a negative impact on the expected benefits. Maybe our findings are due to the fact that corporate decision makers assume a different perspective towards the adoption and usage of IT/ (M)IS in general and, specifically, electronic business concepts than end users do. While end users’ adoption decision is usually determined by short-term objectives (i.e. quickly and effortlessly fulfilling a certain operational task), decision makers’ point-of-view is more strategic and long-term. One could argue that in part, decision makers expect to reap benefits from the effort for implementing e-procurement (especially organizational and process changes, as we have operationalized it), which they also anticipate.

Second, how come that company size seems to have no effect on the adoption of e-procurement? A key reason for this finding may be that with the diffusion of the Internet and Worldwide Web, Web-based purchasing, depending upon the degree of its implementation, is easier, quicker, and cheaper to adopt than many other information systems or electronic business concepts. E.g., even very small companies can order office supplies over the Web, although certainly not every company is likely to build and operate a buy-side marketplace. Among the decision makers questioned in our survey, 43.1% agree to the statement “e-procurement reduces need for IT/ IS compared to prior systems, e.g. EDI”.

Third, as a fraction of 47.2% of the variance in the construct for e-procurement adoption is explained in our model, we conclude that companies’ decision to use e-procurement or not is also strongly determined by other factors not included in our model. There may be many such factors, e.g. corporate strategy, perceived competitive pressure, budget constraints etc. Similarly, the low fraction of 7.2% of explained variance in the dependent construct of corporate success in electronic business suggests that the adoption of e-procurement is only a minor success driver among many others (e.g. sell-side concepts, Web site management etc.).

4.2 Limitations and Weaknesses of the Research

The central shortcoming of our research is that we chose a single indicator variable (item), and not one or more complex constructs, as the empirical instrument for recording the adoption of e-procurement. Although the advantages of this approach are that the respective part of the survey is easy and quick to administer and that the statistical model is kept simple, the disadvantages are limited resolution, reliability, and validity. Ideally, it would have been desirable to further specify, qualify and quantify the implementation of e-procurement and of flanking (e.g. strategic-, organizational-, etc.) measures as well as the specific readiness of every company under these aspects.

Another weakness of the empirical design of our survey is that it was targeted at only one representative from every company who, as far as this study is concerned, had to assess the characteristics of e-procurement from the perspective of his or her company. Pursuing this approach implies that the resulting survey data may be influenced by a variable informant bias, depending upon the interviewee.

The fractions of explained variance in the three (partially) dependent variables in our model must also be reviewed critically. It is important to note that these fractions are not *exclusively* accounted for by the exogenous variables in our model, but that (at least parts of) the same variance can also be explained by other influential factors, for which we do not control.

Lag problems might be another shortcoming of our research. As the implementation of integrated electronic business concepts such as e-procurement may require a considerable investment and the accompanying structural changes take time, it also takes time for the effect on corporate success to become visible or measurable. The fact that e-procurement was still in the emerging phase at the time of the survey implies that a considerable fraction of companies in our survey may have been affected by lag problems. On the contrary, from case studies it is known that the ROI for e-procurement may be reached as quickly as within a year.

5. Conclusion

5.1 Suggestions for further Research

Weighing the contributions of our study against its limitations and shortcomings, it is clear that our contribution must be viewed as a first-level analysis, as a “snapshot”. It leaves a number of issues open for future empirical research. Some suggestions are:

- The survey should be repeated in a similar manner in order to assess how the identified interrelations change with time (as e-procurement further matures).
- Future surveys should be more refined and focus more on e-procurement. Different measures of e-procurement, its usage and implementation, and corporate readiness should be developed.

- Future research should examine if and how the business benefit from e-procurement varies between different industries or markets (market segments).
- Future research should investigate the integrated effect of e-procurement together with other potential success factors in electronic business (e.g. strategy, organization etc.).

5.2 Managerial Implications

Corresponding to the contributions of our research, we can formulate some implications and recommendations for managerial practice:

- E-procurement is one of the factors determining companies’ success in electronic business. It has a rather small, but significant impact.
- While the perceived effort and benefits are important factors governing companies’ adoption of e-procurement, there are also other influential factors which, in sum, are equally important.
- Assessing the necessary effort will in part help executives judge and appreciate the possible benefits their companies can gain from implementing e-procurement.
- Company size is not a relevant factor influencing companies’ adoption of e-procurement. Yet, companies with more experience on the Web are more likely to adopt e-procurement.

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Creating Start-up New Ventures: A Conceptual Approach

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Abstract

There has been limited research into the creation process of new venture start up firms embedded in radical innovations such as the Internet. This study attempts to develop a theoretical perspective on this process that is primarily grounded in diffusion theory but also borrows from other disciplines. The objective is to develop theory rather than test theory. The study develops a number of working propositions and then demonstrates how these working propositions can be operationalized using case data. The result suggests that the process activities over time are dependent on macro and micro activities in line with a flexible master plan rather than a sequence of unrelated linear activities and static objectives.

1. Introduction:

Process innovation represents a new or improved way of developing or providing a product or services either to an end customer or a business [1]. Process innovation can be as simple as the improvement in the way in which a particular function is performed, or as radical as developing a entire new system e.g. just-in-time or creating a new venture based on radical technology such as the Internet. Scholars have split innovation research into two broad areas of inquiry [2]. The first is an economics-oriented tradition while the second is an organisational theory-oriented tradition. Nevertheless, product development is critical because new products are becoming the nexus of competition in industries ranging from software to cars. Furthermore, it is a critical means by which employees diversify, adapt and even reinvent their firms to match evolving markets [3]. More importantly, however, the theoretical question as to how and why suppliers and buyers adopt such innovations and the processes they go through are unclear. Understanding such questions will assist managers as theoretical guidance in this area is limited [6]. It can be argued that product and process innovations are not dichotomous in that process improvements are often driven by new product demands while new products frequently arise out of developments in process engineering.

This paper attempts to describe how start-up new ventures like the B2B e-market firms based on radical technology such as the Internet technology can develop new or improved ways to provide services to businesses using electronic centralised exchanges or B2B e-markets. B2B e-markets are defined as *independent new venture where business buyers and sellers perform marketing and logistics activities using the embedded technological*

innovation (the Internet) on which it is based [4]. Given this definition B2B e-markets are both a 'firm' as well as a 'technological innovation'. For the purpose of this paper, the focus is on the creation of such independent firms and the role of the participants there in.

Evolving high-technology markets such as those based on the Internet receives a great deal of attention as they promise to introduce technological innovations that often create a market discontinuity and lead to new markets [5]. Our understandings of management within the B2B e-market firm and of third parties who provide and develop the technology to the B2B e-market firm is incomplete [3]. There is also little understanding of the links between the creative processes by which managers within B2B e-market firms and other firms use to create an effective product concept [3].

The objective of this research is to develop theory but not test theory. As such the research develops a number of working propositions and is multidisciplinary in nature. Due to the multidisciplinary nature of the research objective, this research is grounded in *diffusion theory*. It also borrows from network literatures and hopes to contribute to new venture literature. The reason for grounding this research in a multidisciplinary context is that no one literature adequately addresses the two facets of the research, that is, the creation process and involvement of participants [6].

Diffusion theory is important to this research because (a) the aim is to understand the process of creating such new ventures by observing the nuances of planning and implementation decisions and (b) it intends to understand the roles played by the different participants in the creation process. Network literature draws on the concept of lead users. Von Hippel [7] claims that in the "high technology area, the world moves so rapidly that the related real-world experience of ordinary users is often rendered obsolete by the time a product is developed or during the time of its projected commercial lifetime". In contrast to Von Hippel [7], Biemans [8] claims that third party participants are the drivers of innovation. Building on the concept of lead users and third party participants, this study adds the concept of the involvement of network champions [9]. Network champions are likely to serve, in part, as brokers and deal makers to bring about new relationships amongst firms at multiple levels. In particular, the concept is one of a catalyst who builds new linkages among multiple firms that have not previously communicated with one another [10]. Thus this concept will be helpful in explaining the relationship of the participants in the business network. Here, a business network is defined as the participants in the B2B e-market firm and the third party participants.

2. Conceptual framework

2.1 Process

2.1.1 Formation of new ventures

Formation of new ventures based on innovation is composed of a set of stages or phases ordered along the

The distinction between macro and micro activity theory has been blurred in most development work [19]. In most macro long-run theories, immediate activity is only implicit and remains vague at best [19]. As a result this theory remains overly simplistic particularly in real-time situations. Micro theories, however, do not consider how immediate actions interact and aggregate into a larger context and as a result micro theories tend to have an overly simplistic view of the long run. However, both macro and micro perspectives are necessary in developing an adequate theory of innovation, because innovations are extended over long periods, yet driven through time by immediate action [18]. In order to develop theory in new

Traditional sequential models have been criticised by scholars because of their inability to illustrate the interactions between the various stages of the development process and the assumption that each stage is completed before the following activity occurs [20]. Moor [20] overcame these shortcomings by identifying parallel activities while at the same time linking the activities to the firm's objectives. More importantly, this linking of activities with the firm's objectives indicates that the business objectives were evaluated at every stage of the development process. This loop-back feature is captured in part by [21]. In contrast to the previous models, Cooper [21] suggests a roadmap for driving a new product/project from the idea stage to product launch by providing a comparison between the second generation stage-gate process and third-generation process that overlaps fluid or conditional 'go', 'no go' stages at the gates. Although an activity based model clearly shows the tasks carried out during each stage and the intermediate forms of development, the model of Cooper [21] suggests that an ordered sequence of activities is involved, by which innovation moves through a process.

Building on these models, this study extends the activity models by arguing that objectives are flexible in a dynamic new venture B2B e-market firm. Figure 1 depicts process activities as dynamic in nature and demonstrates that the external environment and technology may affect on the objective setting process of a B2B e-market firm.

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graph TD
    A[New Venture coming to existence stage] --> B[Idea Generation]
    B --> C[Screening]
    C --> D[Concept Testing]
    D --> E[Test Marketing]
    E --> F[Commercialisation]
    
    B --> G[Business Evaluation]
    C --> G
    D --> G
    E --> G
    
    G --> H[Dynamic Objective Setting Process]
    H --> I[External Market Demands  
by e.g. suppliers and buyers  
and the technology providers]
    I --> H
    
    J[Dynamic process activities] --> A
    J --> B
    J --> C
    J --> D
    J --> E
    J --> F
  
```

The flowchart illustrates the dynamic process of new venture creation. It begins with a box labeled "New Venture coming to existence stage", which leads to a sequence of five boxes: "Idea Generation", "Screening", "Concept Testing", "Test Marketing", and "Commercialisation". Above the "Screening", "Concept Testing", and "Test Marketing" boxes is a box labeled "Business Evaluation". Arrows point from each of these three boxes to "Business Evaluation". Above "Business Evaluation" is a box labeled "Dynamic Objective Setting Process", with a double-headed arrow connecting them. Above "Dynamic Objective Setting Process" is a box labeled "External Market Demands by e.g. suppliers and buyers and the technology providers", also with a double-headed arrow. At the bottom of the diagram is a wide box labeled "Dynamic process activities", with arrows pointing upwards to each of the five main stages of the process.

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In a process approach, the stages are interrelated, as mentioned before. However, process models suggest that each stage is planned and executed in sequence. This is not realistic to the extent that dynamic planning activities can and do take place over time and may not be executed in sequence. Planning activities in some instances may depend on market demands, where the capabilities of the firm and its resources can be configured or reconfigured to match market change [22].

Dynamic capabilities are the antecedent organisational and strategic planning routines by which managers alter their resource base, acquire and shed resources, integrate them together and recombine them to generate new value creating strategies [22-24]. Scholars [25, 26] have described dynamic capabilities in vague terms, such as 'routines to learn routines', that have been criticised as being tautological [22]. Yet, a dynamic capability actually consists of identifiable and specific routines, such as product development, that often have been subject to extensive empirical studies [22]. One can argue that in a B2B e-market environment, however, the creation process must 'fit' the requirements of the market. Dynamic changes could be triggered either by the product (e.g. new software in the market or limitations of the software) or the requirements of the sellers and buyers. More importantly, high-velocity markets (e.g. real-time marketplaces) involve the creation of new, situation-specific knowledge in order to focus on market situations that are fluid (not static) and use simple routines to address strategic planning [22].

Arguably, the B2B e-market environment is not a moderately dynamic market structure; rather it is a high-velocity market structure. As such, planning routines that focus on organisational changes in structure or processes are simple and flexible. Furthermore, the literature reviewed seems to suggest that the objective needs to match the market demands over time. In order to match market demands and the capabilities of the innovation (e.g. computer programming limits of the software) the macro and micro activities need to be flexible. In other words, *the formation of new venture B2B e-market firms depends on dynamic planning of macro and micro activities and a constant review of objectives rather than a sequence of unrelated events based on fixed objectives* in order to match market demands. Therefore, planning routines focus on events to match the market changes (over time) by using simple routines that are not completely unstructured, so that managers can act in highly uncertain situations where it is easy to become paralysed [22]. The preceding arguments based on literature suggest the following working proposition.

WP₁: The formation of new venture B2B e-market firms is dependent on a dynamic interrelated planning of macro and micro activities and a review of objectives, rather than a sequence of unrelated events based on a static objective.

2.1.3 Decision to adopt or reject an innovation

Decision processes play an important role in innovation because decision-makers in the organisation are faced with choices such as to innovate or not, to select from different innovations or to use different methods of implementation [11]. Taylor [27] argues that decision making usually involves four steps, (a) the generation of some subset of alternative courses of action available, (b) a set of consequences attached to each alternative (c) preference ordering in an attempt to rank the consequences of various alternatives and (d) the decision-maker's selection of the first alternative that meets some minimum standard of satisfaction. However, scholars have suggested that decision making is dependent on the condition of technical uncertainty [28, 29]. Schon [29] however, states that uncertainty attributes can be further classified into technical, novelty and marketing uncertainty. Technical uncertainty focuses on the question of whether the innovation is technically feasible, novelty uncertainty focuses on the question of other firms' approach to the innovation and marketing uncertainty focuses on the question of marketability of the innovation.

These attributes of the decision process are relevant to this study. The B2B e-market firms are based on innovation and therefore dependent on technology uncertainty and, being a new phenomenon, will be dependent on novelty and marketing uncertainties. As such, the decision to adopt an innovation such as in the case of B2B e-market firms is shared amongst the functional areas to address uncertainty as each functional area makes a decision on a particular aspect of the creation process and then argues the merits of the decision with other functional areas.

2.1.4 Linear and fixed innovation-decision process.

The decision models rest on the premise that the product development process can be split into a number of decision actions and, as such, the process is divided into several stages, separated by evaluation points [8]. At every point, a decision on 'go' or 'no go' must be made in order to go on to the next stage of the decision making process. However, in a B2B e-market environment, once the initial decision to commit resources to the development process is made, a number of decisions are dependent on subsequent process activities such as, by third parties. For example, selections of appropriate software or decision on selecting the systems design to meet the needs of suppliers and buyers. Furthermore, Rogers' [30] model suggests that the decision process is a sequential activity, yet in a B2B e-market environment the decision process could be a parallel set of activities with inputs by different actors and consequently the model is not flexible.

Generally decision models are easily constructed by taking the stages of the activity-stage model and linking them by evaluation points [8]. Based on Cooper's [31] decision stage model a more elaborate model that distinguishes between technical/production activities and

marketing activities was developed. Calantone and di Benedetto [32] provide empirical validation of Cooper's [31] decision process model that identifies the strength of the relationship between technical and marketing activities. This model suggests that the "needs" of the market (held by sellers and buyers in a B2B e-market environment) and the technical resources provided by third party technology suppliers have a strong or positive effect in contributing to the success or failure of the commercial product.

Arguably in a B2B e-market each stage of the decision process may have an evaluation point at which the decision to adopt or reject an innovation can take place. Furthermore, in a focal business network, suppliers and buyers may affect the design decision of the procurement documents or the process in completing these documents. In such situations, the technical and managerial personnel require input from the users of the system. Because of that, *the decision to adopt or reject an innovation can occur at any point in the decision process of adopting an innovation rather than at a particular point in the process.* This leads to the following working proposition.

WP₂: *The decision to adopt or reject an innovation can occur at any point within the linear innovation-decision process rather than at a fixed stage of this process.*

2.1.5 Implementation of innovation

The interest in diffusion theory for this study is in its consequences for the implementation process. This study seeks to understand implementation not as an outcome of a process but the process itself. In broad terms, the implementation or commercialisation stage of an innovation can be defined as the execution or commercialisation of the innovation where it is put to use [30]. Klein and Sorra [33] observe that innovation scholars have ignored research on innovation implementation. However, cross-organisational studies of determinants of innovation adoption are abundant (see [34]). More common are qualitative case studies that focus on single-site implementation of innovation [33]. Although these studies describe parts of the implementation process, an integrative model that captures and clarifies multilevel phenomenon of innovation implementation is largely missing [33]. Klein and Sorra [33] claim that researchers have neglected the implementation. Furthermore, researchers have neglected the phenomenon that an innovation can be changed or modified by the user [35]. Observations made during the initial interview of the B2B e-market firm suggested that in a B2B e-market environment, suppliers and buyers may request changes, for example, to the "procurement screen" so that it is more user friendly and contains standardised information.

Management scholars have developed an integrative model describing the determinants of the effectiveness of organisational implementation [33]. However, that model

does not focus on the process of implementation. Rather, it identifies a number of dimensions of effectiveness and urges researchers to understand implementation across organisations, using longitudinal data. Its authors believe that a number of single-site studies (e.g. [36]) have rich descriptions of the variety of innovation, implementation, organisational and managerial practices, and characteristics that may influence innovation. However, the use of information from across organisations in a network (e.g. B2B e-market environment) will provide a valuable understanding of the implementation process using longitudinal data [33].

This study focuses on understanding the implementation process of an innovation that can be changed by the user over time in order to meet the requirements of the user of the innovation. In so doing, this study will map the process of how a technological innovation is implemented in a B2B e-market firm over time.

2.1.6 Feedback and redesign

Feedback and redesign refers to the process by which information is collected about a new technology and redesign activities are initiated to enhance the operations of the innovation [37]. The basic assumption is that any new technology will evolve in structure, process and outcome [37]. The authors posit that the evolution is driven by (a) the perceived benefits of the technology (b) the benefits drawn from economies of scope and (c) the technology is subject to change as new opportunities are envisaged over time. Goodman and Griffith [37] argue that empirical evidence supports Goodman's [38] use of feedback and redesign in sustaining change. Leonard-Barton [39] also studied the concept of technology evolving over time to meet the changing needs of different user groups. Due to the lack of empirical data, this study focuses on gaining an in-depth understanding the implementation process in one organisation.

2.1.7 Sequential activities

Adoption-decision models claim that the implementation stage occurs sequentially after the completion of the decision stage [30]. In a start-up new venture like the B2B e-market, the implementation stage also occurs after the decision stage to go ahead with the innovation. However, the implementation stage is subject to constant feed-back loops and refinements that will match the requirements of the users of the product (B2B e-market) and will be subject to further redesign as the market demands over time. Extant literature does not provide adequate information on the sequence of implementation activities [14, 40, 41].

Arguably the *implementation of innovation process* follows a set of steps and each step is dependent on it being *evaluated and redesigned through feedback loops* in order to implement an innovation and perform implementation activities simultaneously rather than as a *linearly sequential*

chain of activities. This leads to the following working proposition.

WP₃: *The implementation of an innovation follows a set of sequential steps where each step interacts with the previous step through feedback loops, rather than a linearly sequential chain of activities.*

2.2 Participants

2.2.1 Direct and indirect impact of champions in networks

The network approach implies two theoretical extensions [8]. First, although the relationship between focal network participants is important (i.e., the relationship between the manufacturers or sellers of raw material and the business buyers), there are other participants that may influence the activities of those within the focal network. A direct relationship may consist of the manufacturer and its immediate suppliers and immediate business customers. A new process that may influence the activities of the buyer firms with its suppliers and business customers constitutes an indirect relationship. Indirect relationships are of importance because (a) given the strategic situation, they influence the direct relationship and (b) changes in the strategic situation can change the buyer's position with regard to both the direct and indirect relationships. As firms are increasingly outsourcing various functions to other firms, third party involvement is a powerful alternative to traditional vertically integrated firm structures; one that can affect the existence and strength of direct and indirect relationships [42]. Direct and indirect relationships are crucial in the context of innovation because participants in these relationships affect the creation process [8]. The second theoretical extension relates to the kind of relationships. This relates to firms having a certain position in a network that can be defined by (a) the function performed by the firm for other firms (b) the relative importance of the firm in the network (c) the strength of the relationship with other firms in the network and (d) the identity of the firms with which the focal firm has a direct relationship [8].

The concept of champion has been documented in the product innovation management literature and is defined as the person, not organisation, who is spirited, almost independent and fully capable and willing to pursue the risk of creating a new venture [43]. In the new venture creation process a number of champions are involved. New venture creation champions are those who are directly involved with the new venture at a management and entrepreneurial level. The implementation champion is characterised as the one who is intimately familiar with the aim of the new venture and has the required skill and experience of the technology and co-ordinates the activities between the new venture and the third parties to achieve fruition of the new venture. This review of literature suggests that in the primary task environment,

network champions may have a direct or positive relationship with third party participant firms, new venture champion and new venture implementation champion but an indirect or negative relationship with supplier and business buyer firms.

WP₄: *In a B2B e-market context (in contrast to EDI), network champions attempt to create direct relationships with new venture champions, product champions and third party participants rather than attempt to maintain direct relationships with suppliers and business buyers.*

2.2.2 Influence of champions on potential participants

A study on innovation reveals that champions influenced top management's acceptance of a project by making apparent the strategic importance of such projects [44]. Burgelman [44] mapped the activities involved in Internal Corporate Venturing (ICV) onto the process model above. While Burgelman's [44] work provides a good foundation to this research as it identifies the importance of product and organisational champions, the study is limiting as it evaluates conditions in one organisation rather than across organisations. Yet the process can occur across organisations, especially in a network environment [8].

This research adapts and extends Burgelman's [44] model by allowing it to (a) operate at an inter-organisational rather than an intra-organisational level of analysis and (b) include the impact of network champions on the process model. In particular, the concept of network champions extends the work on product champions and the organisational champion concept [44], although it is more closely related to the latter than it is to the former. The product champion is one who creates, defines or adopts an idea for a technological innovation and is willing to accept the risk, whilst an organisational champion is a decision-maker. According to Woodside [10, p54] "... network champions are likely to serve, in part, as marriage brokers and deal makers to bring about new relationships amongst enterprises at multiple levels who must interact for the adoption of new ET (electronic technologies) in a manufacturing process". Woodside and Wilson [9] admits that such conclusions are the result of preliminary exploratory study and that detailed description through in depth case study is required of specific networks that emerge in the adoption of new technology. Arguably, in a B2B e-market environment, a network champion works across firms in order to bring about new relationships amongst enterprises at multiple levels.

One can conclude that the *likely acceptance of an innovation* is dependent on *the involvement of network champions who can support potential participants to "buy into" the innovation.*

WP₅: *The involvement of network champions who persuade potential participants to "buy into" the innovation, results in the likely acceptance of the innovation.*

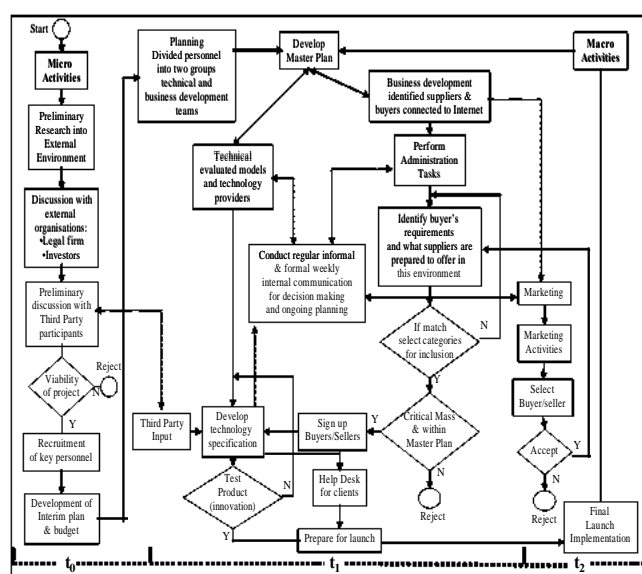
3. An example of operationalizing the first working proposition

Based on data captured during preliminary interviews an integrated flowchart (see Figure 2) was developed from the various functional areas. The integrated flowchart depicts the micro and macro activities over a longitudinal time frame. The concept of the master plan developed suggests that the functional areas used the master plan as a guide: "we had a very much integrated master plan where we basically managed the (creation) process.....we got together (weekly) and reviewed the objectives, strategies that we were developing". From the time of its conception to its final launch the objectives changed which was possible due to the flexible nature of the firm and is captured by the following extract: "the beauty of running a start up firm is that it's constant evaluation of alternatives.....the flexibility that a small agile company gives you, you (can) translate (this flexibility) directly into changes you require to meet the needs".

One can argue that the master plan was an integral part of the planning process and the macro and micro activities were a consultative process between the functional areas. Therefore, the formation of new venture B2B e-market firms is dependent on the consultative process of macro and micro activities in line with the master plan. In turn this master plan is dependent on it being flexible in order to meet the changing nature of the objective over time. The refined proposition to WP₁ is stated below:

P¹: *The formation of the new venture B2B e-market firm is dependent on a consultative process of macro and micro activities in line with a master plan that has the flexibility in changing the objective over time, rather than a sequence of unrelated events based on a static objective.*

Figure 2: Flowchart of process activities as interpreted from the CEO's interview



4. Future Direction and Limitations

Concerns of external validity will be traded off against opportunities to gain insights into a new phenomenon [44]. The caveats pertaining to field research described by Kimberly [45] will be taken into account. Further, a cross-site analysis process will be developed to compare data gathered from different sources in order to triangulate the findings.

New venture B2B e-markets have been widely touted as a revolutionary mechanism for more competitive and efficient operations of business marketing and procurement systems. Yet, many such B2B e-markets are experiencing start-up problems and slower than expected growth. This paper offers a set of working propositions that suggests how the creation, commercialisation, decision and implementation take place for such B2B e-markets. In addition, the working propositions suggest how several key classes of participants can facilitate particular aspects of e-market exchange structure and its acceptance as a technological and organisational innovation. These working propositions are subject to further refinement and development, which will be the focus of future research.

Preliminary observations and interviews offer tentative support although case study evidence in itself will not provide a definitive test of any of those theoretical propositions. It will, however, establish constructs and attributes and contribute to the refinement of theory in the literature on new ventures.

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Consequences of e-Business Initiatives on Business Process Performance – A Model for Analysis

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Abstract:

This paper discusses the consequences of implementing e-business initiatives on business process performance and proposes a model for further analysis. Integrating the operations management literature, diffusion theory and reengineering theories, this model attempts to hypothesize the consequences of implementing e-business strategies by way of redesigning and/or integrating the information, systems and processes and its impact on the business process performance attributes. Using an survey methodology, this study will attempt to measure the extent of implementing e-business initiatives in Australian manufacturing industry and the consequences of those initiatives on business process performance. Developing a theoretical framework/model will help in minimizing the uncertainty associated with such transitions, and explain the dynamic interactions between organizational factors, business process performance variables and information systems. In addition, it will make contribution to the theories dealing with the interface between information systems and operations management in e-business context.

1. Introduction and background:

Despite some initial failures and issues with regard to the implementation of associated changes, e-business is expanding in Australia. Understanding the specific impact of e-business initiatives as an IT innovation on processes and their relationships to other factors such as information systems, and organization are important to develop strategies for managing and improving the business processes. Considering the huge investments already made in these initiatives, and their overarching influence on business in general, it is important to understand the impact on business processes. Based on the literature from information systems and operations management fields, this paper analyses the consequences of implementing e-business initiatives on business process performance in manufacturing industry and proposes a theoretical model for analysis.

A report by National Office of Internet Economy (NOIE) in Australia [7] observed that the e-business readiness of Australia is ranked second only to USA.

According to this report, about 62% of Australian companies are now reporting cost savings of 1 to 5% achieved by online marketing and sales, and efficient online financial transactions. Though the number and value of electronic transactions between businesses, government and customers is steadily increasing, the current levels and volumes are not significant in Australia. At present, the B2C (Business-to-Consumer) and B2B (Business-to-Business) transactions are worth 0.17 per cent and 1.1% of the GDP respectively [7]. Generally, the manufacturing industry is observed to be lagging behind the finance, banking, insurance and other service sector in the introduction of e-business initiatives.

In spite of its advantages and potential benefits, implementing e-business initiatives often poses challenges to many businesses. Some of the challenges are back-end integration, transforming business processes, integrating information systems and IT applications, reliability of operational data, hierarchical and functionally oriented organisational structure, and performance measurement of e-business processes [4][10].

It is well recognized in the literature that adoption of information technology enables businesses to achieve competitive advantage. However, the consequences of adoption and their impact on the organizational performance are considered too complex to study. Generally, there are very limited studies on the consequences of technology adoption [7][6], though there are several studies that analysed the implementation and diffusion of technologies in different settings. Unlike other IT innovations, e-business initiatives are generally pushed into the organization and therefore does not involve the adoption component of the classical diffusion model by Rogers [9]. Because of the indirect and unanticipated consequences, and their complex cause and effect relationships, it is considered difficult to measure the consequences of IT innovations [9]. Even though it is difficult to measure impact in specific performance terms, many organizations, however, are able to achieve competitive advantage by using IT as an enabler, while others by deploying it as a tool in the redesign of business processes [8][11]. Software vendors and consultants who sponsor research on IT innovations generally assume that the consequences of such e-business initiatives are

positive. However, several IT innovations such as ERP systems, CRM and SCM softwares, and other applications are reported to have negative impacts and did not seem to realise the full benefits espoused by the vendors [3].

2. Model for analysis:

Taking some components of the Barnes et al [1] framework for the study of e-business in operations management literature, Rogers' diffusion theory and reengineering theories by Davenport from information systems literature, the following theoretical model is developed to analyse the impact of e-business initiatives on business process performance. Rather than studying them separately, this model helps to study the factors inherent in e-business initiatives, the impetus these factors give for initiating various organizational changes and their effects on business process performance variables such as cycle time, quality, flexibility and cost. In this context, based on the model proposed and presented at the end of the paper (figure 1), some hypotheses are formulated to be tested empirically in Australia.

In the theoretical framework developed (Figure 1), various e-business initiatives described in the literature are taken as the basis. These initiatives are expected to have an impact on the information systems, business processes and organisational factors. Moreover, the organisational changes as mentioned above can be analysed in conjunction with the attitude of the enterprise towards various e-business initiatives. The sequence of intra-organizational changes can be hypothesized to vary depending upon the sequence of events, whether the organisation took a pro-active approach or re-active approach [8]. In the pro-active approach to the adoption of these initiatives, it is expected that organization would change organizational structure and strategy, staff selection and training, and redesign/automation of business processes and information systems in that sequence. Similarly in the re-active mode, organizations are expected to change the business processes and information systems first and then follow with changes to staff skills, organizational structure and e-business strategy in that order. All these changes and effects are to be analyzed within the context of organizational variables such as structure, size and business model.

The type and motives of a particular e-business initiative(s) are influenced by the nature of customer, the path to the adoption, and the extent of changes to the business processes and information systems. Consequently, the performance of the business processes in generic sense are expected to be dependent upon the extent of this redesign and integration of business processes and information systems in the given organizational context (Barnes et al 2002). Thus, the

understanding of these aspects is important in developing new theories that include e-business initiatives and accompanying organizational changes as relevant variables, rather than studying them separately.

The term business process is very generic and encompasses a wide range of activities in the firm at both strategic and operational level. There are three levels of processes – manage processes, operate processes and support processes [2]. According to Childe et al [2], 'operate processes' are directly involved in producing value for the customer, 'manage processes' are those related with the strategy and business model, while 'support processes' generally support the other two types of processes. The proposed model focuses on the 'operate processes' in the manufacturing organizations that involves processes such as 'develop product, get order, fulfill order, and support product/customer'.

It is also expected that the social and technological issues that involve organisational culture, organisation size, skill levels of staff may become barriers to the implementation of e-business initiatives. For example, conservative nature of the organisation and/or industry, and the general resistance to technology, may pose problems for the transformation of organisational processes. In addition, inability to invest in technology, influence of major partners in the supply chain, lack of sound organisational strategies, and motives of organisations to select and adopt e-business strategies may influence the scope and outcomes of e-business initiatives. In addition, lack of industry standards and open systems, complexity and limitations of legacy systems are some of the technical barriers. While some companies want to lead the industry by adopting technological innovations, other companies are simply following their competitors with the hope of neutralising the competitive advantage of the leader. On the other hand, some organisations have clear objective of exploiting the full potential of e-business strategies and thereby achieve reduced costs, improved service and target specific niche markets.

3. Methodology:

Several studies in the past have tried to explain the e-business phenomenon, its potential advantages, the changes required in management and organization of the companies, and the possible business models. Most of these studies were exploratory in nature and mainly employed case study approaches [5]. Empirical studies that try not only to measure the nature and extent of implementing e-business initiatives, but also identify the way these measures impacted on various organizational changes, and their consequent effect on business process performance are necessary. As this research is measuring

the extent and consequences, a survey methodology is considered appropriate to collect data [12]. The questionnaires will be posted to the top 1000 companies in Australia in November 2003. This paper reports on the first stage of the research project that has helped develop a model for further analysis and empirical testing.

5. Conclusions:

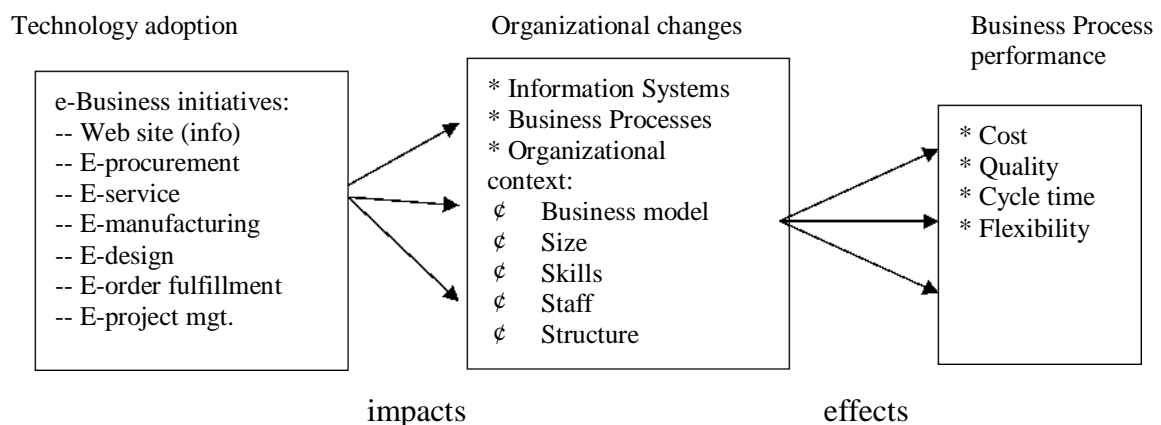
Manufacturing organizations which are traditionally behind the other organizations in services sector, in introducing IT related innovations, are not able to evolve beyond the most basic Internet-enabled applications such as e-mail. Some large manufacturing companies, however, have attempted to implement or have recently implemented ERP systems partially or fully with mixed results in Australia. Reports by NOIE also suggest that there is a need for manufacturing organizations to speed up the adoption of e-business initiatives and to understand the reasons behind this lagging [7]. Some of the reasons suggested include lack of framework within which the analysis of changes required to the processes and systems could be carried out, and difficulty of integration between 'bricks' and 'clicks' processes. Developing such framework will help in minimizing the uncertainty associated with such transitions, and explain the dynamic interactions between organizational factors, business process performance variables and information systems. In addition, it will make contribution to the theories dealing with the interface between information systems and operations management in e-business context.

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Figure 1 – Model for the consequences of e-business initiatives



Understanding User Empowerment In Enterprise Systems Context: Is User Empowerment Predictive Of Enterprise Systems Success?

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Abstract

Empowerment has been an evolving construct for many years and is identified as one of the factors contributing to affective outcomes in the workplace such as increased worker effectiveness, satisfaction and performance. Prior research has generated considerable knowledge on empowerment from management and non-management perspectives. The adoption and implementation of integrated enterprise systems (commonly known as ERP systems), have resulted in dramatic changes in organisational processes. The implementation strategies focus on mapping processes and training end users in using the system but do not appear to focus on engaging the users in the change process. Perhaps the concepts of user empowerment as a focal point of the change management process could improve the successful use of such complex systems. This research program seeks to define the concepts of user empowerment, develop, measure and validate the constructs of user empowerment in an enterprise systems context. In addition, the program will study the correlation of user empowerment with enterprise systems success. The research alludes to several ways that user empowerment influences the enterprise systems success. Organisations need to understand that there are critical human factors involved in a successful implementation and thereby a successful Enterprise System.

1. Introduction

Of the many issues that merit research on enterprise resource planning systems (ERP) success, one of the least researched is the effect of enterprise user empowerment on Enterprise Systems Success (ESS). While some large companies have enjoyed significant gains, others have had to scale back their projects and accept compromised benefits, or even discard implementation of enterprise systems projects.

Conceivably the main cause for this is that the handful of large vendors of enterprise systems dominate the market, promote their products as best practice solutions. The adoption and implementation of integrated enterprise systems (commonly known as ERP systems), have resulted in dramatic changes in organisational processes. The implementation strategies focus on mapping processes and training end users in using the system but do not appear to focus on engaging the users in the change process. Although there have been several studies undertaken to measure manifestations and constructs of Enterprise Systems (ES) success, there is lack of empirical study on the effects of user empowerment on ES success. Perhaps the concepts of user empowerment as a focal point of the change management process during an ES implementation could improve the successful use of such complex systems.

This research program seeks to define the concepts of user empowerment, develop, measure and validate the constructs of user empowerment in an enterprise systems context. In addition, the program will study the correlation of user empowerment with ES success.

2. Literature Review

All ES vendors such as SAP, Portals, PeopleSoft, and Oracle are software packages that promise the seamless integration of all information flowing through a company, across all business processes including customer relationship, vendor management, accounting and finance, supply chain management, marketing, and human resources. ES have increased the ability of organizations to gather more information in greater detail and in real time, and widespread vertical and lateral dispersal of information throughout the organisations [1]. This expanded information makes the users more visible across the organisation and thus is viewed as a means of empowering the users [2]. It is on this potential relationship between ES Implementation and user empowerment that we will focus in the remainder of this paper.

Organisations using ES can be viewed under three distinct categories- those who have successfully

implemented ES; those who never succeeded; and those who are struggling in between the high-end successful organisations and the failures. The next section sets out to define empowerment and then understand the concept by studying its components.

3. Empowerment and Enterprise Systems Context

Empowerment of the employees has been a management goal since the 1980's [3] yet empowerment is an evolving construct and continues to attract management researchers and practitioners [4-12]. Empowerment has been interpreted across a wide spectrum of non-management disciplines such as healthcare, politics, women, minority groups, and education [13]. In management disciplines Conger and Kanungo were the pioneers in establishing a relationship between empowerment and workers' effort-performance expectancies [8, 14].

In the context of management disciplines, empowerment has been commonly perceived in terms of power and authority, rather than as a motivational process shaped by individual differences [4]. Organisations are constantly challenged to sustain and succeed in today's turbulent economic environment of fierce global competition, changing consumer needs, government regulations and globalisation. In such a climate of economic uncertainty organisations embrace change management initiatives in order to adapt and remain a performance driven business [2]. Empowerment is seen as one such practical solution to facilitate the change as it is often considered to be an integral part of a Business Process Re-engineering or Total Quality Management change initiatives [2]. Thus, empowerment is embraced as a management strategy by today's organisations, which aim at enhancing employee satisfaction and improve productivity of the enterprise, thereby contributing towards increased work effectiveness of the employees [15].

3.1. How does empowerment relate to Enterprise Systems?

Livermore and Ragowsky [16] highlight a number of challenges associated with ES implementations. The two key challenges as opposed to other systems are that ERP systems involve the whole organization and require a combination of technical and human expertise to select, develop and implement successfully. Secondly, ES involve re-engineering of the organisation's business processes thereby resulting in organisational cultural change. Given this argument, companies adopting ES need to focus on specific aspects of technical and human factors in order to translate

their efforts to anywhere close to an ES success.

The motivation to investigate empowerment is to understand the role of user empowerment as a predictor in ES success. This calls for an in-depth understanding of the user empowerment concept itself and its underlying constructs should be of paramount interest while studying the framework of user empowerment. The emphasis of the research program is to identify the relationship between the constructs of user empowerment and ES success measures. It is our belief that such an exploration will facilitate better understanding of the ES success' correlation with user empowerment. The next section examines the constructs in user empowerment.

3.2. The Paradigm of User Empowerment

Building on the work of Conger and Kanungo [4], Thomas and Velthouse [8] defined psychological empowerment as intrinsic motivation manifested in four cognitions reflecting an individual's orientation to his or her work role: meaning, competence, self-determination, and impact. Another conceptualisation of empowerment defines it as a pattern of experienced psychological states and argues that each dimension of empowerment adds a unique facet to an individual's experience of empowerment [8]. Conger and Kanungo's [4] definition of empowerment as, "a process of enhancing feelings of self-efficacy among organisational members through the identification of conditions that foster powerlessness" is now conceptualised broadly as a pattern of experienced psychological states [8, 17].

Psychological empowerment differs from the structural concept of user empowerment in that it focuses on intrinsic motivation [8] rather than the expanded discretion a user has over how his/her work is to be done in the immediate work environment [1]. Thomas and Velthouse [8] have explicated a comprehensive, cognitive model of "intrinsic task motivation" to describe the empowerment process in individuals. Cognitive variables, referred to as task assessments are impacted by empowerment. These tasks being an array of activities directed towards a goal. The four dimensions of task assessment are included as cognitive variables of intrinsic motivation. These are: impact, competence, meaningfulness, and choice. The model developed by Thomas and Velthouse provides a synthesis of Hackman and Oldham's [18] work on the motivation construct. Following Hackman and Oldham's propositions empowerment in workplace has been widely explored in relation to leadership behaviour [10, 12, 19-21], power and control as relational constructs [4, 22], power perspective in work groups [15], autonomy and decision-making empowerment [23], organisational downsizing [24, 25], and organisational culture [9, 26,

27].

Spreitzer [14] extended the work of Thomas and Velthouse [8] and hypothesised that a high level of four dimensions namely meaning, competence, self-determination and impact in an individual, result in a high level of empowerment. Further empirical research examined how these four dimensions of empowerment were differentially related to effectiveness, work satisfaction and reduced job related strain [11] but did not examine antecedents of empowerment [28] in context of organisation. The Spreitzer, Kizilos, and Nason's [11] study also was limited in that the researchers did not identify and test for outcomes that could appropriately serve as measures of success for the organisation because after all, the entire exercise of empowerment in workplace, is to gain strategic advantage in current turbulent economic environment [17]. Another area that remains left out of Spreitzer's outcomes of empowerment is lack of adequate measurement of effectiveness in terms of net compounded outcome emerging from empowered behaviours of employees.

The individual is the basic unit of analysis in this research on user empowerment. We pose the question on how this construct affects the organisation both as a process and as an independent variable. The user empowerment process must be embedded as part of design, training, and evaluation and must be an iterative process in itself. For an organisation to be empowered, information is a central component as Psionos et al. [2] state that employee decision making is critically dependent on the timely distribution of the right information in the cycle of various business processes. The logic here is that employees will be more understanding of the reasons for business decisions and as a result more committed to the organisation's action [3]. Simply informing employees via formal authority that they are now empowered, without providing training to develop needed skills and knowledge, will nearly always result in failure [29].

The characteristics of user empowerment within the ES context are: to encourage people to take a more active role in their learning with respect to the adopted ES; to take responsibility for self learning, and; to enable people's participation in demanding decision processes [30]. This latter aspect can be conceived as both self-initiated and initiated by others, making a commitment to common goals, taking risks and demonstrating initiative and creativity [31]. These characteristics suggest user empowerment to be a multidimensional concept similar to the empowerment construct [8, 11, 20, 28] and a dynamic phenomenon [32] that needs to be nurtured by the holistic organisational environment within which it operates [3].

User empowerment in ES context is in many

respects analogous with user involvement that has been widely studied in Information Systems (IS) implementation [33, 34]. User involvement is referred to participation in the IS system development process by representatives of the target group. Doll & Torkzadeh [34] report that end user satisfaction levels are significantly correlated with their involvement in the design of the system. Along similar lines, increased job satisfaction and systems usage are reported as being positively related to involvement in the development process by Lucas [35], or Baroudi et al. [36].

The next section develops and justifies the motivation for the research program and study by giving an overview of the perspectives on ESS and IS success models.

3.3. Justification for the Study

The value proposition of adopting ES from SAP, Baan, Oracle, PeopleSoft and their software packages enticed organisations to invest heavily in these systems. The key drivers in the increased trend to adopt these complex systems can be summarised as: fierce globalisation of business; legacy systems and Year 2000 system concerns; increasing national and international regulatory environment e.g. European Monetary Union; Business Process Reengineering (BPR) and the current focus on standardisation of processes e.g. ISO9000; scaleable and flexible emerging client/server infrastructures; and trend for collaboration among software vendors [37].

When an organisation decides in favour of a new Enterprise Systems, its implementation is a socio-technical process, affecting tasks, people, technology and structure [38]. Markus and Tanis [39] also identify this element and proposed the engagement of the users as a key variable. An organisational change process such as ES implementation may include many factors for success and one of the potential factors is empowering users. This logically follows from the fact that those affected by the change in technology (users of the ES) must be a part of the change. Workgroups and teams specifically, are more likely to be advantaged or disadvantaged by organisational change as compared to individuals. This clearly echoes AES CEO Roger Sant's philosophy on empowerment where he suggests empowerment makes decision making safer since the team feels it is fully accountable and will take more responsibility than if it feels that their manager is accountable [40]. Therefore it makes intuitive sense to consider a more collective measure of user empowerment such as workgroup and if it better facilitates ESS as compared to individual user empowerment. This latter aspect is a focal question of this research project.

Many authors identify change management as a critical success factor for enterprise system success, but fail to clearly articulate the means of engaging the user. Empowerment theory seen above may assist here.

Perspectives on ESS

Organisations have spent significant resources and many years implementing their ES and realised that it is an implementation that was extremely difficult and an expensive change to roll back [41-46]. Research points out that many high profile organisations failed in their ES projects implementation [41-46] [47-49]. The recent collapses and failure of such large scale complex ES implementations initiated several researchers to conduct ES implementation studies that implicitly and explicitly suggest the need to critically evaluate the risks and success factors of ESS [41-46].

Markus and Tanis [39] give a phased approach of an organisation's experience with an enterprise system, which Holland, Light and Gibson [50] echoed. The characteristics of an infused organisation appear to be related to the constructs of empowerment. Models of Information Systems success have been developed [51] and exploited in the Enterprise Systems success area [52] [53]. This research will use the established models as the dependent variable in the correlation study.

4. Empowerment Model

The four dimensions of meaning, competence, self-determination and impact, multiplicatively combine to create high psychological empowerment (see Figure 1) [54], which leads to the positive outcomes of effectiveness, work satisfaction and reduced job related strain. These terms are next detailed.

Meaning

According to the job characteristics model [18], the degree to which jobs are motivating can be measured through five core job characteristics: skill variety, task identity, task significance, autonomy, and job feedback. Hackman and Oldham's research led to the conclusion that "to the extent that a job contains these five characteristics, three psychological states are produced: experienced meaningfulness of the work, experienced responsibility for outcomes of the work, and knowledge of the actual results of the work activities. Spreitzer developed the above meaningfulness of work as the meaning dimension of empowerment. Meaning is believed to be a vital component of an individual's empowerment experience [17] since it acts as the fit between the requirements of one's work role and one's beliefs, values and behaviours [55].

Competence or self-efficacy, specific to one's work, is a belief in one's capability to perform work activities with skill [56]. An indicative outcome of competence would be self-confidence in one's ability to perform the task.

Self-Determination is a sense of choice in initiating and regulating one's actions and the ability to endorse one's actions at the highest level of reflection [57]. The self-determination theory evolved by Deci and Ryan [58] posits that self-determined individuals experience a sense of freedom to do what is interesting, personally important, and vitalizing.

Impact is a state of belief in individuals that they can influence the system, of which, they are an integral part of. Examples of indicative outcomes include *personal initiative* which is characterised by an individual's proactive attitude to work without prompting or direction from others [59]; *voice* which is a behaviour exhibited by group members making suggestions and speaking up in the interest of the company or group even when the group is not appreciative [60]; *taking charge* a discretionary behaviour where organisations motivate employees to go beyond the boundaries of their jobs to undertake constructive efforts that effect how work is executed [61]; *proactive coping* when individuals undertake proactive measures to avoid potential events that may cause stress [62]; and *empowerment* which is a direct result of a sense of belief that an individual's actions are influencing the system [14]. These elements are shown in the Figure 1 below.

4.1. The Research Scope, Questions and Aims

Although there have been extensive studies in ES implementation success, critical success factors of ES success [47] and measuring ES benefits [52, 63], there has been no prior significant research that links the user empowerment aspect of enterprise systems success. It is this gap in the research that this research program addresses.

The literature review to date has enabled understanding of existing models, theories and frameworks on empowerment in workplace. An in-depth analysis helped in clarifying the constructs of user empowerment and provided direction for identifying the research gap in the existing framework of the empowerment concept. Here the object of research is user empowerment and its strength in predicting ES success. The related investigative questions vary in their level of detail, purpose, and include:

- What constitutes user empowerment in an ES context?
- Is there a correlation between user empowerment

and ES success?

- Which factors assist or inhibit ES success?
- How can user empowerment be measured?
- What characteristics of user empowerment are vital to Enterprise System Success?

Thus, the specific aims of this user empowerment research are:

- to integrate measures of user empowerment extending Spreitzer's model and instrument;
- to assess the effects of user empowerment on change management practices in enterprise systems context, and;
- to develop and pilot an instrument for measuring user empowerment and correlate with ES implementation success.

4.2. Objectives of the program of research and investigation

This research project is a part of a larger program of research called Organisational Readiness for Enterprise Systems (ORES). There are three sub-researches embedded within: the affect of organisational culture; leadership and risk aversion issues; and user empowerment. Each of these studies are inter-dependent.

The proposed study will contribute to the parent project "Organisational readiness for enterprise systems" across several of its phases. It is further aligned with several objectives of the main study and will seek to validate several of its propositions. The direct contribution to subsequent phases of the parent study is likely, however dependent on further coordination of team efforts. The research questions listed under objectives of the program of research and investigation (*section 3.2*) have been developed in accordance with the above research aims and propositions.

5. The Research Methodology

The use of an appropriate methodology for a piece of academic research is fundamental to the research's success [64, 65]. The research uses both qualitative as

well as quantitative methods. A multiple case study method is applied. The research will progress in three stages namely pre-pilot in an organisation that has recently implemented an ES; a pilot study within government public sector agencies and; finally the main study across different industry sectors. A survey instrument will be designed and developed for quantitative analysis. The pre-pilot is being conducted to validate the user empowerment survey instrument and will facilitate in validating the instrument for the subsequent phases of the study. The case study methodology adopted can be justified as below: subsequent phases of the study. The case study methodology adopted can be justified as below:

As Yin [66] advocates, a case study method is best suited to a research if it poses "how" or "why" questions criteria, the investigator has minimal control or no control over events, and the focus is a contemporary set of events. The proposed research meets all three conditions i.e. the questions ask "how" and "why" the researcher will have no control of events within the selected organisations, and both user empowerment and ES are contemporary phenomena.

As demonstrated in the literature review, the essence of the research program is concerned with ES stakeholders' (users of the ES) perceptions of their system's development, implementation, and ultimate success. It is not the intention of this research to examine in detail *why* the users hold these views. Thus, the most appropriate philosophy for this research will follow the positivist approach described by Robson [67], i.e. the formulation and testing of hypotheses. Hypothesis testing involves the collection of quantitative data, which is then analysed for statistical significance, using an appropriate technique.



Figure 1. Partial Nomological Network of psychological empowerment in the work place [11]

Organisation Selection

A suitable number of organisations will be chosen from different sectors such as retail, higher education, banking, mining, defense and healthcare. The primary reason for choosing a cross section of sectors within the economy is to achieve a more generic implementation of ES picture across a diverse range of business processes. Another aspect to be considered while selecting these organisations will be the broad range of ES thus making the study generic for extended ES. The chosen organisations will all have implemented their ES (2-4 years ago) or will be in the implementation life cycle during the time when the case study will be conducted. In this time frame the ES success and the strength of user empowerment should be clearly evident for those who

have implemented ES. There are four categories of organisations that will be targeted in the data collection phase. These categories are:

1. Stalled adopters (organisations where the use of the ES has peaked or even stopped)
2. Adapters (organisations who adapt their business processes to suit the purchased ES)
3. Expanders (organisations who seek for additional business functionality)
4. Exploiters (organisations who seek strategic and innovative ways of deploying the ES technology)

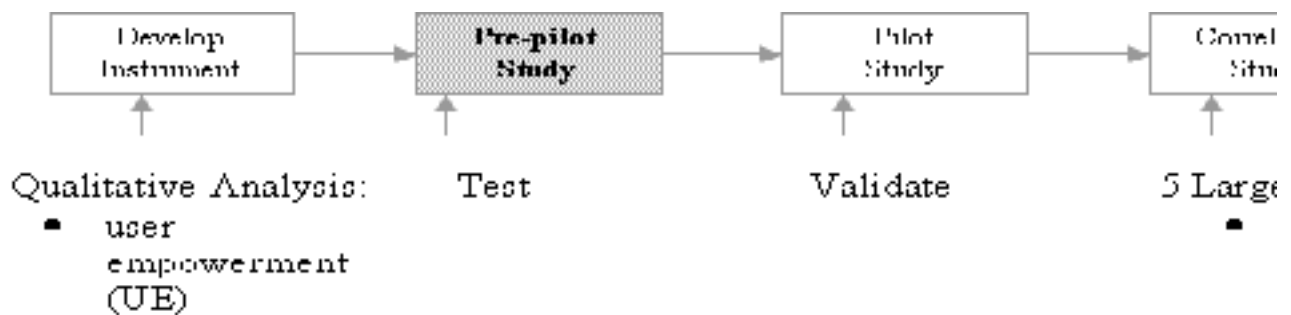


Figure 2: Study progression and phases
Data Collection

Unit of Analysis

It is important to clearly define the units of analysis for measuring user empowerment and ESS and the possible correlation between them. Individual users will be the unit of analysis when measuring user empowerment.

Data will be collected via interviews, questionnaire and survey instruments. The selection of the instrument will be decided upon the nature of the variable being measured. The key informants who agree to participate through these instruments will be notified in advance about the ethical clearance, privacy and confidentiality issues regarding the data collected. The selection of target informants may vary within the range of users of the ES (i.e. senior managers, administrators, operational staff, and specialised staff such as payroll officers to

general users within various business processes of the organisation).

6. Conclusion and Outlook

This paper has presented initial framework of a study aimed at understanding and assessing user empowerment on ES success. The user empowerment constructs have been developed based on the work by [11, 14] and related empowerment literature in order to present a complete set of constructs that explain user empowerment in ES context. Further analysis will be done in relation to the measures of ESS [53] and user empowerment constructs. We are currently progressing with the pre-pilot study to be conducted within department of a large organisation that has implemented an ES. The rest of the study is as shown in figure 2 above.

The intended contributions of the research program are:

- To provide a definition of the construct user empowerment within the ES context.
- To develop, test and validate user empowerment instrument.

To Correlate user empowerment constructs and ESS constructs and finally to correlate user empowerment and ESS.

Note: * Full Paper will be Available on Conference CD-Rom

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The Design of Agents Oriented Collaboration in SCM

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Abstract

In today's global marketplace, individual firms no longer compete as independent entities but rather as integral part of supply chain links. In order to cater for the increasing demand on collaboration between supply chain partners, the technology of intelligent agent has gained increased interest in supply chain management. However fewer researches have clearly investigated the mechanism about agent applications in this area. In this paper we are to study the way how to incorporate intelligent agents into supply chain management from the perspective of agent-oriented system analysis and design. A multi-agent framework for collaborative planning, forecasting and replenishment in supply chain management is developed, in which supply chain collaboration models are composed from software components that represent types of supply chain agent, their constituent control elements, and their interaction protocols.

1. Introduction

Supply chain management system is an integrated system of suppliers, factories, warehouses, distribution centers and retailers. In today's global marketplace, individual firms no longer compete as independent entities but rather as integral part of supply chain links, and there have been increasing attentions on the collaboration in supply chain management. With the increasing research work on collaboration in supply chain management systems, the technology of intelligent agent has been widely applied in this area. A supply chain can be looked as a network of autonomous or semiautonomous business entities collectively responsible for procurement, manufacturing and distribution activities associated with one or more families of related products [1]. There have been a number of researches exploring the agent application in supply chain management and collaboration. However, the approaches involved in most applications are somewhat special, and more efforts are needed to investigate the mechanisms how to incorporate multi-agent technology into supply chain management and collaboration.

In this paper, we will investigate the mechanism how to apply the technology of intelligent agents into the collaboration in supply chain management. The agent-oriented methodology is used for the analysis and design of agent-based systems for supply chain collaboration. In this multi-agent framework, we

propose a society of agent integrated with legacy supply chain systems to cater for the increasing demands on supply chain collaboration between partners and strategic adaptation to dynamic environment. Each agent carries out a specific function; they work together to perform tasks in supply chain collaboration in an autonomous and collaborative fashion. The rest of the paper is organized as the follows. Section 2 briefly reviews the relevant literature on supply chain collaboration and the application of agent technology in supply chain management. The methodology of agent oriented analysis and design is briefly introduced in section 3. Following this methodology, a multi-agent framework for supply chain collaboration is developed in section 4. Finally, some conclusions are addressed in section 5.

2. Literature review

2.1 Collaboration in SCM

Supply chain is a set of activities that span enterprise functions from ordering and receipt of a raw materials through the manufacturing of products and the distribution and delivery to the customers. In today's competitive environment, single enterprises acting alone can no longer provide maximum value to many of today's demanding customers. The new competitive realities are causing suppliers, manufacturers, wholesalers, and retailers alike to rethink their strategic initiatives with their supply chain partners [2]. In recent years, a number of collaborative-based initiatives are addressed for supply chain management. Vendor Managed Inventory (VMI) is probably the first trust-based business link between suppliers and customers. It is an arrangement where the supplier, not the customer, decides when and how much of the customer's stock is replenished. We can also see some similar trends such as Supplier Managed Inventory (SMI) or Joint Managed Inventor (JMI), which are different ways of looking at the same thing [3]. Today, the focus is shifting toward programs like Collaborative Planning, Forecasting and Replenishment (CPFR). CPFR is a collaborative initiative aimed at "making inventory management more efficient and cost-effective, while improving customer service, and leveraging technology to significantly improve profitability" [4]. Nowadays, CPFR has won the support of companies in the drug, grocery, general merchandise, and apparel industries.

2.2 Intelligent agents in SCM

Intelligent agents can be seen as software agents that enjoy such properties as autonomy, co-operativity, reactivity, pro-activity, and mobility. Actually, an agent is a computer system that is situated in some environment, and that is capable of autonomous action in order to meet its design objectives [5]. A generic agent has a set of goals, certain capabilities to perform actions, and some knowledge about its environment. To achieve its goals, an agent needs to reason about its environment (as well as behaviors of other agents), to generate plans and to execute these plans. In recent years, there has been considerable growth of interest in the design of a distributed, intelligent society of agents capable of dealing with complex and distributed problems, and vast amounts of information collaboratively. Software agents offer a convenient way of modeling processes that are distributed over spaces and time. They are good candidates for domains that require constant adaptation to changing environment or demands. Endowed with extended communication capabilities by the advances in network technologies, multi-agent systems are being used in an increasingly wide variety of applications involving inter-enterprise collaboration, extending the boundaries of strategic partnership to wherever the network technologies can reach.

A supply chain encompasses all activities 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. Intelligent agents with their cooperative properties are suitable candidates for collaborative activities in business organizations [6,7]. They can carry out intelligent such tasks as joint decision on orders, monitoring on product activities, and adjustment on replenishment policies, in an autonomous and collaborative way [8, 9]. The combination of supply chain process definitions with an advanced infrastructure in terms of multi-agent systems has the potential to make possible a real strategic competitive advantage for the entire supply chain and will enable new forms of business and work [10]. Nowadays there is an increasing number of researches exploring the agent application in supply chain management, in which the multi-agent paradigm is utilized for modeling and analysis of supply chains. However, the solutions involved in most applications are somewhat special, and more generic approach is needed to support agent application in supply chain management. Furthermore, more efforts are needed to clearly investigate the collaboration mechanisms and collaboration processes in supply chain management, especially at strategic level with respect to multi-agent technology.

3. Agent-oriented system analysis and design

Traditional software development techniques fail to adequately capture an agent's flexible, autonomous problem-solving behavior, the richness of an agent's

interactions, and the complexity of an agent system's organizational structures, and software engineering techniques are specially tailored for the analysis and design of agent-based systems based on agent-specific concepts [11]. The agent-oriented analysis and design process is concerned with how a society of agents cooperate to realize the system level goals, and what is required of each individual agent in order to do this.

In agent-oriented system analysis, we view an organization as a collection of roles, that stand in certain relationships to one another, and that take part in systematic, institutionalized patterns of interactions with other roles. Thus, the organization model is comprised of two further models, role model and interaction model. The *roles model* identifies the key roles in the system, and can be viewed as an abstract description of an entity's expected function. Such roles are characterized by some attributes, e.g. permissions/rights and responsibilities associated with the role. The inevitable dependencies and relationships between the various roles in a multi-agent organization are central to the way in which the system functions. Such links between roles are captured and represented in the *interaction model*, which consists of a set of protocols definitions, capturing the recurring patterns of inter-role interaction.

The design process involves generating three models followed. The *agent model* aggregate roles into agent types, and refine to form an agent type hierarchy, as well as document the instances of each agent type using instance annotations. The *services model* identifies the main services that will be associated with each agent type. For each service that may be performed by an agent, we can document its properties, such as inputs, outputs, pre-conditions, and post-conditions. The *acquaintance model* documents the acquaintances for each agent type; it defines the communication links that exist between agent types.

4. Agent-oriented collaboration in SCM

Based on the above methodology of agent-oriented analysis and design, we will investigate the mechanism how to apply the technology of intelligent agent into the collaboration of supply chain management. A multi-agent framework for collaborative planning, forecasting and replenishment in supply chain management is to be developed, in which supply chain collaboration models are composed from software components that represent types of supply chain agent, their constituent control elements, and their interaction protocols.

4.1 Domain analysis

In this paper, we focus on collaborative planning, forecasting and replenishment in supply chain management. With such collaboration, a customer sends data about sale activities and inventory status to a supplier, and the supplier then uses the data to generate replenishment forecast that will be shared with the customer before it is executed. The kind of

collaboration between suppliers and customers can be applied in different kinds of partnerships, such as component suppliers and product manufacturers, manufacturers and retailers (or distributors), distributors and retailers. For purpose of simplifying the discussion, we focus on the collaboration between manufacturers and retailers.

With the emergency of new telecommunications and computer technology, the way products are bought and distributed is dramatically affected. The collaboration between manufacturers and retailers can be web-based, EDI based or through other network technology, as shown in Figure 1. According to related issues about collaborative planning, forecasting and replenishment [3], the basic transactions in such collaboration process are outlined in the Figure 2. **Collaboration Planning**, the first step for collaboration, is to make a

collaboration plan, which may contain replenishment policy (e.g. inventory levels, fill rates), monitoring policy (e.g. critical inventory, shipment delay), performance measures (e.g. forecast accuracy rate, on-time delivery), communication process, and so on.

Product Activity Reporting is the backbone of collaborative supply chain management, in which the manufacturer's sale and inventory information is typically sent to the manufacturer on a scheduled basis. Based on the report of product activities, the manufacturer may perform **replenishment forecasting** and create order suggestions if necessary. The retailer can review the order suggestions and then determines if the order suggestions are proper or need modifications. Subsequently, an order may be generated based on such **joint decision** from both sides.

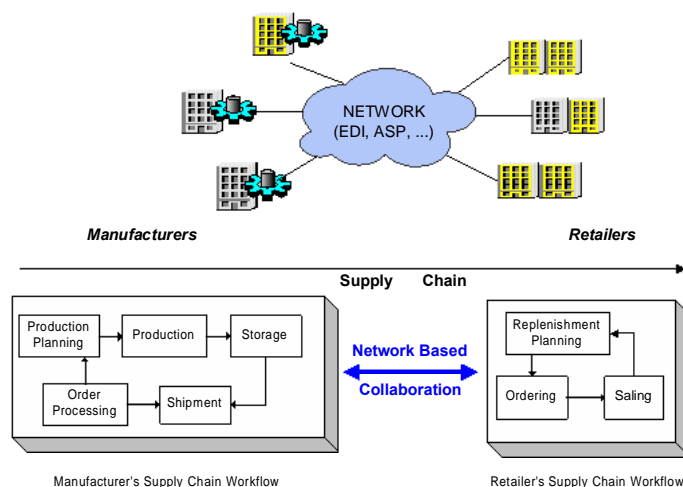


Figure 1. Network-based Collaboration in Supply Chain

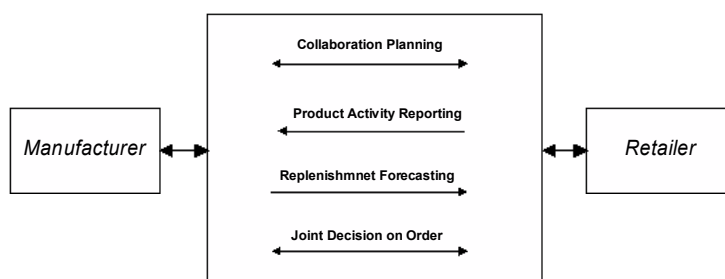


Figure 2: Transactions in the Collaboration Process

After an order is generated based on the consensus from both sides, the manufacturer will inform the retailer what product to expect from him. There are several kinds of message being used for this transaction. The *Validated Order* used as purchase order acknowledgment contains the product numbers and quantities ordered on the retailer's behalf. Then, the manufacturer picks and ships the order and transfers a *Shipment Notice* to tell the retailer exactly what is being sent and when it is shipping. When the shipment is received, the retailer transfers a *Receipt Advice* to tell

the manufacturer exactly what was received. The manufacturer can then match this to his purchase order to determine any potential problems and send out an *Invoice* to the retailer for payment.

4.2 Agent hierarchy

Moving from the above analysis on supply chain collaboration, we design the agent model and present it as agent hierarchy in Figure 3. We classify these agent roles into three classes, task agent, user agent and

information agent; each class contains several sub-

classes as the follows.

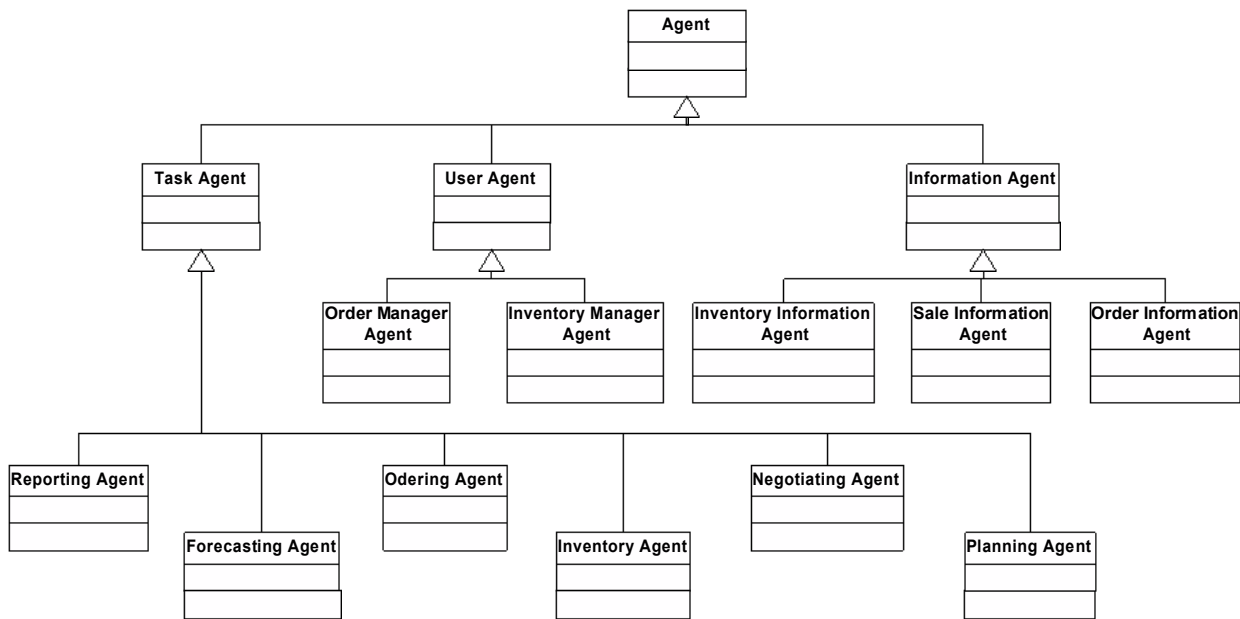


Figure 3. Agent hierarchy for supply chain collaboration

4.2.1 Task agent

Several kinds of task agent are proposed to carry out business operations involved in the supply chain collaboration.

- The **Reporting Agent** is to send the retailer's sale history file and current product activity reports to the Forecasting Agent of the manufacturer on a scheduled basis.
- The **Forecasting Agent** is responsible for conducting data analysis on retailer's sale history and current product activity reports to generate replenishment forecast or order suggestion. The order suggestion is made on the calculation of reorder point according to the replenishment agreement between partners.
- Once receiving an order suggestion from the Forecasting Agent, the **Ordering Agent** will ask the order manager for check and modification, and then send it to the Inventory Agent for review and confirmation. If the order quantity is over pre-defined limitation, the Inventory Agent will ask the inventory manager for validation. After validation, the order is sent back to the manufacturer side for confirmation and execution. Subsequently, the Ordering Agent will start to monitor the process and progress of this order.
- If the order suggestion is not accepted by the retailer side, a **Negotiating Agent** can be activated to guide both sides to make an online discussion in order to achieve some consensus for the joint decision. Also, the manager of both sides can start this agent for negotiation

on other issues, e.g. adjustment on collaboration plan.

- The **Inventory Agent** is charged with the inventory management for the retailer. Besides reviewing order suggestion from the manufacturer, this agent will keep track on inventory status, raw materials/components shipment and receiving. For example, if one kind of raw material in the inventory is detected in a critical status, the Inventory Agent will ask the Forecasting Agent to generate a replenishment order suggestion in a real time fashion.
- The **Planning Agent** is proposed to make collaboration plans for supply chain partners. It can also make suggestions about collaboration adjustment based on its planning knowledge and analysis on supply chain performance, and send it to managers for reference. When the managers decide to adjust the plan, the Planning Agent can help distribute the content of the adjustment to related agents. For example, the modified replenishment policy will be sent to the Forecasting Agent and Inventory Agent to adjust their activities.

4.2.2 User agent

User agents act as effective bridges between the users and the system in order to make the human-computer interface more intuitive. There are two kinds of user agent in this system; each represents a type of user who interacts with the system. The **Order Manager Agent** enables the order manager of the

manufacturer to read replenishment forecast, check order suggestions, validate orders, control progress of orders, and negotiate with the retailer through the help of several task agents. The **Inventory Manager Agent** enables the inventory manager of the retailer to review and validate order suggestions, check inventory status, negotiate with partners, and etc.

4.2.3 Information agent

Information agents are responsible for operations on multiple, heterogeneous and distributed information sources with a view to controlling resources of business processes. Although there is no need for centralized storage of all knowledge regarding supply chain collaboration, there could be consistent knowledge repositories that maintain and integrate all information related to collaboration tasks. In this way, the various agents that make up the system can exchange knowledge regarding entities involved and deal with supply chain management in a collaborative manner. In our system there are three types of information agent, **Order Information Agent**, **Inventory Information**

Agent, and **Sale Information Agent**, each responsible for access to the corresponding information resource. Moreover, such information resources may form an important base for agents' collaboration in supply chain.

4.3 Agent architecture

Based on the above description of various agents in the system, we are to design the internal structure and operations of each agent as its service model. Generally, the design of agent architecture considers an agent knowledge base, its operational facility and its external interface. Knowledge is required by each agent to perform its internal and external activities. It consists of resource status information, rules for particular tasks, information about other agents, and so on. The operational facility can execute different functions and provide collaboration with other agents. The external interface envelops an agent and provides access to it via a well-defined interface. It is also the primary conduit for communication between agents.

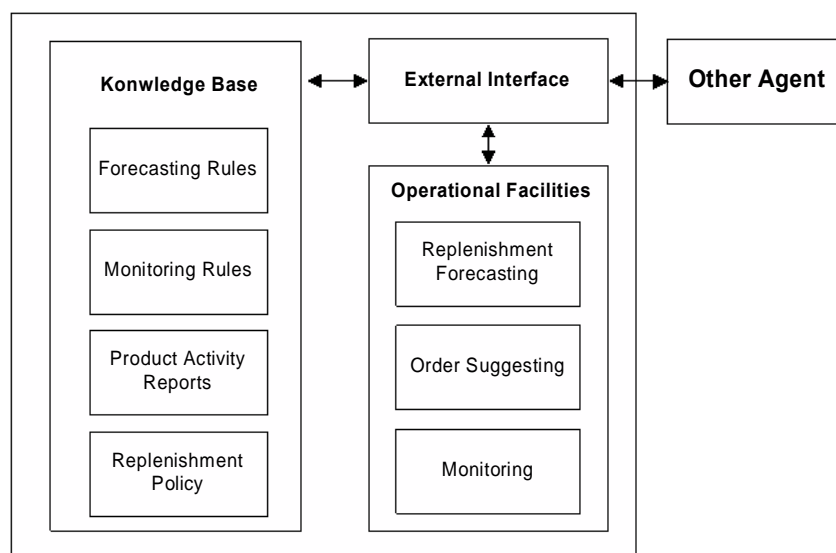


Figure 4. Architecture of a Forecasting Agent

In the interests of brevity, we only present the architecture of the Forecasting Agent as an example. As presented in Figure 4, the **external interface** enables the Forecasting Agent to communicate with outside, i.e. receiving product activity reports from the Reporting Agent and sending order suggestions to the Ordering Agent. The **operational facility** is represented by a set of functions followed. The replenishment forecasting function is responsible for conducting data analysis on current product activity reports as well as retailer's sale history to generate replenishment forecast. The order suggesting function works based on the calculation of reorder point specified in the replenishment policy, e.g. stock level, fill rate, and etc. The monitoring function is proposed to keep track on product or sale activities to detect unexpected events happened in the retailer side.

Knowledge is required by the Forecasting Agent to perform its internal and external activities. There are several types of knowledge for this agent to perform various tasks, including forecasting rules, monitoring rules, product activity reports, and so on. Furthermore, the Forecasting Agent can access the sale information through the Sale Information Agent to assist its forecasting activity.

4.4 Agent communication and collaboration

Interaction among agents, an important aspect on research of multi-agent system, is set up on the base of lower-level data communication that takes charge of transferring data without semantic from end to end. Unlike data communication, interaction among agents

is mainly control information with semantic and knowledge. KQML (Knowledge Query and Manipulation Language) is a language that is designed to support interaction among agents [12]. Message transferring with respect to information flows models the exchange of information and contributes to the collaborating processes between supply chain agents. For instance, after a purchase order is created based on the joint decision between the manufacturer and the retailer, several types of message may be transferred between the two sides, such as “validated order”, “shipment notice”, “receipt advice” and “invoice”. All the messages are structured documents based on KQML language, and can be dealt with by each agent

according to the event selection mechanism that is subject to some control rules such as first in first out (FIFO).

Our collaborative multi-agent environment is to provide the application independent framework to meet the infrastructure needs of everyone involved in supply chain collaboration. With the multi-agent environment, collaboration goes beyond the simple, serial exchange of information between varied disciplines or domains. It ensures that knowledge can be shared and used at the moments when it can best impact the work. The interaction and collaborations among agents in our system are described in Figure 5.

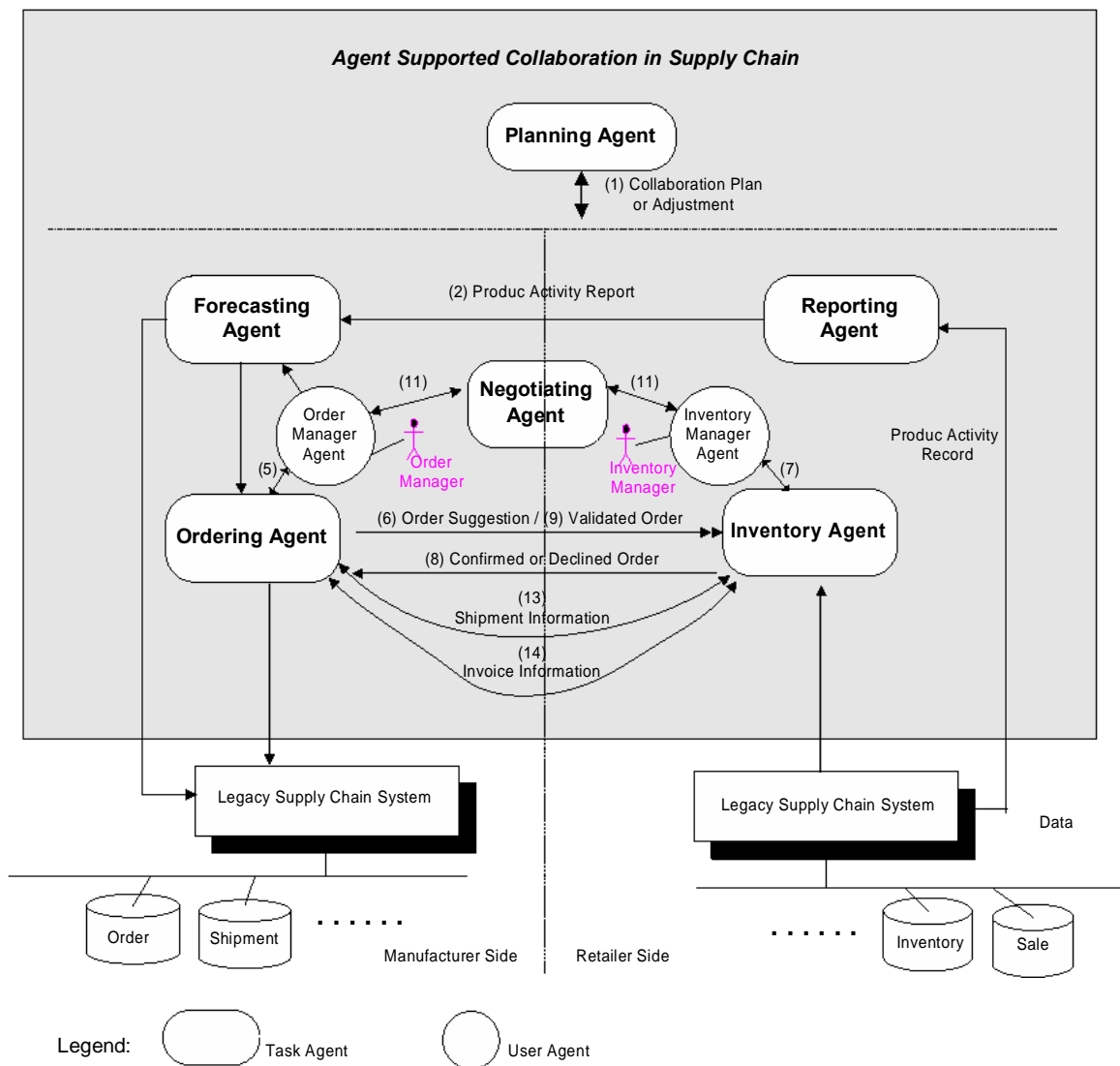


Figure 5. Agent interaction in supply chain collaboration

As shown in Figure 5, the first step for supply chain collaboration is to make a collaboration plan between partners, which may include replenishment policy, communication process, monitoring policy, performance measures, and etc. The managers can

submit the collaboration plan to the Planning Agent and let it distribute the plan to related agents to initiate their activities (1). The Reporting Agent sends current product activity reports to the manufacturer on a scheduled basis (2). Then, the Forecasting Agent

conducts data analysis on these reports and generates replenishment forecast (3) or order suggestions (4). After receiving an order suggestion from the Forecasting Agent, the Ordering Agent will ask the order manager to check or modify this suggestion (5) and send it to the Inventory Agent for automatic validation (6). If the order quantity is over pre-defined limitation, the Inventory Agent will ask the inventory manager for check and modification (7). After such process, the order is sent back to the manufacturer side (8) for confirmation (9) and execution (10). If the order suggestion is not accepted by the retailer side, a Negotiating Agent can be started to facilitate both sides to make a discussion for some consensus if possible (11). When the products are to be delivered to the retailer (12), the Ordering Agent will transfer a shipment notice to the Inventory Agent (13). Then, the Inventory Agent will check the matching of the product order and the shipment notice, and send receipt advice for payment while receiving the expected products (14).

5 Conclusions

In this paper, we applied the methodology of agent-oriented analysis and design to the system development of supply chain collaboration. Based on the analysis on supply chain collaboration paradigm, a multi-agent system framework is developed, in which various types of agents are proposed with their internal services and external interactions to perform collaborative activities in supply chain management. The key concepts in this methodology are agent roles, which have associated with them responsibilities, permissions, and can interact with one another in certain ways specified in the protocols of the respective roles. We believe this work is not only of pragmatic value for supply chain collaboration applications, but also assists a precise understanding of some concepts and terms in agent-oriented system development.

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Strategic Learning and e-Business Solutions in a Pharmaceutical Organization.

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Abstract

This paper analyzes how e-business solutions facilitate strategic learning in a globally operating industrial organization. Because of confidentiality, the case company is called here The Pharmaceutical Company. The theoretical framework consists of strategic composition[®], an interpretation of autopoiesis theory (the theory of self-producing systems). The framework emphasizes both interaction with the business environment and self-referentiality to ensure efficient utilization of accumulated knowledge.

The Pharmaceutical Company is a healthcare company that manufactures and markets pharmaceutical products and services for certain illnesses. It is not only a world leader in the care of one serious illness but also has a leading position in some other pharmaceutical product areas.

The Pharmaceutical Company has created comprehensive web-based solutions that are centrally coordinated, locally maintained, and enable interactive communication between the company, consumers and professionals.

Development of these solutions has resulted in much of the tacit knowledge becoming explicit, thus facilitating organizational learning both at the coordinating and local levels. The Pharmaceutical Company's web solutions have also facilitated interaction with consumer and professional communities, as well as provided a medium for education. Many parties outside the company have thus become more firmly involved in the learning processes and have gained the opportunity to improve their knowledge.

Although many regulations prevent using the information produced by the system, even that information available within the limits of the regulations has remained underutilized. The Pharmaceutical Company has many potential opportunities to learn from the interaction offered by its web-based e-business solutions.

1. Introduction

1.1 E-business solutions as enablers for strategic learning and knowledge management

For many firms, the major motivation for implementing e-business solutions is to increase efficiency and service capability, and to enable new business processes. This paper assumes that e-business can also increase innovativeness, learning and a capacity for renewal that are increasingly important factors affecting the competitiveness of a firm.

However, it is not clear how firms utilize e-business solutions for learning, knowledge creation and renewal. Motivation, opportunities and methods to apply e-business solutions may vary widely across various businesses. The firms could learn from their customers and markets by tapping into potential information and knowledge that can be channeled through e-business solutions. They could also learn from each other, by sharing knowledge about their plans, progress, experiences, and best practices. Big corporations have relatively good opportunities to acquire knowledge about feasible solutions outside the firm, to test them and to invest in them.

The theoretical background and key concepts, such as autopoiesis theory, the living composition[®] model, major knowledge flows, boundary elements, e-business and knowledge management will be defined briefly in Appendix 1.

1.2 Research project

This paper is part of the research project "Strategic Management of Innovativeness, Renewal Capability and Knowledge, and the Role of e-Business", which aims to investigate three different internationally operating organizations that utilize e-business in their business relations. The project analyzes the following organizations:

- the case company of this paper is a globally operating pharmaceutical company that has developed a comprehensive and culturally sensitive business-to-consumer e-business solution. E-business solutions are also used to connect the firm with professionals.
- Metso Paper (part of Metso Corporation) is an example of a global corporation that is developing e-business solutions to support the

product life cycle of the paper machines supplied to customer firms.

- Outokumpu Copper Products OCP Europe - Electrical Power & Components Unit, has created a sophisticated business-to-business extranet solution for a relatively small number of customers. The customer relationships are based on long-term contracts, and interaction with them is complex by nature.

These companies were selected among internationally recognized innovators and frontrunners in the strategic application of e-business. The purpose is to create new knowledge and to facilitate benchmarking and learning from their experiences. They differ considerably from each other in the methods used to apply e-business.

The study applies a qualitative multiple-case study methodology, which can convey rich and dense data about complex, dynamic research phenomenon. Four persons were interviewed for this case study at Pharmaceutical Company eBusiness Department on June 7th 2002:

- Manager, eBusiness Department
- Project Manager, the communities' site
- Project Manager, the professionals' site
- Project Manager, an additional illness' site

The interviews were conducted in English, recorded and transcribed.

The research project has been financed by the Foundation for Economic Education, and later also by Seinäjoki Polytechnic. The project reports have been finalized at the Tampere University of Technology. The author extends a warm thanks to all persons and organizations that have contributed to this study.

1.3 Research question

It is not clear how firms utilize e-business solutions for their own learning and knowledge creation, and more importantly how they exploit e-business-enabled interaction with the customers and increased, more rapid access to new knowledge. Therefore, this study investigates two research questions:

How does The Pharmaceutical Company learn and create new knowledge by utilizing e-business solutions?

2. The Pharmaceutical Company

The Pharmaceutical Company is a healthcare company that manufactures and markets pharmaceutical products and services. It is a world leader in the care of a very

general illness, and also has a leading position in other product areas. The story of The Pharmaceutical Company started in the first decades of this century. The current company is a result of a merger. The company has production facilities in almost ten countries, and affiliates or offices in about 70 countries. The Pharmaceutical Company reaches out to almost 200 countries around the world. The company has about 20,000 employees.

The Pharmaceutical Company specializes in products and services for the treatment of a serious illness that can occur at all ages. The illness is becoming increasingly common in developed and developing countries.

3. E-Business Solutions at the Pharmaceutical Company

3.1 E-business strategy at Pharmaceutical Company

According to the manager of the eBusiness Department, the e-business strategy of The Pharmaceutical Company consists of three focus areas. One focus is corporate communication, which covers the corporate site and all the affiliates. The second area consists of websites that focus on patient communities and professionals, while the third area covers the products.

Although the content of Pharmaceutical Company's e-business solutions is basically local, it is based on shared structures and principles created at the eBusiness Department at the headquarters. The strong orientation towards localization allows for differences in culture and lifestyle, regulations, logistics, and other relevant aspects. In addition to the local pages, there is also an international version for the professionals' website.

We have the international one (version), yes. Because if we have people on the ground in each country we can include local events and local debate on the site, which we cannot do from the headquarters. Which is why we have the international one. But it needs some resources to maintain. And they are very expensive. (Project Manager)

The availability of Internet connections and the capability of the population to use it are improving, which has implications for the applications directed at consumers.

The challenge is Internet because most of the older people are not looking into the Internet today. But also that is changing. For example we can see that women in the age of 40 and up are looking into the Internet. Whereas the people over 60 years don't. But in the future people in that age will be familiar about the Internet and use it. (Manager)

The Pharmaceutical Company uses communities to increase the awareness of the company. The illness community is the largest one. ---. However, the representatives of Pharmaceutical Company emphasize that they are not allowed to collect information about the patients.

The heart of the e-business strategy is that the websites launched by Pharmaceutical Company are based on *a content management system*, which offers a useful user-friendly interface, where people can easily update the content if they have basic word-processing skills. The strategy also includes *local infomasters*. They are not technology specialists who do coding or maintain web services.

Local infomaster is responsible for moderating the community, making sure that there are always updated news on the front page and links to the interesting stories about local initiatives, facilitating the dialog and so on. That is a very important part of the site. And that's why don't call them the 'webmaster' which is the normal term, but an infomaster. We are more interested in a person with an information background or a journalist or something like that than a tech person. (Project Manager)

The website structure has become quite comprehensive, and the challenge is to ensure that consumers and professionals can find the right information.

We have been focusing on creating a lot of awareness and having a lot of sites in these areas and different countries. So right now we are in a situation where we have awful lot of sites. In each country they look similar and they got the same corporate visual identity (CVI). But now we are trying to re-think, because our corporate site has a lot of visitors. We have like 100.000 visitors a month. --- Right now I'm trying to focus on to find out how we can use what we have to get more traffic and to use all these sites in a better way, to link them together in a better way, so we can get our customers to the right places. So we are trying to re-think the portal or the corporate site and to use that as the main portal. (Manager)

The purpose is also to support the sales representatives in different countries where the regulations and cultures vary considerably.

3.2 Organizing e-Business Projects at The Pharmaceutical Company

The eBusiness Department is a part of international marketing. The department has 13 full-time employees and 7 student workers. It coordinates the development of websites globally and provides the strategy. There is also

a group of about six persons in the US because they have special needs. The objective is that there is one web coordinator in each affiliate, but this is not always the case.

We have a central hosting of the web pages. We have a strategy trying to align the technology so that we're not having different content management systems in different countries. We are coordinating, trying to have a central platform. And it is our job to control that they are to the CVI. (Manager)

It can take ten years to develop new pharmaceutical products. The development process includes many phases, such as clinical trials. The development of marketing materials starts about three years prior to product launch. Therefore, the market research department works very closely with R&D. The eBusiness Department joins the process about one year before the launching of a new product in order to conduct communication planning. Each country is responsible for the local sales and promotion of products in individual countries, and the local managers are responsible for the launches. It therefore also makes sense that they manage their own campaigns. The websites form part of that campaign.

The department provides support for all the sites, but in principle it does not pay for the content. However, because some of the affiliates lack sufficient resources, the department has been working with the content as well as providing support. When implementing new project development and IT development, the department uses different web vendors, including The Pharmaceutical Company's IT department.

Corporate communication has responsibility for the public corporate website. The manager sits on the steering committee to ensure that the department can influence decisions concerning strategy for the new portal and other matters related to web services.

3.3 Architecture and infrastructure

About 80 % of the Pharmaceutical Company's websites are based on Site Manager content management system, which is proprietary technology developed by a local software firm. The new development is taking place in a commercial system. Also other alternatives have been available. The content management market is not entirely mature market yet, and therefore The Pharmaceutical Company is working with several different systems. The purpose is to focus on off-the-shelf products that are supported by larger companies. The primary idea is that the system should be so easy to use that there is no need for technical persons but rather for journalists or communication person to work with the sites. (Project Manager)

3.4 The Pharmaceutical Company Websites for Patients and Patient Communities

The websites for patients are open to anyone in about 20 countries. The current version represents the third generation created since 1999. The eBusiness Department has developed a general platform or template and many different modules that the local affiliates can select and add on to their sites. All sites are published in the local language to enable local users to search and find information in their local language. There are also many cultural differences that have to be taken into account in the content of the webpages.

The websites do not include any recommendations for the patients. Instead, they provide patients with a tool to keep better track of their condition. All recommendations should come only from their own personal physician.

We are not collecting patient data, we only can use it to give the patient better information or better service. --- The person creating a profile (onto the website) has to explicitly tell if we can use the data. Otherwise the data is just locked and we cannot see it. But if we are allowed to look at the data we can check it to see how people use the site. --- We can use the patient's data for analysis and for developing new functionality of the site or whatever we find necessary. But today we don't use it. (Project Manager)

The webpages aim at creating user communities and facilitating interaction between The Pharmaceutical Company and the patients, as well as among the patients. The patients can be divided into two groups, each of which requires a different approach.

We are segmenting our consumers into groups, but mainly we have two groups. We have the **active patients** and typically they are people who are very active and do a lot of sports. They want to take care of their illness, they want to be able to perform. They also know about the illness. And they will go back to the doctor and try to influence and say "I have read about this product and this is something for me". And then you have another group, which is called the **more passive group**. (Manager)

The Pharmaceutical Company home page contains an '**I wish' theme**' with case stories about different patients from all over the world. They include statements such as "I wish no-one ever gets this illness again". The purpose is to demonstrate that the webpages are for the patients and that the company cares about patients and is involved in their stories, instead of just selling products.

The local front page typically contains much information, including a calendar of events, useful links, and

information about products and devices. The **library** (R&D) part of the site contains information about the illness.

Then you have a **dictionary**, the words people don't understand. The illness is quite complicated, there is a lot of complicated words and people can look at them here to see explanations for them. --- In this kind of site we have some **applications** as well. (Project Manager)

Users can create **personal profiles** and register information about themselves in order to use it in the interactive pages on the site. They can, for example, save their personal measurements in a **diary** and create a **scorecard**, as well as keep track of their doctors, specialists and all other persons involved in their health care. However, they only need to provide the information required to use or search that part of the site, in so far as it makes sense to ask information.

At this moment we are only providing graphs and so on, and the people have to do the conclusions about their illness themselves. (Project Manager)

All my values should be between certain values, within the green area. And if I have values below or over that, then I can see that this is not good. --- If the patients just use this tool as intended then they would be able to see some kind of development in their disease. --- This is part of the personal diary what we call the personal scorecard. The medical measures are interesting for the patients with this illness. And the patients can track this data. For instance they can set up a goal, and they can see how they are doing compared to that goal. If I get a "red traffic light" it means that I am in a high risk. We have some predetermined intervals where these values should be in according to the international diet lines to treatment of the illness. And if you are not between within these intervals then you would get these highlights, the red and yellow. (Project Manager)

As to the more **interactive parts** of the site, The Pharmaceutical Company has found that live chat is not easy to do when dealing with a relatively limited number of people. There is almost never anyone in the chat room. Therefore, the chat has been replaced by a moderated chat forum that is facilitated by the infomaster and the local affiliate.

Maybe the most successful module, especially in certain countries is '**ask the experts' sites**. In an affiliate, for example, 12 to 15 experts are connected to the sites as well as patients, doctors, nurses and all kinds of health care

professionals. And the users of the site can then ask whatever questions in life, and they send the questions to the site --- For example in one country the *infomaster* arranges a meeting with local specialists, and says that on Monday from 6 to 7 we have this chat with this person. And then people come and they discuss something with that person and they have questions and so on. But if we just have it as a local chat over time, then people drop in from time to time but there is never any real discussion. So it has to be a moderated chat with an interesting person. Otherwise it does not work. ... The other thing is the debate that it's separated into different topics. We have 'the café' and 'the children' and 'the young people' and 'the parents' at this moment. And then people just start discussions and share experiences and talk about their teenage kids and how they smoke and all the things they do that they should not be doing. --- People are interested in sharing their experiences and it just has to be started. (Project Manager)

Questions can be sent to the *expert panel*, with all questions being posted thereafter on the site together with their answers, since most of these questions can also be of interest to other users of the site. Thus, when submitting a question, users are always informed that all questions will be answered and all answers will be published on the website. The objective is to answer the questions within a week.

There are also many applications, such as a cookbook, that are useful for the patient.

I think we have a thousand recipes or something like that in English, approved by dietists and they can just take from these, have them translated locally and update. (Project Manager)

The web pages help in educating different types of patients. "We force the people to think themselves about their treatment, to improve their treatment".

And we have an interesting thing, it's a *quiz*, it's actually a *jeopardy about the illness*... and it's combining film and sport and music with topics related to the illness. And then it's a good way for teenagers and for young people interested in playing games to learn about the illness while playing. We have both a grown-up, a teen and a child version. (Project Manager)

The quiz is interrupted and I have a little *case story*. And based on this case I have to decide if I should take medicine, or should I exercise or whatever to get better. And then in this case I suggest that I need a little of juice. And then OK, that was right. And then I get back to the quiz. So at times the quiz is interrupted and you

have a case story where you have to decide something related to your therapy. (Project Manager)

This is a *game for smaller children*. ...And it's kind of based on the Tamaguchi idea. You have your own little Pet and you need to take care of it. You name it, so it is your own personal pet, it is called a Pet. And I can play with her, I can go roll skating. And there is a little game here. And all the time this Pet reacts, so I can always measure the indicators of her illness. I can go on the fridge. Now I give her some cheese and I measure again. And now it's better. ... And now the Pet is getting some of these symptoms of the illness. I can see the value is a way too high. And then I can give some medicine. So the Pet is taking some medicine. And this is basically a tool for the parents to play with the kids, basic things about taking medicine, doing other necessary things and a way to teach while you learn ... You also get emails from your Pet. And if you haven't been playing with your Pet for 10 days or something, you can get an email saying "I miss you, please come and play with me". (Project Manager)

In one country the site is focused on the *young people*. You can go in and there will be a movie about a guy – he is falling in love - how he is telling her he has this illness and so on. So, that's trying to focus with young people and how they live --- If you are a young person you know that you have to live with this for the rest of your life. It must be hard ... (Manager)

The '*Living with the illness*' sites contain lots of articles about the illness. The headquarters has made a basic pack of content for the site, and the local affiliate can add on to it.

In principle, the web pages do not include information about Pharmaceutical Company's products. Instead, they provide information about products in general.

And it is one of the core systems - CRM Customer Relationship Management systems - for the sales. We have learned from this that it is very hard job to sell things, that it is huge difference between marketing and sales. Because here the patient is not just buying books or cd's or things like that. Here they are buying things that they are putting into their own body. (Project Manager)

3.5 The Pharmaceutical Company's Websites for the Professionals

The "Illness information for the professionals" website is offered as a service from The Pharmaceutical Company

to health care professionals, such as physicians, nurses, pharmacists, and trainers. There is an international version, and a couple of national versions. The site contains professional information and research, such as up-to-date medical information, educational resources, and the latest research in the illness. An editor reads through medical journals and creates a short calendar describing events and current debate within the field. An abstract database allows physicians to search in journals for abstracts. An image bank provides images of body parts commonly affected by the illness. The site also includes an event calendar, praxis tools, and a monthly newsletter co-edited by an in-house doctor, a medical advisor who works for the website (but not as a 'netdoctor' directly serving patients).

And we don't get anything other in return than our corporate branding. There is no product branding in this service. The goal is to signal that The Pharmaceutical Company is "being there" and we actually do stuff for the doctors and not only for profit. And we try to improve the care of the illness. --- And I think actually that the project was launched to improve the care of the illness given our offering from our company to help patients. (Project Manager)

The US is a bit different because they have another way of looking at a disease. A different definition. (Project Manager)

Physicians are a difficult target group for a website, since the information should meet a high standard of quality and be highly relevant.

Actually most complicated aspect of this work is to find the right content and the right level. --- You have to put something relevant on the website for the doctors. If you put too much product information on this website it wouldn't look objective and then they wouldn't use it. --- If they click in a certain place they will get a screen that says "you are now leaving objective information and it's being product universe". So, the products are not far away, but they are not in the base all the time (Project Manager)

Education is one of the objectives of the site. Many guidelines already exist on topics such as how to treat the illness and how to educate the patients. The eBusiness Department does not write the content for such pages, because it is at such a high level, but rather hires opinion leaders to write the text.

We have some cooperation with some international organizations concerning the illness. We have people in house who have a lot of good contacts with these organizations. They prepared guidelines, which we have put on into the Internet for them as a service to the

organizations. --- We actually do not write the guidelines, it is the international organizations. So we actually just collaborate with them. They do the writing and we pay for some of the technical stuff. --- Then we use some vendors. A vendor in Holland produces news about the illness, and they have a panel of doctors who check out what is happening in the world of the illness. --- Then we have in some of our affiliates people hired to actually to write. They have journalistic background. (Project Manager)

It is very difficult to make a website like this because FDA - the US drug administration¹ - they have a very tight schema or rules of what you can tell or not tell. So, for example with this site in the US we have to be very focused on not mentioning our own products at all. But we can mention our competitors' products. (Project Manager)

Regulatory aspects are more difficult than the medical and legal aspects.

At the moment I am working together with the US affiliate and at the same time our IT department to get the US site up and running and to get the content on the site approved by our internal approval organ in the US. And there are so many regulations in the US, it's very long process. We have legal, medical and regulatory assistance. The regulatory people know what the FDA authorities in the US know and what their requirements are. So they tell that to me and say: "You have to do this and this and this". And they review this every time I come with something new and they have to review it. So that's one part of it, and another part is actually to get ideas for content. And that's very difficult because you work within this framework of rules and regulations. And then they of course check all that clinical stuff. (Project Manager)

3.6 Organizational Learning

The development and maintenance of the websites facilitate learning in several ways on both local and global levels. However, this capability is not fully utilized.

The most important part is that our *local affiliates* are learning about their customers from these questions. And we don't have any organizational rules or systems to handle this ... I mean saying as we probably don't have it when people take the phone and call into the company and ask questions about the product, then we

¹ Food and Drug Administration

don't collect this information to learn and to develop products in a better way and so on. This is of course something that we have to deal with. --- But it is on the local level. It is on informal and local level and it is not coordinated globally. And that is of course a challenge because we have to find out how we can utilize all the information we can get out of these sites ... all the different questions and all the contacts when people use the contact part of the site (Project Manager)

The professionals' site is primarily a tool to get in contact with professionals and opinion leaders. The Pharmaceutical Company gets a lot of organizational learning via the site.

And the doctor might give us his comments on some of the articles or something like that. But also at conventions we have used that site to get in contact with them. And in general we work together with people who write stuff on the site. That's a good way to collaborate with the opinion leaders. (Project Manager)

As to the eBusiness Department, one of the objectives is to develop "Web intelligence" and to improve the services offered to the target groups.

If you look at my department we could be much more learning about ... I think we are focusing on it but we are on the first step of learning and ...because we have been so much focusing on getting in out there, and now we want to see what we can get back from it. It hasn't been the main focus until this year. I think it is very important, also the *web intelligence*: how we can get the information back now. --- Is to make sure the effect of the internet sites, to get that information back and then to use that as an evaluation of how the sites are doing, and if the sites are used the right way or if we should change something. We also want to see how much we can collect some of all the information we get about the users. In some cases we do collect a bit because we ask people to register on some of the pages but also here there are a lot of regulations and country specific regulations, so we have to be really careful. (Manager)

Actually, we have invested in a statistics system which is more like a reporting system rather than an intelligent system, but still we can get some information about how many users, where they go, on which pages and so on. So we just evaluated a product site and found out that there was really a bit interest for the site, but they only look on the front page and then they lost the interest. We could see how they lost the interest and they didn't go to the right pages, where the

real product information was. --- So we have evaluated the sites and we made a proposal on how we could change the content and make it more relevant for the customers. (Manager)

Actually there has been one online survey. We asked about what they think about the website and what they would like to read there, and asked them to compare it to other websites, and general comments. We got a lot of frustration of that. And then we have made a focus group where I think there was 12 people trying the website together with one person getting their comments. (Project Manager)

4. Conclusions

This case study aimed at investigating the research question

How does The Pharmaceutical Company learn and create new knowledge by utilizing e-business solutions?

4.1 How Does the Company Learn and Create New Knowledge by Utilizing e-Business Solutions?

The Pharmaceutical Company is a knowledge-intensive company. The success of the company is based on the development and application of explicit scientific knowledge. The development of the products occurs through a long and complex procedure overseen by R&D specialists. The Pharmaceutical Company has also developed comprehensive and interactive websites that cover the most important partners: the consumers and the professionals.

4.2 Classification

According to Skyrme's classification [2001], The Pharmaceutical Company's internet-based e-business solutions can be classified as interactive solutions and partially as trading solutions. They are not 'brochureware'.

4.3 Learning through design and implementation

During the implementation of the web solutions, a large amount of knowledge that was previously in tacit form has now become explicit. This has facilitated organizational learning both at the coordinating and local levels. It is most likely that designing and maintaining the websites has promoted organizational learning and increased awareness of company stakeholders at The Pharmaceutical Company. For example, the creation of community sites has made the eBusiness Department and the affiliates more sensitive towards the different perspectives of the various customer groups and

professionals, and of the cultural and regulatory differences.

The Pharmaceutical Company's web solutions also facilitate interaction within the consumer and professionals' communities, and promote their educational aim. These solutions have thus allowed The Pharmaceutical Company to reach many parties outside the company, to more tightly connect them to the learning process, as well as provide these stakeholders with an opportunity to improve their knowledge.

4.4 Learning Through Continuous Utilization of the Websites; Websites as Boundary Elements

The sites provide access to an extensive amount of data that is, to a large extent, protected from access by legislation and regulations. However, the legally available data has great potential as a source of organizational learning on global and local levels for market analysis, product development and other learning purposes. This potential has remained underutilized at The Pharmaceutical Company mainly due to the absence of a shared explicit framework or concept of organizational learning. Such a framework would help to coordinate various parties, processes, knowledge resources and ICT systems to facilitate the learning process.

Through the web solutions, The Pharmaceutical Company has become aware of its business environment and of many changes occurring within this environment. The websites serve as interactive boundary elements that help to distribute knowledge between the firm, user communities and professionals, as well as to monitor and collect information. The solutions facilitate the utilization of experts and opinion leaders within and outside the company.

Many regulations prevent the firm from using the information and knowledge produced by the system. However, even that information which could be used within the confines of the regulations has not been very efficiently utilized. These unutilized opportunities would allow Pharmaceutical Company to learn from the interaction enabled by its web-based e-business solutions. For example, using CRM Customer Relationship tools would require screening of essential information from the data for learning, R&D and marketing purposes.

In general, the creation of interactive websites can also support the development of business strategies. They have opened up possibilities to improve customer, partner and supplier processes, as well as enable extended reach, coverage, and presence.

Other types of boundary elements may also exist at Pharmaceutical Company, but they are not studied in this paper.

5 Benefits of the Research Project

This research project will link e-business solutions to major knowledge flows and thus to organizational learning and renewal. This is a relevant approach because e-business solutions may facilitate innovativeness and learning. E-business may thereby become an increasingly central component in the innovativeness, renewal and underlying dynamics of the organization.

The research project contributes to the following areas:

- Strategic management, innovation capability and strategic learning.
- Knowledge and information management.
- Customer and market information management. 'Boundary' management.
- E-business, Internet technologies and interactive solutions.
- New organizational structures and processes. Digitalization of business processes.
- CAS Complex Adaptive Systems, self-producing systems and living organizations.

Moreover, the study helps to test and further develop the relatively new theoretical and methodological framework of strategic composition[®]. This project provides new evidence to support the use of autopoiesis theory (and Complex Adaptive Systems theories in general), a promising approach to organizational learning and renewal phenomena.

An earlier study (Maula, 1999) investigated four management consulting firms. This research project will introduce several new aspects, such as:

- Investigation of a manufacturing company.
- Focusing on openness, supported by interaction and knowledge flows, and linking it to learning and innovativeness
- Investigating openness in the light of e-business.
- Testing the generalizability of the existing theoretical and methodological framework.
- Focusing on selected strategic components, and especially e-business in the role of a boundary element.

In general, the study provides new empirical evidence on boundary elements, and especially on the role of e-business solutions for knowledge management and strategic learning.

APPENDIX 1

THEORETICAL BACKGROUND AND KEY CONCEPTS

Autopoiesis theory

The study is based on an interpretation of the *autopoiesis theory*, which combines general systems theory and complexity theory. The theory explains the properties and behavior of self-producing (autopoietic, living) systems ('auto'=self, 'poiesis, poein' = to produce, create; greek). The theory was developed originally by Humberto Maturana and Francisco Varela in the fields of neurophysiology and phenomenological biology [3], [4]. Autopoiesis theory and its implications have been described by Mingers [7]. It has been applied in the context of organizations, for example, by von Krogh and Roos [1], [2].

Living composition[®] model and major knowledge flows

The *living composition[®] model* is an interpretation of the autopoiesis theory in the organizational context [5], [6]. It provides a systematic, theoretically justified and empirically tested methodological framework for analyzing organizations as living systems. The main assumption is that living organizations are simultaneously open and closed (self-referential) systems. Living organizations are featured by two major knowledge flows:

- Knowledge flows that facilitate openness, innovativeness and interaction with the environment ('organizational senses').
- Knowledge flows that facilitate self-referentiality ('organizational memory') and enable efficiency.

In this study the focus is on 'organizational senses'. The main conclusion from the autopoiesis theory and living composition model is that knowledge-intensive organizations are *simultaneously open and closed* (self-referential) systems. The model explains how organizations can simultaneously operate both efficiently and innovatively if knowledge flows are organized properly [5], [6]. This means that the conventional dilemma between exploration (creativity, innovativeness) and exploitation (efficiency) can be re-framed in the light of the theory and model.

Boundary elements

An autopoietic system is a unity with identifiable boundaries and contained within and producing a boundary. The living composition[®] model identifies ten components that also include boundary elements. The boundary elements include various roles and functions that can be embedded not only in people but also in ICT

solutions (Maula, 1999, and forthcoming). The boundary elements have a central role in organizational renewal and learning capability. In a living organization, the connecting and absorbing boundary between a firm and its environment can provide new services for the customers, as well as new competences and learning capabilities for the firm itself.

E-business

E-business may have radical implications for the organizations' structures, business processes, products, services and knowledge flows among organizations and their customers and other parties. In this study, e-business is defined as electronic internal and external communication that can cover the whole value chain (business-to-business, business-to-consumer) and can also include the suppliers' and consumers' activities.

According to Skyrme [8, pp 42-43], internet-based e-business solutions undergo four phases on the way to becoming mature organizations:

1. *Brochureware* includes transferring marketing material onto the web.
2. *Interaction* means two-way information flow, however without any online integration into the firms' core systems.
3. *Trading* includes full e-commerce activities with online credit card payment processing, as well as good links to product and service information as well as non-competing specialist portals.
4. *Integration* means that the website is fully integrated with the organization's core computer systems including customer management, order fulfillment and finance systems. Web pages are customized and information flows seamlessly between the supporting systems.

By mid-2000, most of organizations were at the second or third stage on the e-business path.

E-business and knowledge management

Few organizations have fully integrated knowledge management into their main business processes and management decisions. Most organizations need to accelerate their progress along the e-business path in order to exploit the advantages of the Internet for capitalizing on their knowledge [8, pp. 25, 43]. However, even efficient utilization of the firm's own existing knowledge is not sufficient. A more general trend can be identified: the shift from inward looking perspective to an external one. Most knowledge initiatives aim at improving internal processes by utilizing existing knowledge. Thereafter, the focus shifts to knowledge creation and innovation, the creation of new and better products and services. The next logical move is to extend

the scope of knowledge management beyond the enterprise, which means that more information and knowledge flows across the boundary between an organization and its marketplace in both directions.

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Customized Web Interaction and Its Effect on Consumer Behavior and Evaluations

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Abstract

The goal of this paper is to provide insight into the effectiveness of site customization. In the marketing context, the term customization is often used to refer to the tailoring of products and services to the individual customer's needs and wants. Online customization offers customers the opportunity to tailor a web site to their needs and wants. The customization of web sites can provide customers with added value but may also increase their switching costs. In this paper we will investigate the possible effects of site customization on individual customer perceptions and purchase behavior.

1. Introduction

During the last century, several developments have dominated marketing theory. From the production concept, focusing on efficient and low costs production facilities allowing products to be widely available, theory has evolved to the customer concept, where the focus is on shaping offers, services and messages to individual customers [15]. One of the main differences in these concepts is the role of information, especially individual customer information. Implementing the customer concept requires the availability of information about individual customers. For example, a direct marketing approach lets marketers identify needs and wants of individual customers and target customers based on these pre-identified preferences [14].

The focus on individual customers and forming a long-term relationship with these customers to mutual benefit is core to relationship marketing theory (e.g., [4], [21]). Creating products and services tailored to individuals needs and wants, creates long-term relationships and competitive advantage (e.g., [27], [7]). The combination of relationship marketing and mass-customized products and services has proven its worth [23]. Moreover, the availability of information technology allows customization of not only products and services, but also communication and distribution [25]. To initially customize these functions closest to the marketplace, that is the downstream functions, makes the most sense [16].

The tailoring of products and services to the needs and wants of individual customers, has received considerable

attention since the rise of relationship marketing. Web site customization is a new example of tailoring to the needs and wants of individual customers. Companies incorporate several interactive functions in their websites, ranging from customer-specific wish lists to MyCompany.com sites. Customization functions are found in many Web sites, both in business-to-business (B2B) markets and in business-to-consumer (B2C) markets. For example, Marshall Industries, an electronic distributor, offers customers the opportunity to search for parts by their own internal reference part number. Customers have to key in once which internal reference numbers correspond to which Marshall part numbers. At subsequent visits, customers are able to use their own internal numbers (www.marshall.com). Other well-documented examples are Dell in B2B markets, and Amazon, Musicblvd, and Yahoo in B2C markets. For instance, the Dell's password protected Premier Pages contain for each corporate customer only the products, prices, approval procedures, service and support information that is appropriate to that particular customer. Dell has developed more than 35,000 Premier Pages in 12 languages.

In the direct marketing literature the advantages of personalization are recognized and its importance is often stressed. Customization of Web sites, however, provides more opportunities to tailor information and services to the specific needs of individual customers. In practice, many companies are experimenting with customized sites, and in the business press one can find ample anecdotal evidence of their success. However, although the importance of site customization has been stressed in conceptual papers, to our knowledge no academic study provides empirical evidence for it.

The application of site customization leads to several questions. For instance, what are the consequences of customization in relation to product variety, advertising and promotions [20]? How does customization influence the satisfaction with the online channel [26]? How does the interaction with customized technology effect customer evaluations and behavior [18]? With this study we aim to provide insight into the effectiveness of web site customization. More specifically, we will answer the following four questions: What is web site customization? How can we determine the effect of site customization on customer attitudes and behavior? How can we measure

the extent to which customers are using site customization features? Using data about 900 customers of a national retailer who have used the company's site for at least one year, we will answer the final research question: to what extent can the hypothesized effects of site customization be shown in an empirical study?

The remainder of this article proceeds as follows. The second section discusses site customization and provides an answer to the question what it is. The third section discusses the effectiveness of site customization. That is, how the effect of site customization on customer evaluations and behavior should be determined. The fourth section discusses the data collection and analysis and provides an insight into the effect of site customization on customer evaluations and behavior. The fifth section concludes and identifies areas for future research.

2. Online Customization

There are many ways to customize (elements of) a product. The term product is used here in a broad sense, including both the primary product or service and supporting services, as well as the information communicated to customers about these elements and their use [30]. Most opportunities for customization exist for products that can be digitized. Digital products can be customized at almost zero marginal costs, examples include customized music cd's and sites that offer the opportunity to monitor your own portfolio of stocks. For non-digital products the mass customization literature offers a variety of cost-effective customization approaches. Many companies offer components (or modules) that customers can combine into 'tailor-made' products, well-known examples reach from pizzas and clothing to cars and personal computers. Dell customers can configure and evaluate multiple systems online with choices from hundreds of components and obtain instant price quotes, enabling them to select the best possible PC given their budget and performance requirements.

Customization of web sites, according to Srinivasan et al. [24] indicates the ability of an e-retailer to tailor products, services and the transactional environment to individual customers. Wind and Rangaswamy [29] offer an extended view with their theory of customerization, where a customized site is used to create a customized product or service. Angehrn and Meyer [1] describe online customization as the degree to which the Internet is used to provide individualized services to users. Rowley [22] also describes customization as the tailoring of web site and product offerings to suit specific customers, based on customer profiles. Thus, site customization refers to making a site tailor-made based upon information explicitly provided by the customer.

Besides site customization, the concept personalization is often referred to in an Internet setting. Hanson [9] uses the term personalization to describe a special form of product differentiation, transforming a

standard product or service into a specialized solution for an individual. The term personalization most likely originates from the direct marketing theory. In the DM theory, personalization implies tailoring a mailing to individual customers through for instance a personalized letter heading [10]. Site personalization can be considered as the collection of individual customer data in order to provide an individual online experience.

So, both site customization and personalization are focused on collecting and using individual customer data on customer preferences in order to make the site more customer-specific. The difference between both concepts is that site customization is initiated by the customer. The customer explicitly decides to provide the supplier with information about preferences needs and interests [12]. User names and passwords limit access to only the authorized customer, thus enabling suppliers to build extranets with specific customers. The provider initiates site personalization. Based on the information the supplier has collected about the customer, e.g. purchases or click stream data, the supplier adapts the contents of web pages to improve their relevancy for this customer. For example, if a customer searches for maintenance information the site can offer links to the maintenance of any available product or links to only those products that have been bought by that particular customer. This differentiation based on customer control was empirically tested by Burke [5]. His research indicates that customers prefer the one-to-one marketing options that give them control over acquisition, dissemination and use of their personal information.

The level of customer awareness and customer control in respect to the tailoring process characterizes site customization and personalization. Based on the awareness (customer and/or organization), Wallin [28] distinguishes between four types of customization, where the level of awareness is different for the parties involved. If the customer deludes the organization, i.e. through filtering, the customer has the highest level of awareness. When neither the organization nor the customer is aware, the filtering is performed by a third party and is referred to as censorship. The other two forms are the closest related to site customization and personalization as described. If an organization personalizes the information, the firm has the highest awareness and it can be considered as the provider deluding the customer. With site customization both parties should be aware of the tailoring process, referred to by Wallin [28] as collaboration between the organization and the customer.

Hanson [9] provides a similar distinction in relation to the level of customer control. If the customer controls the tailoring process, he refers to adaptive customization. The terms cosmetic and transparent customization are used to describe customization strategies where the organization is in control. Collaborative customization describes the strategy where both parties have some level of control. Table 1 provides an overview of the characteristics mentioned for both site customization and site

personalization and the corresponding strategies provided by Wallin [28] and Hanson [9].

Table 1. Characteristics of customization and personalization

	Web Site Customization	Web Site Personalization
Customer awareness	High	Low
Firm awareness	High	High
Wallin	Provider and customer collaborate	Provider deludes customer
Customer control	High	Low
Firm control	High	High
Hanson	Collaborative customization	Cosmetic or adaptive customization

Both forms of online tailoring, site customization and site personalization, have much in common. Both concepts have the objective to provide a tailored experience via the Internet. In order to achieve this experience, both concepts collect and apply personal information. Only with respect to the method of data collection there is a difference. In the case of site personalization, the supplier collects information based on expressed behavior online, which is less obvious to the customer. In the case of site customization, the supplier explicitly asks the customer to provide personal information in order to tailor the experience. Research has shown that combining site personalization with site customization increases the satisfaction with the personalization elements over which the customer has less control [19]. In this paper we will focus on site customization. However, given the close relationship with site personalization, much of what we will discuss, e.g., how to determine the effectiveness of site customization, will be relevant for personalization too.

3. Effectiveness of Web Site Customization

In order to provide tailored web site experiences suppliers collect and use personal information, where the method of collection can be either explicit (asking the customer for information) or implicit (through observing customer behavior). Site customization can have an effect on both customer evaluations and behavior [18]. Examples of customer evaluations include satisfaction and loyalty, while behavior can be related to the site visiting behavior or to purchases.

The customer evaluations can be related to the site or the organization. Site customization is expected to improve satisfaction and loyalty. The satisfaction can be related to the site, but might also be related to elements outside of the site. The same holds for loyalty, due to the

expectation that web site customization provides more value and therefore improves relationships (e.g., [17], [2]). In order to determine the effect of site customization on evaluations both aspects, i.e. evaluations with respect to the site as well as other elements of the organization, will be taken into account.

Customer behavior may be related to behavior in the web site, such as web site stickiness. Web site stickiness is characterized by the duration, the intensity and the frequency of web site visits. The concept reflects the overall attractiveness of a web site, portrayed in customer online behavior. However, behavior may also be related to the purchases customers make. These purchases can be made either online or offline. In cases where the site does not contain a transaction function, which is the case for most current web sites (e.g., [8], [11], [3], [6]), purchasing behavior only refers to offline purchases.

So, in order to define the effects of web site customization, we focus on the three main concepts, e.g. web sites stickiness, customer evaluations and customer purchases. We assume a direct influence on all three main concepts, e.g. web site customization has a direct influence on stickiness, customer evaluations and customer purchases. Assume that a web site uses customer profiles to customize the content and product suggestions. Then, it is conceivable that the tailored content will influence the attractiveness and the evaluation of the site and that the product suggestions will influence the evaluation of the organization and the purchases. Therefore, web site customization would have a direct effect on all three concepts, as presented in figure 2.

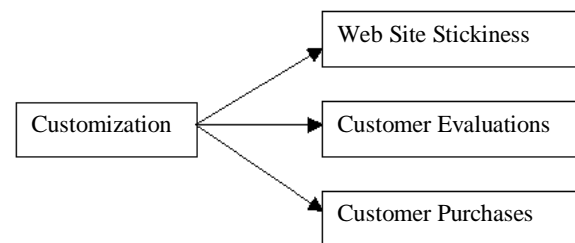


Figure 2. Conceptual models reflecting the effects of web site customization

Based on this model, hypotheses with respect to the effect of site customization on web site stickiness, customer evaluations and customer purchases can be formulated.

- H₁: Web site customization has a positive effect on web site stickiness.
- H₂: Web site customization has a positive effect on customer evaluations.
- H₃: Web site customization has a positive effect on customer purchases.

Besides these hypotheses, due to the exploratory nature of this type of research, the relations between the concepts will be investigated as well.

Until now we have considered site customization as a homogenous concept. In practice, however, there are various types of customization that can be distinguished. Firstly, for several site customization features the benefits are clear and customers can determine them beforehand, while with other customization features customers have to wait and see to what extent they will benefit from providing the supplier with personal information. Being able to determine the background color of a web site, allows the customer to instantaneously determine the benefits of the feature. Providing a web site with preferences implies that the customer will have to wait and see how well the supplier is able to provide product suggestions based on these preferences.

Secondly, the level of customer awareness also affects the effectiveness of customization. For instance, explicitly providing a site with preferences will make the customer aware of the process and will increase his/her expectations. If the customization is implicit, it is less obvious to a customer and will have a less direct effect on for instance customer evaluations and purchases.

Thirdly, it is possible to make the distinction between customization features, i.e. a shopping list, and customized features, i.e. product suggestions. Suppose a web site has both features: a shopping list and product suggestions based on provided preferences. A shopping list allows customers will most likely be tailored at each visit of the feature, for instance to add or remove products. Providing preferences is a feature, which is tailored once, that is, the preferences will most likely listed once. However, the page with the product suggestions, e.g. the customized feature, might be visited at each web site visit.

In our measure of the extent to which customers use site customization features we will take into account the different types of features with respect to the customer benefits, customer awareness and customization versus customized features. Moreover, when measuring the level of customization, the number of available and the number of used customization/customized features should be taken into account. A distinction between customization and customized features should also be made. A correction for the degree of page views and the degree of visits should also be incorporated.

In order to determine the effects of web site customization data is necessary on an individual customer level. It should also be possible to link all of the different measures to individual customers. That is, for each individual customer it should be known (1) what he/she does in terms of customization, (2) how intensive he/she visits the site, (3) what his/her evaluations are with respect of the site and the organization and (4) what purchases he/she has made.

4. Data Collection and Analysis

In our empirical study, we focused on the effect of the use of customization features of a non-transaction web site on the stickiness, perceptions and offline purchases of the customers of a large national retailer. Purchase data and site usage data of individual customers is available for a period of one year. After this year, the users of the web site completed an extensive online questionnaire. All the data can be linked on an individual customer level by means of customer ID card numbers.

The site mainly offers information and entertainment but also provides product suggestions based on information provided by the users. The site requires the customers to log on at every visit, providing a customized experience for each individual customer. The customization features the site offers, ranges from product suggestions based on information provided by the customer, to online address books with an online gift planner.

It was decided that only those users who had at least visited the web site four times were included in the analyses. Of these users only those were included who had completed the questionnaire. Eventually, this resulted in a sample size of 900 users.

So far, only some preliminary analyses, e.g. correlations, have been performed. We are still in the process of testing the model as presented in figure 2. The extent to which customers use the customization features had a direct relationship with the online satisfaction and the stickiness of the web site. We did not find a direct relationship between customization and offline purchases. So far, it seems that site customization has an influence on web visits, i.e. the duration, intensity and frequency of the visits, and the evaluation of the site.

5. Conclusions

With this study we aimed at determining the effectiveness of site customization. In order to do so, we have shown that conceptually site customization and site personalization do not differ that much. The difference between these concepts mainly lies in the method of collection of personal information. The objective, providing individual customers a tailored web site experience, and the use of the information, however, remain highly similar. The opportunities the Internet offers to customize products and services are extensive and provide ample opportunity to engage in true one-to-one relationships.

Moreover, Dell offers anecdotic evidence of the effects of site customization. Both personalization and customization are iterative processes that are beneficial to both parties: customers receive functions and offers that better match their needs and suppliers decrease waste and increase the customer's switching costs. Huizingh [13] found that customization of the Web site is an important determinant for Web site success.

The preliminary results of our empirical study indicate

that the extent to which customers use site customization features is only related to online perceptions and behavior. The effect on purchases made offline was not significant. So, it seems that the effects are limited to the environment where the customization of the communication takes place and is not extended to other channels in which the supplier and the customers interact. Further research into the relationships between the various possible effects of site customization should provide more insight into the structure of the chain of effects of web site customization.

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An Algorithm for Warehouse Capacity and Replenishment Scheduling Decisions

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Abstract

In our paper, a Singapore chemical manufacturer procures a kind of raw material from Europe and the material arrives at a fixed quantity with a cycle of about two months according to their long term contract. The material can be stored for only one week in normal conditions. So the manufacturer has to rent a special warehouse to hold the material before it is transported into the workshop, which happens at the beginning of each week. But at that time the manufacturer cannot know the exact demands of its customers each week. So understock and overstock of the material may exist. The manufacturer has to decide the capacity of the special warehouse and the replenishment quantities to the workshop each week.

The total costs make up of three parts: the cost due to the warehouse capacity constraint, the cost due to the workshop inventory constraint and the inventory cost at the warehouse. Because the material is transported and stored in tanks, we build up a newsvendor model with discrete variables. And it is an integer quadratic programming with linear constraints. Then we convert this integer quadratic programming into a binary quadratic programming, and then into an integer linear programming. Thus, existent software, such as ILOG CPLEX can be used to solve the problem.

Keywords: stochastic lead time, discrete newsvendor model, binary integer linear programming

1. Introduction

In real life, due to the different supply contracts (lead time, order quantity etc.), different industrial requirements (emphasis on quick delivery or on transportation economy etc.) and different supplier-buyer relationship, logistic decision making may be complex

and diversified and the crucial decision variables may be completely different. Unlike usual papers, ours makes the decisions of the warehouse capacity and replenishment quantity to the workshop jointly.

In our project, a Singapore chemical manufacturer procures a kind of raw material from Europe and the material arrives at a fixed quantity with a cycle of about two months according to their long term contract. The manufacturer has a long term contract with its outside supplier to replenish the warehouse's inventory at a fixed quantity of two hundred tanks with a period of about two months (We have the distribution of the period's length. At the same time the manufacturer faces uncertain demands. And due to the operational complexity and related high costs, a Just-in-Time system is infeasible in this company and we can only replenish the workshop's inventory from the warehouse at the beginning of every week. A kind of special trucks with the capacity of only one tank is used for the transportation from the warehouse to the workshop. So the transportation fee from the warehouse to the workshop is unrelated to our decision.

2. Notations and Modeling

We assume that the manufacturer gives an order of fixed number to the warehouse at the beginning of the t^{th} week after the last replenishment, and the preplanned interval between two replenishments of the warehouse is T weeks and the fixed order quantity is R . As we mentioned above the trucks transporting containers from the warehouse to the factory's workshop has a capacity of one tank, so every T weeks a fixed number of R trucks are necessary and the transportation cost is fixed. Thus our decision will not change the transportation cost and

it can be ignored in our model. Since all the goods are packaged in tanks until being consumed in the factory and the left inventories in the factory after a week will be discarded, the demands in the factory at the t^{th} week can be modeled as discrete random variables D_t with the probability mass function $P(D_t = j) = p_j^t$, $\sum_{j=0}^{D_m} p_j^t = 1$. If the order quantity of the factory from the warehouse is too large, a holding cost of h_f per tank per week will occur. On the contrary, if the replenishment quantity at the factory is too small, the production will break and a penalty cost of p_f for the shortage per tank per week will occur. We should decide the proper quantities from the warehouse to the factory at the t^{th} week Q_t to optimize the total costs. We also need to decide the capacity of the warehouse due to the uncertainty of lead times from outside supplier and the factory's demands. If the warehouse is too large, a penalty cost of co per tank occurs (this cost is reasonable since the over capacity will last all the T weeks), and if it is too small, the company will have to rent other warehouse to hold the inventory and lead to an incremental cost is cu (this incremental cost may be the additional transportation cost from the temporary warehouse to the factory). The goods arrive at the warehouse i weeks ahead of the plan with a probability of p_i , and the inventory level of the warehouse at the end of t^{th} week is I_t if the replenishment arrives as plans. Define

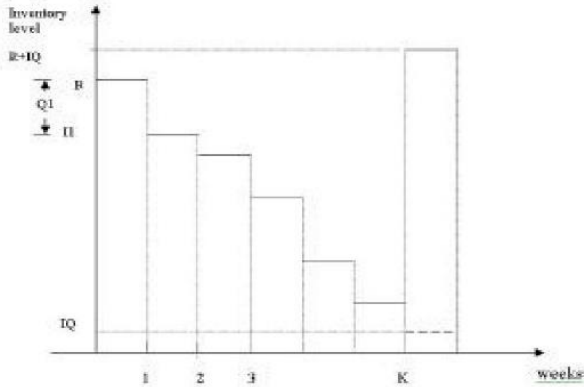


Figure 1: Inventory Level of the Warehouse

$K(Q_w, Q_1, Q_2, \dots, Q_T) := \max\{k : I_m(k) \leq Q_w\}$ as the week of the warehouse's inventory clearance, then every T weeks, the costs caused by the capacity of

the warehouse is

$$co \sum_{i=0}^K (Q_w - I_m(i)) p_i + cu \sum_{i=K+1}^{L_m} (I_m(i) - Q_w) p_i,$$

the warehouse's inventory cost is

$$\sum_{t=1}^T I_t t h_w + R h_w \sum_{t=0}^T t p_t,$$

the second part is caused by the advance of the warehouse's replenishment and is irrelevant to our decision of $Q_w, Q_1, Q_2, \dots, Q_T$, so we can ignore it; in each week the costs caused by the imbalance of the factory's demand and the replenishment quantity is

$$p_f \sum_{D_i=Q_i+1}^{D_m} (D_i - Q_i) p_{D_i}^i + h_f \sum_{D_i=0}^{Q_i} (Q_i - D_i) p_{D_i}^i$$

so our problem is

$$\begin{aligned} \text{Min. } & co \sum_{i=0}^K (Q_w - I_m(i)) p_i + cu \sum_{i=K+1}^{L_m} (I_m(i) - Q_w) p_i + \\ & \sum_{t=1}^T I_t t h_w + \sum_{i=1}^T [h_f \sum_{D_i=0}^{Q_i} (Q_i - D_i) p_{D_i}^i \\ & + p_f \sum_{D_i=Q_i+1}^{D_m} (D_i - Q_i) p_{D_i}^i] \end{aligned}$$

s.t.

$$I_t = R - \sum_{i=1}^t Q_i, \quad (1)$$

$$\sum_{t=1}^T Q_t = R, \quad (2)$$

$$I_m(t) = R + I_{T-t} = 2R - \sum_{i=1}^{T-t} Q_i, \quad (3)$$

$$I_m(K) \leq Q_w < I_m(K+1) \quad (4)$$

$$Q_t \geq 0, t = 1, 2, \dots, T, Q_w \geq 0 \quad (5)$$

Constraint (1) expresses the relationship between the planned inventory level and the transportation quantity to the factory. Constraint (2) states that the replenishment of the warehouse is used for T weeks' demands for the factory. Constraint (3) is used for calculating the maximum inventory level at the warehouse if the replenishment arrives at the warehouse t weeks ahead of the schedule. Constraint (4) is the definition of the cutoff level K .

In order to express the sum of K (a random variable) variables in a convenient way, we make the following conversion. Define

$$x_t^{(K)} = \begin{cases} 1 & \text{if } t \leq K \\ 0 & \text{if } t > K \end{cases},$$

then $K = \sum_{t=1}^T x_t^{(K)}$,

$$x_t^{(T-K)} = \begin{cases} 1 & \text{if } t \leq T-K \\ 0 & \text{if } t > T-K \end{cases},$$

$T-K = \sum_{t=1}^T x_t^{(T-K)}$, and $x_t^{(K)}$ and $x_t^{(T-K)}$ have to satisfy the constraint (6) $x_{T+1-i}^{(T-K)} + x_i^{(K)} = 1, \forall i = 1, 2, \dots, T$

$$x_t^{(T-K-1)} = \begin{cases} 1 & \text{if } t \leq T-K-1 \\ 0 & \text{if } t > T-K-1 \end{cases},$$

$T-K-1 = \sum_{t=1}^T x_t^{(T-K-1)}$, and obviously, there is constraint (7) $\sum_{t=1}^T x_t^{(T-K-1)} + 1 = \sum_{t=1}^T x_t^{(T-K)}$

$$x_i^t = \begin{cases} 1 & \text{if } i \leq Q_t \\ 0 & \text{if } i > Q_t \end{cases},$$

then $Q_t = \sum_{i=1}^{Q_m} x_i^t$, the problem becomes:

$$\begin{aligned} & co \sum_{t=0}^T \left(\sum_{i=1}^M x_i^w - 2R + \sum_{i=1}^{T-t} \sum_{j=1}^{Q_m} x_j^i \right) p_t x_t^K + \\ & cu \sum_{t=0}^T \left(2R - \sum_{i=1}^{T-t} \sum_{j=1}^{Q_m} x_j^i - \sum_{i=1}^M x_i^w \right) p_t (1 - x_t^K) + \\ & \sum_{t=1}^T \left(R - \sum_{i=1}^t \sum_{j=1}^{Q_m} x_j^i \right) th_w + \sum_{t=1}^T [h_f \sum_{D_t=0}^{Q_m} \left(\sum_{j=1}^{Q_m} x_j^t - D_t \right) p_{D_t}^t x_{D_t}^t \\ & + p_f \sum_{D_t=0}^{Q_m} \left(D_t - \sum_{j=1}^{Q_m} x_j^t \right) p_{D_t}^t (1 - x_{D_t}^t)] \end{aligned}$$

s. t. constraints (6) and (7),

$$x_t^K, x_i^w, x_i^t = 0, \text{ or } 1, \forall i = 1, 2, \dots, Q_m, \forall j = 1, 2, \dots, M,$$

$$\forall t = 1, 2, \dots, T;$$

$$x_{i+1}^w \leq x_i^w, \forall i = 1, 2, \dots, M-1;$$

$$x_{i+1}^t \leq x_i^t, \forall t = 1, 2, \dots, M-1, \forall i = 1, 2, \dots, Q_m-1;$$

$$x_{t+1}^K \leq x_t^K, \forall t = 1, 2, \dots, L_m;$$

$$\sum_{t=1}^T \sum_{i=1}^{Q_m} x_i^t = R;$$

$$2R - \sum_{t=1}^T \left(\sum_{i=1}^{Q_m} x_i^t \right) x_t^{(T-K)} \leq \sum_{i=1}^M x_i^w;$$

$$\sum_{i=1}^M x_i^w < 2R - \sum_{t=1}^T \left(\sum_{i=1}^{Q_m} x_i^t \right) x_t^{(T-K-1)}.$$

This is a quadratic binary problem. In the following paragraph, we convert it to linear binary problem. When the two factors have the same subscription, such as x_i^t and x_j^t , it is easy to see that $x_i^t \cdot x_j^t = x_i^t$, if $i \leq j$. When the two factors have different subscription, we need the following theorem.

Theorem x, y are binary variables, then $x \cdot y$ is equivalent to the a variable and a group of constraints: z , subject to $z \leq x, z \leq y, z \geq x + y - 1, z \geq 0$.

The proof is easy from the following table,

Table 1: Convert Multiplication to Linear Constraints

x	0	0	1	1
y	0	1	0	1
$x + y - 1$	-1	0	0	1
$x \cdot y$	0	0	0	1
z	0	0	0	1

This theorem provides a general method to convert a quadratic binary programming to a linear programming. However, this conversion will increase the number of decision variables and constraints. So it is only suitable to small scale problems. Define

$$x_{it}^{wK} := x_i^w \cdot x_t^K,$$

$$x_{ijt}^{fK} := x_j^i \cdot x_t^K,$$

$$x_{tjD_t} := x_j^t \cdot x_{D_t}^t,$$

$$y_{ij} := x_i^{(K)} \cdot x_j^{(T-K)}$$

$$z_{ij} := x_i^{(K)} \cdot x_j^{(T-K-1)}$$

then,

$$\text{Min.}(co+cu) \sum_{t=0}^T \sum_{i=1}^M p_t x_{it}^{wK} - 2R(co+cu) \sum_{t=0}^T p_t x_t^K + (co+cu)$$

$$\sum_{t=0}^T \sum_{i=1}^{T-t} \sum_{j=1}^{Q_m} p_t x_{ijt}^{fK} + 2Rcu - cu \sum_{t=0}^T \sum_{i=1}^{T-t} \sum_{j=1}^{Q_m} p_t x_j^i$$

$$-cu \sum_{t=0}^T \sum_{i=1}^M x_i^w p_t + R \sum_{t=1}^T th_w - \sum_{t=1}^T \sum_{i=1}^t \sum_{j=1}^{Q_m} th_w x_j^i +$$

$$(h_f+p_f) \sum_{t=1}^T \sum_{D_t=0}^{Q_m} \sum_{j=1}^{D_t} p_{D_t}^t x_{D_t}^t + (h_f+p_f) \sum_{t=1}^T \sum_{D_t=0}^{Q_m} \sum_{j=D_t+1}^{Q_m} p_{D_t}^t x_j^t$$

$$\begin{aligned}
& -(p_f + h_f) \sum_{t=1}^T \sum_{D_t=0}^{Q_m} D_t p_{D_t}^t x_{D_t}^t - p_f \sum_{t=1}^T \sum_{D_t=1}^{Q_m} \sum_{j=1}^{Q_m} p_{D_t}^t x_j^t \\
& + p_f \sum_{t=1}^T \sum_{D_t=0}^{Q_m} D_t p_{D_t}^t
\end{aligned}$$

s. t. constraints (6) and (7),

$$x_{i+1}^w \leq x_i^w, \forall i = 1, 2, \dots, M-1;$$

$$x_{i+1}^t \leq x_i^t, \forall i = 1, 2, \dots, Q_m-1, \text{ and } t = 0, 1, 2, \dots, T;$$

$$x_{i+1}^K \leq x_i^K, \forall i = 1, 2, \dots, T-1;$$

$$x_{it}^{wK} \geq x_i^w + x_t^K - 1, \forall i = 1, 2, \dots, M, \text{ and } t = 1, 2, \dots, T;$$

$$x_{it}^{wK} \leq x_i^w, \forall i = 1, 2, \dots, M, \text{ and } t = 1, 2, \dots, T;$$

$$x_{it}^{wK} \leq x_i^K, \forall i = 1, 2, \dots, M, \text{ and } t = 1, 2, \dots, T;$$

$$x_{ijt}^{fK} \leq x_t^K + x_{ij} - 1, \forall i = 1, 2, \dots, T, j = 1, 2, \dots, Q_m,$$

$$\text{and } t = 1, 2, \dots, T;$$

$$x_{ijt}^{fK} \leq x_t^K, \forall i = 1, 2, \dots, T, j = 1, 2, \dots, Q_m,$$

$$\text{and } t = 1, 2, \dots, T;$$

$$x_{ijt}^{fK} \leq x_{ij}, \forall i = 1, 2, \dots, T, j = 1, 2, \dots, Q_m,$$

$$\text{and } t = 1, 2, \dots, T;$$

$$y_{ij} \leq x_i^{(K)} + x_j^{(T-K)} - 1, \forall i = 1, 2, \dots, T,$$

$$\text{and } \forall j = 1, 2, \dots, T;$$

$$y_{ij} \leq x_i^{(K)}, \forall i = 1, 2, \dots, T, \forall j = 1, 2, \dots, T;$$

$$y_{ij} \leq x_j^{(T-K)}, \forall i = 1, 2, \dots, T, \forall j = 1, 2, \dots, T;$$

$$z_{ij} \leq x_i^{(K)} + x_j^{(T-K-1)} - 1, \forall i = 1, 2, \dots, T,$$

$$\text{and } \forall j = 1, 2, \dots, T;$$

$$z_{ij} \leq x_i^{(K)}, \forall i = 1, 2, \dots, T, \forall j = 1, 2, \dots, T;$$

$$z_{ij} \leq x_j^{(T-K-1)}, \forall i = 1, 2, \dots, T, \forall j = 1, 2, \dots, T;$$

$$\sum_{t=1}^T \sum_{i=1}^{Q_m} x_i^t = R;$$

$$2R - \sum_{t=1}^T \sum_{j=1}^{Q_m} x z_{tj} \leq \sum_{i=1}^M x_i^w < 2R - \sum_{t=1}^T \sum_{j=1}^{Q_m} x z_{tj}.$$

This is a linear binary problem with $Q_m T^2 + Q_m^2 T + T^2 + T Q_m + T M + 3T + M$ variables and $3Q_m T^2 + 6T^2 + 3MT + Q_m T + M + T + 1$ constraints. Actually the problem could be much smaller because we can ignore many unreasonable values of decision variables if we have some historical data, so many x_i^t, x_{Kt} etc. can be replaced by 1s directly. In our project, the warehouse replenishes the inventory about per twenty weeks with a fixed

order quantity of $R = 200$, the factory does so per week with a delivery quantity of at most $Q_m = 20$. So the problem has 15960 binary decision variables and 45121 constraints. We use ILOG CPLEX 7.1 (Intel mobile CPU 1.6G, and 256M RAM) to solve this problem. After the preprocessing of CPLEX, there are 34422 rows and 11841 columns left and it spends about half an hour to get a solution within the 0.01% error of the optimal solution.

When the problem's scale becomes larger, we can get the solution iteratively. First we can split the domains of decision variables into several large intervals (just like in the above, we select 1 as the interval) and in the same method we can decide which interval should be selected to get the optimal solution. Then we can split the cutoff intervals into several smaller intervals with a proper number so that we can handle them, the same method is used for selection of these smaller intervals. Iterate these steps until we can shorten the intervals to 1. Then we can get the optimal solution.

4. A Numerical Example

pl=[0.3, 0.3, 0.2, 0.1, 0.05, 0.05, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]

Table 2: Values of Parameters

co	cu	hw	hr	p
0.9	0.5	0.3	0.9	1

0, 0, 0, 0, 0, 0]

pd[t, 21 - t] = 0.6, pd[t - 1, 21 - t] = pd[t + 1, 21 - t] = 0.2,

We can get $Q_w=200$, Cost=1488.32, and

$Q=[20, 20, 20, 20, 20, 20, 20, 20, 20, 9, 9, 2, 0, 0, 0, 0, 0, 0, 0, 0]$

3. Conclusions

In this project we met an unusual problem as common papers. We need to consider the warehouse capacity and the factory replenishment jointly. Due to the small scale and containerization of the problem, we build a discrete model. A method of solving quadratic binary programming is designed.

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Transcending the Digital Divide: Paving Itinerary for Conducive Digital Economy

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Abstract

In recent years, due to dynamic evolution of information and communication technologies (ICTs) and the increasing importance of ICT diffusion in the process of economic growth, there exists the need for a broad and systematic comparison of the ICT framework development of countries around the globe. The Information Age that is upon us holds out the promise of a new world of shared prosperity, a global renaissance. At the same time, it also holds out the danger of economic exploitation, societal devastation and a new era of imperialism and colonialism. It can be spurned if we can bridge the economic and development gap, the information and knowledge gap and the great divide within.

A key element to extending the information revolution is identification, development and utilization of information assets. Information and knowledge is the new fuel of the economy. In this information economy, economic development means harnessing the information and knowledge assets of a community to help local businesses succeed in the new environment.

1. Introduction

There are many economic, political and cultural issues wrapped up in the digital divide. The facts suggests that there is a wide gap in computer use between rich and poor countries, and between rich and poor within most countries, and this gap often is a reflection of religious, ethnic and racial distinctions that shadow economic divisions throughout the world.

This gap, the "digital divide", threatens to cut off populations and seize the chance to participate in the affairs of the broader society. For some citizens technology brings the promise of inclusion, opportunity and wealth; for others, greater isolation and increased poverty. Herein lays the present tragedy and the making of a future catastrophe. It urges the important need to probe relationships between the public, corporate, and nonprofit sectors to address the critical questions for democracy in the information age.

The task is not just about reviving the weak economy. Real sustainable economic growth will come from expanding the information revolution to all parts of society. It is evident that the value of a network increases exponentially in relation to the number of users and the same is true for markets and economic activity. By leaving some behind, we impoverish not only those individuals; we also impoverish ourselves.

Local knowledge and information assets can be drivers of that economic development activity by:

- Capturing and using that knowledge as an information product;
- Using local knowledge to identify new entrepreneurial opportunities; and
- Developing the local knowledge and social capital base to facilitate innovation.

There is a need to work on narrowing the digital divide as much as possible by allowing all to exploit the Internet revolution, with elaborate global coordination and cooperation. This paper focuses on the subjects that are responsible for this divide and possible renaissance of improved information society. The Internet may follow a pattern similar to the telecommunications revolution of the 19th and 20th centuries. The last decade has seen the developed countries benefit from the Internet far more than the emerging countries. Countries such as China and India can narrow this Internet digital divide by effectively exploiting the Internet in their countries.

2. Economic Development

Economic development and the digital divide go hand-in-hand for many reasons. Communities with tools and skills to compete in digital economy are at distinct advantage over communities that don't. A community with a well-educated, technology-literate population is more likely to attract and sustain new businesses, and which in turn attract well-educated, technology-literate people into the area. Conversely, a community that lacks reliable access to technology and the skills to use it is less likely to attract and sustain new businesses that could potentially serve as a catalyst to economic prosperity. Simply put, if communities are to remain competitive in attracting, retaining and developing businesses in today's economy, they must develop modern telecommunications facilities and cultivate a well-trained workforce to stay viable.

Two critical success factors for, that should be kept track of, transcending the digital divide is adequate funding and good planning. Although, it is too early to make any firm conclusions about the overall nature of a desired future digital society, as these subjects are in a constant state of definition, redefinition and evolution, present state of knowledge illustrates some important, basic, approaches.

- Social inclusion.
- Effective and efficient use of IT& human resources.
- Building services around citizens' choices
- Providing information responsibly

- Making government and its services more accessible online.

3. Some Facts

Electronic readiness of a country is another critical success factor for digital divide. E-readiness assessment is a major international assessment of countries' capacity to exploit the opportunities offered by ICTs and helps to map out the factors & the deficiencies that contribute to this capacity. Such assessments are momentous in the case of countries like India where statistics on one hand shows that Indian IT professionals are most sought after in the world and India is among the largest software solution providers whereas on the other hand, approx. 50 percent of the population has not even seen the computer. Over the past few years, a number of electronic readiness assessments have been carried out. In fact, India has been assessed 11 times at the global level. Some of them are given below:

- The July 2002 EIU ranking ranks India below Sri Lanka at 43rd out of 60 as E-business follower.
- The January 2001 IDC ranking found that 55 of the countries navigating the information Super highway account for 98 per cent of all IT in 150 countries. It ranked India at 54 and Pakistan at 55 among the group of elite 55.
- The May 2001, Mc-Connell ranking of EReadiness Assessment indicated that substantial improvements were needed in the area of Connectivity. Improvements are also required in the areas of E-Leadership, E-Business, Information security and Human Capital.
- The Global Information Technology report, 2002-03, ranked India 37, above China which is ranked 43rd, where as the 2001-02 report ranked India 54.

The enabling factors are constructed to reflect the preconditions for quality network infrastructure as well as future network proliferation and use in the country. The enabling factors are constituted of

- Information Infrastructure and Hardware and software support
- ICT policy of a country and Business & Economic Environment.
- Networked Society
- Networked Economy that is e-commerce, e-government and general infrastructure.

Networked society assesses quality of learning using information and communication technologies, the extent of their use and societal and demographic factors. Networked Economy considers the extent to which the public and private sectors are participating in the networked world.

4. Role of Private Sector

About using Knowledge Management as an approach for finding appropriate information in a work situation in Knowledge Intensive Industry is the ability to find appropriate information in a work situation is a

Knowledge Intensive activity that is relevant to Knowledge Management. Modern Knowledge Management increasingly adopts knowledge sharing approaches, such as communities of practice, commercial information technology that is to support knowledge management tends to draw on Electronic Service for knowledge management.

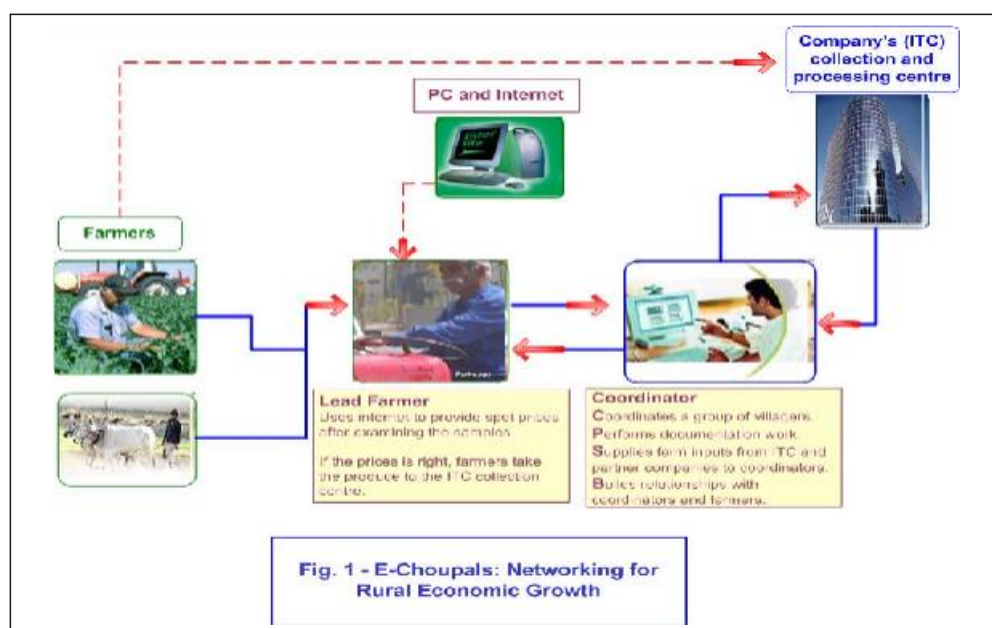
Organisations are incessantly looking for means to stimulate innovation and creativity, within and across work groups, functions and geographical boundaries. One of the ways to achieve this is through tacit knowledge exchanges in the form of sharing and transfer of knowledge by means of narratives, storytelling, reminders, best practices etc. At the same time, organisations are turning more towards information technology and seek ways of leveraging their investments in Information and Communication Technologies, Web technologies, in particular, to foster knowledge exchanges between individuals and work groups. The Web may be applied in new, innovative ways to draw dispersed community members together virtually and in particular, to promote tacit knowledge exchanges

The importance of industrial contribution can be reckoned by studying the case of an Indian company ITC's International Business Division, which in 6000 villages, creates e-choupals where they use computers and the internet to conduct their business. The target product is wheat and if ITC manages to capture the value of this wheat over next couple of months through these e-choupals, it will be a step closer to its dream of being India's largest agri-produce processor which services 100,000 villages covering 10 million farmers by 2007. The more audacious game plan of ITC is to create "An information superhighway to connect the rural economy". That means using the e-choupals as a single point of contact between farmers and a range of suppliers of agri-inputs and consumer goods – Monsanto, Eicher, Nagarjuna Fertilizers, *et al.*

To start with, choupal is a village square in north India where people gather to exchange gossip, to watch TV, talk work and the weather, etc. before they finally head home. These quaint trends are enabled with a PC, and provided an Internet access is termed as e-choupal with a business model build around. ITC started with these e-choupals to gain control over soyabean market and traded soyabean worth Rs 1600 million during last year. For its business models success, ITC created soya processing and collection centre. Then it started scouting villages around these centres for lead farmers to lead choupals. The computer was placed at this lead farmer's house and he was trained to use it. The information on daily prices was made available through Internet, at lead farmer's house. Information regarding best practices in farming and weather forecasts are also supplied. Co-ordinators were created who were responsible for market documentation, supplies farm inputs from ITC to lead farmers and build relations with and within lead farmers.

The concept is being picked out as evidence of how corporations can smartly fill institutional voids in emerging markets using power of Information Technology. This experiment creates enough communication capacity to connect with a market segment that is currently underserved but clearly has purchasing power. In the end, the rural India is the beneficiary by two ways, firstly by getting good yields for the crops and secondly knowing the power of IT and Internet. The concept is related rightly to the roots of those who till date were earning the least advantage of the ICTs.

This community-centric model of ITC (Fig. 1) not only instigates the rural economy through the means of Internet but paved the way for those who were lacking due to the unawareness of the use of Information super highway. Indirectly, this also creates inquisitiveness to learn more about the dominance of ICTs.



5. Conclusion

As a composite of the application of technology to government and bridge the digital gap, the solution falls beneath a large technological umbrella that includes:

- Instigating policies to promote private sector to participate and promote programmes that support the enlistment of digital society.
- The automation of public systems and the online delivery of services.
- The widespread adoption of network-based technologies and the migration to the Internet environment;
- the application of electronic capabilities and practices to governmental environments, to reduce costs and client fraud and to increase efficiency;
- The use of information and communication technologies (ICTs) to facilitate the conduct of business and foster economic growth;

- The fundamental reengineering and streamlining of the structures of government and the nature of public administration;
- The use of ICTs to foster new levels of democracy and citizen engagement, from electronic town halls to the online voting booth and new levels of political accountability.

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B2B E-commerce and BPR for Establishing the Competitive Supply Chain

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Abstract

This paper deals with the problems frequently facing contemporary businesses including the problems of quality, lead times, quantity flexibility, customization, service and cost through supply chain management. To increase the competitiveness of the supply chain, the importance of increasing its velocity, variability visibility and value – 4vs - has been proposed. Understanding the importance of increasing competitive advantages through supply chain management, a referential model based on the 4vs is provided in detail. It is argued that B2B e-commerce and business process reengineering from the perspective of customers to create value are both important for the success of the proposed model and for establishing the competitive supply chain.

Key words: supply chain management, e-commerce, business process reengineering, competitive advantage

1. Introduction

E-commerce can be regarded as to carry out business activities over the informational network. There are four basic categories for these activities: the activities regarding Business to Business (B2B), Business to Consumer (B2C), Consumer to Business (C2B) and Consumer to Consumer (C2C). The B2B e-commerce can achieve for a business and its counterparts the elimination of repetitive data inputting because only one party has to input the needed data. The correctness of the data input is also enhanced for the same reason. The completeness of the data input is also improved because incomplete data will be automatically rejected. With the data regarding the items required being correctly and completely input, a business can strengthen its ability to fulfil the requirements of its customers and improve its quality. As Crosby [1] points out that “[i]nstead of thinking of quality in terms of goodness or desirability we are looking at it as a means of meeting requirements”.

The B2B e-commerce can also achieve for a business and its counterparts the reduction of lead times and the improvement of services. Instead of sending related data to each other through post or facsimile and ensuring their reception, they can be transmitted over the informational network in seconds and after office hours. Tremendous lead times can be saved and the service can be improved up to 24 hours a day. The partnership between a business and its counterparts can then be strengthened. The cost of labor and operation cost can also be considerably saved.

Business process reengineering (BPR) that is to re-think and re-design fundamentally and thoroughly the ways in which a corporate conducts its business in order to improve its performance dramatically [2-3], must be considered when implementing B2B e-commerce. To gain the best out of the co-operations from external counterparts such as customers by means of B2B e-commerce, a business should redesign its own business processes to remove unnecessary activities first. In addition, using information technology to facilitate BPR cannot be used in the way to simply speed up how a corporate used to conduct its business. A new way of conducting business must be sought out in advance and the new business processes can then be implemented by information technology.

Under severe global competition, ways of dealing with the problems of quality, lead times, quantity flexibility, customization, service and cost through supply chain management need further investigation. Incorporating B2B e-commerce and BPR, a referential model that intends to deal with these problems, is thus provided for establishing the competitive supply chain.

This paper will proceed as follows: section 2 will discuss the background of the research; section 3 will provide a referential model; section 4 will summarize the paper.

2. Background to the Research

2.1 Supply Chain Management

The Supply Chain Council (SSC) points out that supply chain management includes all the efforts made for transforming materials to finished products and distributing them to end customers and that the members of a supply chain range from suppliers to end customers. Severe global competition has forced the management of the supply chain to focus and compete simultaneously on quality improvement, lead time reduction, higher quantity flexibility, customization enrichment, service enhancement and cost reduction [4-9]. To increase the competitiveness of the supply chain, the importance of increasing its velocity, variability and visibility, has been proposed [10-13]. Velocity refers to the ability to quickly fulfil internal and external customer's demands. Variability refers to the ability to fulfil the fluctuated and changing customer's demands. Visibility refers to the ability to make transparent the status of resources.

To emphasize the customer orientation, this paper argues the importance of value. Each process and activity

should be carefully reviewed to ensure that it creates value for customers. As Seybold [14] points out that companies are so concentrated upon fine-tuning their own products that they fail to understand how their products fit into the real lives of their customers and how value can be delivered. Based on the 4vs – velocity, variability, visibility and value – the paper will investigate into the literature and propose a referential model to facilitate the establishment of the competitive supply chain.

2.2 Velocity

Due to the difficulties in accurately predicting the demand in the market and the depreciation of inventory within a short period of time, customers now days stop providing sales forecast for a business in advance. Instead, they give their orders to a business after they have taken orders from their own customers. This has forced a business to increase its ability to quickly fulfil its customers' demands under severe conditions such as "955" and "982". "955" and "982" refer to the severe due date conditions that 95% and 98% of ordered goods must delivered within 5 and 2 days respectively. To fulfil these requirements, all the processes of a business must be redesigned to eliminate unnecessary activities and to reduce all the lead times reducible. These processes include the processes of ordering, designing, procuring, manufacturing and distributing.

2.3 Visibility

The application of electronic commerce through the adoption of information technology to enabling rapid and effective intra-organizational and inter-organizational communication and coordination, to removing intra-organizational and inter-organizational barriers and to achieving customer satisfaction, has also been getting more and more emphasized [15-20]. In the area of intra-organizational communication, the use of information technology enables a business to have a clear picture of the availability of all its inventory resource, machinery resource and human resource in its factories, warehouses and branches around the world. This visibility provides a business with a foundation to calculate its ability to fulfil its customers' demands within due dates set by them and to figure out where the products ordered should be manufactured. This visibility also enables a business to minimize its inventory level, increase inventory turnover, and as a result, sell products with a small margin and lower its demand in capital.

In the area of inter-organizational customer communication, the development of Internet has provided a low-cost and yet rapid and boundaryless option because Internet is an open-structure environment that supports a variety of platforms and is compatible with existent facilities of a business. Internet enables instant information exchange and sharing too. In a traditional supply chain, the information such as product information or order information is exchanged between manufacturers and customers through mails or facsimiles. In addition, the

information such as production or inventory status is held by manufacturers and it takes a long process for manufacturers to share this kind of information with their customers. However, through Internet, information exchange and sharing can be instant.

2.4 Variability

In the modern world where customer's demands are getting more and more customized and cost reduction through inventory reduction has become an important consideration, make-to-order (MTO) strategy has been widely adopted. Generally speaking, there are three kinds of production strategies: make-to-stock (MTS), assemble-to-order (ATO) and make-to-order (MTO). MTS production strategy emphasizes on satisfying customer's unified demands through the inventory of finished products. Under this production strategy, finished products have been manufactured and manufacturing process has completed before customer's orders are issued. Therefore, the lead time for order fulfillment under this strategy is the shortest but its success depends on high level of costly finished product inventory. Its success also depends highly on accurate sales forecast because if the forecast goes wrong the inventory left will be costly finished product inventory.

ATO production strategy emphasizes on satisfying customer's differentiated demands through assembling pre-designed differentiated modules to finished products. Under this strategy, pre-designed differentiated modules have been manufactured before customer's orders are issued. Therefore, the lead time for order fulfillment under this strategy is still short (the time needed for assembling) but its success may be less dependent on costly finished product inventory. Its success is also less affected by sales forecast because if the forecast goes wrong, the inventory left will be less costly commonly usable modules for many differentiated products rather than costly and single purposed finished products. MTO production strategy emphasizes on satisfying customer's customized demands through designing and manufacturing according to customer's customized orders. In principle, manufacturing under this strategy cannot begin before the issuance of customer's orders. No finished products are stocked despite that sales forecast of finished products is still required for the procurement of materials needed. Therefore, the lead time for order fulfillment under this strategy is the longest but its success depends least on costly finished product inventory. Its success is also least affected by sales forecast because if the forecast goes wrong, the inventory left will be least costly materials rather than costly finished products. As a result of the growing importance of MTO for enhancing variability, this paper will particularly address the model proposed under this production strategy.

In addition to the customers' changing demands, their fluctuated demands also challenge a business' ability to manage its supply chain. Modularization and the same materials or components used in differentiated products are two strategies that can be adopted at the product

design stage to deal with the challenge. These two strategies enable a business to quickly re-allocate materials previously arranged when its customers change the products ordered because a considerable amount of materials can be used in or taken from other orders.

2.5 Value

Anderson and Narus [21] indicate that a growing number of businesses have drawn their attention to what their customers value to gain marketplace advantages over their less knowledgeable competitors. Lin and Su [22] also argue that transformation of better understanding of customers to long-term and promising customer relationships and formulating CRM strategies in this way can create valuable marketing opportunities, increase customer value and enhance customer satisfaction in the pursuit of business excellence. The value of products come from what customers want from them and why. Therefore, value creation should begin with a business' choice of who their customers are and its understanding of their priority regarding its branding, quality, due dates, quantity flexibility, product variety, service, price and innovation which as whole is the reason for their purchase. In this paper, supply chain management regards the chosen customers and their priority concerning its branding, quality, due dates, quantity flexibility, product variety, service, price and innovation as given from the function of marketing. Under this assumption, the task of supply chain management is then to redesign all the processes by means of BPR to make sure that unnecessary activities are removed and that the redesigned processes create values according to the list of priority as perceived by chosen customers.

3. The Proposed Supply Chain Integrative Model (SCIM)

Based on the importance of the velocity, visibility, variability and value factors mentioned above to the success of supply chain management, this paper proposes a model which enables the effective communication among the internal functions and external partners of a business for the successful implementation of the competitive supply chain. To reduce complication, this paper assumes the existence of certain management information systems which make visible and provide the following information: order information, customer-related information, production information, and shop floor status. Besides it also assumes that B2B e-commerce and BPR from the perspective of customers has been implemented to ensure the accessibility and acquirement of the above-mentioned information. To understand the model, the ideas of master production scheduling (MPS), material requirements planning (MRP) and capacity requirements planning (CRP) must be introduced.

3.1 MPS, MRP and CRP

Traditionally MPS is to decide what, when and how many end items will be manufactured and this decision is made under the consideration of a business' sales forecast, backorder, production capacity, material resource and production strategy. Material requirements planning (MRP) is to calculate the needed amount of materials and the needed procurement lead times of insufficient materials for master production schedules previously given. Therefore, accurate master production schedules can be used for MRP to calculate the right quantity of materials needed and coordinate the arrival of materials in order to reduce the material inventory level and procurement lead times. As American Production and Inventory Control Society (APICS) defines MPS as a representation of sales forecast, backorder, other demands, the quantity projected available and the quantity available to promise (ATP) and a representation of the planned production of different products of each product group and their quantity and schedule and how the facilities are arranged.

Accurate master production schedules can also dampen the utilization oscillation of production capacity. Inaccurate master production schedules may cause many problems. Without knowing exactly what, when and how many end items will be manufactured, production will be in chaos and production capacity will frequently swing between redundancy and insufficiency. Capacity requirements planning (CRP) is to decide and allocate the needed production capacity for master production schedules previously given. When production does not proceed according to schedule, MRP will be neglected because it will not matter so much if materials will arrive with the right quantity and at the scheduled time. When MRP is neglected, inventory levels of some items of materials or work-in-process (WIP) will go up on the one hand. However, on the other hand, inventory levels of some items of materials or WIP will be insufficient before production and chaotic production will be further postponed and procurement lead times will be increased. Inventory level of finished products will have to increase to deal with the immediate market demand because no one can estimate exactly what, when and how many finished products will be manufactured. Therefore, MPS is important for dampening the utilization oscillation of production capacity, reducing lead times, inventory levels of materials, WIP and finished products and coordinating the arrival of materials.

More importantly, a clear consideration of MRP and CRP is also very important before MPS can be finalized. Traditionally MPS, MRP and CRP are decided separately. Traditionally MPS is considered first and the decision regarding what, when and how many end items will be manufactured is made. Then MPS is taken as an input for MRP explosion. However, if the exploded MRP shows that materials will be unable to arrive with the right quantity or at the scheduled time or that production capacity will not be available for the time scheduled for production, there is no clear defined channel for modifying the MPS already made.

Therefore, this paper argues that it is necessary to integrate MPS with MRP and CRP. From the perspective of lead times and inventory level reduction and efficient utilization of production capacity for enhancing velocity, visibility, variability and value, a well-defined model for clearly integrating MPS with MRP and CRP is very important too. Thus, this paper will propose a model

considering MPS, MRP and CRP together with BPR from the perspective of customers implemented and certain management information systems already existent which provides the information mentioned above. The proposed internet-based Supply Chain Integrative Model (e-SCIM), as shown below in Figure 1, will be discussed in further detail in the following section.

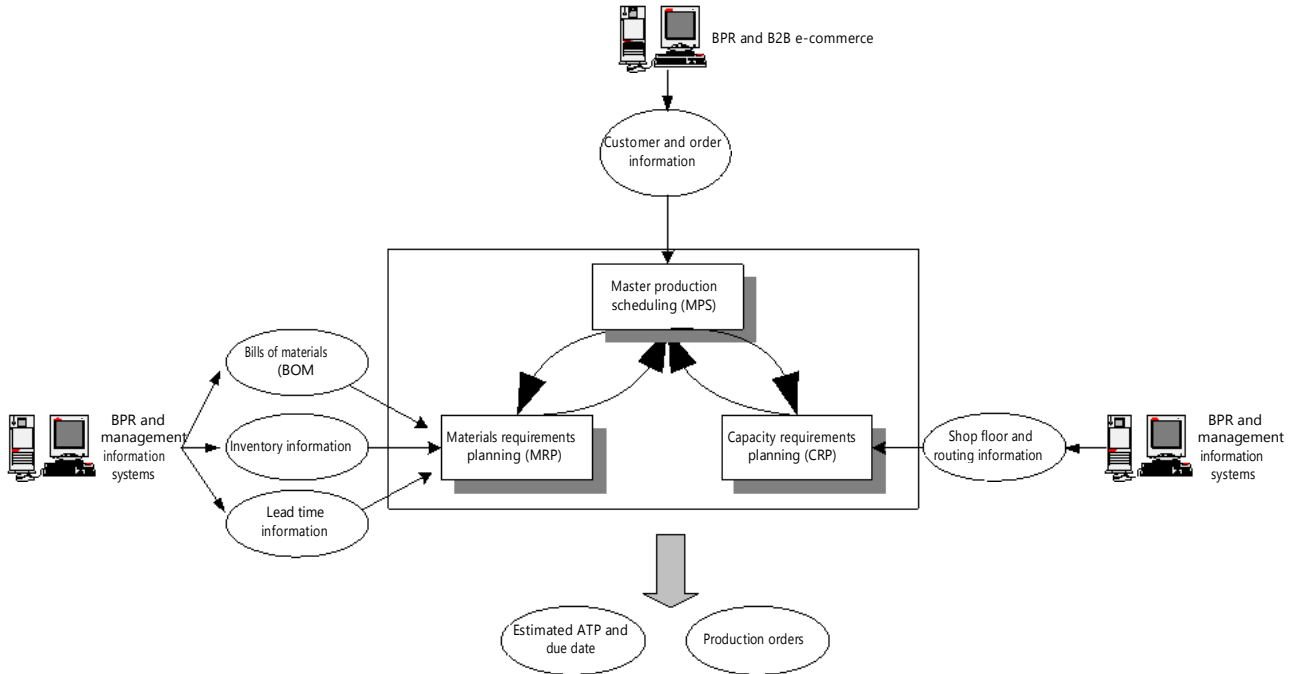


Figure 1: The informational inputs and the thorough consideration of MPS, MRP and CRP of the e-SCIM with BPR, B2B e-commerce and management information systems being implemented.

3.2 e-Supply Chain Integrative Model (e-SCIM)

In the proposed e-SCIM, the model needs the inputs of order information, customer-related information, production information, and shop floor status in order to determine the estimated due date and the quantity available to promise (ATP) and to generate production orders. Adopting the MTO strategy because of its growing importance, the e-SCIM considers the basic functions of MPS, MRP and CRP as a whole as depicted in Figure 2. The variables of the model are shown below in Table 1.

As shown below in Figure 2, the operating process of the model begin with customer's issuance of an order of a specific product that determines net demand $N(t)$ under MTO production strategy. Other products in the order may be processed later on in the same way. It is assumed here that the procurement of materials has been done according to sales forecast of that product. MPS is initiated and $M(t)$ is set to be equivalent to $N(t)$. That is, $M(t) = N(t)$. In addition, the net demand achievable $N_a(t)$ is also set to be equivalent to $N(t)$, i.e., $N_a(t) = N(t)$, assuming in the beginning that all the net demand can actually be satisfied at the interval t . Then Gross demand of item I_{mn} is determined by the explosion of $M(t)$ of finished product to the needed quantity of the n th item at level m according to the BOM. The value of I_{mn} projected available at interval t ,

$P(t)$, is the sum of I_{mn} projected available at the previous interval, $P(t-1)$, and the planned quantity of I_{mn} to be manufactured or received at this interval, $S(t)$, and the reduction of the gross demand of I_{mn} at interval t , $G(t)$. That is, $P(t) = P(t-1) + S(t) - G(t)$. If the $P(t)$ of item I_{mn} is no less than zero, which means the quantity of item I_{mn} is sufficient, there will be no arrangement of manufacturing or procurement of item I_{mn} . If all the items at level m are not fully exploded, the next item I_{mn+1} at level m is exploded and its $G(t)$ calculated. However, if all the items at level m are fully exploded and yet all the items at all levels are still not fully exploded, the first item at the next level $Im+1n$ is exploded and its $G(t)$ calculated. If all the items at level m are fully exploded and all the items at all levels are also fully exploded, the e-SCIM is arranged and completed. Then $ATP A(t) = M(t) = N_a(t) = N(t)$ and the estimated due date is the end of the interval t .

Table 1: Variables of the e-SCIM.

Notation	Variable	Detail description
$N(t)$	: Net demand	In principle, the net demand is determined mainly by customer's orders under the MTO production strategy. However, net demand may be modified according the policy of a business. This variable is denoted by $N(t)$ in this model where t refers to the interval t .
$N_a(t)$	: Net demand achievable	The net demand achievable refers to the demand that can actually be satisfied at the interval t .
$M(t)$	: MPS	$M(t)$ here refers to the quantity of finished product to be manufactured at the interval t . Under the MTO strategy, $M(t) = N(t)$ in principle.
I_{mn}	: The n th item at level m	The n th item at level m (a material or WIP) according to the BOM of a particular finished product
$G(t)$	: Gross demand of item	Gross demand of item I_{mn} is determined by the explosion of $M(t)$ of finished product to the needed quantity of the n th item at level m according to the BOM.
$S(t)$	: Planned quantity of item to be manufactured or received	The originally planned quantity of item I_{mn} to be manufactured or received through procurement. When the quantity of item I_{mn} is not sufficient, this value needs to be adjusted.
$\Delta S(t)$	: Insufficient quantity of item to be manufactured or received	When the quantity of item I_{mn} is not sufficient, additional quantity to be manufactured or received needs to be arranged.
$P(t)$	: Item projected available	Item projected available refers to the projected quantity of I_{mn} available at a particular interval.
$PdL(t)$	: Production lead time available for item	Production lead time available refers to the available manufacturing quantity (transformed from production lead time including queue, setup and run time) for I_{mn} at a particular interval.
$\Delta PdL_i(t)$	: Production lead time unavailable for item	Production lead time unavailable for item refers to the insufficient manufacturing quantity (transformed from production lead time including queue, setup and run time) for I_{mn} at a particular interval.
$\Delta PdL_r(t)$	: Production lead time unavailable for finished product	Production lead time unavailable for finished product refers to the transformed insufficient quantity of finished product $\Delta PdL_r(t)$ from the insufficient quantity of item $\Delta PdL_i(t)$ at a particular interval due to the unavailability of production lead time.
$C(t)$	: Capacity available for item	Capacity available refers to the available manufacturing quantity (transformed from capacity) for I_{mn} at a particular interval.
$\Delta C_i(t)$	: Capacity unavailable for item	Capacity unavailable for item refers to the insufficient manufacturing quantity (transformed from capacity) for I_{mn} at a particular interval.
$\Delta C_r(t)$	: Capacity unavailable for finished product	Capacity unavailable for finished product refers to the transformed insufficient quantity of finished product $\Delta C_r(t)$ from the insufficient quantity of item $\Delta C_i(t)$ at a particular interval due to the unavailability of product capacity.
$\Delta PcL_i(t)$	: Procurement lead time unavailable for item	Procurement lead time unavailable for item refers to the insufficient quantity that cannot be procured in time for item I_{mn} to be received at a particular interval.
$\Delta PcL_r(t)$	: Procurement lead time unavailable for finished product	Procurement lead time unavailable for finished product refers to the transformed insufficient quantity of finished product $\Delta PcL_r(t)$ from the insufficient quantity of item $\Delta PcL_i(t)$ at a particular interval due to the unavailability of procurement lead time.
$A(t)$	: Available to promise	Available to promise (ATP) here refers to the accumulative quantity of finished product that is stocked or is planned to be manufactured and that has not been promised to any customer.

However, if the $P(t)$ of item I_{mn} is less than zero, which means the quantity of item I_{mn} is not sufficient, the insufficient quantity of item I_{mn} to be manufactured or received through purchasing $\Delta S(t)$ needs to be arranged. Ideally $\Delta S(t)$ should be set to the value to make $P(t)$ equal zero. That is, ideally $\Delta S(t) = G(t) - P(t-1) - S(t)$. On the one hand, if item I_{mn} needs to be manufactured, the production lead time has to be considered. If the production lead time available $PdC(t) - \Delta S(t) > 0$, the production lead time is sufficient for additional production of item I_{mn} .

The production capacity has to be considered next. If the capacity available $C(t) - \Delta S(t) > 0$, which means the production capacity is sufficient for additional production of item I_{mn} , the question regarding if all the level m items are fully exploded is similarly considered and the rest processes are process 8, 9, 10 or 11 (see the numbered arrow in Figure 2) as mentioned above. On the other hand, if item I_{mn} needs to be procured, the lead time for procurement has to be considered. If the latest date when procurement must be done is later than the date when planning is made, which means time is still sufficient for

additional procurement of item I_{mn} , the question regarding if all the items at level m are fully exploded is similarly considered. The rest processes are process 8, 9, 10 or 11 (see the numbered arrow in Figure 2) as mentioned above. If production lead time unavailability, capacity unavailability or procurement lead time unavailability does not happen after all the items at all levels are fully exploded, the e-SCIM is arranged and completed. Then $ATP A(t) = M(t) = N_a(t) = N(t)$ and the estimated due date is the end of the interval t .

However, if the $P(t)$ of item I_{mn} is less than zero, which means the quantity of item I_{mn} is not sufficient, the insufficient quantity of item I_{mn} to be manufactured or received through purchasing $\Delta S(t)$ needs to be arranged. Ideally $\Delta S(t)$ should be set to the value to make $P(t)$ equal zero. That is, ideally $\Delta S(t) = G(t) - P(t-1) - S(t)$. On the one hand, if item I_{mn} needs to be manufactured, the production lead time has to be considered. If the production lead time available $PdC(t) - \Delta S(t) > 0$, the production lead time is sufficient for additional production of item I_{mn} .

The production capacity has to be considered next. If the capacity available $C(t) - \Delta S(t) > 0$, which means the production capacity is sufficient for additional production of item I_{mn} , the question regarding if all the level m items are fully exploded is similarly considered and the rest processes are process 8, 9, 10 or 11 (see the numbered arrow in Figure 2) as mentioned above. On the other hand, if item I_{mn} needs to be procured, the lead time for procurement has to be considered. If the latest date when procurement must be done is later than the date when planning is made, which means time is still sufficient for additional procurement of item I_{mn} , the question regarding if all the items at level m are fully exploded is similarly considered. The rest processes are process 8, 9, 10 or 11 (see the numbered arrow in Figure 2) as mentioned above. If production lead time unavailability, capacity unavailability or procurement lead time unavailability does not happen after all the items at all levels are fully exploded, the e-SCIM is arranged and completed. Then $ATP A(t) = M(t) = N_a(t) = N(t)$ and the estimated due date is the end of the interval t .

However, if the item I_{mn} needs to be manufactured and its $PdL(t)$ (Production lead time available) $-\Delta S(t) < 0$, which means the production lead time is insufficient for additional production of item I_{mn} , Production lead time unavailable for item $\Delta PdL_i(t) = \Delta S(t) - PdL(t)$. Thus, Production lead time unavailable for finished product $\Delta PdL_f(t)$ may be obtained through transforming the insufficient quantity of item $\Delta PdL_i(t)$ via calculating how many finished products cannot be manufactured at the particular interval t due to the unavailability of production lead time. Then MPS is rearranged and $M(t)$ is reduced to $M(t) - \Delta PdL_f(t)$ and the whole processes restarts.

If production lead time is sufficient but $C(t)$ (capacity available) $-\Delta S(t) < 0$, which means the production capacity is insufficient for additional production of item I_{mn} , Capacity unavailable for item $\Delta C_i(t) = \Delta S(t) - C(t)$. Thus, Capacity unavailable for finished product $\Delta C_f(t)$ may be obtained through transforming the insufficient quantity of item $\Delta C_i(t)$ via calculating how many finished products cannot be manufactured at the particular interval t due to the unavailability of production capacity. Then MPS is rearranged and $M(t)$ is reduced to $M(t) - \Delta C_f(t)$ and the whole processes restarts.

If item I_{mn} needs to be procured and the latest date when procurement must be done is earlier than the date when planning is made, which means time is insufficient for additional procurement of item I_{mn} , $\Delta PcL_i(t) = \Delta S(t)$. Thus, Procurement lead time unavailable for finished product $\Delta PcL_f(t)$ may be obtained through transforming the insufficient quantity of item $\Delta PcL_i(t)$ via calculating how many finished products cannot be manufactured at the particular interval t due to the unavailability of procurement lead time. Then MPS is rearranged and $M(t)$ is reduced to $M(t) - \Delta PcL_f(t)$ and the whole processes restarts.

When production lead time unavailability, capacity

unavailability or procurement lead time unavailability happen(s), the finalized $M(t)$ will be less than net demand available $N_a(t)$ after all the items at all levels are fully exploded. The difference between $N_a(t)$ and $M(t)$ will be arranged for MPS at the next interval $t+1$. That is, $M(t+1) = N_a(t) - M(t) = N_a(t+1)$. In addition, $N_a(t)$ is reduced to $M(t)$. The whole processes begin again until at a particular interval $t+x$ the arranged MPS $M(t+x)$ equals $N_a(t+x)$. Then the e-SCIM is arranged and completed. As can be seen in Table 2 below, the estimated due date is the end of the interval $t+x$. Assuming the due date required by the customer is at interval $t+y$. In this situation, if $t+y1 \geq t+x$, $ATP A(t+y) = N(t) = A(t+x)$ and due date is the end of interval $t+x$. If $t+y2 < t+x$, $ATP A(t+y) = N(t) - \sum_{i=1}^{y-1} N(t+i) + N_a(t+y2) + \dots + N_a(t+x) = A(t+y2)$ and due date is the end of interval $t+y2$. When this happens, the order will undergo a different process. Manual intervention as to consider working overtime, partial shipment, alternative materials and processes, or outsourcing and to negotiate with customers, will take place to ensure that the order can be fulfilled as negotiated.

Table 2: The related intervals, net demand, MPS, net demand achievable, due date and ATP in a planning horizon T.

Planning horizon T	z intervals										
	Interval	t	t + 1	...	t + y ₂	...	t + x	...	t + y ₁	...	t + z - 1
Net demand N(t)	N(t)										
MPS M(t)	M(t)	M(t+1)		M(t+ y ₂)		M(t+x)					
Net demand achievable N _a (t)	N _a (t)	N _a (t+1)		N _a (t+ y ₂)		N _a (t+x)					
Due date				Customer's due date t+ y ₂		Estimated due date t+x		Estimated due date t+x			
ATP A(t)				A(t+ y ₂)		A(t+x)		A(t+x)			

4. Discussion and Concluding Remarks

B2B e-commerce and BPR from the perspective of customers will reduce the manual and iterative operations and improve communication among the customers and the sales department and the production department of a business. This is done through the elimination of repetitive data input, the correctness and completeness of data input, and as a result a business will have a stronger ability of to fulfil the requirements of its customers and improve its quality. B2B e-commerce and BPR from the perspective of customers can also achieve for a business and its counterparts the reduction of lead times and the improvement of services and thus contribute to its velocity, visibility and value regarding quality. Through the proposed e-SCIM and the corresponding BPR and information systems needed to implement the model, it is expected that the manufacturing lead times can be reduced. The reason for manufacturing lead times reduction is that unnecessary queuing for production capacity availability can be eliminated when production schedules became

accurate. In the situation when production schedules is not accurate, it is very likely that production capacity is still not available when all the materials, components, assemblies or WIP needed for production are ready. This will contribute to a business' ability to enhance its velocity. Through the adoption of MTO, modulization and multiple-purpose materials and components strategies, it is expected the variability of a business can be improved. Variability is also improved when a business is able to communicate quickly with its customers and its internal functions can communicate quickly among themselves through the enhancement of its velocity. It is also expected that the procurement lead times, on-time shipping rate and inventory cost can be reduced. The procurement lead times can be reduced because all the materials needed will arrive at the specified dates when production schedules become accurate, material requirements can be well planned and the production process will not postpone for the lack of few materials. On-time shipping rate can be increased because of accurate production schedules and due date estimation. The material, WIP and finished product inventory cost can be reduced because all kinds of the inventory can be less stocked when production schedules and estimated due date become accurate. These can contribute to the enhancement of a business' velocity and value regarding due dates and cost. It has also been considered to adopt the advantage of customization and inventory level reduction of the MTO strategy and to improve its difficulties in inaccurate due date estimation, long due dates, the calculation of ATP, the management of production capacity constraints and no finished products stocked for dealing with production uncertainty.

Therefore, the proposed e-SCIM enables a business to compete on quality improvement, lead time reduction, higher quantity flexibility, customization enrichment, service enhancement and cost reduction. It is demonstrated that the ability to improve velocity, visibility, variability and value of the supply chain can be enhanced effectively by means of the e-SCIM, which considers the basic functions of MPS, MRP and CRP as a whole, and through the deployment of the modern IT via connecting the business with the information systems of its internal functions and with its customers over B2B e-commerce. The author has been involved in many e-business projects and the proposed model has been being implemented in a real world environment. The initial result demonstrates B2B e-commerce and BPR from the perspective of customers to create value are both important for the success of the proposed model and for establishing the competitive supply chain.

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A Knowledge Management Performance Evaluation Model Based on Fuzzy Set Theory

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Abstract

As the knowledge-based economy time comes, the core of business process is transforming financial intensive into technology intensive and knowledge intensive gradually. However, the value of knowledge itself can't be measured easily. We must evaluate and investigate the performance of knowledge management through activities of knowledge management process. During the performance evaluation process, many uncertain factors must be considered. It is also involved ambiguity occurred by human subjective judgment. Therefore, a performance evaluation model of knowledge management is proposed in this paper by combining Fuzzy Delphi with Fuzzy AHP. Finally, a numerical example is given to demonstrate the procedure for the proposed method at the end of this paper.

Keyword: Knowledge Management, Measuring Performance, Fuzzy Delphi, Fuzzy AHP

1. Introduction

When the knowledge becomes the key resource of the enterprise, how to apply knowledge appropriately to produce new knowledge and value is an important issue for business management.

Drucker[8] indicated that knowledge will become the most important sources for promoting business advantage. However, lacks of the effective measurement tool, knowledge cannot be exploited sufficiently. In recent years, many businesses have realized that knowledge management is the most important issue to increase their competitiveness. Therefore, the performance evaluation and measurement become a key point of promoting knowledge management plan successfully. However, the evaluation process of knowledge management must consider many uncertain factors such as attitude of employee, professional ability, and the subjective judgment of managers. Thus, it is difficult to evaluate the performance of knowledge management easily. Therefore, an evaluation model of knowledge management is proposed in this paper by combining fuzzy set theory with analytic hierarchy process (AHP).

2. Literature review

2.1 Knowledge Management

Liebowitz and Beckman[15] identified that knowledge management contains the following definitions.

- (1) The knowledge management is a systematic process that creates knowledge clearly. Raise the relevant knowledge in business with applying avail knowledge.
- (2) The knowledge management uses the experience, knowledge and expert knowledge to create new ability. It makes the business possesses the excellent performance, encourages innovation and increases the value of customers.

Papows[17] proposed seven reasons of implementing the knowledge management.

- (1) Globalization. If Organizations all around world own an important competitive advantage, namely it can share experiences and resources effectively.
- (2) Speed. As of the business shortens the lead time and obtain the valid business operations, we must get the information and the knowledge valuable quickly.
- (3) Service orientation. If attaining quick response, all essential information and related operations must make the employee work on-line in any time and change the action procedure.
- (4) Saturation of workers. Employees have higher turnover at knowledge age. We usually need a set of system to keep the knowledge of the worker and reuse them.
- (5) More close relation of business. The WWW is also a resource that learns the new information. Each organization must integrate it in usual learning processes.
- (6) Technique. Advanced information system, group software and WWW assembly together provide technique foundation of knowledge management for the company.
- (7) Competition. The organization regards its intelligent capital as the force and promotes the competitive advantage of the organization systematically.

Sarvary[18] identified the knowledge management is the integration of the business flow via creation of business and using a process of collective knowledge. This process includes three flows as follows.

- (1) Organization learning. The company acquires the process of the information or knowledge.
- (2) Generalize knowledge. It is a process that information

is converted and integrated knowledge. The knowledge can resolve the problem of the commerce.

(3) Propagation knowledge. Making organization members can acquire and use the process of company community knowledge.

Synthesize above the viewpoints of the knowledge management, knowledge management is a process for business to increase the competitiveness by creation, transformation, diffusion and deposition of knowledge.

2.2 Knowledge management activities

The knowledge management flow indicates the different attitudes of knowledge management in business management process. The definition of knowledge management flows includes knowledge creation, knowledge transformation, knowledge diffusion and knowledge storage. Some illustrations of knowledge management activities are shown in Table 1.

2.3 Performance evaluation

The performance evaluation in nature is the control function in the business management activities. Being able to generate influences or take action in before the event or activities steering by the establishment of the performance evaluation system. The appraisal must depend on the reasonable and valid performance indicators and reach to the object of performance evaluation. Concretely, the performance evaluation has four objects[19] :

- (1) The object of the fulfillment to weigh the extent of success.
- (2) Providing the suggestion or correct amendments to the organization redevelopment.
- (3) Providing the feedback mechanism to manager.
- (4) Evaluating the internal input and output.

Because knowledge management flow of business and its performance evaluation have the subjective recognition, and is seen as problems of multi criteria, we can use many appraisable theories of multi criteria to reach reasonable performance evaluation. Therefore, this paper uses the linguistic variables to represent the subjective judgment of decision makers, and combine Fuzzy Delphi method with Fuzzy Analytic Hierarchy Process method (Fuzzy AHP) to propose a performance evaluation model of knowledge management.

3. Fuzzy Theory

3.1 Triangular fuzzy number and linguistic variable

The original concept of fuzzy sets in the pioneering

paper of Zadeh was introduced as an extension of usual sets, by enlarging the truth value set of grade of membership from the two value set $\{0, 1\}$ to the unit interval $[0, 1]$ of real numbers[20].

3.1.1 Triangular fuzzy number

Triangular fuzzy number can be defined by a triplet $\tilde{T} = (l, m, u)$ and $a \leq b \leq c$ (shown as Fig 1). The fuzzy number is the so-called triangular fuzzy number with its characteristic member function written as[1, 12] :

$$\mu_{\tilde{M}}(x) = \begin{cases} \frac{x-a}{b-a}, & a \leq x \leq b \\ \frac{c-x}{c-b}, & b \leq x \leq c \\ 0, & \text{otherwise} \end{cases} \quad (1)$$

3.1.2 Linguistic variable

A linguistic variable is a variable whose values are linguistic terms [21]. The concept of linguistic variable is very useful in dealing with the situations are too complex to be reasonably described in quantitative expressions [21]. For example, the membership functions of the term set {Very Unimportant (VU), Unimportant (U), Medium (M), Important (I), Very Important (VI)} for representing weights of the importance of knowledge management. The linguistic values can also be represented via triangular fuzzy numbers.

3.1.3 Distance measurement

Let $\tilde{M}_1 = (a_1, b_1, c_1)$ and $\tilde{M}_2 = (a_2, b_2, c_2)$ be two triangular fuzzy numbers, then the vertex method is defined to calculate the distance between them as[5]:

$$d(\tilde{M}_1, \tilde{M}_2) = \sqrt{\frac{1}{3}[(a_1 - a_2)^2 + (b_1 - b_2)^2 + (c_1 - c_2)^2]} \quad (2)$$

3.2 Fuzzy Delphi Method

This paper adopts Fuzzy Delphi Method to select the evaluation indicators. The Fuzzy Delphi Method is one of the specialist forecasts, its main object lies in obtaining the consensus of specialists, looking for to the opinion of the uniformity of the particular object [7].

The traditional Delphi method is one effective method, which enables forecasting by converge a possibility value through the feedback mechanism of the result of questionnaires, based on experts' judgments. However, the weakness of the traditional Delphi is that it requires repetitive surveys of the experts to allow the forecast values to converge. Therefore, Fuzzy Delphi Method uses Linguistic variable to express opinions of each expert, acquiring better integrative results [11, 13].

The Fuzzy Delphi Method is applied in this paper to find out the evaluation indicators. The steps are described as follows :

Step1. The expression of the specialist opinion

Each expert makes use of the Linguistic variable representing the importance weights of the decision criteria (shown as the Table 2).

Step2. Integrate fuzzy evaluative values of experts

Using Fuzzy Delphi Method to integrate fuzzy evaluative values of all experts in this step. If the l th expert judges the importance of the k th indicator is shown denoted by $\tilde{W}_{lk} = (a_{lk}, b_{lk}, c_{lk})$, the fuzzy weight \tilde{W}_k of the k th indicator, then \tilde{W}_k can be calculated as:

$$\tilde{W}_k = (a_k, b_k, c_k) \quad , \quad k = 1, 2, \dots, n \quad (3)$$

$$a_k = \min_l \{ a_{lk} \}, b_k = \frac{1}{m} \sum_{l=1}^m b_{lk}, c_k = \max_l \{ c_{lk} \}$$

Step3. Selecting evaluative indicators

Using Centroid Method to transform fuzzy weight of each indicator \tilde{W}_k into single value. S_k [14]. It can be calculated as:

$$S_k = \frac{a_k + b_k + c_k}{3} \quad (4)$$

Set a threshold value as t and select a suitable evaluative indicator. The rule of selection is described as follows:

- (a) If $S_k \geq t$, then accept the k th initial indicator as evaluative indicator.
- (b) If $S_k < t$, then delete k th initial indicator.

3.3 Fuzzy Analytic Hierarchy Process Method (Fuzzy AHP)

Buckley[2, 3] proposed that AHP method on the criteria's appraisal can't present appraisal subjective judgment and criteria in real situations. Therefore, Fuzzy AHP is proposed by combining fuzzy set theory with AHP to reflect true environment decision analysis suffers of subject. Making use of the Fuzzy AHP undertaking appraisal step justification as follows:

Step1. Based on features decomposed by each attribute to

create the hierarchy levels.

Step2. Calculate fuzzy positive reciprocal matrix. Converting the linguistic evaluation into triangular fuzzy numbers to construct the fuzzy decision matrix and determine the fuzzy weight of each criterion.

Step3. Calculate fuzzy weight. According to Lambda-Max method, we can calculate the fuzzy weight value [6].

4. Performance Evaluation Model

The knowledge management activities are divided into knowledge creation, knowledge diffusion, knowledge transformation, and knowledge storage in this paper. The performance evaluation framework of knowledge management is shown as Fig. 2.

The processes of knowledge management performance evaluation model is described as follows:

Step1. Calculate the fuzzy weight value of the evaluative dimension.

- (1) Each expert use linguistic variable of the Table 3 to calculate the KM performance of each dimension. And give a linguistic variable to represent the relative importance in two dimensions [2]. Giving comparative and important evaluation of extent in pair-wise comparisons.
- (2) Using Fuzzy AHP to calculate the fuzzy weight as \tilde{W}_i^p of each expert.
- (3) Using Average Method to integrate fuzzy weight value of each expert with regard to each dimension into \tilde{W}_i .

$$\tilde{W}_i = 1/p (\tilde{W}_i^1 \oplus \tilde{W}_i^2 \oplus \dots \oplus \tilde{W}_i^p) \quad (5)$$

Step2. Calculating evaluative value of each dimension

- (1) Each expert use linguistic variable of the Table 3 to calculate evaluative values and weight values of evaluative indicators within each evaluative dimension.
- (2) Using Weighted Average Method to integrate all of fuzzy evaluative value of all experts within each evaluative dimension. It can be computed as:

$$\tilde{X}_{ij} = \frac{1}{p} \{ (\tilde{X}_{ij1} \otimes \tilde{W}_{ij1}) \oplus (\tilde{X}_{ij2} \otimes \tilde{W}_{ij2}) \oplus \dots \oplus (\tilde{X}_{ijp} \otimes \tilde{W}_{ijp}) \} \quad (6)$$

Where \tilde{X}_{ij} is the j th indicator's fuzzy evaluative value within i th dimension after the integration of all experts. \tilde{X}_{ijp} is the j th evaluative indicator's fuzzy evaluative value of the p th decision-maker within the i th dimension. \tilde{W}_{ijp} is the j th indicator's fuzzy weight value of the p th expert within the i th dimension.

- (3) Calculating fuzzy evaluative value in each dimension

as:

$$\tilde{X}_i = \frac{1}{n_i} \{ \tilde{X}_{i1} \oplus \tilde{X}_{i2} \oplus \dots \oplus \tilde{X}_{in_i} \}, i=1,2,\dots,m \quad (7)$$

where \tilde{X}_i is the fuzzy evaluative value of the i th dimension. n_i is the evaluative indicator's numbers of the i th dimension.

(4) According to the fuzzy weight value and fuzzy evaluative value of each dimension, calculating comprehensive fuzzy evaluative value as:

$$\tilde{P} = \frac{1}{m} \sum_{i=1}^m (\tilde{X}_i \otimes W_i) \quad (8)$$

where \tilde{P} is the comprehensive fuzzy evaluative value, and m is the numbers of dimensions.

(5) Calculating the distance value of comprehensive fuzzy evaluative value \tilde{P} and the linguistic variable L_i of each evaluative value (shown in Table 4). Distance measurement is computed as:

$$d(\tilde{P}, L_i) = \sqrt{\frac{1}{3} [(P_1 - l_{i1})^2 + (P_2 - l_{i2})^2 + (P_3 - l_{i3})^2]} \quad (9)$$

where $\tilde{P} = (p_1, p_2, p_3)$ is the comprehensive fuzzy evaluative value. $L_i = (l_{i1}, l_{i2}, l_{i3}), i=1,2,3,4,5$ is the linguistic variable of evaluative value.

(6) If the distance between comprehensive fuzzy evaluative value \tilde{P} and the linguistic variable L_i is the minimum value, it represents that L_i is the integral evaluative value of KM activities.

5. Example Description

According to the business knowledge management performance evaluation framework (shown as Fig. 2) in this paper. Suppose there are three experts to evaluate the performance of KM. The step is described as follows:

Step1. The hypothesis makes the pair-wise comparison matrix by the three expert's important extent to each evaluative dimension as follows:

$$\begin{aligned} \tilde{T}_1 &= \begin{bmatrix} (1,1,1) & (7,8,9) & (1,2,3) & (7,9,9) \\ (0.11,0.12,0.14) & (1,1,1) & (0.14,0.2,0.33) & (1,3,5) \\ (0.33,0.5,1) & (3,5,7) & (1,1,1) & (5,7,9) \\ (0.11,0.11,0.14) & (0.2,0.33,1) & (0.11,0.14,0.2) & (1,1,1) \end{bmatrix} \\ \tilde{T}_2 &= \begin{bmatrix} (1,1,1) & (1,3,5) & (3,4,5) & (7,9,9) \\ (0.2,0.33,1) & (1,1,1) & (1,3,5) & (7,9,9) \\ (0.2,0.25,0.33) & (0.2,0.33,1) & (1,1,1) & (5,7,9) \\ (0.11,0.11,0.14) & (0.11,0.11,0.14) & (0.11,0.14,0.2) & (1,1,1) \end{bmatrix} \\ \tilde{T}_3 &= \begin{bmatrix} (1,1,1) & (3,5,7) & (3,4,5) & (5,7,9) \\ (0.14,0.2,0.33) & (1,1,1) & (0.2,0.33,1) & (5,6,7) \\ (0.2,0.25,0.33) & (1,3,5) & (1,1,1) & (3,4,5) \\ (0.11,0.14,0.2) & (0.14,0.16,0.2) & (0.2,0.25,0.33) & (1,1,1) \end{bmatrix} \end{aligned}$$

Step2. Calculating fuzzy weight value of each decision-maker within dimension via Fuzzy AHP as :

$$\begin{aligned} \tilde{W}_1^1 &= (0.45, 0.06, 0.25, 0.04) \\ \tilde{W}_1^2 &= (0.3, 0.16, 0.11, 0.03) \\ \tilde{W}_1^3 &= (0.48, 0.14, 0.16, 0.05) \\ \tilde{W}_2^1 &= (0.55, 0.09, 0.32, 0.04) \\ \tilde{W}_2^2 &= (0.54, 0.28, 0.15, 0.03) \\ \tilde{W}_2^3 &= (0.58, 0.14, 0.23, 0.05) \\ \tilde{W}_3^1 &= (0.55, 0.22, 0.39, 0.06) \\ \tilde{W}_3^2 &= (0.54, 0.33, 0.16, 0.13) \\ \tilde{W}_3^3 &= (0.58, 0.15, 0.25, 0.05) \end{aligned}$$

Therefore, integrates the fuzzy weight value of each decision-maker within evaluative dimension as:

$$\begin{aligned} \tilde{W}_1 &= (1.23, 0.36, 0.52, 0.12) \\ \tilde{W}_2 &= (1.67, 0.51, 0.7, 0.12) \\ \tilde{W}_3 &= (1.67, 0.7, 0.8, 0.24) \end{aligned}$$

$$W_1 = 0.52, \quad W_2 = 0.18, \quad W_3 = 0.22, \quad W_4 = 0.08$$

Step3. Decision-makers use linguistic variable (shown as Table 5 and 6) to give their assessment value. According to data of Table 4. The first dimension value can be computed as:

$$\begin{aligned} \tilde{x}_{11} &= \frac{1}{3} \{ [0.5, 0.6, 0.7] \otimes [0.7, 0.8, 0.9] \oplus \\ &\quad [0.5, 0.6, 0.7] \otimes [0.3, 0.5, 0.7] \oplus \\ &\quad [0.5, 0.6, 0.7] \otimes [0.7, 0.8, 0.9] \} \\ &= (0.28, 0.42, 0.58) \end{aligned}$$

Step4. Calculating evaluative value of each dimension as:

$$\begin{aligned} \tilde{x}_1 &= (0.16, 0.25, 0.35) \\ \tilde{x}_2 &= (0.07, 0.14, 0.25) \\ \tilde{x}_3 &= (0.18, 0.28, 0.36) \end{aligned}$$

Step5. Calculating fuzzy evaluative value of comprehensive effects according to the weight value of each dimension is $\tilde{P} = (0.28, 0.46, 0.63)$.

Step6. Calculating the distance value of comprehensive fuzzy evaluative value and the linguistic variable of each evaluative value via distance measurement as:

$$d(\tilde{P}, \tilde{F}) = \sqrt{\frac{1}{3}[(0.28-0.7)^2 + (0.46-0.9)^2 + (0.63-0.9)^2]} = 0.38(\text{VG})$$

$$d(\tilde{P}, \tilde{B}) = 0.35(\text{G})$$

$$d(\tilde{P}, \tilde{E}) = 0.25(\text{MG})$$

$$d(\tilde{P}, \tilde{D}) = 0.15(\text{F})$$

$$d(\tilde{P}, \tilde{C}) = 0.01(\text{MP})$$

$$d(\tilde{P}, \tilde{H}) = 0.08(\text{P})$$

$$d(\tilde{P}, \tilde{V}) = 0.16(\text{VP})$$

$$d(\tilde{P}, \tilde{R}) = 0.26(\text{CP})$$

$$d(\tilde{P}, \tilde{G}) = 0.95(\text{CG})$$

Step7. If the distance value is the minimal, it's represented the whole performance evaluative value as namely the corresponding linguistic variables is [Medium poor].

According to the foregoing results, the knowledge management performance of this business belongs to "Medium Poor".

6. Conclusion

From the viewpoint of the business, knowledge management is based on the knowledge embedded in the process and allowed that business to operate profitably in providing attractive products and services to customers. The knowledge has become the most important practical factor. To demonstrate a business benefit, knowledge must be measured.

In general, business must reach a balance between intangible and tangible assets. The proposed model provides business systematic processes to measure the business performances evaluation in knowledge management. Using the linguistic variable and fuzzy Delphi method, managers can evaluate and understand the overall performance in knowledge management easily and effectively.

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Table 1 Activities and contents of knowledge management

Knowledge management activities	Contents
Knowledge creation [16]	Organizational knowledge creation involves five main steps : (1) Sharing tacit knowledge (2) Creating concepts (3) Justifying concepts (4) Building a prototype (5) Cross-leveling knowledge.
Knowledge transformation [16]	Knowledge Spiral brings up knowledge creation having four paths included from tacit to tacit(Originating-sharing tacit knowledge between individuals), from tacit to explicit(Conversing-having group conversations to form concepts), from explicit to explicit(Documenting-converting knowledge into explicit forms), from explicit to tacit(Internalizing-making explicit knowledge tacit once more). It is mainly aimed at the interaction of tacit and explicit knowledge to show the path of the knowledge management removal at the same time, by the criterion knowledge oneself whether be easy to be explicit, and then aimed at the knowledge to be easy to be explicit or not, depend on the different path to design the more likely knowledge removal mechanism.
Knowledge diffusion [9]	Knowledge diffusion suffers the impact of common knowledge in employee easily, containing common language, common symbol, collective expertise, consciousness that share, know the individual knowledge realm.
Knowledge storage[4]	The business is considering how to store knowledge resource. It can adopt the knowledge to extract, the knowledge diffusion, structured etc.

Table 2 Linguistic variables for the importance weight

Linguistic variables	Triangular fuzzy number
Very Important	(0.7,0.9,0.9)
Important	(0.5,0.7,0.9)
Medium	(0.3,0.5,0.7)
Unimportant	(0.1,0.3,0.5)
Very Unimportant	(0.1,0.1,0.3)

Table 3 Linguistic variables for the ratings

Linguistic variables	Triangular fuzzy number
Equal importance	(1,1,1)
Equal importance	(1,1,3)
Both of them	(1,2,3)
Rather importance	(1,3,5)
Both of them	(3,4,5)
Very importance	(3,5,7)
Both of them	(5,6,7)
Extreme importance	(5,7,9)
Both of them	(7,8,9)
Absolute importance	(7,9,9)

Table 4 Fuzzy evaluative value of Decision-maker

Dimension		Knowledge Creation		Knowledge Transformation		Knowledge Diffusion		Knowledge Storage		
Evaluative indicator										
Expert 1	Evaluative value	C	MG	C	MP	MG	MP	MG	F	MP
	Weight value	I	I	I	MI	VI	VI	VI	VI	
Expert 2	Evaluative value	C	MG	MP	P	MG	C	MG	MP	F
	Weight value	MI	I	MI	MI	I	I	I	I	
Expert 3	Evaluative value	C	MG	MP	MP	G	C	MG	MP	MP
	Weight value	I	VI	MI	MI	I	VI	I	I	

Table 5 Linguistic variables of weight value

Linguistic variables	Triangular fuzzy number
Considerably unimportant (CUI)	(0.1,0.2,0.3)
Very unimportant (VUI)	(0.1,0.3,0.5)
Unimportant (UI)	(0.3,0.4,0.5)
Medium unimportant (MUI)	(0.3,0.5,0.7)
Common(C)	(0.5,0.6,0.7)
Medium important (MI)	(0.5,0.7,0.9)
Important (I)	(0.7,0.8,0.9)
Very important (VI)	(0.7,0.9,0.9)
Considerably important (CI)	(1, 1, 1)

Table 6 Linguistic variables of evaluative value

Linguistic variables	Triangular fuzzy number
Considerably poor (CP)	(0.1,0.2,0.3)
Very poor (VP)	(0.1,0.3,0.5)
Poor (P)	(0.3,0.4,0.5)
Medium poor (MP)	(0.3,0.5,0.7)
Fair (F)	(0.5,0.6,0.7)
Medium good (MG)	(0.5,0.7,0.9)
Good (G)	(0.7,0.8,0.9)
Very good (VG)	(0.7,0.9,0.9)
Considerably good (CG)	(1, 1, 1)

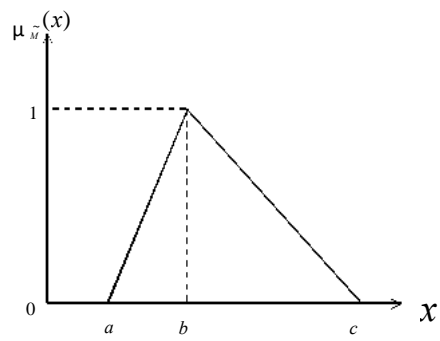


Fig. 1 Triangle fuzzy number $\mu_{\tilde{M}}(x)$.

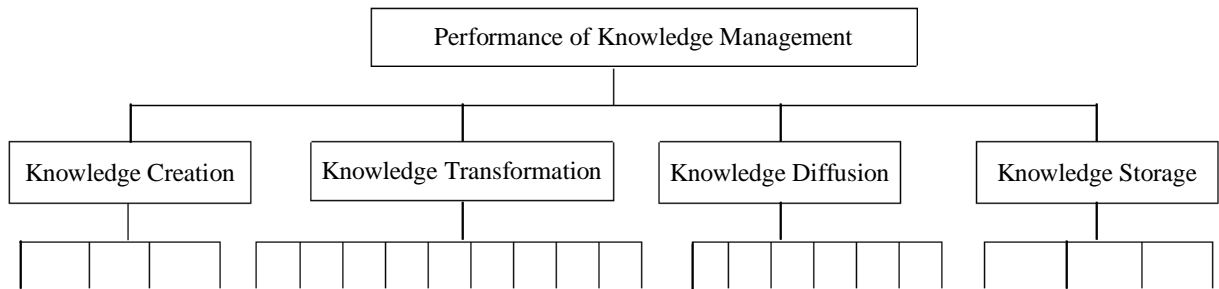


Fig. 2 Evaluative framework

An Integrated Lot-size Model of Deteriorating Item for one Vendor and Multiple Retailers Considering Market Pricing Using Genetic Algorithm

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Abstract

In this paper, we propose a model to study influence of pricing and deteriorating rate on the supply chain level net profit and total inventory where genetic algorithm is used for determine the optimal solution. A one-vendor and multi-retailer supply chain for a single deteriorating finished product and raw materials is analyzed. Under the proposed strategy, the vendor buys a non-deteriorating materials to vendor a deteriorating finished product, delivers the finished product to all retailers by common replenishment periods based on VMI (vendor managed inventory) being implemented. All retailers who buy the finished product sell the finished product on their markets. In all of these markets, the finished product in different markets has substitution each other since consumers may have opportunity to buy the finished product from different retailer and Cobb-Douglas demand function is introduced to describe this market attribute. After developing an integrated product-inventory-marketing model for deteriorating product, genetic algorithm is conducted to calculate the optimal pricing and inventory policies. Finally we present the results of a detailed numerical study that analyses the market and deteriorating rate related parameters influence on the supply chain level net profit and inventory level.

1. Introduction

A lot of research efforts have been made and several integrated inventory models have emerged in order to minimize the inventory cost of deteriorating products for both vendor and buyers. Goyal (1977) [6] proposes a joint economic lot size (JELS) model where the objective is to minimize the total relevant costs for a single vendor, single buyer system. Banerjee (1986) [1] generalizes Goyal's model by incorporating a finite production rate for the vendor and gives the optimal joint production or order quantity. Goyal (1988) [8] extends Banerjee's model again by relaxing the lot-for-lot production assumption and argues that the economic production quantity will be an integer multiple of the buyer's purchase quantity and shows that its model provides a lower or equal joint total relevant cost as compared to Banerjee's model. Kohli and Park (1994) [12] investigate joint ordering policies as a method to reduce transaction costs between a single vendor and a homogeneous group of buyers. They present expressions for optimal joint order quantities assuming all products are ordered in each joint order. Lu (1995) [15] considers a one-vendor multi-buyer integrated inventory

model and gave a heuristic approach for joint replenishment policy. Banerjee and Banerjee (1992) [2] consider an EDI-based vendor-managed inventory (VMI) system in which the vendor makes all replenishment decisions for his/her buyers to improve the joint inventory cost. But most of these previous works on integrated vendor-buyer inventory systems do not consider raw material procurement decisions except for the work by Woo, Hsu, and Wu (2001) [22]. Their model is extended to become a three-level supply chain in which one raw material is considered. However, they do not consider marketing policies and deteriorating products in VMI Vendor Managed Inventory.

Several researchers have integrated marketing policies and deteriorating products into inventory decisions for infinite time horizon. Kotler (1971) [13] first incorporates marketing policies into inventory decisions and discussed the relationship between economic ordering quantity and price decisions. Ladany and Sternleib (1974) [14] study the effect of price variations on demand and consequently on EOQ (economic order quantity). Goyal and Gunasekaran (1995) [10] extend the previous work considering perishable goods in a multi-stage inventory model. Although both of the advertisement and price are considered in their papers, they are treated as input parameters and the impacts of advertisement and price are only analyzed by sensitive analysis in their numerical example, without considering the substitution of finished products where Cobb-Douglas demand function is considered. Moreover, they do not consider supply chain context, only limited to a vendor or manufacturer. However, in reality, there are significant differences between deteriorating rates among raw materials, and between finished products. In such circumstances, the raw materials' deteriorating rates can be neglected when compared with that of the finished product. However, this issue has not yet been widely considered in previous VMI works. Moreover, it has been a challenge to calculate the optimal solution for deteriorating product as reported in the literature. Both Goyal and Gunasekaran (1995) [10] develop a computer program for finding their optimal solution by using an exhaustive search method and consume a large amount of computer resources. Fortunately genetic algorithms have been demonstrated successful in providing good solutions to many complex optimization problems and thus received increasing attentions. Their uses have been well documented in the literatures, such as that of Goldberg (1989) [5], Michalewicz (1994) [16] and Fogel (1994) [4], for a wide

variety of optimization problems. GA (genetic algorithm) has also been applied to supply chain optimization.

In this paper, we propose a model to study the influence of pricing and deteriorating rate on the net profit and total inventory cost of the supply chain. GA is used for determining the optimal solution from the proposed model. A one-vendor and multi-retailer supply chain for a single deteriorating finished product is analyzed, also considering the raw materials. Under the proposed strategy, the vendor buys non-deteriorating materials for producing deteriorating finished products, and delivers the finished product to all retailers by common replenishment periods based on VMI (vendor managed inventory). All retailers who buy the finished product sell the finished product on the markets. In the markets, the finished product sold by different retailers has substitution each other since consumers may have opportunity to buy the finished product from different retailers and Cobb-Douglas demand function is introduced to describe this market attribute. After developing an integrated product-inventory-marketing model for deteriorating product, genetic algorithm is conducted to calculate the optimal pricing and inventory policies.

This paper will be organized as follows. Section 2 introduces assumptions and notation. In Section 3, we analyze the system and develop an integrated product-inventory -marketing model for deteriorating product. Section 4 presents a genetic algorithm for calculating the optimal pricing and inventory policies. Section 5 gives a detailed numerical study to analyze the influence of parameters such as market and deteriorating rate on the net profit and inventory level of the supply chain. Section 6 concludes the paper by closing remarks.

2. Assumptions and Notations

The supply chain system considered in this paper includes only one vendor and only one type of finished product are considered. This vendor provides the finished product to multiple retailers and buys multiple raw materials in order to produce the product.

2.1 Assumptions

The following assumptions are used to derive the mathematical model:

- (1) Demand rate is determined by the retail price and the attributes of the markets and is a function of the retail price and a concave function with respect to each retail price; finished products in different retailer have substitution each other since the product is procured from the same vendor. And the units from the raw materials are immediately available.
- (2) Common replenishment cycle is performed by the vendor and all retailers in the supply chain based on VMI.
- (3) Deteriorating rate for the finished product is deterministic and deteriorated finished product is replaced and repaired.
- (4) The deteriorating cost per unit is different when they are in the different owner. For the deteriorating finished

product occurred in retailer i , the deteriorating cost for each finished product is its retail price. However, the deteriorating cost for the vendor is its production price.

2.2 Notations

M	Number of retailers considered;
$i=1,2,\dots,m$	Index of retailers;
p_i	A decision variable, retail price for retailer i (\$/unit);
D_i	Demand for retailer i per unit time, a function of p_i , (\$/unit/time);
a_i	A positive number which is determined by retailer i 's market;
β_{ij}	Substitution elasticity for retailer i 's demand with respect to retailer j 's price;
α_i	Price elasticity;
H_{bi}	Holding cost of the finished product for retailer i , (\$/unit/time);
ζ_i	Transportation cost for retailer i (\$/unit);
p_0	Production and raw material cost per unit finished product (\$/unit);
C	A decision variable, Common replenishment cycle for the vendor and all retailers;
n	Integral number of production batches per raw materials procurement cycle, which is a decision variable, and $n>1$;
A	Ordering cost per raw materials order for the vendor;
S	Fixed cost for the vendor per common replenishment cycle;
T_i	Ordering cost for per retailer i 's order;
M	Usage rate of raw material for producing each finished product;
P	Production rate for the vendor, which is a known constant;
H_{vm}	Holding cost per unit finished product;
t_{vi}	Production time for the vendor to satisfy the requirements of retailer i in the common replenishment cycle;
H_{vp}	Holding cost of the finished product for the vendor, (\$/unit/time);
θ	Deteriorating rate of the finished product;(percentage/units/time)
Q_i	Lot size for retailer i ;
TC_{bi}	Total inventory cost for retailer i ; per unit time, (\$/time);
H_p	Holding cost of the finished product for the vendor in the common replenishment cycle C , (\$);
TC_{vp}	Total inventory cost of the finished product for the vendor per unit time, (\$/time);
HC_{vm}	Holding cost of the raw material for the vendor in the common replenishment cycle C , (\$);
TC_{vm}	Total inventory cost of the raw material for the vendor per unit time, (\$/time);

JTC	Joint total inventory cost for the supply chain system per unit time, (\$/time);
π	Total net profit per unit time, (\$/time).

3. Model

The net profit of the supply chain level that we studied is equal to the net revenue minus the total inventory cost. In this section, firstly we calculate the net revenue; secondly the total inventory cost is put forward; and lastly the integrated model is proposed.

3.1 Net Revenue

The product demand D_i for retailer i is a general function of (p_1, p_2, \dots, p_m) and downward sloping with respect to its own price p_i . That is

$$\frac{\partial D_i}{\partial p_i} < 0. \quad (1)$$

Since all retailers offer the substitutable products, the other retailer's retail price will influence the demand volume of retailer i , we assume that

$$\frac{\partial D_i}{\partial p_j} > 0 \quad i=1, \dots, m \text{ and } j \neq i. \quad (2)$$

This represents a common definition of substitutable products, which goes back to Samuelson (1947) [19] and see also Vives (1990) [21]. In other words, each retailer can expect its sales volume to go up, whenever one of another retailer increases its price.

Assume product demand rate for each retailer at the retail price p has a Cobb-Douglas form (Nicholson, 1989) [17], that is

$$D_i(p) = a_i p_i^{-\alpha_i} \prod_{j \neq i} p_j^{\beta_{ij}} \quad i=1, \dots, m, \quad (3)$$

where $p = [p_1, p_2, \dots, p_m]^T$, $\alpha_i > 1$, $a_i > 0$, $\beta_{ij} \geq 0$ for all i and $i \neq j$.

The product is sold by the system at the retail price p_i per unit, which yields net revenue of:

$$\text{net revenue} = \sum_{i=1}^m D_i \cdot (p_i - p_0 - \zeta_i) \quad (4)$$

3.2 Total Inventory Cost

In our model, we assume that the vendor purchases raw material outside to produce its finished product. The procurement lot size of raw material is assumed to be an integral multiple of the usage of each production batch. This policy has also been considered in some previous works by Goyal (1977) [7], Goyal and Deshmukh (1992) [9] and Goldberg (1989) [5] etc, which are more general than the lot-for-lot procurement policy adopted in other works such as that of Sarker and Parija (1994) [20] and Nori and Sarker (1996) [18]. The product is then delivered to multiple retailers at a common replenishment cycle. We assume that all enterprises to cooperate the supply chain wide profit function.

In this section we calculate the joint total inventory

cost for the vendor and all retailers. The inventory levels for all retailers and vendor are shown in Fig 1.

The change of inventory level for retailer i , notified by $I_i(t)$, during common order cycle C can be described by the following equations:

$$I_i'(t) = -\theta I_i(t) - D \quad 0 \leq t \leq C \quad (5)$$

with the boundary conditions

$$I_i(C) = 0. \quad (6)$$

The solution of the differential equation of Equation (5) - (6) is

$$I_i(t) = \frac{D_i}{\theta} (e^{\theta(C-t)} - 1) \quad 0 \leq t \leq C. \quad (7)$$

For retailer i , the maximal inventory level, that is, the order quantity of retailer i , is

$$Q_i = I_i(0) = \frac{D_i}{\theta} (e^{\theta C} - 1). \quad (8)$$

So in the common replenishment cycle C the retailer i 's total inventory cost is given as

$$\begin{aligned} \int_0^C H_{bi} I_i(t) dt &= \int_0^C H_{bi} \frac{D_i}{\theta} (e^{\theta(C-t)} - 1) dt \\ &= \frac{D_i H_{bi}}{\theta^2} (e^{\theta C} - 1) - \frac{D_i H_{bi} C}{\theta}, \end{aligned} \quad (9)$$

and total deteriorating cost is

$$p_i(Q_i - D_i C). \quad (10)$$

The retailer i 's total inventory cost is given as

$$TC_{bi} = \frac{1}{C} [T_i + \frac{D_i H_{bi}}{\theta^2} (e^{\theta C} - 1) - \frac{D_i H_{bi} C}{\theta} + p_i(Q_i - D_i C)]. \quad (11)$$

From Fig.1., it can be seen that the finished product inventory level notified by $I_{vi}(t)$ for the vendor follows the differential equation:

$$I_{vi}'(t) = P - \theta I_{vi}(t) \quad 0 \leq t \leq t_{vi}, \quad (12)$$

with boundary conditions:

$$I_{vi}(0) = 0. \quad (13)$$

From Equations (12)-(13), we have

$$I_{vi}(t) = \frac{P}{\theta} (1 - e^{-\theta t}) \quad 0 \leq t \leq t_{vi}, \quad (14)$$

where t_{vi} is determined by $I_{vi}(t_{vi}) = Q_i$. The solution is

$$t_{vi} = -\frac{1}{\theta} \ln[1 - \frac{D_i}{P} (e^{\theta C} - 1)] \quad (15)$$

Then, the vendor's holding cost for the finished product in the common replenishment cycle C is

$$\begin{aligned} H_p &= \int_0^{t_{vi}} H_{vp} I_{vi}(t) dt = \int_0^{t_{vi}} H_{vp} \frac{P}{\theta} (1 - e^{-\theta t}) dt \\ &= \frac{H_{vp} P}{\theta^2} (\theta t_{vi} + e^{-\theta t_{vi}} - 1) \end{aligned} \quad (16)$$

And the vendor's decaying cost for the finished product in the common replenishment cycle C is

$$p_0(P \sum_{i=1}^m t_{vi} - \sum_{i=1}^m Q_i) \quad (17)$$

Now the total inventory cost per unit time of the vendor is

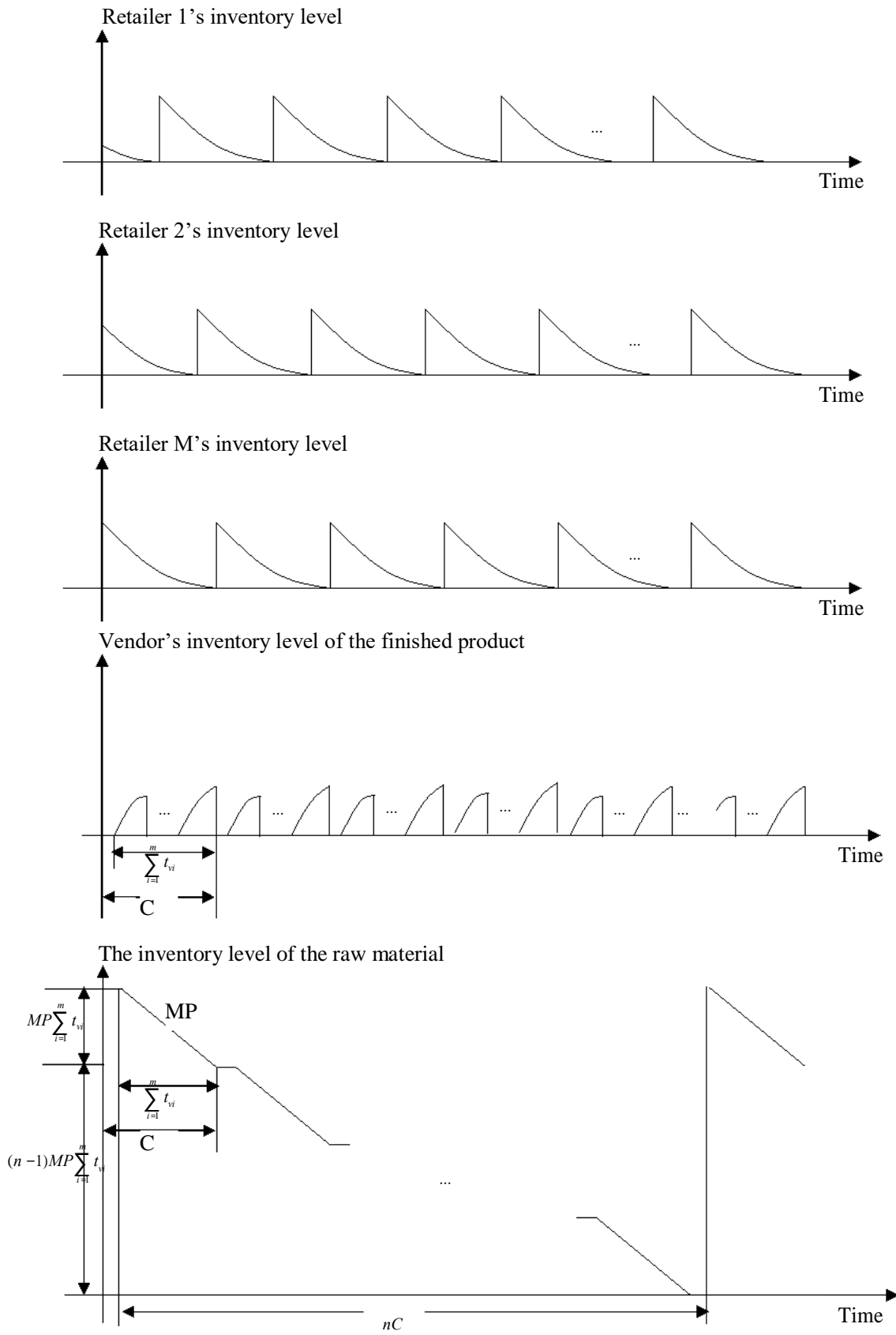


Fig. 1. The inventory level for all retailers and the vendor

$$TC_{vp} = \frac{1}{C} [S + \sum_{i=1}^m \frac{H_{vp} P}{\theta^2} (\theta t_{vi} + e^{-\theta t_{vi}} - 1) + p_0 (P \sum_{i=1}^m t_{vi} - \sum_{i=1}^m Q_i)] \quad (18)$$

Assume that the raw material's replenishment cycle for the vendor is integral multiple of the finished product's replenishment cycle. The holding cost of the vendor in its replenishment cycle nC is

$$HC_{vm} = H_{vm} \left[\frac{n}{2} \sum_{i=1}^m \sum_{j=1}^m (MPt_{vi}) + \sum_{j=1}^{n-1} (jC \sum_{i=1}^m (MPt_{vi})) \right] \\ = \frac{nMPH_{vm}}{2} (\sum_{i=1}^m t_{vi})^2 + \frac{n(n-1)CMPH_{vm}}{2} \sum_{i=1}^m t_{vi} \quad (19)$$

The total inventory cost per unit time of the raw material for the vendor is

$$TC_{vm} = \frac{1}{nC} (A + HC_{vm}) \quad (20)$$

Therefore, the joint total inventory cost for the vendor and all retailers per unit time is

$$JTC = TC_{vm} + TC_{vp} + \sum_{i=1}^m TC_{bi} \quad (21)$$

3.3 Supply Chain Level Net Profit

From the above analysis, by the net revenue described in Equation (4) minus the total inventory cost described in Equation (21), we can get the following model, notified by SCLNP.

$$\pi = \sum_{i=1}^m D_i p_i - \sum_{i=1}^m D_i p_0 - \sum_{i=1}^m D_i \zeta_i - JTC \\ = \sum_{i=1}^m D_i p_i - \sum_{i=1}^m D_i p_0 - \sum_{i=1}^m D_i \zeta_i - \frac{1}{C} \left\{ \frac{A}{n} + S + \sum_{i=1}^m T_i \right. \\ + \frac{(n-1)CMPH_{vm}}{2} \sum_{i=1}^m t_{vi} + \frac{MPH_{vm}}{2} (\sum_{i=1}^m t_{vi})^2 \\ + \sum_{i=1}^m \frac{H_{vp} P}{\theta^2} (\theta t_{vi} + e^{-\theta t_{vi}} - 1) + \sum_{i=1}^m \left[\frac{D_i H_{bi}}{\theta^2} (e^{\theta C} - 1) - \frac{D_i H_{bi} C}{\theta} \right] \\ + p_0 (P \sum_{i=1}^m t_{vi} - \sum_{i=1}^m Q_i) + \sum_{i=1}^m p_i (Q_i - D_i C) \} \quad (22)$$

$$\text{and } \sum_{i=1}^m t_{vi} \leq P \quad (\text{capacity constraint}), \quad (23)$$

where Q_i , D_i and t_{vi} are determined by Equations (8), (15) and (3) respectively.

In the integrated inventory model, the decision variables are retail price $(p_1 \ p_2 \ \dots \ p_m)$, common replenishment cycle C , the integral multiple number n to maximize the net profit π . A closed form analytical solution cannot be obtained for the objective function to calculate the optimal decision variables. So to this kind of function, both Goyal and Gunasekaran in 1995 and Luo in 1997 are to develop a computer program for finding their optimal solution by using an exhaustive search method. In their method, for all each possible

combination of decision variables is calculated and this may consume a large amount of computer resources since there are much more continuous variables $(p_{b_1} \ p_{b_2} \ \dots \ p_{b_m})$ in our model. So the genetic algorithm for the model is developed in the following section.

4. Genetic Algorithm

Genetic algorithms have demonstrated a considerable success in providing good solutions to many complex optimization problems and received more and more attentions. They have been well documented by numerous pieces of literature, such as that of Goldberg (1989) [5], Michalewicz (1994) [16] and Fogel (1994) [4], and applied to a wide variety of optimization problems. In this section, a genetic algorithm for solving the optimal solution for model SCLNP to maximize the supply chain level profit is designed as follows:

- Step 0: Input parameters pop-size, pm, pc, pr, M, and N, where pm, pc and pr is the percentage of mutation, crossover and reproduction respectively.
- Step 1: Initialize pop-size chromosomes (the first generation).
- Step 2: Evaluate the pop-size chromosomes by fitness function.
- Step 3: Selection.
- Step 4: Alter the chromosomes by crossover and mutation operations.
- Step 5: Evaluate the pop-size chromosomes by fitness function.
- Step 6: Selection.
- Step 7: Repeat the 2nd to 6th steps till the third termination condition is satisfied.
- Step 8: Report the best chromosome as the optimal solution.

5. Numerical Example

This section presents a numerical example for model SCLNP. The related input parameters are given in Table 1. As an illustration, the case of $m=3$ are discussed. The unit time is one year and the monetary unit is U.S. dollar. The optimal decisions for all retailers and the vendor are shown in Table 2 and the sensitivity analysis for the parameters that associate with market and deteriorating, i.e., a_i , α_i , β_{ij} and θ are shown from Table 3-6.

Table 1: Input parameters

Parameters	Value	Parameters	Value
P	60000	M	0.95
p_0	40	θ	0.02
A	5000	ζ_i	3
S	2000	α_i	1.45
T_i	1000	a_i	20000000
H_{bi}	80	H_{vm}	15
H_{vp}	40	β_{ij}	0.01

Table 2: optimal decisions of the base example

(p_1, p_2, p_3)	$\sum_{i=1}^3 D_i$	N	C	JTC	π
(154.95, 154.95, 154.95)	44276.81	3	0.04771	279384.71	4677414.84

The parameter a_i represents the attribute of customer markets of retailer i ; in which the larger of a_i , the larger of demand volume of customer i . From Table 3, it can be seen that with the increasing of a_i , the demand of the vendor which is the sum of the demands of its retailers is increasing constantly. The demand volume increases from 10205.57 at $a_i=0.5$ to 59968.11 at $a_i=3.5$ by 487 %. P_1, P_2 and P_3 decrease at first when the capacity of the vendor is full before $a_i \leq 2.5$. However when the capacity of the vendor is used up after $a_i \geq 3$, with the increasing of a_i , all prices begin to go up and

JTC increases by 2.67 from 1251180.68 at $a_i=0.5$ to 334708.00 at $a_i=3.5$ whereas π increases by 7.39 from 1109766.82 at $a_i=0.5$ to 8202461 at $a_i=3.5$. When the replenishment cycle of the finished product decreases constantly since when the demand of the vendor goes up rapidly with the increase of a_i before $a_i \leq 2.5$. With the increase of a_i after $a_i \geq 3$ where the capacity of the vendor is used up, the increasing of the retail price deduces the penalty of the deteriorating cost per unit finished product goes up and such the replenishment cycle of the common replenishment cycle decrease too.

Table 3: Sensitivity analysis where a_i is changed

a_i (107)	(p_1, p_2, p_3)	$\sum_{i=1}^3 D_i$	n	C	JTC	π
0.5	164.00, 164.00, 164.00	10205.57	2	0.11972	125180.67	1109766.82
1	158.46, 158.46, 158.46	21441.64	2	0.08067	185896.66	2289635.59
1.5	156.32, 156.32, 156.32	32791.98	2	0.06371	235410.31	3480610.46
2	154.95, 154.95, 154.95	44276.81	3	0.04771	279384.71	4677414.84
2.5	154.18, 154.18, 154.18	55742.76	3	0.04168	319706.79	5877672.20
3	166.45, 166.45, 166.45	59968.11	3	0.03986	334251.51	7066984.50
3.5	185.40, 185.40, 185.40	59968.23	3	0.03965	334708.00	8202461.33

Table 4: Sensitivity analysis where α_i is changed

α_i	(p_1, p_2, p_3)	$\sum_{i=1}^3 D_i$	N	C	JTC	π
1.15	451.92, 451.92, 451.92	59969.97	3	0.03753	341299.39	24181502.3
1.25	275.92, 275.92, 275.92	59968.39	3	0.03923	336838.44	13571187.0
1.35	186.70, 186.70, 186.70	57216.98	3	0.04089	325475.18	7896685.77
1.45	154.95, 154.95, 154.95	44276.81	3	0.04771	279384.71	4677414.84
1.55	135.74, 135.75, 135.75	32750.91	2	0.06385	234812.22	2801737.00
1.65	122.90, 122.90, 122.90	23559.22	2	0.07696	195104.79	1687361.87
1.8	110.82, 110.82, 110.82	13763.88	2	0.10289	145784.39	787662.38

a_i represents the elasticity of markets of retailer i ; in which the larger a_i is, the more price sensitivity for the market of retailer i . From Table 4, it can be seen that with the increasing of a_i , the price of the finished product

reduced rapidly; the price is 451.92 at $\alpha_i=1.15$ whereas the price is 110.28 at $\alpha_i=1.15$ by 341.10. Accordingly $n, \sum_{i=1}^3 D_i, JTC$ and π reduce and the

finished product replenishment cycle C is increasing.

From Table 5, with the increasing of β_{ij} , P_1 , P_2 , P_3 , $\sum_{i=1}^3 D_i$, JTC and π go up while C decreases and n keeps unchanged. Something needs to be noted that when β_{ij} is equal to 0.05 P_3 becomes Infinity. Likewise, when β_{ij} is equal to 0.08, P_2 and P_3 both become Infinity. The

infinity price of P_i means D_i becomes zero, which leads to the decreasing of retailers. It can be seen that when β_{ij} is equal to 0.08 the prices of three retailers are 547.78, Infinity and Infinity respectively. That is, only one retailer should be left while another two should be canceled.

Table 5: Sensitivity analysis where β_{ij} is changed

β_{ij}	(P_1, P_2, P_3)	$\sum_{i=1}^3 D_i$	N	C	JTC	π
0	150.33,150.33,150.33	41819.58	3	0.0493	270253.37	4218795.06
0.001	150.78,150.78,150.78	42063.13	3	0.04822	271165.11	4262479.02
0.005	152.60,152.60,152.60	43037.41	3	0.04852	274797.88	4441961.47
0.01	154.95,154.95,154.95	44276.81	3	0.04771	279384.71	4677414.84
0.03	165.65,165.65,165.65	49369.98	3	0.04481	297877.96	5757515.32
0.05	170.45,170.45,Infinity*	59967.47	3	0.03565	315691.32	7328893.33
0.08	547.78,Infinity,Infinity	59967.47	3	0.02734	310124.20	29533606.3

*When the optimal P_i calculated by GA is larger than 10^9 we give Infinity to P_i there.

From Table 6, with the increasing of θ , JTC arises to 513343.84 at $\theta = 2$ by 86.15% comparing with that of by from 275764.28 at $\theta = 0.001$, and π is decreased by 5.19% from 4680974.66 at $\theta = 0.001$ to 37037420.10 at $\theta = 2$. The decrease of π by 5.19% is relatively small comparing with the increase of the joint inventory cost JTC , 86.15% since in this example the inventory cost is relatively small compare with π . With the increase of θ , at first, the demand of the vendor

$\sum_{i=1}^3 D_i$ rises and all retailers' prices goes down before $\theta = 1$, but then both of them drop down from $\theta = 1$ to $\theta = 2$. C and n increase constantly with the increase of deteriorating rate θ ; which means that with the increase of the deteriorating volume for the finished product and the decrease of the demand of the vendor the common replenishment cycle C will be ascended and the replenishment cycle for the raw material increases too since there is no deterioration for the raw material.

Table 6: Sensitivity analysis where θ is changed

θ	(P_1, P_2, P_3)	$\sum_{i=1}^3 D_i$	N	C	JTC	π
0.0001	155.00,155.00,155.00	44259.98	3	0.04843	275764.28	4680974.66
0.005	154.98,154.98,154.98	44263.03	3	0.04819	276657.44	4680092.53
0.01	154.97,154.97,154.97	44267.44	3	0.04802	277568.71	4679197.14
0.02	154.95,154.95,154.95	44276.81	3	0.04771	279384.71	4677414.84
0.05	154.89,154.89,154.89	44300.97	3	0.04665	284752.15	4672134.04
0.1	154.80,154.80,154.80	44339.44	3	0.04496	293482.22	4663540.94
1	154.64,154.64,154.64	44405.83	4	0.02986	416114.48	4541142.59
2	155.30,155.31,155.30	44130.84	5	0.02312	513343.84	4442923.33

6. Conclusion

In this paper, an integrated model for a one-vendor, multi-buyer supply chain where the Cobb-Douglas demand function is modeled. The vendor and all buyers to place the replenishment orders at common replenishment cycle based on vendor management inventory. The vendor buys raw material that is no decay to produce a finished product by a finite production rate and transport them to its retailers. All retailers sell the finished product in its market and customers can buy the product from different retailers. So the finished product sold by different retailers has the attribute of substitution. The

problem of determining the optimal the common replenishment cycle for the finished product, the replenishment cycle for raw materials and all retailer's price and be modeled as an integrated model in our paper. After modeling the problem, a genetic algorithm is proposed to give the optimal decisions. An extensive numerical study was conducted to understand the influence of various parameters related to market and deteriorating rate. The numerical study revealed that the decrease of the deteriorating rate θ and the increase of the elasticity of its own price α_i and substitution elasticity β_{ij} contribute to the net profit of the supply chain and vice versa. And Here that should be noted from

our integrated model that with the increase of the β_{ij} , the whole market is improved, and even the β_{ij} is better enough the number of the retailers may be decreased.

Acknowledgement

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IT Diffusion Stages in the Network Era of Chinese Companies *

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Abstract

One of our recent studies revisited Nolan's stages theory on IT growth in the context of Chinese companies and concluded that IT spending and learning with regard to IT management are not as tightly linked as is implied in Nolan's stages theory. The study also revealed that aggregate IT spending can be better explained by a technology diffusion process on the population level. Based on the findings, in this paper, we re-consider Chinese companies' IT spending growth pattern, and in turn, their IT application history over the past 20 years from a perspective of IT diffusion stages, highlighting the special characteristics of the network/Internet era. We project that the IT diffusion process in China's Network Era would experience four stages and has currently reached the third. Also, we propose some important issues to be further addressed.

Keywords

IT management, Stages theory, Diffusion of innovation, IT spending, Chinese companies.

1. Introduction

Both practitioners and academics have been concerned with the process of IT diffusion and absorption in enterprises since late 1960's. Former research has produced various models to describe the IT growth processes in different organizations during different periods of the history of IT development. Nolan's stages theory, as a well-known model regarding the link between IS management and IT spending in organizations, has shown its practical usefulness and intuitive plausibility while continuing to appeal to practitioners and consultants.

Nolan's theory was based on observations of US organizations. But application of information technology in China started much later and research on IT strategy and IT growth here is also weaker than in the West. Meanwhile, the context of using IT in China, including social, historical, technical, cultural, and management characteristics, is greatly different from that in other

countries. In other words, there must be something special about IT growth processes in Chinese enterprises.

On the other hand, empirical studies of various organizations over years have revealed mixed results in different countries and under different contexts. Therefore, there are good reasons to re-assess Nolan's classical theory in the light of new data from Chinese companies and find out in which ways this concept may be a useful guide for IT management decisions, and then may serve as a framework to interpret the IT growth process in China's Network/Internet Era.

Thus, we conducted a survey study to further develop Nolan's stages theory, as well as to analyze the IT growth process of Chinese companies. Based on data collected from 94 Chinese companies, we revisited Nolan's stages theory and concluded that aggregate IT spending can be better explained by a technology diffusion process on the population level. With such findings, we re-considered Chinese companies' IT spending growth pattern, and in turn, their IT application history over the past 20 years, highlighting the special characteristics of the network/Internet era.

2. The survey

In our questionnaire, we asked IT managers to provide absolute values of their organization's annual IT budgets for the period between 1989 and 2001, as well as additional information about company size, ownership structure, profitability, industry, and the year in which they began to use new technologies such as LANs and the Internet. From two rounds of survey, we have in total received 94 answers usable for data analysis after eliminating incomplete or obviously invalid responses. The results of these data collection methods can be seen in Table 1.

The sample characteristics can be seen from Table 2. Manufacturing companies clearly dominate in our sample. This corresponds to the percentage of manufacturing companies among all Chinese companies, which is 44% [15]. Also, the sample is dominated by State-owned firms while privately held firms come second. Thus, our sample can be characterized as predominantly consisting of Chinese firms. Regarding firm size, the sample is rather

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evenly distributed among the four size categories indicating that small, medium, and large companies are

about equally represented in our sample.

Table 1 Data collection methods

Round	Method	Enterprises	%
1st (March 2002)	Questionnaire	21	22.34%
2nd (April-June 2002)	Interview + Questionnaire	40	42.55%
	Phone + Questionnaire	29	30.85%
	Email+ Questionnaire	4	4.26%
Total		94	100.00%

Table 2 Sample characteristics

Characteristics	Groups	Number	Percentage
Sector	HQs of Groups	14	14.89%
	IT and Electronic	7	7.45%
	Traditional Manufacturer	30	31.91%
	Commerce and Trade	17	18.09%
	Service	16	17.02%
	Agriculture	8	8.51%
	Others	2	2.13%
Ownership	State>50%	52	55.32%
	Collective>50%	6	6.38%
	Private Chinese>50%	25	26.60%
	Foreign>50%	6	6.38%
Size (number of employees)	A. <100	25	26.60%
	B. 100-500	30	31.91%
	C. 500-1000	10	10.64%
	D. >1000	29	30.85%

3. Revisiting Nolan's stages theory

Nolan proposes that companies progress through a series of well-defined stages, labeled Initiation, Contagion, Control, and Integration, as they learn to absorb new information technologies. According to this 'stages theory', companies have to start a new learning cycle with each major innovation in the field of information technologies as has happened with the mainframe computer, the micro computer and the Internet (ushering in the so-called Data Processing, Micro and Network Eras respectively). In each learning cycle, IT budget growth curve would display an S-shape, which is tightly linked to companies' learning curve regarding the management and use of (successive waves of new) information technology (see Figure 1). Also, Nolan has specified a number of dimensions (called growth processes), or benchmark variables, along which learning must take place such as the application portfolio, technology characteristics, user awareness, and management techniques [19].

Initially proposed in 1973, the stages theory has itself evolved considerably over 20 years driven by both Nolan and others [7][16][17][18]. Some empirical studies also found support for the stage concept in this theory [21][11][9]. Some other studies, however, have provided negative evidence for the stages theory [12][1][10][13][5]. Generally, most of the critiques come down to two basic

questions. Namely, does the S-shaped IT-budget (or spending) curve really hold for Chinese companies, both on population and company level? And furthermore, if the curve does hold, is it tightly linked to the organizational learning process regarding IT management, as Nolan has addressed?

Our first effort was to clarify the above ambiguities and further develop Nolan stages theory (details of this study are specified in another working paper). Based on data collected, we found that aggregate spending behavior of these companies follows an S-shaped growth curve, as would be predicted by Nolan's stages theory, while patterns of individual companies appeared to be differing. A further investigation with a 'del' test for the cross-classification data indicated that such aggregate behavior of company spending could be better accounted for by a population-level diffusion process, rather than a company-level learning process, which is implied in Nolan's stages theory.

Thus, we concluded that IT spending and IT management learning are not as tightly linked as is stated in Nolan's stages theory. But on the population level, as well as for large companies, the stages theory could still provide an insightful framework from a diffusion perspective. In these cases IT spending curves could serve as an indicator of the diffusion process, along which a series of diffusion variables could be specified and

aligned in the light of the context studied, so as to evaluate and predict the overall trends of innovative technology

applications.

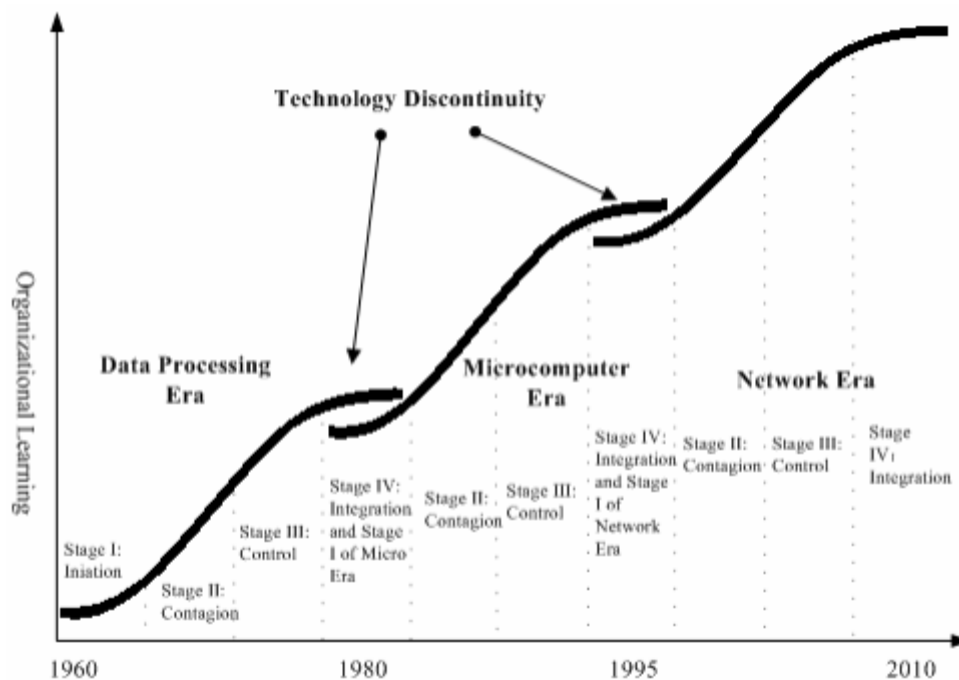


Figure 1 Nolan's stages theory

4. IT Diffusion Stages in the Network Era of Chinese Companies

A few years ago, we conducted a survey study about Chinese companies, comparing the characteristics of these organizations' IT application processes with those of US organizations featured in Nolan's stages theory and highlighting some of the key factors that affect the IT growth and management of IT in China [2]. Due to limitation of survey extent, many important issues were left untouched. Besides, in that study we have followed the concepts and terminology of the 'learning' stages model Nolan proposed. But the above discussion indicates

that the 'learning' explanation does not hold the promise as a good framework for interpreting such processes. Based on the above findings, it seems warranted to re-consider Chinese companies' IT growth process from a perspective of IT diffusion.

The aggregate IT spending curve for our sample is shown in Figure 2. Visual inspection clearly indicates that this curve follows an S-shape which has been manually fitted on the data in this figure too. To confirm this impression, we have statistically fitted several functional specifications on our data. With the results of the tests, we conclude that our data can indeed be best described as following an S-shaped growth pattern on the aggregate level.

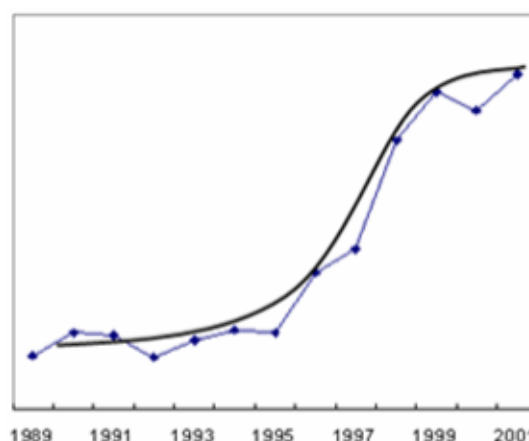


Figure 2 Aggregate IT spending growth in sample companies

It was not until 1992 had Internet been introduced into China [3], so we assume that the Network of Chinese companies started around 1992. To link the IT spending growth with diffusion stages, we first plotted the adoption frequency of Internet in companies against time, as

illustrated in Figure 3. To confirm this impression, we have statistically fitted several functional specifications on our data. With the results of the tests, we conclude that our data can indeed be best described as following an S-shaped growth pattern on the aggregate level.

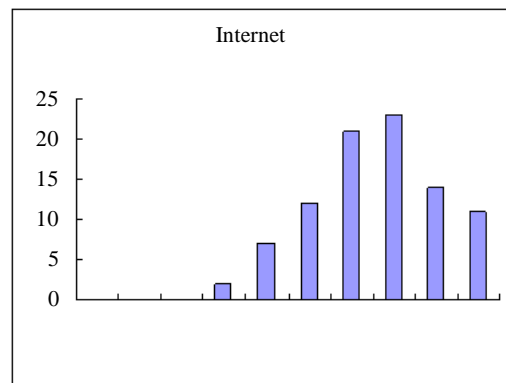


Figure 3 Adoption frequency of Internet in sample companies

The diagram displays a bell shape, which is indicative of a diffusion process on the population level [20], resulting from adoption being spread across time and companies, with a few companies (usually called innovators) leading the adoption of a new technology, followed by the majority of their peers (often separated into the early and late majorities) and a few companies adopting the technology late relative to their peers (usually called laggards). By combining the IT spending growth curve and the Internet adoption frequency pattern,

the IT diffusion stages in the Network Era of Chinese companies can be roughly distinguished. As illustrated in Figure 4 (these smoothed curves are generated by Microsoft Excel, based on real data of 1992 through 2001, as has been used in Figure 2 and Figure 3, and predicted data of 2002 through 2006, as shown with the shadowed area), we project that the IT diffusion process in China's network era would experience four stages and has currently reached the third.

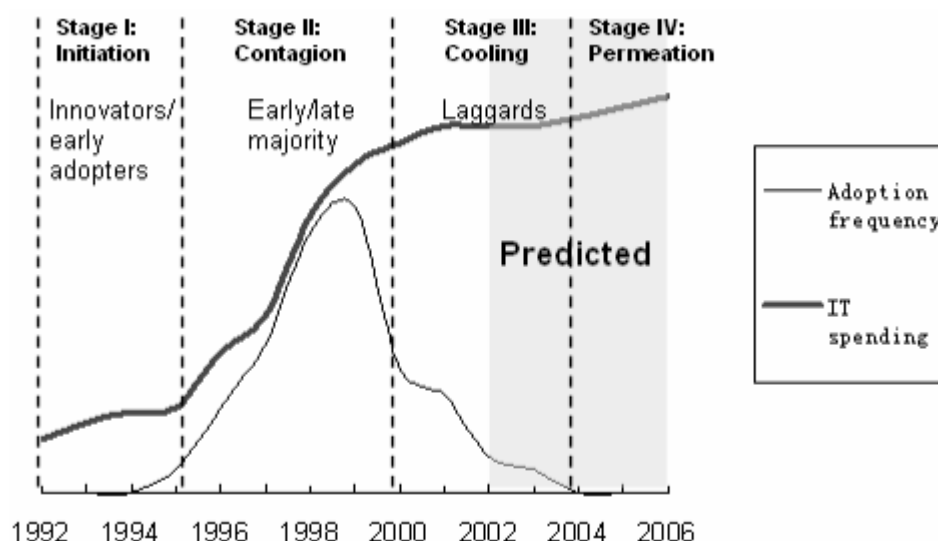


Figure 4 IT Diffusion Stages in the Network Era of Chinese Companies

In Nolan's stages theory, the terminology used to describe individual stages seems to be derived from both company level learning and aggregate level diffusion explanations. Specifically, the terms 'Initiation' and

'Contagion' are indicative of an explanation referring to an epidemic process while the terms 'Control' and 'Integration' seem to refer to a management-level learning process. Such mixture brings confusion into the

framework and restricts it from better describing the diffusion process on the aggregate level. In fact, learning is an individual behavior and can not be explained on the aggregate level. For better description, we suggest the usage of “cooling” and “permeation” for Stage III and Stage IV.

4.1 Stage I: Initiation (1993-1995)

Between late 1992 and early 1993, the Internet came into being in China. In 1994, the first backbone network was built and connected to the Internet [3]. Activated by the “Golden Bridge” Project of the Chinese central government and influenced by the “Information Highway” of the US, Chinese enterprises noticed the great future of business networks and the Internet. Some enterprises went on building local area networks and a few started trying emails. These companies acted as the innovators. But generally speaking, the emphasis of Chinese enterprises’ IT application was still on how to control and integrate microcomputers. So it is reasonable to say that between 1993 and 1994, Chinese enterprises’ IT diffusion process was in the ending period of Micro Era and also the initiation stage of the Network Era.

From the second half of 1994 onwards, development of the Internet in China took off. The most significant achievements during that period were the construction of ChinaNet and CERNET [3]. In a very short period, all kinds of Internet services came forth and the influence of the Internet expanded continuously. Meanwhile, microcomputer applications in enterprises matured. Most enterprises actually benefited from the value that IT brought to business. Thereupon, more and more enterprises turned their eyes to the Internet, started to build network applications, and became early adopters of the Internet technology. By 1995, the adoption of the Internet technology had reached a critical mass, which is significant for technologies strongly subject to network externalities [14], and preparation for network expansion was generally finished.

It is worth noting that the initiation stage of the Network Era in China is rather short comparing to the corresponding stage of the Micro Era. In the study of Chen and Jiang [2], the initiation stage (the study treated it as two related stages, namely initiation and penetration, partly because of its long time-span) of the Micro Era lasted all through 1980s.

There are three possible reasons for this observation. First, having experienced the Micro Era, managers of Chinese enterprises had realized the strategic importance of information technology and paid active attention to IS application and IT development. In this situation, when companies moved on into the Network Era, Chinese enterprises proactively embraced the new technology and started to apply it immediately. In contrast, the beginning stages of the Micro Era are much longer because, at that moment, IT application in Chinese enterprises was almost non-existent and it took a relatively much longer period to prepare for expansion.

Secondly, from 1992 the reformation and opening policy in China was further quickened. Driven by the government’s economic policies, enterprises were eagerly searching for development opportunities. When looking back to the Micro Era, we find that in the first half of the 1980s economic reforms were tentative and just beginning while most enterprises were still taking their bearings. In this atmosphere, initiation and penetration in the Micro Era could not be quick.

The third reason for the “quick-in” characteristic of Network Era is related to the Internet, the most important technology of this era. The IT growth processes of Chinese enterprises in the Network Era resemble that of the Internet in China. The speed of application and development of the Internet significantly exceed those of microcomputers.

4.2 Stage II: Contagion (1995-2000)

Late in 1995, the contagion stage of the Network Era began. Majority of the companies became adopters and the aggregate IT spending started rising remarkably. Surrounded by the atmosphere of global networks, encouragement from governments, seduction of firms, and the prospect of magnificent new products, many enterprises augmented their network applications in a hurry and the phenomena of expansion without planning once experience in the Micro Era were repeated. Redundant projects and waste of resources were rather common phenomena in those years.

In 1997 and the years thereafter, the emergence and flourishing of e-commerce pushed the “leaping” pattern to its climax. The tide of e-commerce firstly hit the foreign trade industry before sweeping across various industries. Still, the accelerating forces from governments could not be ignored during this period. It was not until 1999 that the “Network Economy” began cooling down. With the collapse of the “Internet bubbles”, more and more enterprises sat down to consider the actual importance of networking and e-commerce for their long term business plans of IT applications. The contagion stage of the Network Era was coming to an end and the cooling stage, labeled as few adopters and limited spending growth, set in.

4.3 Stage III: Cooling (2000-2004)

The majority of the companies would have adopted the networking technology and only a few laggards would become adopters in this stage. Most of the companies that have adopted the new technology shift their focuses to better control of IT applications and start to ponder upon the real value that IT might bring. Since the year 2000, “Reengineering” has been popular in Chinese enterprises. Adjustment of business processes and improvement of IT applications have been complementing each other [4]. Through BPR and Information Resource Planning, the enterprises tried to obtain highly centralized control of IT applications and

stroved to get beyond the redundant projects and isolated information islands left behind by the expansion. Meanwhile, IT strategic consulting played an increasingly important part in IT application and some famous consulting firms strengthened their presence in China's IT consulting market. Many of the enterprises in our survey cut down budgets for IT implementation and increased budgets for IT consulting. Overall, the cooling stage lasted for nearly three years and may well carry on into 2004.

4.4 Stage IV: Permeation (2004-?)

Judging from the patterns of the aggregate IT spending curve and the adoption frequency diagram, the last stage of the Network Era may start around 2004. By then, most Chinese companies would have adopted the Internet technology and generally few would-be adopters would still be left. It is a stage in which the technology completely penetrates and the adopters gradually development their applications. Meanwhile, a new major innovation may bring the next technology era, and the IT diffusion process would step into the initiation stage of that era. We think that the technology which will dominate the next era might be M-Commerce or business intelligence. However, it is quite possible that the innovation is still to appear in the coming years.

5. Issues and discussions

We feel that our findings may arouse some worthwhile endeavors and re-open the discussion of some important issues on IT management, especially the issue of introducing new IT into organizations.

First, we have shown that IT spending curves could serve as an indicator of the diffusion process. Therefore, along the aggregate IT spending curves, a series of diffusion variables could be specified and aligned in the light of the context studied, so as to evaluate and predict the overall trends of innovative technology applications. In a review, Fichman discussed 18 empirical studies of innovation diffusion theory and provided a framework mapping two classes of technology (low knowledge burden, low user interdependencies, versus high knowledge burden, high user interdependencies) against locus of adoption (individual versus organizational) and resulting in four IT adoption contexts [6]. We feel that this classification seems meaningful also to the stages analysis. It would be worthwhile that these specifications of contexts are incorporated into the aggregate level stages theory and some variables are borrowed from that framework.

Second, we have stated that the company-level IT spending curves do not commonly follow an S-shape and cannot be directly regarded as indication of organizational learning, but our survey has revealed that many large companies' IT spending indeed display an S-shape on the company level. We think that the S-shaped spending

pattern of large companies could itself be the result of a diffusion process on the company level. A learning process is about the behavior of an individual, while a diffusion process is about an aggregation. From this point of view, large companies are special because they incorporate the characteristics of the two levels. On the one hand, they are individual companies and would follow a learning path to effectively managing IT; on the other hand, large companies are themselves aggregations of a number of smaller units and therefore diffusion processes are likely to take place inside the bodies. The classification of Fichman [6] on locus of adoption also implied the importance of paying attention to the diffusion inside an individual company body, as well as in a body of many companies.

The difference between a company- and a population-level diffusion process is that, on the company level, diffusion is relatively more constrained and, to some extent, determined by the level of the company's IT management. Briefly, the company level diffusion process could be, on the same level, tightly linked to the company's learning process regarding IT management. Also, we note that Nolan's stages theory was originally proposed based upon observations on some large US companies [16]. Therefore, it may be reasonable to say that the S-shaped spending growth pattern is indicative of and caused by company level learning for, and only for, large companies.

The third issue of further interest is the different IT spending growth patterns of different sectors of companies. As mentioned, in our survey, we divided the companies into 6 major sectors, namely headquarters of groups, IT and electronic, traditional manufacturer, commerce and trade, service, and agriculture. IT spending growth curves for these sectors are illustrated in Figure 5. For better comparison, we have normalized the resulting data by taking the number of 1992 as the base.

Visual inspection reveals that although 3 of these 6 curves follow a clear S-shape, patterns of different sectors vary significantly. Furthermore, the IT spending curve of commerce and trade sector is very special. There is a significant oscillation with a clear peak and trough in the growth process of this sector. Thus, it can be inferred that each sector has its own characteristics which significant affect the diffusion process. In an early stages model introduced by Greiner [8], it was stated that companies in different industries of different growth rate would take different paths of organizational development. This implies that industry growth rate may be taken as one of the factors that determine the IT diffusion process on the sector level. However, such a variable seems inadequate to explain the IT spending curve of commerce and trade sector shown in Figure 5. There must be some other characteristic factors whose effects should be taken into considerations.

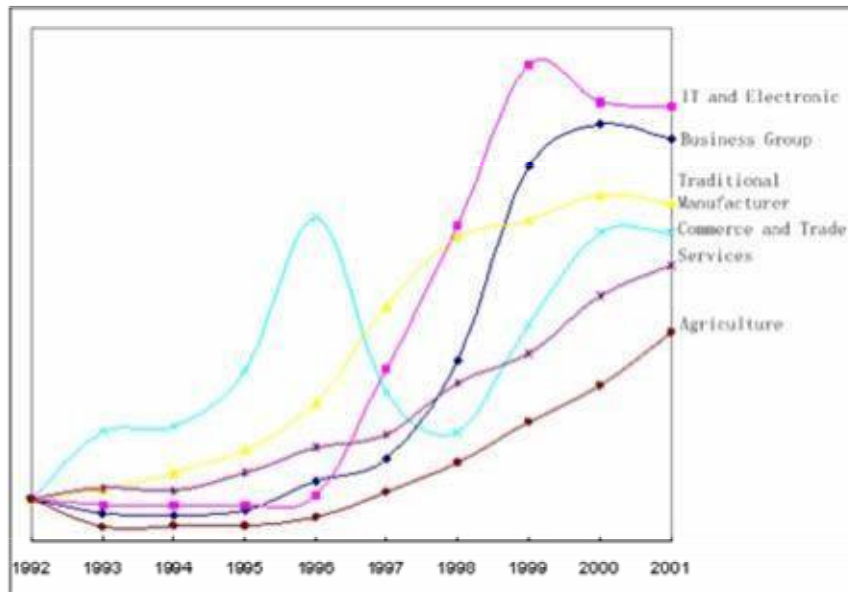


Figure 5 IT spending growth curves of different sectors

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A Case Study of VMI using TOC

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Abstract

A vendor managed inventory (VMI) is a process whereby a supplier maintains an inventory for a retailer by generating orders for the retailer based on its demand information. In this relationship, the supplier is responsible for maintaining the retailers' inventory levels and transportation and transaction costs. The performance measurements that are associated with the theory of constraints (TOC) have been widely advocated as a mechanism of linking operational objectives to the global goals of an organization. In this paper, we use a case study of the Procter & Gamble to illustrate the application of TOC in VMI. The results show that the quality of service and the inventory level can be improved.

1. Introduction

Supply chain management (SCM) has become an important topic in many disciplines. The core objective of the SCM is to minimize system-wide costs while satisfying service requirements. Note that the supply chain is a dynamic relationship which includes all of the activities – i.e. manufacturing and assembly, warehousing and inventory control, distribution, and customer service – that are involved in delivering products or services from raw material providers to customers. Supply chain management (SCM) then coordinates and integrates all of these activities into a

seamless process. With increasing global competition and the emergence of e-business, supply chain management is considered to be a powerful approach to cutting costs and increasing profits.

Marient [1] identifies strategic alliances as among the key supply chain enablers. Strategic alliances concern how external companies (customers, suppliers, and logistic-service providers) are selected as business allies and how inter-company relationships are built and managed whereby a supply chain links all of the chain partners, including departments within an organization, and the external partners, including suppliers and third party providers. A successful alliance enables managers in companies across the supply chain to take an interest in the success of other companies and to work together to make the whole supply chain competitive. Strategic partnerships typically lead to long-term strategic benefits for both partners.

However, demand forecasting is one of the most difficult tasks for both retailers and suppliers in a supply chain, especially when the product life cycle is short and made-to-order requests are common. In addition, the demand variation of suppliers is much greater than the variation of retailers due to the bullwhip effect [2]. Regardless of these difficulties and uncertainties, enterprises must still rely on forecasted demand to make managerial decisions, e.g. resource allocation, capacity planning, production planning, and cost control, etc. [3]. Thus, to achieve the congruent supply chain goal, it makes sense to create cooperative partnerships between

suppliers and retailers to leverage the knowledge of both parties. Simchi-Levi et al. [4] state that various types of retailer-supplier partnerships (RSPs) can be placed on a continuum. The lowest degree of partnership (on the far left) is information sharing, whereby the vendor plans the demand based on limited information provided by the retailers, and at the other end (the far right) is a consignment scheme, whereby the vendor completely manages and owns the inventory until the retailer sells it. This partnership is implemented by the strategy known as vendor-managed inventory (VMI). VMI is a planning and management system that is not directly tied to inventory ownership. Under VMI, instead of the customer (the retailer) monitoring its sales and inventory for the purpose of placing replenishment orders, the vendor (the supplier) assumes the responsibility for these activities. In the past, many suppliers operated vendor-stocking programs whereby a representative visited a customer a few times in a month and restocked its supplies to an agreed-upon level. As popularized by Wal-Mart, VMI replaces these visits with information gathered from cash registers and transmitted directly to a supplier's computer system via Electronic Data Interchange (EDI). Suppliers can now directly monitor sales of their products and decide when to initiate the replenishment process. However, VMI is an expensive proposition for suppliers. Investments must be made in new systems, software, and employee training. This brings us back to the question of whether there is a payoff.

Over the last few years a number of semiconductor companies have implemented shop-floor control procedures based on the theory of constraints (TOC), which was developed by Goldratt [5] and focuses on constraining resources, subordinating the remainder of the plant to keeping the bottleneck work centers running at their maximum capacity, and simultaneously working on elevating the bottleneck to

improve its performance. The TOC is a problem-solving approach that can be applied to many business areas. The five steps of the TOC are: (1) identifying system constraints; (2) deciding how to exploit the system constraints; (3) subordinating everything else to that decision; (4) elevating the system constraints; and (5) if in the previous steps the constraints have been broken, then returning to step 1, but not letting inertia become a system constraint. The concepts of TOC have been used to develop production-scheduling rules that are collectively known as optimized production technology [3]. The TOC has been implemented in many different areas, such as operations, finance and measures projects, distribution and supply chains, marketing, sales, managing people [6], job-shop manufacturing [7], the service industry [8], project management [9], among others. Moreover, the performance measurement system in the TOC has been recognized as the global goal of many organizations, and it is profitable. We apply TOC to VMI to improve the quality of service and reduce the inventory level among suppliers and retailers. The remainder of this paper is organized as follows. Section 2 discusses related works on the development of VMI, and section 3 focuses on VMI adoption. Section 4 discusses the applications of the TOC in VMI, and section 5 provides a case study. Section 6 draws conclusions and provides suggestions for further research.

2. The development of VMI

VMI, which is sometimes called the continuous replenishment program [10], is a pulling replenishing practice that is designed to enable vendors to respond to demand by obtaining actual consumption data with additional forecasts from the retailer. In the retailer-supplier partnership (RSP) continuum, VMI is the highest degree of cooperation, and vendors make the

primary decisions about placing orders and inventory control. The vendor is entitled to view every item that the retailer carries, as well as point of sale (POS) data. In VMI, the supplier decides the appropriate inventory levels of their products (within previously agreed-upon bounds), and the appropriate replenishment policies to maintain those levels. Holmstrom [11] reported that the demand variability for the vendor was reduced from 75% to 26% in the pilot implementation. Total stock was down 30% and the order/delivery lead-time was cut from 48 to 10 hours.

The history of VMI can be traced back to the early development of quick response (QR) between general merchandise retailers and their suppliers. Due to intense competition in the textile industry, leaders in U.S. apparel manufacture formed the Crafted With Pride in the U.S.A Council in 1984 [11]. The Council commissioned a supply chain analysis, and the results showed that the delivery time for the apparel supply chain was 66 weeks from raw materials to consumers, 40 weeks of which were spent in warehouses or in transit. To reduce the lead-time and inventory cost, the report proposed a QR strategy. A QR strategy is a partnership wherein retailers and suppliers work together by sharing information so that they can quickly respond to consumer needs. Under this strategy, suppliers receive POS data from retailers and use it to synchronize their production and inventory control with actual sales at the retailer. However, the retailer still makes the decision to generate orders and the supplier must improve demand forecasting and production scheduling by using POS data alone. Milliken and Company, a textile and chemicals firm, was one of the first to adopt QR, which reduced lead-time from 18 to 3 weeks [12].

Similar to the textile industry, a group of grocery industry leaders created a joint industry task force called the efficient consumer response (ECR) working group in 1992. The group appointed Kurt Salmon Associates Inc.

[13] to examine the grocery supply chain to identify opportunities to increase competitiveness. The subsequent report identified a set of best practices, which if implemented could substantially improve overall performance. Kurt Salmon and Associates found that “by expediting the quick and accurate flow of information up the supply chain, ECR enables distributors and suppliers to anticipate future demand far more accurately than the current system allows”.

A further development from ECR was the continuous replenishment program (CRP). CRP is a move away from pushing products from inventory holding areas to grocery shelves based on consumer demand [10]. In a CRP strategy, which is sometimes called rapid replenishment, vendors receive POS data and use it to prepare shipments. In an advanced form of CRP, suppliers may gradually decrease inventory levels at the retail store or distribution center as long as the service level is met [14]. Thus, inventory levels are continuously lowered. Other topics in inventory replenishment are discussed by Waller et al. [15], Cetinkaya and Lee [16], and Chaouch [17].

In the history and development of RSP, one phenomenon stands out. That is, RSP was driven by competitors as they strove for survival and success. Such competition allowed the progressive development of RSP strategies and the establishment of industry standards through the joint efforts of companies that were originally at loggerheads. This implies that the partnership was extended from a single supply chain to multiple yet integrated supply chains. The implementation of RSP benefited both retailers and suppliers, and eventually the end-consumer. The RSP strategies are summarized in Table 1. When partnership moves from one level to the next on the RSP continuum, new skills should be learned and employed by the vendor.

3. The Adoption of VMI

Many success stories from various industries have been told of VMI. Examples include the Wal-Mart/P&G arrangement, Fasson MPD (which is a division of Avery-Dennison) and Worsleys (the only inter-merchant paper trader from the U.K. in continental Europe), Baxter International and a large number of hospital customers in North America, and YCH in Singapore [18]. Moreover, Stundza [19] showed that the application of supply alliances such as VMI could cut costs and reduce inventories in metal industries. Kaipia et al. [20] presented a time-based analysis for measuring the benefits of VMI in different circumstances. The results revealed that VMI was a much more efficient solution for low volume items. The motivation behind RSP and VMI strategy is that both parties work together to maximize the competitiveness of the supply chain. However, the most obvious benefits of VMI are the inventory cost reduction for retailers and total cost reduction for suppliers that arise from coordinated production and distribution with better demand forecasts. The identified benefits of VMI program can be found in the Simchi-Livi et al. [4] and Vendor Managed Inventory [18] studies.

Despite the numerous benefits of VMI, some concerns need to be taken into account. In the Aichlymayr [21] survey of VMI implementations, the concerns were as follows. (1) Vendors' administrative costs increased, as did their responsibilities and the amount of work that needed to be done. (2) The implementation time was long due to the trial and error approach. (3) The system was hard to use with volume discounts and special pricing – alternate pricing strategies were sometimes necessary. (4) In the short run the system was complicated because the roles of employees, vendors and customers could be unclear upon implementation. (5) Retailers risked losing control and flexibility, especially when the adopted

procedures were innovative. (6) There was potential for arguments about the handling of over-stocked or obsolete goods, and specific agreements were needed between manufacturers and retailers.

To implement VMI, three enablers are essential: organization infrastructure, information technology, and training [4]. VMI strategy involves a high degree of partnership between retailers and suppliers, and it changes fundamental ways of doing business. The commitment from the senior executives of both parties is the first attribute of organizational infrastructure that will ensure the success of a VMI program. The feeding of previously confidential sales and inventory data to suppliers necessitates determination and commitment from very high levels. A certain degree of mutual trust and a regular review scheme must be in place to maintain the alliance. Moreover, the introduction of VMI may also shift power from one group to another within an organization. This is because suppliers need to collect more information online and the daily contact with retailers moves from sales and marketing departments to logistic departments. This organizational change must be considered in the re-structured scheme, and job responsibilities have to be re-assigned.

Information technology, including the technology itself and integrated production systems, is another important enabler in VMI. Forms of technology such as bar codes are essential to accelerating the data input and maintaining data accuracy. Electronic data interchange (EDI) or Internet technology (such as XML) is also useful in creating direct links between retailers and suppliers. Note that a direct link can avoid entry errors and diminish data transfer time. Once real time data are available, an integrated enterprise system such as enterprise resource planning (ERP) [11] can be used to incorporate planning, inventory, production, and distribution into a fully implemented VMI strategy.

Beside organizational change and technological adoption, suppliers also need to adopt new skills and practices such as forecasting, inventory control, supply chain management, and retail management, etc, into their operations. Therefore, a comprehensive training program is important for the relevant managers and operators. The Simchi-Livi et al. [4] and Vendor Managed Inventory [18] studies provide a systematic approach to VMI system adoption in 5 stages.

Stage 1. Present & Align: The first stage covers the concepts, benefits, and requirements of VMI, and requires the participation of senior managers. These managers must commit to the possible costs involved, the human resources needed for establishment/ maintenance, and the concept of having someone else managing their inventory. They need to ensure that all employees who will be conducting the relevant activities into the VMI concept. Moreover, they must align the firm's objectives with those of its supplier, define the scope of the partnership, and formulate the contractual terms of the agreement. This should include decisions about ownership, credit terms, ordering responsibility, and performance measures.

Stage 2. VMI system design: A steering committee is formed to take control of the project. It defines the project schedule and scoreboard to assess feasibility against VMI requirements. Information is defined and logistic processes are established. The necessary information systems are identified and acquired. EDI formats are defined and EDI transmission testing is conducted before a VMI training program is implemented.

Stage 3. Pilot Run: The process is validated by user acceptance testing. Problems are identified and the process is refined.

Stage 4. Implementation: Dual systems (VMI and the original system) are run according to a transition plan. Then, VMI goes live if the system adoption works smoothly.

Stage 5. Monitor and review: The scoreboard is updated. Problems and improvement areas are identified and acted upon to achieve targets.

This implementation approach provides a general reference. Any stage can be modified to fit individual VMI program needs.

4. Applying TOC to VMI

As suggested by Goldratt and Fox [22], three new measures can be added to the traditional measures such as net profit, return on investment (ROI), and cash flow. They are (1) throughput – the rate at which the system generates money through sales; (2) inventory – the money that the system invests in purchasing things to sell; and (3) operating expenses – the money that the system spends to turn inventory into throughput. Goldratt and Fox also presented a relationship among the global performance measures. That is, if throughput increases while inventory and operating expenses decrease, then net profit, ROI, and cash flow will increase. In contrast, if throughput decreases while inventory and operating expenses increase, then net profit, ROI, and cash flow will decrease. Based on the TOC performance measurement, throughput is equal to the final net sales rather than shipments or any other measures that are commonly used. Moreover, inventory is valued at the cost of raw materials rather than on a cost accumulation basis. Operation expenses take in all other costs. For example, all overhead costs that are traditionally allocated to inventory as it migrates through the production process are considered as operating expenses. The direct labor of employees is considered as part of these expenses. Thus, the TOC changes the accounting scheme for performance measures. Here, the

TOC performance measures will be used to relate functional measures to the performance of VMI. In addition, the repetitive TOC steps, i.e. identifying system constraints, exploiting system constraints, subordinating the firm's operations to those constraints, elevating the system constraints, and returning to the first step, are used for continuous improvement in VMI. Managers can also use "thinking system" techniques, such as evaporating clouds and effect-cause-effect diagrams, to facilitate their decision making [22]. These techniques help managers to challenge conventional thinking and to find the root causes of the problems that they face. A detailed application of TOC is described in the following case study.

5. Case study

As mentioned earlier, consumer demand drives replenishment orders and shipping in CRP. This process can be distributor managed, supplier managed, or third party managed (by an agent or outside service). The most common CRP is Vendor Managed Inventory (VMI), in which the vendor manages its customer's inventory and ensures that the replenishment process optimises the customer's warehouses or retail stores. The vendor must receive regular sales off-take and inventory data from the retailer, and forecast demand and deliver the required quantity to the retailer. VMI can operate at either the retailer's warehouse or store level, depending on the sophistication of business operations and information technology adoption. In implementation, the retailer's warehouse transmits daily inventory levels and off-take or store order data to the vendor; and the vendor is responsible for creating orders to ensure that the warehouse can meet the retailer's product need. In this paper, we use the VMI piloting program between Procter & Gamble (P&G) and Wellcome, a CRP software package called the Key Account Replenishment System (KARS), as

the case study. The main function of KARS is to generate suggested order quantities based on retailers' off-take and inventory information. The logic behind the KARS calculation of order quantity is illustrated below.

A key factor in the success of VMI operation is the demand projection to cater for both normal demand and abnormal demand that arises from promotions, new product introductions, out of stock products, or seasonal variations. Other than demand projection, factors such as order calculation (considering the current stock level, order to delivery lead time, and others), safety stock requirements, and delivery optimization in terms of pallet and truck loads are important. In KARS, there is a built-in forecasting model for estimating daily demand off-take at a distribution centre (DC). The rationale behind the forecast calculation is to predict the amount of products that the will DC required according to sales off-take in the past 8 weeks. Note that the formula for demand forecasting considers the 8-week-averaged sales off-take as well as customer service level. The past 8 weeks off-take divided by the achieved customer service level is the base for future demand projection. The customer service level has been incorporated in this calculation to minimize the chances of underestimating future demand when products have been out of stock (OOS) in the previous sales period. Demand projection is converted into a suggested order by taking into account the stock requirement and delivery optimization. Stock requirement is determined by stock-on-hand, safety stock for demand variation, order frequency, and lead-time. Here, the safety stock requirement is based on the standard deviation of the past 8 weeks off-take. The delivery optimisation minimizes order sizes and determines pallet size and truck loads.

In this case study, non-cosmetic products (88 stock keeping units (SKUs)) are chosen to evaluate the performance of a VMI. The results of the key performance indicators are shown in Table 2, and are grouped into 2 categories: (1) success criteria, or the direct measurement of the degree to which VMI objectives have been achieved, e.g. reduction in inventory and increase in service quality; and (2) the process performance that is related to monitoring process efficiency and effectiveness, e.g. the line fill rate and on time delivery. Significant improvement after VMI implementation in phase I (from September, 1998 to April, 1999) led to an inventory reduction from 24 to 13 days, which was already very close to the target of 10 days. However, some areas demanded further improvements, such as the high occurrence of overrides (which are considered as constraints in the TOC). Manual intervention, in particular the modification of purchase order quantities by the retailer, occurred frequently and had an adverse effect on the automation process. Several potential causes of overrides were identified: demand created by new channel openings, manual input for promotional items, and manual input for new products. In phase II (May, 1999 to November, 1999), with the adoption of the five TOC steps, we ascertained the override quantity on how much inventory should be maintained was identified. The key performance measurement for inventory was the turnover rate (step 2 in the TOC). The performance measurement aspects of throughput, inventory, and operating expenses were used for internal management decisions. The management also used the effect-cause-effect and cloud decision-making techniques, and was trained in the use of underlying performance measurement methods. For override analysis, the occurrences were first compared against different causes of overrides. The objective was to identify the percentage of overrides that were caused

by different factors, namely data related issues and the handling of promotional orders and new products. Special attention was needed to observe any override clustering among certain product categories, brands, or SKUs (step 3). Moreover, the success rates of both KARS suggested quantity and Wellcome override quantity were measured and compared to reflect the necessity and accountability of the override process. The formula to measure success in the proposed order quantity and override order quantity was as follows (step 4):

$$\text{Success} = \frac{\text{inventory on hand} + \text{replenishment quantity} - \text{Wellcome DC off-take}}{\text{KARS suggested order quantity}}$$

The KARS suggested order quantity and Wellcome's override quantity were considered to be successful when the actual Wellcome DC off-take was less than the quantity that was recommended by either party plus inventory on hand. This implies that order quantity can fulfil actual DC demand. After applying TOC to VMI, the results of the performance indicators can be improved (step 5, see the last column in Table 2). This case study can aid in the understanding of how VMI implementation can be more effective and efficient.

6. Conclusions

VMI can help companies to (1) eliminate repetitive purchasing activities, (2) lower the cost of processing claims, (3) reduce inventory, (4) increase inventory turnover, and (5) solidify the supplier-retailer relationship. By implementing VMI, suppliers and retailers can focus on the same issue – how to sell the right products to the end customer at the right time. This changes the supplier's focus from encouraging the retailer to buy more to helping the retailer to sell more. Moreover, when the TOC is applied in VMI, its benefits increase. VMI is not a new concept – automated inventory replenishment by suppliers has been an issue

in the retailing world for more than 30 years. However, as shown in our case study, VMI can be utilized through integration with TOC, information technology, and other elements. Similar trends, such as supplier management inventory (SMI) or joint managed inventory (JMI), are merely different ways of looking at the same thing.

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Table 1. Comparison of four major RSP strategies

RSP Strategy	Decision Maker	Inventory Ownership	New Skills Employed by Vendors
Quick response	Retailer	Retailer	Forecasting skills
Continuous replenishment	Contractually agreed levels	Either party	Forecasting & inventory control
Advanced continuous replenishment	Contractually agreed to & continuously improved levels	Either party	Forecasting & inventory control
VMI	Vendor	Either party	Retail management

Table 2. The performance of VMI

Time Indicator	Baseline (Target)	9/98-4/99 VMI (Phase I)	5/99-11/99 VMI -TOC (Phase II)	12/99- present
Inventory (days)	24 (10)	13	16	11
DC in stock (%)	NA (95)	94	98	98
Order generation turn-around time (minutes)	NA (15)	26	17	16
Order confirmation turn-around time (minutes)	NA (15)	45	20	16
Line fill rate (%)	94 (95)	95	93	95
On time delivery (%)	100 (100)	100	100	100
Billed accuracy (%)	99 (100)	100	100	100
Number of overrides (%)	NA (10)	20	9	8
EDI usage	NA (Yes)	Yes	Yes	Yes

Branding in Cyberspace: Implications for Marketing & Management

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Abstract

Branding in cyberspace, cyberbranding, digital branding or e-branding is attracting the attention of many corporate executives in both traditional and internet companies. Branding as a marketing concept is universally known. Branding is the effort of a company to evoke a particular response in the end user/consumer's mind about a particular product or service.

The brand is not only that product or service, but also all of the emotions, perceptions, and impressions experienced by the person buying or using that product or service. Companies spend trillions of dollars each year in efforts to brand their company, their products, and their services. But at the end of the day, brand managers can't actually dictate what a brand really is. They can try everything possible to convey a certain message about their brand, but it is still the impressions left in the mind of the end user that dictate the success or failure of the brand.

What is cyberbranding? How is it different from traditional branding? What are the major cultural issues in cyberbranding? What is cyberbrand equity? How should a manager create and grow strong brands in a digital environment? How should one deal with merging brand entities? These important questions are addressed in this article. The article also suggests that marketers should view cyberbranding not in isolation, but alongside traditional branding while extending some enduring principles generally associated with traditional branding.

1. Introduction

When Philip Morris acquired Kraft several years ago, it paid six times the value of Kraft's physical net assets. The Philip Morris CEO indicated that his company needed a portfolio of brands that had strong customer relationships that could be leveraged to enable the tobacco company to diversify itself, especially in the retail food industry [1]. In other words, Philip Morris was prepared to pay billions of dollars for a set of customer

and trade brand relationships and the anticipated support such relationships would provide.

What then is a brand? One official definition by Interbrand, the London-based brand consulting firm, is "a mixture of tangible and intangible attributes, symbolized in a trademark, which, if properly managed, creates influence and generates value" [2]. Brand is therefore the sum of visual, emotional, rational, and cultural images associated with a company or a product that set them apart from their competitors. The brand Volvo, may conjure images of safety. When consumers think Nike, they might think of Michael Jordan or the Nike slogan "Just Do It." Brand recall accompanied by positive associations with a brand makes a customer's product selection easier and enhances the value and satisfaction gained from the product.

While Brand X cola or even Pepsi-Cola may win blind taste tests over Coca Cola, the fact is that more people buy Coke than any other cola and, most importantly, they enjoy the experience of buying and drinking Coca Cola. The fond memories of childhood and refreshment that people have when they drink Coke is often more important than a little bit better cola taste. It is this emotional relationship with brands that make them so powerful [1].

2. What Makes Up a Brand Identity?

A brand comprises three things: what a company sells, what a company does, and what a company is. Invariably, a brand represents a set of promises. These promises include implied trust, consistency and a set of defined expectations. Strong brands occupy a position in the mind of the customer that is unique to that brand. Brand identity includes brand names, logos, positioning, brand associations, and brand personality. A good brand name gives a good first impression and evokes positive associations with the brand. A positioning statement tells, in one sentence, what business the company is in, what benefits it provides and why it is better than the competition. Imagine you're in an elevator and you have 30 seconds to answer the question, "What business are

you in?" Brand personality adds emotion, culture and myth to the brand identity by the use of a famous spokesperson (Bill Cosby - Jello), a character (the Pink Panther), an animal (the Merrill Lynch bull) or an image (You're in good hands with Allstate) [3, 17].

Brand associations are the attributes that customers think of when they hear or see the brand name. McDonalds television commercials are a series of one brand association after another, starting with the yellow arches in the lower right corner of the screen and following with associations of Big Mac, Ronald McDonald, kids, Happy Meal, consistent food quality, etc. [1]

Branding is more than just ensuring that customers recognize a logo or product name. Branding means creating an emotional association (such as the feeling of success, happiness, or relief) that customers form with the product, service, or company. There are two basic techniques for branding: direct experience and indirect messaging. With direct-experience branding, users attribute emotions directly. For example, when customers test drive a car or eat a restaurant meal, their direct experience influences their feelings toward that vehicle or establishment [1].

However, marketers can't give users a direct experience for most products and services, so they need to use indirect messaging for their branding. For example, Nike sponsors sporting events to encourage the attendees to associate Nike products with the fun and excitement of the sport. Companies also create slogans ("Avis: We Try Harder," or "Built Ford Tough") and use them everywhere. TV commercials, magazine ads, and billboards are all indirect messaging. But this form of branding needs repeated exposure —conventional advertising wisdom says that a message isn't effective until the customer has received it at least 10 times [1].

3. What is Cyberbranding?

According to Deidre Breakenridge(19xx), If you take a logo, a company, a promise and a full set of values and expectations and mix them all together, what you get is the traditional meaning of a brand. However, if you have the same mixture of elements and put them on the Internet, they do not make up all the components of a cyberbrand. The Internet Breakenridge argues allows the brand to move into a new realm, and makes it possible for consumers to experience the brand on an interactive level.

Branding in cyberspace is no different than traditional branding. Huberman spent some time discussing the issue of branding in Cyberspace. First he provides a simple definition of a brand: a simple encoding of the attributes and reputation of an individual or firm. The purpose of a brand is to solve the problem of having to

search a large space or to choose from many options. Huberman goes on to say that in cyberspace, many firms can easily offer the same service to the same markets. These brands interact either as substitutes (competitors) or as complements in what is known as umbrella branding, in which complementary brands are associated in the consumer's mind [4].

The Internet continues to innovate new paradigms that allow manufacturers and service providers to link directly to their target customers. These paradigms are likely to change the nature of commerce. However, in an increasingly globalized economy, the Internet now can also affect the value of the brands in which companies have invested so much time and capital. Daily, companies launch new media campaigns, many of which incorporate today's interactive technologies, to keep their products and brand names visible amid the myriad choices facing today's consumers around the world. But they may fail to consider how these campaigns will affect their brands' value and reputation in the long run. Consumers desperately need a tool to cull the many suitors for their pocketbooks. Thus, reinforcement of a consistent, trustworthy brand message across many media is an important means of promoting product awareness and loyalty in a bewilderingly cluttered marketplace [5].

Though the internet revolution has put many companies on the defensive in protecting their names and reputations, the Internet can also help promote a brand's name and image in new markets in a variety of ways. Naturally, the Internet provides a forum for disgruntled consumers to broadcast their resentment of a brand across the world to millions of potential readers and customers alike, undermining the consumer trust and reputation for quality upon which brands depend. Thus, companies need to understand the factors that contribute to a brand's equity and the ways in which the Internet and the global economy can affect it.

4. The Difference between Cyberbranding and Traditional Branding

Organizations of all types, including privately held and publicly traded companies, non-profit associations, and even cities, countries and individuals are recognizing the value of using their brands to improve performance and build deep relationships with their customers. The reason for this rush to branding is simple. Intense market place competition and the ease of product duplication means that brands are the defacto means of simplifying the decision-making process for buyers and users. If managed properly, brands create difference, relevance and affinity. Branding on the internet is not that much different than traditional branding [6].

The combination of the brand and the technology that communicates its message is a powerful combination.

With each combination comes what Breakenridge refers to as a *differentiating factor*. Print and broadcast media for instance had positive brand factors in their early days. Print media's instant credibility and broadcast media's opening up consumer's ears and eyes to audio and visual entertainment were unique to the two media. With each factor came the opportunity for the brand to be more persuasive to evoke consumer action [7,15].

The Internet and the Cyberbrand entice consumer action with several differentiating factors. The Internet is the one place where a consumer can interact with a brand for hours prior to an actual purchase. Because of technological enhancements, the consumers interaction with the brand can be in the form of audio, video, or 3D animation. The bond between the consumer and the brand is enhanced as a result of constant one-to-one communication. Chat sessions, message boards and the ability of the consumer to request information or make a service inquiry are all various forms of the two-way communication that results from a cyberbrand relationship [7].

5. Global & Cultural Issues in Cyberbranding

The concept of branding is universally known. Only countries have borders; brands do not, as long as they are respectful of global issues. Brands travel across global boundaries and impact different nations in various ways. Global marketers strive to achieve a balance between art and science. The art of branding has its creative meaning that is universally accepted by all. Global brands are capable of enlightening scores of populations, bringing experience and fulfillment of expectations. The science is the careful research and development of the global brand, the precise method of communication, and the calculated timing of its message. When the balance of art and science is achieved, it doesn't matter if Coke is bought in a store in the United States or on the roadside in Mongolia. Either way, the Coke brand evokes a refreshing experience and a "good time" feeling [7].

The debate continues about whether the global branding paradigm is applicable to all brands and all product and service categories. The increasing availability of information via the Internet, both in breadth and depth, and increasing commercial globalization have helped expedite an answer. If companies do not globalize brand images, then consumers who encounter dissonant brand images, intended for different regional audiences, will become dissatisfied when they see an image that differs from the one they have entrusted the brand to maintain. Thus, not only does global branding reduce marketing budgets, but it is necessary to maintain long-earned equity in all markets entering the information age [5].

The World Wide Web not only delocalizes a company's customer base, but it is also the technology by which a

company can most easily introduce interactivity into its marketing and customer service activities. The age of interactivity will obviate mass-market technology. Companies will have to design products and services to meet the specific needs of individual consumers: Custom products beat standard ones 100% of the time. Though the range of variations may be narrow, the dialogue between the company and the consumer must empower the customer [5].

Inconsistencies are taboos in brand management. Consumer research suggests that consumers unconsciously perceive an incongruous representation of a brand—through its name, advertising, and packaging, experience dissonance, and subsequently switch brands. Companies wishing to establish a presence in cyberspace should do so carefully. Web sites should provide the same feel, format, and images that have proved successful in advertising campaigns. The Internet is primarily a tool to strengthen existing equity, not to establish it (except for a few niche industries that have their foundation in the Internet, such as Internet gambling, pornography, and book distribution) [5].

Another ongoing challenge for marketers according to Deirdre Brekenridge is to realize that worldwide brands carry the burden of cultural intricacies. As a matter of fact, in Asia-Pacific regions, "a common Chinese idiom describes Asia as an area of great treasures but a place filled with hidden dragons and tigers," may sum up the obfuscation marketers face when promoting global products. With language and culture posing the biggest threats, western marketers need a thorough understanding and appreciation of a region before introducing a brand in that region. Research is always imperative in a global effort. Common mistakes made by marketers include lack of research in the translation of names and spelling. Not verifying translation in the Asia-Pacific region can be the downfall of a brand. It is therefore no coincidence that Pepsi-Cola means "a hundred happy things" in Chinese, and is considered a lucky name [7].

6. Creating & Growing Brands in a Digital Environment

Consumers have different values, lifestyles, and resources, which guide their purchasing decisions. Consumers also prefer different advertising styles and content and use media representations in different ways to appraise a brand. Some consumers respond well to endorsements from "trusted" professionals, whereas others don't. Some people want detailed product information, whereas others want their purchasing decisions to be as simple as possible. Understanding a brand's target consumer through psychographic profiles is an excellent way to ensure that advertising through print and broadcast media presents the brand image and "attitude" appropriately. The Internet's increased interactivity and selectivity for loyal customers make

psychographically integrated marketing even more important in cyberspace [1,13].

Regardless of the clear advantage, many companies are likely to make some common mistakes in relation to their brands in cyberspace. They may adopt a one size fit all approach in handling both their Internet users and traditional channel users alike. One reason for this assumption may be the similarity of the demographic composition of both user groups. However, Internet users have significant attitudinal differences. Companies may also erroneously assume that the Internet is just another channel of distribution for their product and/or service. In reality, the Internet is far more than that. It is a new category with much broader one-to-one reach. Therefore, the Internet must be seen in proper context and used effectively to strengthen the brand [6].

7. Merging Brand Entities

Co-branding is the practice of placing a company's logo or content on someone else's Web site. It could be a clothing, toy or fragrance label on a department store site. It could even be a comic strip on a news site [8,12].

The fundamental value of co-branding arrangements is that an asset of one party -its brand and image- is acting as a magnet to draw surfers onto the Web site of another party. Ideally, this is a win-win situation. The Web site benefits by the increased traffic. The brand owner enhances its image and brand strength by associating with a wider range of products or services, as well as possibly an alternate distribution channel for its own products or services [18].

In addition to increasing traffic and boosting brand awareness, co-branding generates the following advantages: an expanded base of users and shoppers; diversified content; integrated clicks, bricks-and-mortar operations; additional sources of revenue; and a virtual alternative to a merger or acquisition [14].

But co-branding can do more than add value and drive traffic to lesser-known e-tail sites. If not properly structured and monitored, they can weaken or dilute a brand. In order to protect the integrity of everyone's brand and realize the desired benefits of co-branding, agreements need to be ironed out addressing the myriad issues that can result from the relationship [8].

8. Implications of Cyberbranding for Marketing & Management

With the Internet revolution sweeping the globe, firms are struggling to understand how to leverage this new opportunity. Many small and medium enterprises view the Internet as an unique vehicle to help them compete on an even basis with larger firms"[9]

Moore and Andradi (1996) reviewed the "key competitive dimensions which will determine who dominates in the future development of business on the Internet" and proposed that "the winners on the WWW will be leading brands, big access providers and firms with existing relationships with customers." Moore and Andradi's proposition is based on the four competitive dimensions of (1) access, (2) brands, (3) content and (4) relationships – areas in which they argue, large firms have the advantage. Nevertheless, they suggest that co-branding with leading companies, short-burst advertising on leading service providers, and being a specialist player are the means by which small firms can compete in the digital environment with their larger competitors [9]. They argue that small and "less well known" brands can leverage their brand value and add credibility – a challenge to marketers on the Internet) – to their company through strategies such as co-branding and strategic alliances with larger, more established brands on the Internet (5).

In cyberspace, marketing is more than just finding a catchy way to get the masses to buy a product. There are myriad factors a brand considers when jockeying for position in a competitive industry--among them the speed of the Internet, the sheer number of users online at any given time and the relative inexpensiveness of creating a website.

To say traditional, offline branding tactics--such as TV advertising's demographic targeting--don't necessarily translate well online and that companies, especially in a heated market such as telecom, must find new ways to reach and retain customers might be stating the obvious. But, according to Rob Frankel, president of robfrankel.com, a Los Angeles-based brand consulting firm, it's surprising how little so-called marketing experts know about the Internet [10].

So although cyberbranding and offline branding aren't exactly apples and oranges, they don't grow on the same tree, either. There are particulars that should be considered carefully when attempting to create a credible brand--or maintain an existing one--online. Attention to a few details can save time, money and headaches, not to mention achieve the goal of a strong brand and customer loyalty[11].

9. Conclusion

According to Breakenridge, the best brands have stood the test of time. They are the brands in our history that have been nurtured, supported and communicated effectively and have adapted over time to socio-technological changes. One hundred years from now, Coke, Pepsi, Heinz and Campbell's and many other well known brands will still capture a remembered feeling or positive experience (whatever the brand means to the user). These brands occupy a position in the consumer's

mind and heart. They have overcome adversities and challenges. If brands such as Yahoo!, Amazon, MSN, AOL and eBay continue to brand with the constant speed and strategy that has been exhibited so far, one hundred years from now they too will maintain their powerful brand presences.

Undoubtedly, the Internet represents an opportunity and challenge for existing brands as well as start-ups. It is now evident that the ease of establishing a brand and the significance of branding in cyberspace is more difficult and more important than previously thought. Nevertheless, the justification for building a brand and the process and discipline in managing one have been tested in the brick and mortar environment over the long term. It is arguable that the existing brands are at an advantage in migrating to the internet because they already understand the power of brands, and have brands.

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Key Problems to be solved in Supply Chain Collaboration Management

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Abstract

Supply chain members of independent enterprises are different from each other in strategies. Conflict in benefits is inevitable. The supply chain management system (SCMS) based on information system usually emphasizes on the function of the information technology. To achieve collaboration management, four main problems must be solved: 1) Belief among supply chain members, 2) Motivations of supply chain members, 3) Allocation of interests among supply chain members, 4) Integration of supply chain information system. This paper intends to analyze these key problems, and put forward some resolutions.

Key words: Supply Chain Management, SCM, SCMS

1. Introduction

With the entering of the 21st century, the trend of social information, economic globalization and electronic business accelerates increasingly, and the enterprises face more vigorous market competition than ever. The competition among single firms is gradually turning to competition among supply chains.

In order to enhance the competition ability of the supply chain, it is most important to intensify the cooperation among members of the supply chain, through which we can make the operation of supply chain among members as smoothly as the operation of a business enterprise to meet final customers' needs with high speed and low cost. Numerous researches and practice on supply chain management indicate that it needs to establish a mechanism of credibility and cooperation among enterprises and a cross organization supply chain management information system to plan in collaboration, in order to realize supply chain collaboration management.

However, because the supply chain members are independent enterprises, and the strategy of each

enterprise is different from another, there must be inevitable conflict in benefits. But the supply chain management system (SCMS) based on information system usually emphasizes the function of the information technology, and neglects the further analysis of members' benefits, therefore, it often suffers from the boycotting of members in application. To achieve safe and perfect collaboration management, many problems need to be solved. Mainly there are four problems as following:

- 1) Belief among supply chain members
- 2) Motivations of supply chain members
- 3) Allocation of interests among supply chain members
- 4) Integration of supply chain information system

This paper intends to analyze these key problems, and put forward some resolutions.

2. Belief among supply chain members

Belief is the foundation of successful cooperation, and supply chain particularly emphasize belief among all members. According to game theory, if your partner distrusts you, and your best choice must be distrust. When all partners trust each other, the game process can have the best solution. If you trust others excessively, but others misuse your trust, it is easy to cause damage or loss to you. It is a long process from distrust to trust, which demands all the member's efforts.

In the real life, there are many distrustful phenomenon, for example, mutual blockade of market and technique information between enterprises; deceitful information to cheat others to acquire the advantageous position in negotiation, and make use of the loophole in the contract to coerce the other party. Once these phenomenon occur, the distrust atmosphere spreads everywhere as a plague does, which becomes the obstacle of cooperation of supply chain.

The reasons for distrust among members are different.

First, the law environment is an important reason. Under the morbid environment of law, management with credibility cannot get the protection from laws, therefore, a lot of enterprises adopt accurate measures, and it is difficult to establish trust. Second, the ideas of social moral ethics decide the trustful relation of the social members, and also affect that of enterprises. In a society with credibility, if someone presumes to breach the credit principle, he must suffer the rebuke from the social members. Finally, quality of leaders is an important factor. If the leaders have received good education, have strong sense of responsibility, and put the credit principle to an important position, thus it is easy to establish the relationship of trust.

It is not only the enterprises' duty to resolve the problem of trust, but also the duty of all society. To make laws perfect is a way to establish the moral standard of credibility. As a member of the supply chain, while cooperating with other members, on one hand it is necessary to establish a credit evaluation system, only cooperate with enterprises with high degree of credibility; on the other hand, it is necessary to implement the credit principle actively to influence cooperation partners.

3.Motivations of supply chain members

Motivation decides behavior and further affects result. As the partners belong to different benefit corpuses with different strategy and operation mode, they also take different position in the supply chain. With the differences in management background, motivation and foundation, the partners in the supply chain show different behavior. The demand to participate in the supply chain needs to be deeply analyzed.

Every member in a supply chain must look after its own interests and its shareholders first and foremost. That is the fundamental nature of free enterprise, and the source of its strength. Then it is the interests of supply chain as a whole. It is impossible to request the member to abandon its own interests, but to obey the whole interests of the supply chain.

According to the position, members in the supply chain mostly have the following motivations:

Core enterprise. Each supply chain has a core business enterprise as a leader that contributes most values to the

supply chain, and it's usually the supply chain's organizer, planer and coordinator. At the same time, the core business enterprise is also an independent enterprise, which has its own goal of development. Because of its special position in the supply chain, it is easily self-centered, and tries to consolidate the position as group leader, and control the decision-making right of product and pricing. For achieving this purpose, it may try to baffle information circulation among members, and make use of the information's dissymmetry to control the whole supply chain.

Upstream supplier. Upstream suppliers' scales are quite different. The small-scale suppliers are usually in the subordinate position in the supply chains, expressing the obedience to the core business enterprise, extending the scale hard, and strengthening themselves in order to increase their own positions. For avoiding being controlled by a certain manufacturer, they serve many manufacturers at the same time to increase the selectivity of sales; therefore they would not like to build a very deep alliance with a certain manufacturer, preventing being abandoned by other manufacturers. As for large-scale suppliers (like the raw material producers), they supply many supply chains for mutually competing at the same time. Each supply chain's demand is not large enough to account for a very big portion. These suppliers care most about the demand change of the final consumers; therefore it is not easy to establish a close cooperation with manufacturers.

Downstream distributor. For the distributor, the consumer resources and the understanding of consumer requirements are its advantage in bargaining with manufacturer in the supply chain. Similar to the upstream supplier, the small-scale distributor is in subordinate position, but the large-scale retailer usually own its brand, a good image in the consumer mind, while its own strategy usually become an important baffling factor for its supply chain cooperation.

The motivation's influence on the supply chain cooperation is objective. It requires that members in the supply chain should pursue common goal with great similarity as well as few differences. If the targets differ from each other greatly, such enterprises cannot stay in a particular supply chain over a long period of time. At the

same time, the core enterprise should not regard itself as center, and take much care about general situation of the supply chain. The core enterprise should have the leader's bosom, concern and forgive, and set an example for its members as to benefit the development of the supply chain.

4.Allocation of interests among supply chain members

The supply chain is a value-added chain. It is a continuously value-adding process of raw materials through supplier, manufacturer, and distributor to final consumer, creating value for customer. Each member contributes to the increased value and the contribution is the member's input. As reward, members deal with certain price and allocate the profits. Under the traditional mode of operation, relation among members is only simply trading. Price is set by market competition. But under the environment of supply chain management, the members' relationship is cooperative and common developing relationship, creating customer value. Price is set by much more complicated factors which include inner cooperation factor of current supply chain, the market competition factor, and the problem of the whole benefits and partial benefits.

First, the internal benefits allocation of supply chain has no sound basis. Whole supply chain creates the value through collaboration. It is hard to distinguish how much an activity contributes; therefore the allocation of the added value(deal of price among members) has no scientific standard. Usually supply chain members set a market basis according to certain market rule, i.e. reasonable profits under normal operation. For the excess profits brought by cooperation (the cooperation makes cost lower, and should have excess profits), according to the both parties certain role, they set certain percentage of allocation. Under real circumstance, some supply chain members (particularly a leader of alliance) usually thinks they played a more important role in the value-added process, therefore, they hope to monopolize the exceeding profits, which easily causes the other members' dissatisfaction.

Second, the unreasonable allocation can result in the collapse of the supply chain. The principle of market

competition is the basic principle for business enterprises. There exists a problem. If the supply chain members compete fully and set certain price through negotiation, it is against the intention of the supply chain cooperation, and makes the small and medium enterprises in the disadvantageous position due to their position and information dissymmetry. This may force some members to turn to the other supply chain, and become the rivals.

Finally, the allocation of interests results a new problem of whether sacrificing the partial benefits to protect the whole benefits of the supply chain. For example, if the final consumer brings up a new demand, and the demand may represent the future development of the supply chainproducts. Therefore, the whole supply chain shouldpositivelydevelopnewproductstomeetthe needs of the future markets. However, in the process of new product development, members' investments may differ greatly, but the future benefits do not have big differences. There exits risk in the success of the new products development, and the performance of the product in the future market is not determined. For the members of big investment, whether to sacrifice theirpartialbenefitsandcreatebenefitsforthe whole supply chain becomes crucial.

5.Integration of supply chain information systems

The thoughtof supplychain managementdevelops with information technology, and it's an achievementofthe informationages. Supplychain management system(SCMS) is a bridge connecting the supply chain members, as were a platform of communication, and a necessary tool for supply chain collaboration management.

Supply chain management the system (SCMS) derives from the basis of Enterprise Resource Planning (ERP). ERP is used for the management of a single enterprise, with functions of planning, purchasing, stocking, manufacturing, selling and finance. It tries to optimism the resources of business. After entering the ages of supply chain management, collaboration of Ultra-firms becomes

an important content of the supply chain, which cannot be realized in ERP systems. There comes the SCM software, used for the collaborative planning among business enterprises. Some business enterprises adopt the ERP systems, the others may use MIS or MRPII, then appeared several solutions:

The first is electronic commerce based on EDI. This method aims at the processing of ordering and purchasing, transforming information through EDI or Internet. The management scope is limited. The information of SCMS and enterprise inner management systems cannot link together well. EDI is the initial stage of supply chain management.

The second is ERP plus SCM. The members apply ERP system to manage internal business, and apply SCM to integrate the ordering, planning, purchasing and service with other members. The advantage of this method is that each business's internal management is not influenced, and the initial investment can be protected. The disadvantage is that data exchange between SCM and ERP is comparatively difficult in real time processing.

The third solution is the complete adoption of SCM. Each member adopts the same platform to share data completely. This method can realize supply chain collaboration management. The disadvantage is the limitation of functions, and only close members can use this solution.

Ultra-firms SCM needs to resolve the problems of shared information, communication, and integration with internal systems of enterprises. No ideal solution is available at present time. Because of the above-mentioned problems of trust among enterprises, motivations and benefits allocation, some members do not prefer the integration of information, they even boycott the SCM application. Therefore, each supply chain partner need to set reasonable goals for system construction, and adopt its own methods to realize integration of information system according to their distinguished circumstances.

6. Conclusion

The future competition is the competition among supply chains. We must utilize the whole function of the supply chain to realize management collaboration. In the

process of management collaboration, there are protruding problems of trust, motivation, allocation of interests and integration of information systems. Only by solving these problems can we make supply chain meet customers' needs better, create values for customers, and maximize interests of all members.

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Beyond Tayloristic Hierarchies: More Flexibility and Autonomy or “electronic Babel of tongues”? Consequences and Perspectives of Organizational Changes

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1. Research objectives and aims of the projects

This paper deals with changes in working principles and communication environments during the introduction of computer-mediated information and communication in companies. Our findings indicate that social consequences (e.g. decrease of hierarchical barriers, self-organization, self-responsibility) are interrelated to organizational (e.g. management of change), technological (e.g. infrastructure, implementation) and personal dimensions (e.g. experiences with media use, gender, position). Figure 1 illustrates the assumed interdependencies.

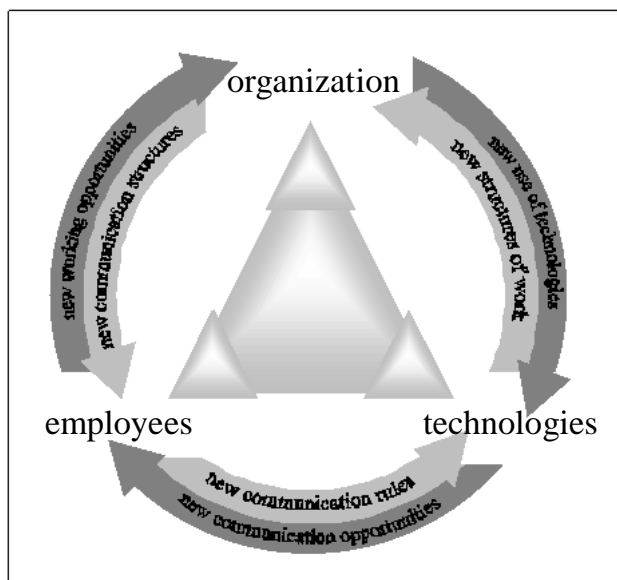


Figure 1 The “ETO-triangle” as a frame of research

In other words: technologies do not determine their use by itself. Their integration in companies’ structures and operations seems to be a complex matter. Success of organizational changes is driven by the acceptance of social and working environment. Especially learning-by-doing processes, activities for teambuilding (“empowerment”) and the employees capability to create

companywide rules of practice can be interpreted as success factors. Additionally our results suggest that the direct integration of outsiders (e.g. suppliers, customers, retailers) is less a technological fact, it rather seems a question of business culture (e.g. leadership) and mental factors (e.g. employees open-mindedness, managerial attitude). The findings focus experiences with working in projects or teams, job satisfaction, mental work load and well-being. Also the use of computer-mediated communication and social consequences (e.g. bypassing, e-mail overload, information push and pull phenomena) are analysed.

The outlined aspects are elaborated in two ongoing scientific projects at the University of Trier. Both studies will likely be finished at the end of the year 2003 (for further details see www.ceb-trier.de/spirit and www.uni-trier.de/~comm). The project SPIRIT is merely concerned with 9 case studies in Germany and California. About 290 employees filled out a standardized questionnaire within this project. Furthermore explorative interviews have been conducted. This research is funded by the German Federal Ministry for Education and Research (BMBF). The second project (Trier communication study) is based on quantitative surveys in more than twenty german organizations (n=500 employees). The presented results will provide actual information about the use of new technologies and the challenge of implementing new organizational structures.

In chapters 2 and 3 the field of organizational change is drafted as well as characteristics of “digital” communication. The related social consequences for users and organizations are often vague and discussed in the sense of future scenarios. In view of that the outlined phenomena are contrasted with first findings of the above mentioned empirical studies (see chapter 4).

2. From “analog” to “digital”: Changes in communication patterns

„Markets are conversations [and] conversations among human beings sound human. They are conducted in a human voice [and] people recognize each other as such from the sound of this voice. The Internet is enabling

conversations among human beings that were simply not possible in the era of mass media.“ [7, p. 16] This description of the future of communication draws attention towards a phenomenon that is often associated with the use of new communication technologies in organizations. New media enable direct communication and decrease the impact of gatekeepers or hierarchical barriers. It is possible to establish “digital bridges” regardless of hierarchical levels. Concepts like virtual or modular organizations are feasible particularly because of computer-mediated communication. The implementation of such new structures is often accompanied by a decline of face-to-face-contacts. Telephone and e-mail replace personal meetings and enforce the virtualization of communication. As a consequence facial expressions and gestures are not available as resources of additional information. Referring to Watzlawick et al.: There is no „analog“ communication [9]. This leads to the question, how employees deal with this changing quality of communication. Possibly new rules are established around „digital“ communication (in terms of Watzlawick et al.). Additionally employees’ motivation and trust in the relative advantage of new technologies have strong influence on the efficiency of new organizational structures.

3. Technology and redefining organizational structures

Production concepts like partly autonomous (production-) teams or the “modular firm” need new administrative structures and an integrated use of information and communication technologies. These new networks lead to a change of working conditions and opportunities. Temporal and spatial restrictions are becoming more and more obsolete and enable various concepts of flexibility. For example, companies with telework-projects more often have access to new media than others. In 2001, 84% of US-companies having experiences with telework also had e-mail-access for the major part of their employees, whereas only 52% of the firms without telecommuters. Compared to Germany and other European countries this gap in e-mail access is remarkable (difference in Germany 21%, in Finland 24,2%, in United Kingdom 29,8%) [2, p. 71]. But the quality of organizational communication and the efficiency of organizational processes is not only a technological matter. If new and direct connections between departments or workgroups emerge, ways of coordination and consultation, especially of positions not involved in these networks, become necessary. Too much information is dysfunctional, but no information as well. Or in the words of Katz and Kahn: “[...] unrestricted communication produces noise in the system. Without patterning, without pauses, without precision, there is sound but no music. Without structure, without spacing, without specifications, there is a Babel of tongues but no meaning.” [6, p. 226] Modern technologies play a key role in organizing labour. Nevertheless actors, technology and context have to be considered not as distinct entities studied separately, but

rather as elements constantly interacting. For this a wellknown position of organization science has to be remembered: “To speak of organization is to speak of communication.” There is a need for concepts of social integration to prevent processes of exclusion. In 1977 Beard already stated: „The success of an organization is determined by how well its members perform, and the success of organizational communication is a function of how effectively organizational members communicate. The ways in which individuals receive, interpret, and transmit messages and the ways in which those messages affect the individuals’ motivations are therefore the factors central to organizational communication.“ [1, p. 33] This seems still to be true.

4. New forms of responsibility and experiences with organizational changes: First results of empirical studies

By implementing „self-services“ (e.g. document management, groupware) access to a variety of information is made possible, but self-organization on the individual level is required as well. Employees and management staff have to take more responsibility for receiving information and installing communication flows to prevent delays in decision making. Digital communication alone will not guarantee an efficient bridge between levels and positions involved. The availability of information does not substitute the need for processing it and drawing conclusions. This means that leadership, hierarchy and face-to-face still seems to be important dimensions.

First results of SPIRIT research indicate that market orientated objectives are central for implementing so called e-business projects in Germany. For example, speed-up business processes, integration of customers demands, lower costs or better competitiveness are expected. The industrial work organization seems to imply inflexibility (e.g. span of control, long decision processes). Therefore companies make use of internal project teams or special task forces and try to reduce hierarchical division of labor. As a consequence Webers’ (1864-1920) [10, p. 128] bureaucratic and “rational” way of organizing decisions competes more and more against the approach of new, flexible team structures in administrative operations. In view of that the majority of senior or middle management (62%) attain explicitly the goal of promoting team-work while integrating new technologies. According to own statements 54% did not achieve this strategic objective so far. Consequently one might pose the legitimate and provocative question (with reference to [11], p. 99): Is dynamic team-work “the heart of a lean” company? Some answers should be discussed in this paper.

Figure 2 illustrates findings concerning experiences with team and project work. Participants answers were collected on the basis of a six-point scale (1=strongly disagree up to 6=strongly agree). For example, the majority (53%) of employees who participate in teams partly or strongly stated longer times to reach common

decisions. But answers vary with the number of members involved in the team-work activities. Especially those who usually work closely together with 8 or more employees reported such impressions (average: 3,75). In contrast workers with less number of colleagues more frequent denied this statement (average: 2,93).

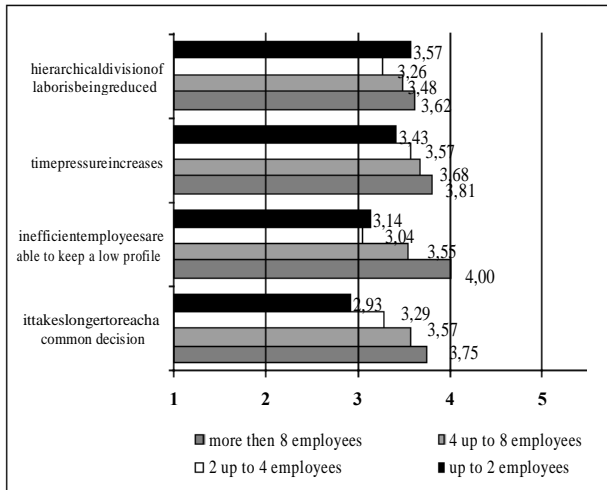


Figure 2 Experiences with team and project work (mean values, SPIRIT project)

More generally our research indicates new kinds of freerider-problems or of bystander-phenomenons like diffusion of responsibility while distributing management functions among team members. Furthermore unclear responsibilities (e.g. fixing deadlines, authority as a spokesman), complicated documenting work (e.g. saving of different versions, formalization of procedures) or a decline of motivation in case of higher-educated staff may come along with “anti-tayloristic” team-structures. That is why the ideal of more autonomy in companies’ decision processes and new concepts of employees participation sometimes seem to be valued as an unpracticable or less attractive alternative, especially from members in leading positions. Or in the words of a young Vice President of a Start-Up-Company in the Silicon Valley who has been interviewed within the SPIRIT project: „A company cannot be run as a democracy.“

Communication and the access to information can be seen as a main resource of organizational power. When e-mail and new communication and information technologies enable direct communication, the positions of formerly gatekeepers will be threatened. The results of the Trier communication study, which focus the impact of new media on organizational structures and processes, indicate that e-mail use lead to a decrease of hierarchical influences in organizational communication (see figure 3). Nevertheless the bypassing-phenomenon – passing over of persons which have to be involved according to formal rules of the organization – seems to be no direct consequence of technology itself [8, p. 94].

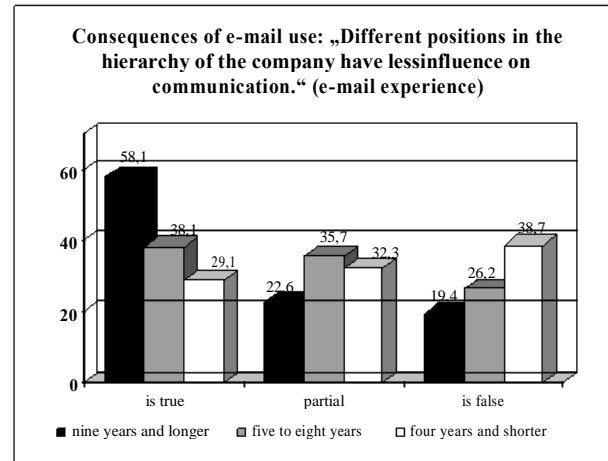


Figure 2: Consequences of e-mail use (Trier communication study)

The experiences of the employees on the one hand and the organizational culture and structure on the other hand define the impact of new media as well. The findings of the study show that employees use e-mail for informal communication only by and by (for further details see [5]). A private use of computer-mediated communication enforces an informal e-mail use. Even when it comes to consequences of e-mail use for social life in the enterprise, the results indicates that perception of e-mail changes in the course of time. For example, the “short-time-users” noticed more often a decrease of social contacts by the use of e-mail than the “long-time-users”.

However new companywide rules of communication can only emerge when a homogeneous perception is given. In our project, the employees in lower hierarchical positions had longer experiences with e-mail as those in higher positions. Moreover the management perceive new media less dominant for daily work. According to Goecke, this result may not surprise [4, p. 53 et sqq.]. Anyhow this can lead to heterogeneous media-skills (“digital-divide”) in organizations which will make it difficult to elaborate new (shared) communication rules. Therefore the attitude toward a decreasing influence of hierarchy on organizational communication patterns is often very different. In consequence of different tasks, different intraorganizational media-skills will be inevitable.

5. Production and Administration: Integration or Coexistence

These different media skills and uses could be an obstacle for implementing integrated information systems as well. For example the efficiency of electronic bulletin boards or even “employee-self-service”-systems is strongly related to the “internet-readiness” of users. Whereas the daily work in administrative departments is dominated by computer activities, employees in the field of production seldom have access to companies’ digital network. A possible consequence of this intraorganizational “digital divide” could be a coexistence of incompatible structures.

For example the use of digital and analogue information and communication systems for the same purpose (e.g. forms, newsletter) might happen. The efficiency of electronic workflow systems is reduced. Nevertheless the vision of “e-manufacturing” includes new concepts of production management. Flexibility of former on-site activities or services increases (e.g. the internet-technology allows maintenance services without the personal presence of workers). As a consequence, models of flexible work will emerge even in the production sector. Volkswagen for instance generated a system with more than 160 modes of flexible work. But an asynchrony of working hours may dissolve and recombine existing formal as well as informal groups. Different working hours may cause changing line-ups in workgroups. In this way, it could be difficult to establish or preserve personal relationships. When co-workers constantly change, informal structures will be weakened. In this sense personal access to new media cannot only be seen as a benefit for formal exchange but as a channel for informal structures as well. E-mail for example allows asynchronous communication between dislocated workers and “keeps people talking and juices flowing. E-Mail in workplace encourages communication.” [3, p. 3]

The “cluetrain manifesto”, an interactive elaborated internet-book which describes the new rules of markets in the internet-economy, outlines the dialogue between customer and worker as an alternative for the marketing activities of the enterprise [7, p. 25]. Maybe today this view seems to be too euphoric. But it points out that for an integration of all workers in e-business concepts of companies a direct and unrestricted access is favorable. Currently the most part of blue-collar workers cannot walk across digital bridges. Whereas in the production part access often is only given for the head of the department the majority of the administrative staff is working on the “digital highway”. For this reason a decline of hierarchical structures in the administrative part of organizations can be observed, while the hierarchy in the production part is still unchanged. To ensure a successful organizational change, the described digital gap has to be prevented or even closed. One possibility could be the installation of so called “kiosk-systems”, that is computer terminals in non-computer related workplaces. This enforces an integration in new digital networks. The results of our project indicate that private use during breaks might have a beneficial effect. On the one hand closing the gap will improve the efficiency of implemented electronic information systems. On the other hand it could result in similar forms of information flows in administrative and production parts. In other words: the access to new media might build the missing bridges that enable the next step in organizational change.

6. Summary

The outlined phenomenon of intraorganizational gaps are obstacles in the process of organizational change. Especially the “digital divide” of production and administrative part has to be changed. For a consequent

e-business reorientation of the company this separation has to be reduced by implementing electronic bridges. However, to find a common speech is not only a technological matter. The results of our both projects indicate that the emergence of new communication rules has to be seen as a bargaining process. Or in other words: In the ‘electronic babel of tongues’ it has to be found a new common language for the whole organization.

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T2B Model – Experiencing the Successful Conversion of Traditional Enterprise to e-Business

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Abstract

Successful selling over the Internet involves organizing the entire value chain around the Internet and determines where they can exploit technology to add value. Such conversion in small and medium size enterprises (SMEs) is still at its infant stage; knowing on the large enterprises' experiences, this enlarges the non-empirical qualitative learning and possibilities for empirically testable theories to come up with a well-structured framework for such conversion. Based on theories from technological innovation literature, this paper presents an integrated model for T2E (Traditional to Electronic) business conversion for SME. Our novel T2E model makes use of a 3-layers hybrid approach: which unifies the technique of IDEF [Integrated Computer-Aided Manufacturing (ICAM) DEFinition] to assist in business process design; the concept of Business Process Reengineering (BPR) for business structure re-organization; and Innovation Diffusion (ID) theory for progressive introduction of new e-business functions. Our model is intended to minimize the impact of operational and cultural changes on SMEs while taken the critical successful factors of e-business projects in consideration. The feasibility of our conceptual framework is testified by a case study SME - Valentino World Fashion (VW), Inc.

Keywords: T2E (Tradition to Electronic) Business conversion; Business process reengineering; Innovation Diffusion; Integrated Computer-Aided Manufacturing; Critical successful factors

1. Introduction

Today, SMEs could not afford to fall behind in taking e-Business initiatives to reach customers, to collaborate with

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business partners and to keep pace with competitors. Large enterprises had now found difficulties to promote their use of e-Business product and serve the highly segmented market, which on one end of the spectrum are multinationals and top-level domestic corporation while the other end are SMEs that are not yet ready to upgrade and transform their system. Many software vendors claim to provide SMEs extending from front office Customer Relationship Management (CRM) to back office Enterprise Resources Planning (ERP) applications and platform infrastructure. However, the e-Commerce initiative is believed to have more social-managerial issues to resolve than technical issues no matter how small is the company. It is clear that there is much changing drivers in management strategies, working culture and marketing plan between e-business and conventional business [5, 10, 15] besides the dramatic changes in its intra and extra-organizational processes.

When enterprises manage the impact of changes imposed by e-business, they typically proceed with Business Process Reengineering (BPR). T2E conversion in business need a detail but flexible, careful but innovative planning from the start, that integrated re-engineering process for dynamic strategic, managerial and technical consideration which interact and influence among each other constantly within an enterprise. This axiom supports the argument of Fixed Point Theorem [18, 19]. We concluded that speedy conversion from T2E would never catch up with the dynamic market changes. The key issue of e-business is process, process that inter-connect enterprise's individual business processes into a dynamic e-business network that open to authorized suppliers and potential customers. So this network should be flexible. This research proposes a novel dynamic T2E framework, which takes into consideration of changes and proactively adapt to the anticipated changes.

1.1 The e-Business System Life Cycle

Electronic stores need a strategic plan that react and adapt to changes, to survive and sustain profitability, to leverage investment in IT and to capitalize on knowledge through organizational learning. Disruptive technology (technology that replaces process) and creative technology (technology that enhance process) can cause a dichotomy in how organization operate and embrace IT-enabled change [13], we therefore regard that developing e-Business application should not constrain business possibilities under the limitation of computing technologies, but rather puts business sense into IT by developing each e-Business process that is business-focused and customer-centered. We recognize e-Business project should focus on business processes re-organization that adopts IT to enhance their connectivity and functionality for value adding. Hence, set up business vision and requirements are always the critical first step. The e-Business application development system life cycle provides us the foundation to construct our T2E

framework: the initial phase in the cycle involves the BPR for core business functions transformation into a series of conceptually defined web-based processes. This involves requirements acquisition and analysis that yields a corporate requirement document regarding the e-business set up.

1.2 E-Business Adoption Barriers for Traditional Business

The main barriers of their IS adoption and to develop a Web presence are simply the concern of knowledge deficiencies, lack of financial budget or slack resources, unconfident that the Web would not lead to more efficiency or lower costs [26, 27]. We have therefore identified from our literatures and case studies search that the critical success factors to adopt e-business in SMEs are as follows:

- $\frac{3}{4}$ It is important to have innovative and E-Business knowledgeable CEO.
- $\frac{3}{4}$ The SME must possess adequate financial resources and E-business knowledgeable employees.
- $\frac{3}{4}$ The E-Business must offer a better alternative to existing practices in the SME.
- $\frac{3}{4}$ The E-business system must be secure, easy to use and to understand.
- $\frac{3}{4}$ The E-Business system must be scalable, able to react and adaptive to changes.

The first two factors regards to human and organization issues of SME. The last three factors focus on the system design and implementation model. Our model also attempts to resolve the primary barriers of unfamiliarity with web and lack of guidance to start the T2E conversion process, by employing the theory of diffusion in our model.

2. From Traditional Business to e-Business

The T2E business transformation involves both the conversion of necessary legacy processes to web-enable applets and the integration of new enhanced modules to enable a value chains system. We propose to unify the concept of BPR for re-engineering the existing processes via organizational learning; Innovation Diffusion (ID) Theory for enhancing change management in new integration; and IDEF method as the modeling standard for design documentation in our T2E methodology. The hybrid use of these techniques and concepts accordingly should combine the advantages in providing a total solution.

2.1 Architecture of a B2C Web site

The typical architecture of a B2C e-store includes two tiers: the external tier is a web system that manages the customer ordering information; and the internal tier is an enterprise resource planning system.

External Tier Architecture - External tier architecture includes four typical subsystems: (1) a product management system, (2) a customer management system, (3) an ordering management system and (4) a payment management system.

The external tier is typically a web system. It is important to ensure that each of the following four major business processes corresponded to a web-enabled sub-systems.

- (1) **Product management system** - manages its stock with a workflow merchant for the products return and replenishment.
- (2) **Customer Management System** - offer customers the ability to update their profile, review their orders and payment history.
- (3) **Ordering Management System** - manages sales transactions and customer details, which includes capturing the transaction information.
- (4) **Payment Management System** - manages payment data, includes definition of preferences such as billing address, ship-to address and its verification.

Internal Tier Architecture - The Internal tier architecture typically includes an Enterprise Resources Planning (ERP) system in a company of medium scale or above.

2.2 An Introduction to IDEF

IDEF (Integrated Computer-Aided Manufacturing (ICAM) DEFinition) methodology [3, 21] is the successful end-result from the planning work of American Air Force-ICAM. The objective of ICAM is to upgrade manufacturing production by applying systematization of IT. It is a structural method for manufacturing using computer technology, and through this, it enables managers to understand the context of manufacture production more easily. The ICAM plan had developed an IDEF method that stated properties about manufacturing, then inter related the properties of statement and abstract them into graphics, to enhance communication.

2.3 Business Process Reengineering (BPR)

To perform T2E business transformation, we have extended the concept of BPR to our Total BPR that revise the integrated business processes via constant organizational learning for better system adaptability. Three important elements of context in Total BPR with organizational learning efforts: Vision, dialogue, and system thinking. The bottom line of system thinking is leverage seeing where actions and changes in structures can lead to significant, enduring improvement [22]. As much bigger payoffs are expected by revising the basic nature of the work performed rather than by just improving the source code itself that support the business process, we propose to integrate BPR actions with T2E organizational learning efforts as the solid building block of our

methodology. Total BPR procedure is not a one time process for T2E conversion, it is expected to be constant practices that carry out in the physical organization whenever there is new business vision and dialogue are formally identified. New business process could than be abstracted by corresponding conceptual e-business process and plug into the existing e-business system. Therefore, the principle of “High Cohesion and Low Coupling” (HCLC) is applied in the modular design with Total BPR approach for e-business application development. The challenge in our Total BPR is to restructure or structural transform the SME traditional business through e-Business, to determine whether the company should focus on core competencies or seek vertical and forward integration to provide integrated services so as to develop a single web-platform for the SME’s market. Our Total BPR attempts to abstract traditional and visionaries potential e-business changes conceptually by representing the pre-state and post-state of change after BPR in terms of As-Is and To-Be Models.

2.4 Building e-stores progressively

We therefore deploy the Innovation Diffusion (ID) Theory of Rogers [25] in of model to ensure thorough consideration in quality of service requirements in terms of sufficient knowledge on site architecture, network capacity and system software structure are all acquired before system implementation.; we have deployed his theory and relabeled them with our unique T2E activities. Our BPR

model is complement to the innovation diffusion view of implementing Enterprise Resource Planning (ERP) systems of Rajagopal [24] which consists of similar stages of Initiation, Adoption, Adaptation, Acceptance, Routinization and Infusion. The original ID theory of Roger is thus proven to be also feasible in application of e-Business development other than ERP implementation. We have built our T2E conversion activities base on the ID Theory of Rogers, who regards a new product or concept adoption can be classified into five stages: (1) Perception; (2) Interesting; (3) Evaluation; (4) Trial; (5) Adopt.

3. The T2E Business Conversion Methodology

The methodology framework is classified into five stages: (1) introducing management model, (2) choosing management model and channel thinking, (3) process analysis, (4) process simulation and (5) system establishment.

3.1 The Methodology Framework

The complete conceptual framework for successful e-Business transformation is presented in the following Figure 1. Our model is complement to the IS Adoption Model for small business [26] in conceptual term. Our model has also recommended specific tools; approach and techniques to enable these considering factors are taken care of in our model:

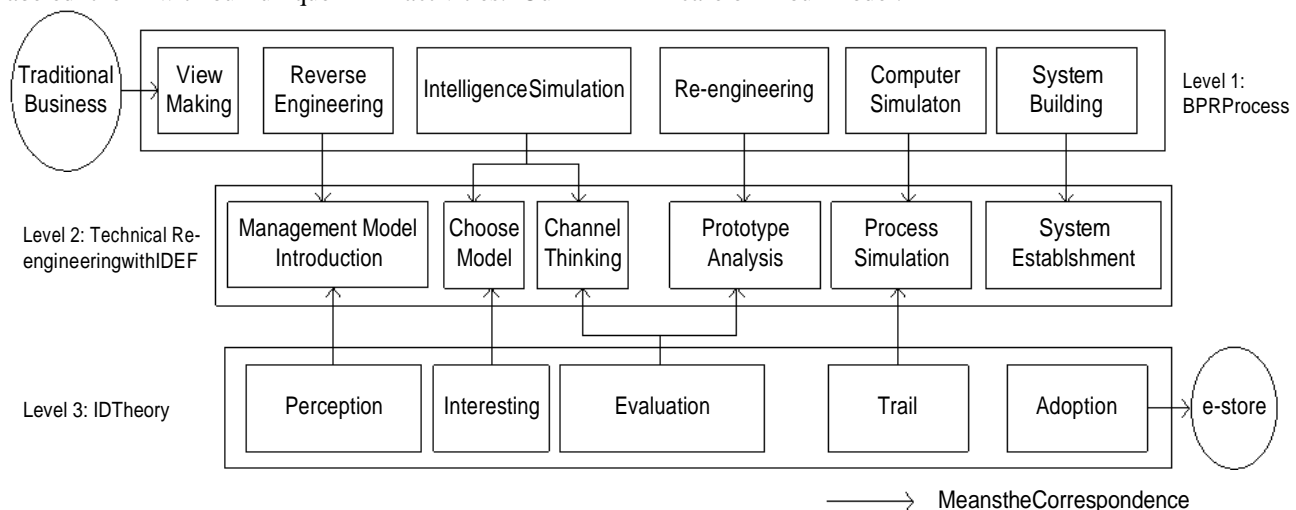


Figure 1: The conceptual framework for T2E process.

Stage1: Management model introduction.

The first stage uniquely declares the difference between the conventional stores and e-stores using an AS-IS (what the enterprise is currently doing) model and a TO-BE (what enterprise will do) model to ensure that the organization recognizes the changes and its impacts to business. Management support is important at this stage.

Stage2: Choosing a management model and Channel thinking.

Upon Stage 1, a management model could be decided for designing the e-Business plan.

Choosing an appropriate management model

The management model of *traditional stores* could be broadly classified into three types: (1) General stores, e.g. an independent shop; (2) Direct / Multiple store, e.g. Chain of retail stores and (3) Department

store. Whereas the management model of *e-stores* can be classified into another three models: (1) Single store; (2) Monopoly store and (3) Mall. Management could select an appropriate management style above by modeling the differences in processes, logistic and cash flow by AS-IS Model for current traditional business and by TO-BE Model for e-Business.

Channel thinking for building e-stores

McNaughton regarded that marketing activity could occur through three types of channels: distribution, transaction, and communication [16].

• Communication Channel

- ¾ Organizing and communicating interactively between customer and company [20].
- ¾ Acquire customers' information and comments on new products [7, 11, 12].

• Transaction Channel

- ¾ Improve transaction visibility [17].
- ¾ Improve revenues by exploiting cross-selling opportunities [9].
- ¾ Streamline transaction processing, thereby reducing task complexity, paper works and transaction cost [1, 14].
- ¾ Practice customization [12].

• Distribution Channel

- ¾ Eliminate large inventories and practice on Just In Time (JIT) business [4].
- ¾ Shorten supply chain and reduce commission and operating cost [8].
- ¾ Reduce delivery cost and ensure instant delivery of e-product/service.

Stage 3: Process Analysis for Building e-stores

e-Business has further caused changes on logistics flow, transitive cash flow and information flow [6]. This stage proposes to design operational process with the principle of HCLC to enable flexibilities in coping with changes. Coupling or association among and between processes as well as cohesion of functions within a process could be more easily identified by examining the AS-IS (traditional business) and built the TO-BE model (e-business) with power users before the confirmation of investment commitment for the new system is sought from management.

3.2 The Logistic Process Analysis

Business logic are analyzed and represented by IDEF chart for better communication among design team. We focused on the three arenas: Logistic Flow, Cash Flow and Information Flow.

3.3 The Cash Flow Process Analysis

Figure 2 below abstracts the differences of these cash flow processes in the AS-IS model and the To-BE model respectively:

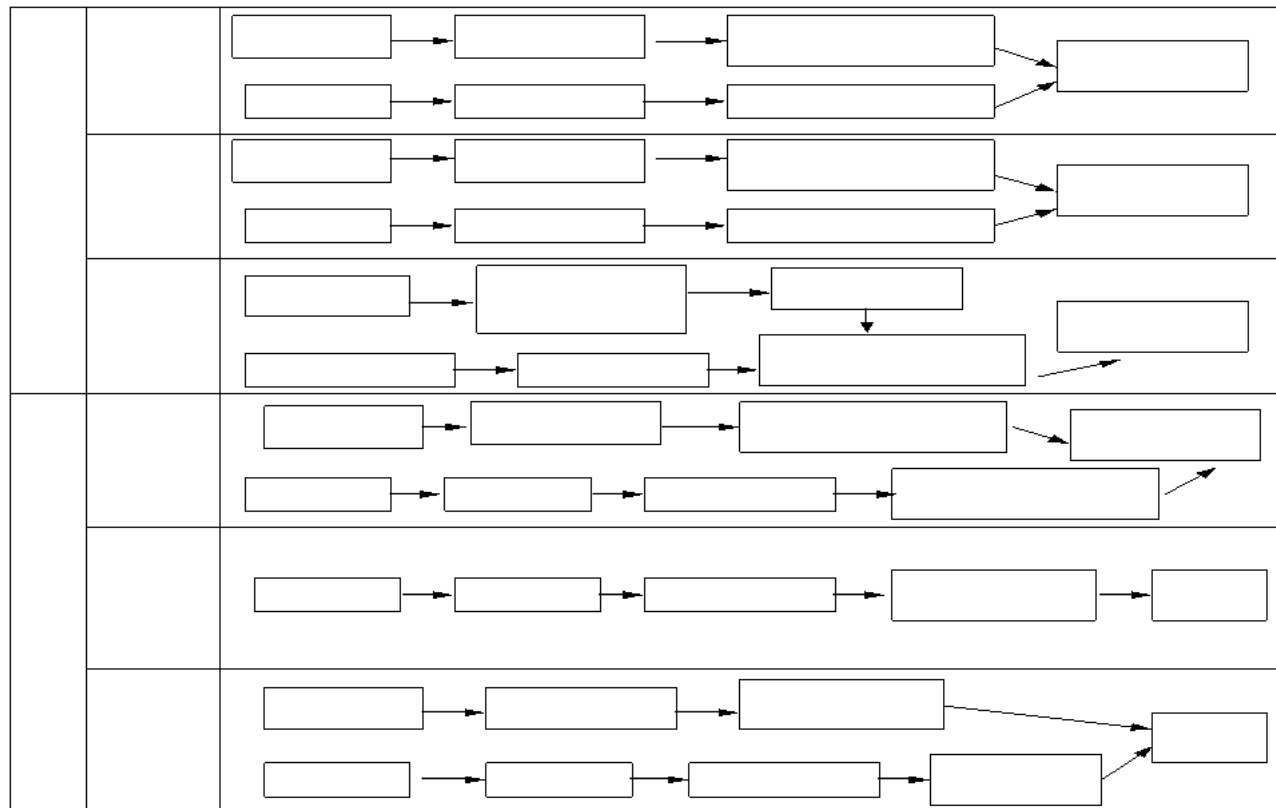


Figure 2: Comparison of cash flow between AS-IS model and TO-BE model.

3.4 Information Flow Process Analysis

This step works on the integration of local information flow among departments within the organization for a complete values chain concept. As such, information flows from upstream to downstream or vice versa is dramatically redeveloped to keep pace with the organizational changes.

By comparing the above As-Is and To-Be models, the SME could then determine on how to use its traditional assets flows and integrate Internet initiatives into its e-Business strategy to create sustainable competitive advantages.

Stage 4: Process simulation.

Simulating models ensure the development team to design a scalable system.

We recommend to deploy the CASE tool AIOWIN [2] to design the IDEF0 model which is the work flow diagrams of an e-store. We then used the Modeling Tool, ProSIM, [23] to convert the IDEF0 model with more design details ready for the simulation software WITNESS [28], to simulate the model. We highlight the five steps of simulation process in our model as follows:

Step1: Building an activity:

The basic concept is to define what is required to control and measure in a model.

Step 2: Building a structure of overall logistics:

Expand and refine the model of step 1 with more detail, in terms of what should be accomplished under its structure and who should be responsible for which activities.

Step 3: A transformation of AIOWIN design to ProSIM for modeling:

When the transformation is completed, the ProSIM system could then transform the input output of AIOWIN into an entity of ProSIM.

Step 4: Build the process arrangement, information flow and status for ProSIM system:

ProSIM establishes the procedural order and inter-relationship of the processes.

Step 5: Transformation from ProSIM system to WITNESS system:

After establishing the process flow, entering the variables in each process in ProSIM system to establish a simulation model (IDEF3), WITNESS [28] is applied in our prototype, to simulate each process of the e-store model by adjusting the variable's value to simulate different scenario. The optimum model (IDEF2) could then be selected.

Stage 5: System establishment.

We have deploy a hybrid approach that unify a combination of knowledge and concepts (BPR, IDEF, ID Theory) as well as techniques and software tools (AIOWIN, ProSIM and WITNESS) to come up with a

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complete and novel T2E business design suite which have taken the consideration of the major e-Business successful factors identified in section 1.2 above.

4. Case study

A case study approach is applied as our empirical study on Valentino World Fashion (VW), Inc., a SME on clothing agent in Taiwan, to evaluate our model for T2E business transformation. While developing an e-store for VW Inc. (i.e. ValentinoWorld.com) based on our T2E methodology framework, we have observed and experienced the successful business conversion.

The VW Company was set up in 1977 with over 20 branches in Taiwan. The company was aiming for business growth and has decided to go for e-Business initiative for more market share.

4.1 Effect of Introducing EC

As the VW targeted for full control of information process built upon a value chain concept, direct transformation of the existing business processes do not map the desired e-operations. We have performed Total BPR on the original business process model of the company. The following e-store processes were identified and implemented:

- On-line stock information: from the stock web database, sales information was made openly available on the net for possible on-line order.
- Pick up/ get / return/ exchange operations: customers could directly handle their necessary information online for order delivery, receiving invoices/receipts for their payments.
- Keep track of customers' information: maintain e-CRM on-line customer information; offer the customers with information of their order status, profile and other information of their individual preferences and interests.

After the T2E business conversion, two additional e-functions and various corresponding information flows were successfully introduced into the system.

4.2 Learning from the T2E Conversion

Our learning from the VW Company experience:

- (1) Traditional stores must identify their strengths and weaknesses before kick off the e-Business initiative. Recognize that additional e-processes are for value adding and not merely for follow the trend in industry is an important start.
- (2) The management may choose from different management models for e-store conversion, but must select a complementary management style with their existing one to minimize impacts of changes in terms of working procedure and culture.

- (3) If cost is a major constraint of the business, the e-business could start by participating in monopoly stores by joining the main portal of the same industry as an affiliation.
- (4) For e-store to grow and be competitive in the e-market, the features of a customer-centered and business-focused e-store to attract Internet traffic are necessary.
- (5) Information: an informative yet simple Graphic User Interface (GUI), a multi-lingual search engine (e.g. both Chinese and English, specific for Taiwan and Mainland China e-Market), rich database, effective store plan, good e-CRM and Internet marketing are important. The bottom line is that the e-customer should be able to come to the web site and complete an e-service process from the beginning to the end in a user-friendly, sensible and intuitively correct manner.
 - Logistics: the e-store itself must have an optimal logistic structure. The bottom line is a complete values chain from order through payment to delivery with a simplest format in fastest time span.
 - Cash flow: secure and safe payment methods that are convincing and reliable. The bottom line is to trade with maximum flexibility and security on Internet.

5. Conclusions

This paper presents a three-layer with five-stage framework as the solution of T2E business model conversion within an SME using a hybrid concept of ID theory, Total BPR and IDEF standard. It is then empirically tested using a case study approach. We have demonstrated the practical feasibility of our model through a case study SME – VW. To the best of our knowledge, the T2E model emphasize the importance of initial management support, organizational learning, and change management as well as simulation before the e-store construction, with the primary objective to minimize the impact of cultural and procedural changes within an organization, is one of the first rigorous studies that examined T2E conversion in SMEs, from a theoretical and empirical perspective.

Future research could build on and extend the proposed T2E model by including potential variables to establish benchmark for measuring the degree of success of e-business conversion in SMEs. Finally, the limitation of this studies is (1) the Asian experience in SME T2E conversion, that might not be general enough to represent a generic model; (2) Quantitative data to empirically measure the effectiveness of our T2E model is not available for publish due to confidentiality. As such, the research method employed in our empirical studies was qualitative. (3) Difficulties to put a commercial web site in a lab setting for evaluation of its quality. Future research could

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examine these possibilities. Notwithstanding these limitations, this paper has proposed and tested aT2E model for T2E business conversion for SMEs, in Asia perspective.

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Implementing a Three-Tier Data Warehouse

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Abstract

This paper aims at developing a 3-tier inter-universities data warehouse prototype for the Egyptian universities. The implementation scope is restricted to the student enrollment process. The bottom-up approach and the multi-tier (3-tier) client/server architecture were used to implement the proposed prototype. The implementation required a number of steps to be undertaken. First, a star schema data warehouse was built based on an operational database of a public university. Second, another star schema data warehouse was built based on an operational database of a private university. Third, data from the two warehouses were abstracted to formulate the inter-universities data warehouse (tier 3). Hence, a data cube based on the resulting inter-universities data warehouse was developed using an OLAP server (tier 2). The data cube is then accessed by a client tool (tier 1) for the purpose of query and analysis. Although two universities were used to implement the inter-universities data warehouse, this scenario could be applied with any number of universities in a quite similar way. This inter-universities prototype is scalable and flexible to retain more than two universities regardless of the size of the operational databases. The inter-

universities prototype fosters the coordination between participating universities and supports the decision making process. The proposed system could be used to generate a variety of strategic reports.

1 Introduction

Data warehousing is gaining popularity as organizations realize the benefits of being able to perform sophisticated analyses of their data [31]. The quality of data and the variations in its form are the toughest obstacle to building good data warehouses [8]. Organizations moving toward the approach of adopting data warehouse should discuss and answer the following questions: What to put in that data warehouse? The principal task will be determining: what to extract from data sources, how to extract it, transform it, and invariably, clean it. Then, where will the data be stored? How the information is delivered to end-users? There are many different approaches, of course, and they need not be mutually exclusive [2].

2 Data warehouse (DW) definition

Several definitions have been proposed by [17], [34], [3], [24], [2], [4], [7], [1], [33], [13], [23]. Inmon and Hackathorn [17] defined

DW as a subject-oriented, integrated, time-variant, and non-volatile collection of data used in support of management's decision making process. Devlin [7] said that a DW is simply a single, complete, and consistent store of data obtained from a variety of sources and made available to end users in a way they can understand and use in a business context. Adamson and Venerable [1] defined it as a design aimed at getting data out; it is all about getting answers to business questions. Marakas [23] said that the data warehouse contains a copy of the transactions which should not be updated or changed later by the data warehouse but could be updated by the transaction system from which the DW was originated. According to Marakas [23] and Inmon [16] there are four main characteristics that generally describe a DW. Those are Time-variant, Non-volatile, Subject-oriented, and Integrated.

3 DW architectures

The data warehouse application is a client/server application. The role of the client in all the variations generally includes managing the user interaction and formatting and reporting data retrieved from the data warehouse [8]. There are two basic architectures for building a data warehouse. The two-tier data warehouse architecture consists of front-end client components and back-end server components. The two-tier architecture utilizes existing legacy systems as database servers for the data warehouse (tier 2), while LAN-based workstations perform all complex calculations and summaries that go beyond the capabilities of the data warehouse's DBMS (tier 1) [8]. The two-tier architecture is not scalable and does not support large numbers of on-line end users. It encourages the development of *fat-client* front-end systems, in which excessive application processing is allocated to desktop workstations [26]. The multi-tier (*three-tier*) data warehouse architecture or as sometimes called the *thin-client* model, handles the scalability and flexibility problems through the use of an application server between the data warehouse

server and the client. The application server manages the interaction with the data warehouse, performs data filtering, summarization, and aggregation, and sends the results to the client. A variation in the three-tier architecture is the use of a multi-dimensional database (MDD) server that stores the data in a special structure designed to facilitate dimensional analysis. The client remains responsible for managing the user interaction and formatting and reporting resulting data, but requires less processing power due to the reduced calculations and database server interaction [9], [8], [3].

4 The star schema architecture

The best way to build the DW database is by using the Star Schema structure (sometimes referred to as multi-dimensional data modeling). The Star Schema captures the measurements of importance to the business and the parameters by which the business measurements are broken down. It is a direct reflection of how business processes happen. The measurements are referred to as FACTS, whilst the parameters by which a measurement can be viewed are called DIMENSIONS [30], [1], [18].

5 OLAP

OLAP is a common use of a data warehouse that involves real-time access and analysis of multi-dimensional information [32]. OLAP always involves interactive querying of data, following a thread of analysis through multiple passes [27], [29], [14]. There are three major architectures for OLAP systems [6]:

- 1) Multi-dimensional databases OLAP, (MOLAP). MOLAP uses multi-dimensional databases to provide analyses.
- 2) Relational OLAP, (ROLAP). ROLAP uses data directly from relational databases using either a star or snowflake database schema.
- 3) Hybrid OLAP, (HOLAP). In this type, some summarized or aggregated data are stored in a multi-dimensional database,

while other data, such as detailed transaction data, is stored in related relational databases. The user can navigate the multi-dimensional database analyzing the summary (aggregate) data, but if the user requires data that is not stored in the multi-dimensional database, the system automatically generates SQL to retrieve the data from the back-end relational database and then loads that data into the multi-dimensional database, which is referred to as drill-through [6].

6 Inter-organizations data warehouse

An inter-organizations data warehouse can be established between two or more organizations whenever they agree to share data. The separate organizations have separate technologies, IT staffs, data elements, and administrative routines. What ties these diverse entities together is a strong desire to share data for the purpose of producing coordinated overall results. An inter-organizations DW does not come out because a group of organizations just want to share data. Significant planning and arrangement must take place before an inter-organizations DW can go live. All organizations participating in the DW must accept a centralized agreement. The members of the DW agree to the following [19]:

- 1) To define and use conformed dimensions. For instance, all members will use the ITEM dimension in a retail chain. All must agree on the definition of attributes in this dimension so that a compatible set of values from separate dimension tables can be combined together.
- 2) To define and use conformed facts. For instance, all members must agree on the definition of the "revenue" measure in the DW so that separate revenue measurements coming from separate fact tables can be combined mathematically. Whenever conformed dimensions and conformed facts are arranged correctly, the separate organizational members of

the DW are quite free to develop their databases independently.

7 Foundations and significance of research

This research is based on recommendations made by many scholars including: [5], [10], [12]. These recommendations suggest the establishment of an Inter-Organizations Data Warehouse. Inter-organizations data warehouse can be established between two or more organizations for the purpose of producing coordinated overall results, whenever they agree to: share data, use conformed dimensions, and use conformed facts. Inter-organizations data warehouse can help member organizations to enhance their business understanding and accordingly the decision quality [19].

8 Research objectives

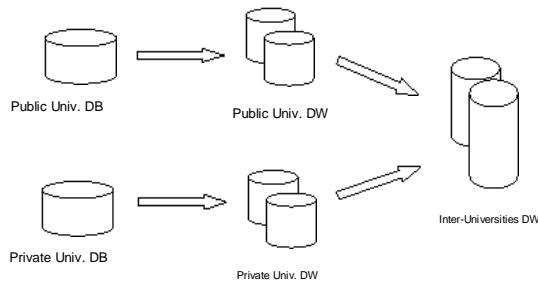
- 1) Developing an Inter-Universities Data Warehouse prototype for the Egyptian Universities;
- 2) Support the decision makers by generating some reports based on the Inter-Universities Data Warehouse.

9 Methodology

The adopted methodology consists of the following components together with their respective mechanisms:

- 1) The bottom-up approach for DW development will be used, and
- 2) A multi-tier (three-tier) client/server architecture will be employed.

The bottom-up approach for DW development will be used as follows. First, a Star Schema Data Warehouse is built on the operational database of a Public University. Second, another Star Schema Data Warehouse is built on the operational database of a Private University. Third, data from the two warehouses is abstracted to form the Inter-Universities DW, as shown in Fig. 1. The multi-tier (three-tier) client/server architecture is deployed as follows. A *data cube* based on



the resulting Inter-Universities DW (tier 3) will be developed and run by an OLAP server (tier 2). The data cube can be accessed by the client's tool (tier 1) for query and analysis as needed. Fig. 1. Bottom-Up Approach for Building Inter-Universities DW

9.1 Data sources

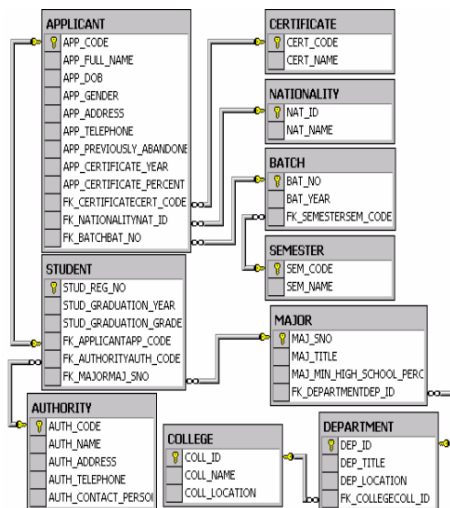


Fig. 2. ER Diagram of the 'Public University' Database

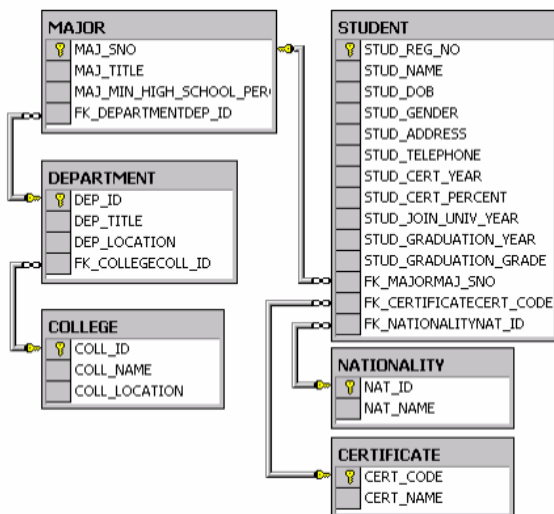


Fig. 3. ER Diagram of the 'Private University' Database

The following sections present a description of the proposed operational databases of the 'Public University' and the 'Private University'. This is done within the scope of student enrollment.

9.2 The public university database

This data source represents any of the Public Universities. An ER diagram of the Public University database, within the scope of student enrollment, is shown in Fig. 2. This database is a downscale of the Admission and Registration database in [12]. The database consists of the following entities: STUDENT, CERTIFICATE, NATIONALITY, MAJOR, DEPARTMENT, and COLLEGE.

9.3 The private university database

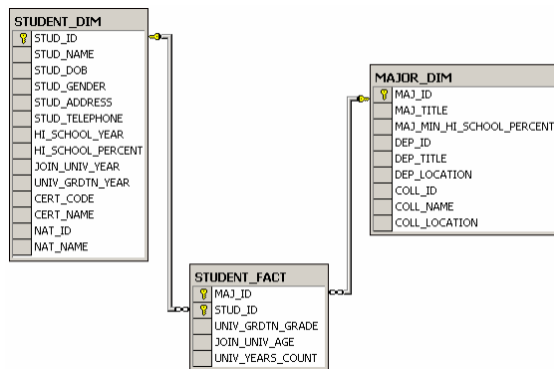
This data source represents any of the Private Universities. An ER diagram of the Private University database, within the scope of student enrollment, is shown in Fig. 3. This database is a downscale of the Admission and Registration database in [12]. The database consists of the following entities: APPLICANT, BATCH, SEMESTER, STUDENT, AUTHORITY, CERTIFICATE, NATIONALITY, MAJOR, DEPARTMENT, and COLLEGE.

9.4 Design of the star schema DW

In the following sections, the steps of designing the Star Schema DW for each university, based on its operational database, are presented. The design steps of a Star Schema DW include determining the grain of the fact table, the dimensional tables, and the measured facts. Then, the design of the Inter-Universities Data Warehouse is presented.

9.5 Design of the public university star schema DW

The Public University Star Schema DW is based on the Public University operational database, presented earlier. Since the proposed Star Schema DW concerns with the process of



student enrollment, the grain of the fact table has been chosen to be the individual *student*. Two dimensions were used: the *Major* (named as MAJOR_DIM), and the *Student* (named as STUDENT_DIM), as shown next.

- **MAJOR_DIM.** It was built by de-normalizing the tables: MAJOR, DEPARTMENT, and COLLEGE.
- **STUDENT_DIM.** It was built by de-normalizing the tables: STUDENT, CERTIFICATE, and NATIONALITY.

The following measured facts of a student were chosen: *university graduation grade*, *age at joining the university*, and *count of years in university*. An ER diagram of the Public University Star Schema structure, within the scope of student enrollment, is shown in Fig.4.

Fig. 4. ER Diagram of the ‘Public University’ Star Schema

9.6 Design of the private university star schema DW

The Private University Star Schema DW is based on the Private University operational database, presented earlier. Since the proposed Star Schema DW concerns with the process of *student enrollment*, the grain of the fact table has been chosen to be the individual *student*. Three dimensions were used: the *Applicant* (named as APP_DIM), the *Major* (named as MAJOR_DIM), and the *Student* (named as STUDENT_DIM), as shown next.

- **APP_DIM.** It was built by de-normalizing the tables: APPLICANT, CERTIFICATE, NATIONALITY, and BATCH.

- **MAJOR_DIM.** It was built by de-normalizing the tables: MAJOR, DEPARTMENT, and COLLEGE.
- **STUDENT_DIM.** It was built by de-normalizing the tables: STUDENT, and AUTHORITY.

The following measured facts of a student were chosen: *university graduation grade*, *age at joining the university*, and *count of years in university*. An ER diagram of the Private University Star Schema structure, within the scope of student enrollment, is shown in Fig. 5.

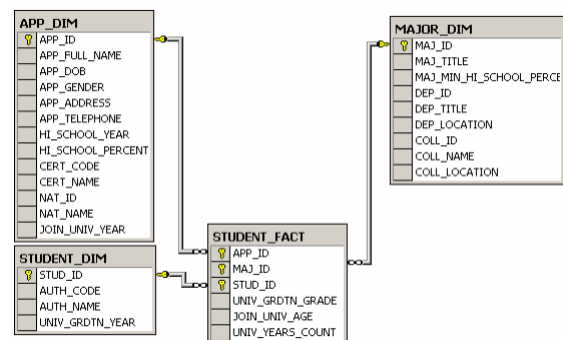


Fig. 5. ER Diagram of the ‘Private University’ Star Schema

10 Design of the inter-universities star schema DW

The Inter-Universities Star Schema DW is based on the two data warehouses: the Public University DW and the Private University DW. By abstracting data of the conformed dimensions and facts from the two data warehouses, the Inter-Universities DW can be built. The conformed dimensions that have been chosen are: the *major* and the *student*. Not all attributes of the two dimensions have been taken. The conformed facts of a student that have been chosen are: *university graduation grade* and *count of years in university* (also, not all of them have been taken). An ER diagram of the Inter-Universities Star Schema structure, within the scope of student enrollment, is shown in Fig. 6.

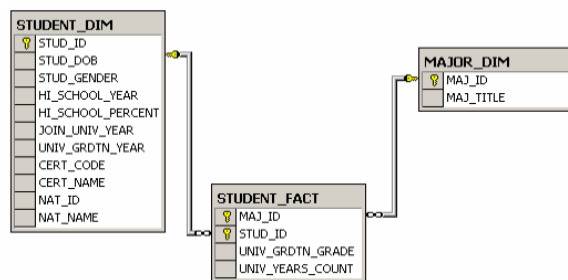


Fig. 6. ER Diagram of the 'Inter-Universities' Star Schema

11 Implementation tools

As mentioned earlier, the bottom-up approach was used for building the Inter-Universities DW, on which a data cube was developed using an OLAP server, to be accessed by the end user. This is referred to as multi-tier (3-tier) client/server architecture. Next, the tools used to implement each tier are presented. The back-end tier is the Inter-Universities DW, and was built using Microsoft® SQL Server™ 2000. The middle tier is the data cube, and was developed and managed by Microsoft® SQL Server™ 2000 Analysis Services. The front-end tier is the end user (client), and uses Microsoft® Excel™ 2000 to access the data cube and generate the required reports. Microsoft® Excel™ 2000 provides a client-based PivotTable® Service component which receives meta data with data from the server in response to a query. PivotTable Service shares much of the same functionality as the server, enabling it to bring the server's multidimensional calculation engine, caching features, and query management directly to the client computer. This client/server data management model optimizes performance and minimizes network traffic [25].

12 Building the star schema data warehouses

Building the back-end tier—the 'Inter-Universities' Star Schema DW—is based on both the 'Public University' Star Schema DW and the 'Private University' Star Schema DW. The Star Schema Data Warehouses were built using the tools delivered with Microsoft® SQL

Server™ 2000 as will be shown. Building each Star Schema Data Warehouse includes two main steps: loading the Star Schema dimensions, and loading the Star Schema fact tables. To load one or more of the Star Schema dimensions and fact tables, it is needed to build a Data Transformation Services (DTS) Package using the DTS Designer delivered with Microsoft® SQL Server™ 2000. The DTS Designer is a graphically oriented tool for building a number of connections and a number of data transformation flows (also known as data pumps) to run between the connections. The DTS Package also serves for mapping operational data model to data warehouse data model. Before creating the required DTS Packages, it is needed to create the Star Schema database structure for each DW and all the tables in it including keys and other constraints.

13 Building the inter-universities star schema data warehouse

The required DTS Package was created with three connections. The first connection to the Public University star schema, the second connection to the Private University star schema, and the third connection to the Inter-Universities star schema.

14 Developing the data cube

The data cube (or as sometimes called OLAP cube) was developed and managed by Microsoft® SQL Server™ 2000 Analysis Services, based on the Inter-Universities DW built above. The MOLAP storage mode (or as sometimes called multidimensional structure) was chosen for creating the proposed data cube. Microsoft® SQL Server™ 2000 Analysis Services system provides PivotTable® Service, which is OLE DB compliant provider. The data cube built above can be accessed for data query and analysis by Microsoft® Excel™ 2000 through Microsoft® OLE DB Provider for OLAP interface. Microsoft® Excel™ 2000 provides the ability to build PivotTable and PivotChart reports based on this interface. Thus, a wide variety of

reports can be generated to fulfill the requirements of various user communities.

15 Sample reports

The following sections present sample reports that are generated as a result of using a random data sample of 1900 records. The data sample contains some personal information about the students joining the university, and some other information about admission, majors, graduation grades, etc.

15.1 Student' high school scores Vs. average university graduation grades

Fig. 7 shows the average university graduation grades of the students against their high school scores in different majors for the university-members of the Inter-Universities DW.

15.2 University demand curve

This report shows the demand curve for education in the universities represented by the number of students joining the universities each year. This report can help the decision maker to arrange the required resources to fulfill the potential demand either on the major level or the university level.

15.3 Graduate students count Vs. University years count

This report shows how many students spent how many years in the university for the different majors. The report helps to show the distribution of graduate students by their university year's count.

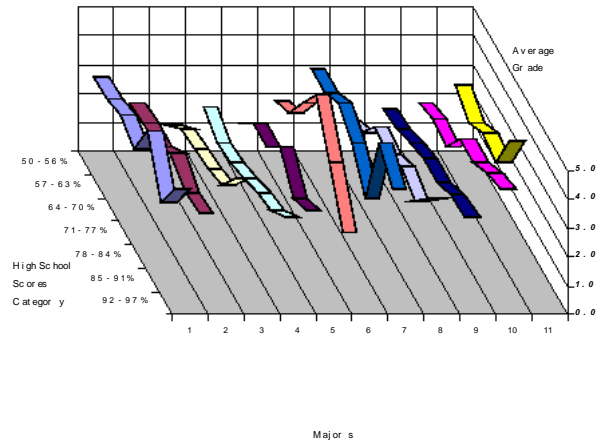


Fig. 7. Students' High School Scores vs. Average University Graduation Grades

16 Conclusions

In this paper the bottom-up approach and the multi-tier (3-tier) client/server architecture were used to develop the Inter-Universities DW. The back-end tier (the Star Schema DW) was built using Microsoft® SQL Server™ 2000 and tools delivered with it. All transformations have been done without changing the operational databases at all. The middle tier (the OLAP data cube) was developed and managed by Microsoft® SQL Server™ 2000 Analysis Services. Analysis Services system provides PivotTable® Service, which is OLE DB compliant provider, to be used by applications from diverse vendors to retrieve data from the server and present it to the user. The front-end tier (end user) uses Microsoft® Excel™ 2000 to access the data cube and generate the required reports. Microsoft® Excel™ 2000 provides a client-based PivotTable® Service component which shares much of the same functionality as the server.

Two universities were used to show how to apply this scenario, but it could be applied with any number of universities in a quite similar way, no matter how big is the size of the operational database since the conformed dimensions and facts have been defined. The proposed system can be used to generate a

wide variety of reports showing overall and detailed information about the evolution of education in universities.

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A Study of Traditional Versus e-Government Service Channels in The UK

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Abstract

This paper examines the reasons individuals would choose electronic self-service delivery methods, more specifically that of the Internet, over more traditional methods of service delivery for government services. The approach taken was based upon a combination of attitudinal technology adoption models and the service quality concept, with data gathered via a questionnaire. Trust, financial security, information quality (all adoption barriers), time and money (both adoption benefits) were found to predict potential usage. The results obtained demonstrated that the current approaches are limited in that they only consider the benefits of technology adoption, they do not consider the barriers to adoption, which is particularly important for electronic public service delivery as a new offering. The results are significant to public service managers if they are to develop plans to increase the take-up of their electronic services.

1 Introduction

In response to increasing consumer power, many organisations have sought to move to Customer Relationship Management (CRM). The core principle behind CRM is for organisations to better understand the needs of each customer, in order that they may personalise their offerings and so increase customer satisfaction, which is believed to develop customer loyalty and increase customer retention Kotler [1]. The Internet has become an important component of the overall CRM approach in that it can be used as an extension to the traditional methods of business.

However, whilst customer retention in e-services is particularly important because of the ease of utilising another provider due to low switching costs, little is known about how consumers perceive and evaluate electronic service delivery. This is of particular managerial importance in the public sector, where all government organisations have to deliver all services electronically by 2005 [2]. Without an understanding of why UK citizens would use electronic service delivery channels over more traditional service delivery methods, government organisations cannot take the necessary strategic actions to meet their citizen adoption targets for

these channels. Therefore, the aim of this paper is to investigate how individuals evaluate electronic channels, more specifically the Internet, for the delivery of government services, and to predict future usage intentions.

2 Literature Review

The consumer decision-making process model [1] is used as the framework to investigate how individuals evaluate on-line self-service delivery options. Thus the assumption is made that the consumer is at the 'evaluation of alternatives' stage where the consumer choice is not between different brands, but between methods of service delivery for a single organisation.

Previous research can be described as varying along a continuum from applying existing theories in a technology context to the development of specific technology adoption approaches. This adoption led approach is applicable since a consumer choosing an electronic service delivery mechanism over more traditional means can be considered as an issue regarding technology adoption. The three main approaches repeatedly used that have sound theoretical and empirical bases, and that are considered in this review are:

- **New theory:** Diffusion of Innovation theory [3, 4] indicates that there are three main factors that are most supported by empirical studies, namely relative advantage, compatibility and complexity. However, these studies all apply to the adoption of technology to information systems for performing job roles, such as the use of spreadsheets [5], and as such may not be as valid when applied to consumers.
- **Extension of existing theory to technology:** Technology Acceptance Model [6] showed that beliefs influence attitudes about information technology, which lead to intentions and subsequently behaviours of actual technology usage. Extensions to the TAM have been thus proposed, predominantly in the area of subjective norms, which are a key part to the theory of reasoned action (TRA), but were not included within the TAM. Venkatesh and Davis [7] acknowledged that there is a need to account for social factors and updated the Technology Acceptance Model (TAM2) by

integrating subjective norms. However, this model still accounted for only 50% of the variance in technology usage intention according to Legris et al. [8], indicating that there are other significant factors not yet identified. Attitudes towards technology have been found to influence Internet usage but the more formalised approach provided by TAM has not been widely adopted in Internet research. In what was found to be one of the first applications of the TAM to the use of the Internet by consumers, O'Cass and Fenech [9] investigated attitudes towards on-line retail purchases.

- **Application of existing framework to technology:** Service Quality (for example, see Dabholkar [10]). The two previous models (Diffusion of Innovation and Technology Acceptance Model) focused specifically upon consumer perceptions of technology and their effect on the intention to use that technology. Recently, another marketing concept that incorporates consumer intentions has been applied to service delivery via technology, namely service quality. Being considered as a differentiator between organisations, it is here being used as a differentiator between service delivery methods of a *single organisation*. In the service quality literature, perceptions relate to post-consumption evaluation of service performance, whereas in the previous two models the approach to perceptions are pre-determined beliefs that lead to attitudes about the product or service. The major issues that are immediately apparent are that the delivery of service via electronic means is still a relatively new concept so that many consumers will not have experienced or interacted with it. It must be also noted that although there is an increasing proportion of the United Kingdom population who use the Internet, this proportion represents still only 50% of the related population. Furthermore, according to Ofcom there is an unequal distribution of the diffusion of the Internet in the UK population: heavier users tend to be younger to middle age groups, larger households and higher income groups [11]. Therefore empirical studies may have to be based upon consumer *expectations* of service quality. The results of the Dabholkar study [10] demonstrated that speed of delivery, ease of use, reliability, enjoyment and control were all significant factors in determining expected service quality. However, the implementation of these attributes can be questioned because the study was aiming to compare consumer decision-making between traditional and technology based service delivery, whereas the instrument questions used these attributes in an *absolute* sense (about the technology), rather than a *comparative* sense.

Discussion

The literature review has highlighted areas where either the approach or the previous applications, have

limitations that may be reduced by combining all three approaches. The attitude-based methods are strong because they are supported by accepted behavioural theory linking perceptions to usage intentions. However, the primary drawback appears to be concerning the antecedents that affect the perceptions towards technology. As mentioned earlier, Legris et al. [8] described how the initial list of factors that affect technology adoption were simplified under the TAM and accounted for only 50% of the variance in technology usage intention.

For the service quality work, the attributes that are important in determining expectations have been well researched through various models, such as SERVQUAL, SERVPERF and the technical/functional model. The specific service quality dimensions have to be modified for the electronic service delivery consideration [12, 13]. However, these models are weaker in the area of linking service quality to customer satisfaction and usage (or re-usage) intentions. Therefore, the proposition is that by combining the attitude-based and service quality based approaches, the theory linking attitudes to behaviours can be exploited (DOI, TAM), with the service quality literature being used to help identify the antecedents that affect these attitudes. However, the antecedents of attitude towards technology adoption have to be defined, placing the onus on both the factors affecting consumer intentions to adopt an online service channel (considered in a comparative manner, i.e. relative benefits) and the factors representing a barrier to adopt the same.

3 Methodology

The analysis is conducted in two stages: the first as an exploratory study to identify the factors that may predict technology usage; the second to test the following hypothesis.

H₁: Each identified factor does not predict the intention to use the technology service delivery option

Whilst many of the principles from the reviewed studies can be used, the following reasons justify the modified approach taken in this research:

- The context here is a publicly available service, not one within the workplace; Whilst people are aware of the Internet, they are unlikely to have received training on how to use it or received direct marketing encouraging them to use it in general, this contrasts with potential users in a work environment; While the use of the Internet for service delivery has increased dramatically, the delivery of government services via the Internet is relatively new, so there are few people who have actually used it.

Thus, rather than questioning individuals on their perceptions developed from actual system usage, and relating this to whether they are actually intending to use it further, the study investigates the importance of the

candidate benefit-barrier factors relating to potential *willingness to use*. That is, the study does not measure actual perceptions, but investigates the factors that individuals consider important in evaluating whether or not to use the service. These factors are important to the service providers (government departments) because they contribute towards the development of attitudes in making the delivery of public services on-line more acceptable.

A self-administered postal questionnaire incorporating 5-point Likert scales was developed. The questionnaire contained 3 parts with parts B & C based upon the literature as indicated in Appendices 1 and 2:

- Part A: factual questions (demographics and previous Internet experience).
- Part B: attitude questions relating to the candidate benefit (Time, personalization, avoid personal interaction, cost, convenience, control) and barrier (visual appeal, safe, reliable, enjoyable, easy to use, confidential) factors.
- Part C: question for 'willingness to use' on-line public service delivery.

Stratified random sampling was performed in Guildford in which 50 streets were selected at random from the list of all streets, using the SPSS random selection facility. Individual addresses in each street selected were also chosen randomly using the same. A pilot study was carried out and consisted of 50 questionnaires distributed

through postal services within 10 streets randomly selected from the list developed. 9 responses were elicited.

Based upon the response rate of 18% from the pilot study, 555 questionnaires were then distributed. A follow-up visit to selected non-respondents was performed in order to increase response rates and finally 111 completed questionnaires were returned.

The reliability of the scales was calculated using Cronbach alpha whereby the scale items in the pilot for benefits and barriers were .75 and .72 respectively and for the final survey these were .83 and .8 respectively. However the reliability may indicate that together the questions measure benefits and barriers, but there was a question that they may not group under the 12 factors proposed as individually the items might not be robust. Therefore, factor analysis was used to identify the underlying constructs that characterise the data response and to investigate the convergent and discriminant validity of the emerging factors.

4 Analysis and Results

Compared to the UK total population census data [14], age range 25-34 and 55+, and people not working full-time were respectively over-represented and under-represented in the sample (Table 1).

Table 1: Comparison of demographic data

Category	Response	Study response (%)	1991 census (%)
Age	18-24	14	13
	25-34	42	20
	35-54	35	33
	55+	9	34
Work status	Full-time	89	46
	Not full-time	11	54

Source: Fieldwork and LGA (2000)

The following table contains the means and standard deviations (SD) for each construct. Each construct is grouped according to the relative benefit and barrier factors.

Table 2: Descriptive Statistics attributed to Construct

Construct	Mean	Standard Deviation
<u>Perceived Benefits</u>		
Avoid Personal Interaction	3.60	0.94
<i>Control</i>	4.20	0.76
<i>Convenience</i>	3.96	0.96
<i>Cost</i>	3.17	1.10
<i>Personalisation</i>	3.55	1.00
<i>Time</i>	4.15	0.80
<u>Perceived Barriers</u>		
Confidential	4.80	0.54
<i>Easy to use</i>	4.34	0.64
<i>Enjoyable</i>	3.46	1.00
<i>Reliable</i>	4.55	0.62
<i>Safe</i>	4.57	0.61
<i>Visual Appeal</i>	3.81	0.89

Source: Fieldwork

The constructs with the largest means (5 = “Strongly Agree” and 1 = “Strongly Disagree”) are those that the respondents have deemed to be the most important. Of

the largest 5 means, only 1 of them is a construct from the ‘relative benefits’ factors (relating to time), which provides an initial indication that, currently, people are more concerned about the risks than the potential benefits. This may be due to the current immaturity of the offering and the lack of exposure that the general public has to government services on-line.

The largest means are those relating to safety, confidentiality and reliability. This is a potentially important observation given that the only potential barrier included within the attitude based models is the ease of use of the technology option. It is interesting to note that a question (“prepared to pay for the online service”, 2.05) within the cost construct has the lowest mean for all questions across constructs, indicating that people certainly would not expect to pay for electronic service delivery even if the level of service exceeded other methods.

Factor Analysis

Exploratory factor analysis was used to identify the constructs that characterise the attitudes towards the on-line delivery of public services. To identify the number of key (also called principal) factors that explain the majority of the variance within the data and satisfying the assumptions of the test the principal component method was used [15]. Tables 3 and 4 summarize the results.

Table 3: Results of factor analysis for 9 extracted factors

Question	Candidate Factor	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9
Q1	Easy	-0.104	-0.008	-0.065	-0.026	0.072	0.026	-0.109	0.419	-0.086
Q2	Time	0.131	0.150	-0.002	0.121	0.162	-0.190	0.170	0.592	0.193
Q3	Safe	-0.006	-0.051	0.017	-0.258	0.072	-0.131	-0.027	0.016	-0.043
Q4	Convenience	0.215	-0.139	0.155	0.085	0.017	-0.218	-0.039	0.272	0.095
Q5	Visual	0.505	0.120	0.011	0.033	0.003	0.081	-0.047	-0.026	-0.048
Q6	Easy	0.093	-0.021	0.030	-0.114	0.151	0.484	-0.169	0.079	-0.084
Q7	Reliable	0.080	0.003	-0.001	0.162	0.257	0.352	-0.046	0.103	0.070
Q8	Visual	0.994	-0.102	-0.154	-0.046	0.073	-0.130	-0.008	-0.092	-0.133
Q9	Time	0.204	0.152	0.199	-0.016	0.236	0.111	0.253	0.168	-0.244
Q10	Control	0.235	0.095	0.198	-0.084	-0.041	0.180	-0.128	0.351	-0.038
Q11	Personalise	0.098	0.321	-0.007	0.091	-0.044	-0.054	0.191	0.277	-0.271
Q12	Convenience	0.287	0.088	0.037	-0.058	-0.230	-0.129	-0.060	0.395	-0.108
Q13	Reliable	-0.057	-0.058	0.282	-0.110	0.108	0.567	0.026	0.063	0.013
Q14	Avoid	-0.003	0.118	-0.001	0.667	0.063	-0.145	-0.056	0.066	-0.167
Q15	Time	0.119	-0.049	0.309	0.176	0.040	-0.095	-0.267	0.273	0.128
Q16	Cost	0.157	0.346	0.062	0.252	0.196	0.020	0.042	-0.003	-0.131
Q17	Reliable	0.097	0.060	0.166	0.105	-0.065	-0.047	0.747	-0.080	0.052
Q19	Easy	-0.050	-0.070	0.182	0.133	0.274	0.259	-0.099	0.248	0.322
Q20	Time	0.096	-0.199	0.246	0.215	0.155	0.067	-0.170	0.126	0.338
Q21	Control	0.064	0.458	0.196	0.017	0.034	-0.031	-0.120	0.035	-0.085
Q22	Avoid	0.099	0.297	0.250	-0.284	0.109	-0.042	-0.132	0.178	0.022
Q23	Safe	-0.079	0.176	0.682	-0.018	-0.141	-0.041	-0.060	-0.108	0.013
Q24	Cost	0.012	0.592	0.029	0.090	0.023	0.042	-0.068	0.012	0.045
Q25	Person	0.033	0.168	0.114	-0.100	0.073	-0.012	-0.012	-0.072	-0.221
Q26	Easy	-0.107	0.130	0.129	-0.060	0.210	-0.211	-0.255	-0.008	-0.178
Q27	Safe	0.048	0.213	0.029	-0.256	0.234	0.033	-0.028	0.098	-0.176
Q28	Enjoyable	0.182	0.185	-0.115	0.080	0.042	-0.049	0.004	-0.096	0.772
Q29	Person	-0.146	0.163	-0.106	-0.241	-0.048	-0.243	-0.240	0.222	-0.216
Q30	Confidential	0.042	-0.007	0.024	0.045	-0.120	0.540	-0.094	0.002	-0.012
Q31	Enjoyable	0.165	-0.090	-0.030	0.052	-0.004	-0.044	0.065	0.073	0.823
Q32	Reliable	0.180	0.100	0.327	-0.142	0.204	-0.049	-0.175	0.024	0.103
Q33	Easy	-0.009	0.106	0.157	0.318	0.254	0.080	-0.167	0.102	-0.278
Q34	Enjoyable	0.078	0.085	-0.076	-0.124	0.737	0.090	-0.085	-0.015	-0.052
Q35	Reliable	0.006	0.030	-0.092	-0.048	0.067	-0.032	0.609	0.048	0.028
Q36	Visual	0.020	0.085	-0.134	-0.005	0.400	0.109	-0.024	0.089	-0.251

Source: Fieldwork n=111

Table 4: New constructs and corresponding reliabilities

	Factor	Reliability
Relative benefits	Avoid interaction	0.52
	Cost	0.66
	Time	0.62
Barriers	Experience	0.78
	Information quality	0.67
	Financial Security	0.70
	Low stress	0.68
	Trust	0.79
	Visual appeal	0.67

Source: Fieldwork

As per Table 3 above, 9 factors were identified (High factor loadings (>0.5) have been highlighted in bold, while moderate loadings (>0.3) have been highlighted in light grey boxes), 4 of which are original factors, and 5 are new factors. Whilst the relative benefit factors of avoid interaction, cost and time remained, the individual factors for convenience, control and personalisation no longer existed. This result does not agree with the studies that have identified these very factors, potentially because of the different application, that is government services over the Internet.

Within the barriers factors, easy to use, security, confidential, reliable and enjoyable have all been replaced with factors that are a combination of the items within the original factors. This is a significant result, since the attitude-based models (such as the Technology Acceptance Model) all have 'easy to use' as the single barrier to adoption. Here, easy to use was not found to be a factor used in evaluating such technology options, but there were five other barrier factors: experience, financial security, information quality, low stress and trust.

An important observation is that the reduction in factors has come from the relative benefits side, rather than the barriers, indicating again that the barriers to use are especially important in determining whether people will adopt public sector on-line service delivery.

Table 4 indicates acceptable reliability (above 0.6) and thus the results are representing people's attitudes although the 'avoid interaction' factor requires further validation through future research. Since the items that load onto each factor (loading > 0.3) do not load onto any other factors (loadings all < 0.3), then both convergent validity (items yield comparable results) and discriminant validity (items do not 'characterise' other constructs) can be inferred [16].

Hypotheses Testing

Whilst the nature of the data is ordinal (use of likert scale for each statement considered on their own), the use of parametric tests is warranted, in line with previous research reviewed earlier in this paper and with the behavioural sciences in general, as the underlying scale is continuous for each construct [17]. The assumptions of the tests used, namely linearity, homoscedasticity (the latter two assumptions were checked after generating scatterplots), random sample, normality and independence of observations are here all satisfied. Pearson linear correlation and multiple linear regression were performed below to test the research hypotheses.

Result Hypothesis H1

H₁: Each identified factor does not predict the intention to use the technology service delivery option

Before testing whether there is actual dependency between the 9 factors and willingness to use, it is useful to investigate whether there is any potential relationship by considering the correlation between each of the factors and 'willingness to use'. Pearson Product-Moment Correlation was used for that purpose (Table 5).

Table 5: Correlation between new factors and 'willingness to use'

Factor	r	r²	Sig. (2-tailed)
Avoid interaction	0.182	0.033	0.061
Cost	0.478	0.229	0.014
Time	0.763	0.582	0.000
Visual appeal	0.328	0.108	0.042
Experience	0.363	0.132	0.002
Financial security	0.651	0.424	0.001
Information quality	0.525	0.276	0.021
Low stress	0.307	0.094	0.033
Trust	0.614	0.377	0.000

Source: Fieldwork n=111

All results were reported as statistically significant at the 95% confidence level except for the 'avoid interaction' factor. Therefore it indicates that there is a relationship between willingness to use and each of the factors identified except for the 'avoid interaction' factor.

More specifically there is a strong correlation ($r \geq 0.5$) between time, financial security, trust, information quality and willingness to use the government online service, and a medium correlation between cost, experience, visual appeal, low stress and willingness to use the government online service. This is reflected in the variance shared by the variables (r^2), with time helping to explain 58% of the variance in respondents' scores on the willingness to use scale, with financial security at 42%, trust at 38%, information quality at 28%

and cost at 23%. The other factors only have an explained variance of 15% or lower.

Since the correlation analysis demonstrated a relationship between some of the constructs, a multiple linear regression analysis was performed to investigate whether any of the factors actually predict willingness to use the technology and see which variables have the greatest effect. Table 6 shows the results obtained.

Table 6: Results of multiple linear regression

	Sum of Squares	df	Mean Square	F	Sig.
Regression	53.377	9	5.931	40.923	0.015
Residual	18.695	101	0.145		
Total	72.072	110			

R	R²
0.566	0.320

	Unstandardized Coefficients	Std. Error	Standardized Coefficients	t	Sig.
	B		Beta		
(Constant)	-2.293	0.429		-5.35	0.000
Avoid interaction	0.040	0.032	0.061	-1.24	0.216
Cost	0.039	0.014	0.160	2.77	0.006
Time	0.168	0.019	0.519	8.96	0.000
Visual appeal	0.030	0.025	0.065	-1.21	0.228
Experience	0.001	0.016	0.002	0.04	0.970
Financial Security	0.097	0.027	0.233	3.53	0.001
Information quality	0.038	0.044	0.191	3.09	0.004
Low stress	0.013	0.027	0.026	0.46	0.645
Trust	0.072	0.023	0.200	3.18	0.002

The interpretation of the results in Table 6 is that the linear combination of the factors was significantly related to the willingness to use the technology self-service option, accounting for approximately 32% of the variance ($F(9,101) = 40.923$, $p < 0.05$).

It can be seen that the strongest significant predictors of willingness to use the technology at the 95% confidence level, are: Time, Financial Security, Trust, Information quality and Cost. In other words the hypothesis is rejected for these factors and accepted for the factors of avoid interaction, visual appeal, low stress and experience.

5 Discussion and Conclusion

The present research identified nine factors that are shown to be reliable measures for characterising the attitudes towards on-line public service delivery. These nine factors were either slight modifications of the original factors ensued from previous studies, or totally new factors; 3 of which were relative benefits (time, cost and avoiding interaction) and 6 of which were barriers to adoption (experience, information quality, financial security, low stress, trust and visual appeal).

The test results showed that all factors except avoid interaction, correlated with a willingness to use electronic government services; time, cost, financial security, trust and information quality were the significant predictors of usage. This result indicates that the previous models are restricted in that they do not consider the barriers to adoption, and that the benefits of usage will never be realised if these concerns are not addressed. This supports the results obtained for the attitude models in previous research that only capture 50% of the usage intention [7], and that success modifications have only increased this percentage incrementally [8]. It is proposed here that those models already capture the majority of the usage intention from the benefits perspective, but that significant advances will not be achieved unless the barriers to adoption are incorporated.

Furthermore, the results differ from some of the published literature in that ease of use and some of the perceived usefulness aspects did not emerge as important from the results. This may be because of previous applications [6, 4] which were predominantly applied in the work environment to technologies introduced for employees, rather than to the Internet.

This research can significantly help public sector managers in better understanding why individuals may choose to receive public services via online channels rather than by more traditional means, and help them to draw strategies for enticing people to use such channels.

Thus, from a marketing perspective, the factors identified that predict a willingness to use on-line service delivery could form the basis of a promotion campaign. Guildford Borough Council [18] has recently distributed information about the convenience benefits of their council tax website. However, within this research convenience was not found to be one of these factors; the literature could focus more on giving assurances to address the concerns of trust, financial security and information quality, in addition to highlighting the benefits of saving time and money (if appropriate).

There are aspects of the research that may limit the interpretation of the results. Firstly, the data were collected solely in Guildford, which is not necessarily representative of the UK population. The sampling method used in this research, namely stratified random

sampling, may however reinforce the validity of the results obtained here.

Further study is recommended to both validate the current scales identified in this research and to investigate whether other factors emerge. The current study could thus be extended to incorporate additional factors such as in own ability [23] to explain more of the variance in the willingness to use the technology.

Appendix 1: Relative benefit factors sources

Factor	Source references	Notes
Avoid personal interaction (no necessity to interact)	Forman and Ven (1991) Hansen (1995) Meuter et al (2000) Prendergast and Marr (1994)	
Control (ability to exert more control)	Cabinet Office (1998) Dabholkar (1996) Liao and Cheung (2002) Zhu et al (2002)	This can be expressed as giving empowerment to the individual
Convenience (ability to receive service how and when required)	Cabinet Office (1998) Meuter et al (2000) Szymanski and Hyse (2000) Zhu et al (2002)	This factor relates to the electronic service being more accessible and available
Cost (ability to save money)	Liao and Cheung (2002)	Includes savings to both the individual and the organisation providing the service
Personalisation (ability to tailor to the individual)	Van Riel et al. (2001)	Includes the technical aspect of being able to customise a public sector website.
Time (ability to save time with the service)	Berkley and Gupta (1994) Dabholkar (1996) Hansen (1995) Liao and Cheung (2001, 02) Meuter et al (2000)	Includes the time spent queuing at government offices or on the phone and also includes the responsiveness of the service delivery.

IT literacy [19], prior experience of using online commercial services [20, 21], culture [22] and confidence

Appendix 2: Barrier factors

Factor	Reference	Notes
Confidentiality (Personal data kept private)	Cabinet Office (1998) Van Riel et al (2001) Zhu et al (2002)	Relates to 'Assurance' SERVQUAL dimension
Easy to use (delivery mechanism has to be easy to use)	Agarwal and Prasad (1998) Dabholkar (1996) Lederer et al (2000) Meuter et al (2000)	
Enjoyable (experience of use should be enjoyable)	Dabholkar (1996) Davis et al (1989) Liao and Cheung (2001)	
Reliable (has to have required and trusted services)	Berkley and Gupta (1994) Evans and Brown (1988) Hansen (1995) Zhu et al (2002)	This factor also includes accuracy and currency (up-to-date) of the information on the website. Direct relationship with 'Reliability' SERVQUAL dimension
Safe (secure with respect to entering financial details)	Cabinet Office (1998) Berkley and Gupta (1994) Evans and Brown (1988) Szymanski and Hyse (2000) Liao and Cheung (2001, 2002)	
Visual appeal (website should look good)	Lederer et al (2000) O'Cass and Fenech (2003)	A technical attribute of the website itself, and can be considered as a technical service quality attribute

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Tracking a Web Site's Historical Links with Temporal URLs

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Abstract

The historical links of a web site include the URLs invalidated due to web site reorganization, document removal, renaming or relocation, or links to document snapshots, which are defined as the document's contents as of a specific point in time. Tracking historical links will allow users to use out-of-date URLs, retrieve removed documents and document snapshots. This paper presents a logging and archiving scheme to track a document's history of changes, and a Temporal URL scheme for users to submit a URL with temporal requirements. With the proposed schemes, a web site is able to track its historical links and provide better searching and information for its users.

1. Introduction

A web site is a system of integrated web documents embedded with links to reference related documents. At any given time, a Uniform Resource Locator (URL) uniquely identifies a document on the Internet. All URLs have the same format: <protocol>://<host>/path-to-document. The <protocol> specifies the method to be used by the browser to communicate with the web server. Common protocols include http, ftp, gopher, etc. The host name is the web server that stores the document. The path to the document is a sequence of directory names and the document name. URLs are also known as the addresses, or paths, of documents on the Internet.

URLs are temporal and exist only for a limited period of time. There are many causes that will render a URL invalid: the host may cease to exist; the host may reorganize by changing its directory structure, hence changing the path to a document; a document may be renamed, deleted, or moved to a different directory. The document may no longer exist or have a new URL.

URLs are published information that may be out-of-date. Internet users gather the URLs of their interests from many sources such as references in books and documents, web page hyperlinks, results of searching with search engines, etc. Very often those published URLs may already be invalid. Requesting a document with an invalid URL may cause a file-not-found error (HTTP 404). Some websites do not handle this error and simply let the browser display the error code. Some web sites redirect users to a default error-handling page typically equipped with search tools. Searching takes

time and may not be successful. Searching web sites storing a large amount of documents is particularly tedious and unfruitful. It may produce a large number of relevant documents but may not pinpoint the document requested by users.

The file-not-found error may be triggered by many causes such as: 1. The document may have never existed in the web site. 2. The document may be deleted. 3. The document may be renamed or relocated to another directory. Rather than simply displaying a file-not-found message, a web site will improve its services by handling each cause separately. For the first case, returning a message such as "file never exists" is more informative. For the second case, returning a message such as "file no longer supported" is appropriate. For the third case, the web site can redirect users to the document's new URL.

Even valid URLs don't necessarily retrieve the user's desired document. A URL may point to a document that is different from the one it pointed to earlier. This may happen because of the renaming of documents and directories. For instance, a document A may be renamed to C and another document B may be renamed to A; hence the URL originally pointing to A is now point to a different document. It may also happen when a web site removes a URL but later reinstates the URL for another document. Users submitting such a URL may get an unwanted document.

A document may have gone through several changes. A URL typically retrieves the current version of a document and its contents may be different from the last download. There are times when users would like to see the previous versions of a document. These previous versions are snapshots of a document. A document snapshot is defined as the document's contents as of a specific point in time. Studying a document's snapshots may help users identify trends and patterns of changes in a document.

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. Tracking historical links basically means recording the time and the type of changes that occurred to a document and its URL. It enables a web site to retrieve the document associated with an out-of-date URL submitted by users, deleted documents, and document's snapshots. This will improve

Web Document

	Added	No change	Relocated/ Renamed	Modified	Deleted
No change	New URL	URL current	Old URL invalid/ New URL	URL current/ Archive snapshot	Old URL invalid/ Archive
Reorganized	Old URL invalid/ New URL	Old URL invalid/ New URL	Old URL invalid/ New URL	Old URL invalid/ New URL/ Archive snapshot	

Figure 1: Effects of web site reorganization and web document changes.

a web site's searching ability and provide better information for users.

Tracking changes has been the research topic in many areas such as managing database snapshots [1], materialized views [4], and document versions [6]. Those researches may focus on tracking the changes (deltas) [5] or tracking document's snapshots. Using a log to record changes [2] [3] and archiving the many versions of a document are typical methods in tracking changes. This research proposes a logging and archiving scheme for tracking historical links and proposes a Temporal URL scheme to retrieve document snapshots. The objectives of this scheme are: 1. For an invalid URL the scheme will be able to distinguish if the document is non-existent, or no longer supported, or it has a new URL so that appropriate action can be taken. 2. For a valid URL the scheme will allow users to retrieve the document snapshots. 3. For a valid URL that retrieves an incorrect document, the scheme will allow users to resubmit the URL and inform the web site to process the URL as a historical link.

An analysis of the problem and the designs of solutions are presented in Section 2. The temporal URL scheme and algorithms for processing historical links are presented in Section 3. Section 4 is a summary.

2. Problem Analysis and Solution Designs

2.1 Problem analysis

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 other 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, either the difference between the old and the current version needs to be recorded so that the snapshot can be reconstructed, or the old version is archived. Tracking the difference between two unstructured documents such

as web documents is not easy. Here, archiving is assumed. A deleted document is archived as well for later retrieval.

Figure 2 illustrates the progression of a web site. T_0 is the time when the web site is initiated, and T_i denotes a point in time when its contents change. Period i is the interval of time between T_i and T_{i+1} . Assuming the path of a valid URL is unique within the web site, a valid path leads to a document currently published. In the sequel, paths and URLs are used interchangeably. There are two sets of paths in period i : VP_i , a set of all valid paths, and HP_i , a set of paths becoming historical at T_i . Note that HP_0 is null. In Figure 2, paths that produce two dotted arrow lines such as P_1 in period 0, and P_4 and P_5 in period 3 represent documents that are renamed or relocated. In this case, only the document's path has changed but the document has not changed. Therefore, there is no need to archive any documents, but it is necessary to chain the old path to the new path in order to track the change. Paths that produce two solid arrow lines such as P_3 in period 1, and P_3 and P_5 in period 2 represent documents that are modified. In this case, the path is still valid but the document before the change needs to be archived as the document's snapshot. Paths that produce one solid arrow line, such as P_2 in period 1 and P_3 in period 3, represent documents that have been deleted. Those documents must be archived.

A path in HP_i may be repeated in HP_j , just as P_3 is repeated in HP_2 and HP_3 . To make a historical link unique, the time the path was published is added to the path. Hence P_3 in HP_2 is identified as $P_3 + T_1$ and P_3 in HP_3 is identified as $P_3 + T_2$. Similarly, a current path may duplicate a path in the historical links, as is the case of P_1 . By adding its published time, $P_1 + T_3$ is distinguishable from the historical link $P_1 + T_0$. The historical links of a web site before T_i are the union of sets HP_0 to HP_{i-1} , ($HP_0 \cup HP_1 \cup \dots \cup HP_{i-1}$). Assuming T_i is the last time the web site changed then the web site's historical links are the unions of sets HP_0 to HP_i , and the current links are VP_i . The union of historical links and the current links represents all the paths that are currently in use or have been used in the past. Every link in the union is uniquely identified by the value (path + path published time). This composite value is an example of a

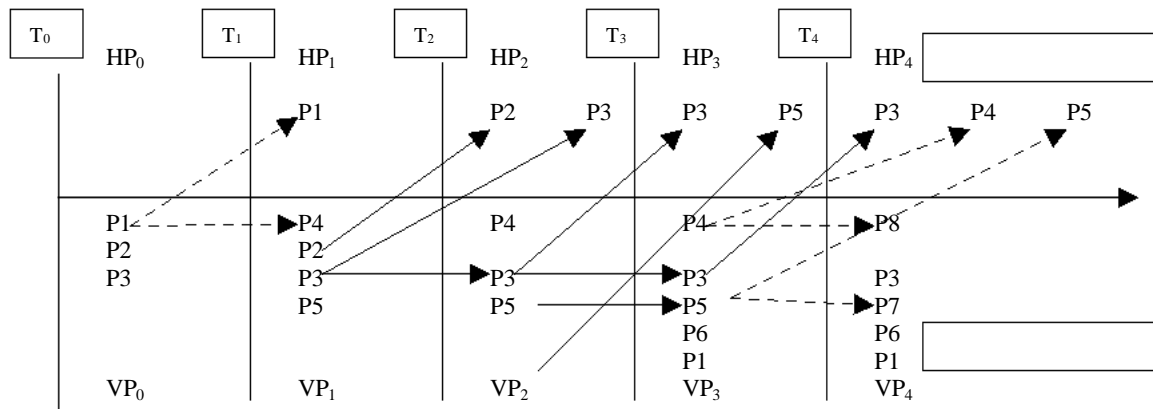


Figure 2: An example of the progression of a web site with changes since its creation.

Temporal URL (discussed in Section 3). For any path P_x published at time T , the temporal URL ($P_x + T$) uniquely identifies a document that is currently or was once associated with P_x at time T .

2.2 Solution Designs

This section explains the scheme to track the historical links. The scheme has two major components: logging the changes to web documents and archiving deleted documents including document snapshots. The log, named TemporalURLLog, is designed to keep the history of changes to web documents. It has four fields: URL, PublishDate, ExpireDate, and NewURL. The URL field records a document's path; the PublishDate records the time the document is published; the ExpireDate field records the time this URL becomes invalid; should the change create a new URL for the document, the NewURL field records the document's new URL and serves as a link to chain all log entries related to the same document together. This log has a composite key of URL + PublishDate. The value of URL + PublishDate uniquely identifies a document in a web site's history. The Archive is a directory that stores deleted files and document snapshots. Those archived files are saved in the Archive using URL + PublishDate as file name. The log is maintained according to the log maintenance algorithm described below:

TemporalURLLog maintenance algorithm Changes to web documents are recorded in the log by the following rules:

New document: When a new document is added to the web site, a new entry is entered with its path and the time the document is published. The ExpireDate and the NewURL are set to null. Hence, log entries with a null ExpireDate are current document entries. Initially, all current documents have an entry in the log with null ExpireDate and null NewURL.

Deleted document: The log entry associated with the document is the entry of which the URL equals the document's URL with a null ExpireDate. First, it locates the entry and changes its ExpireDate to the time the document is deleted. Then, it saves the deleted document in the Archive with URL + PublishDate as file name.

Modified document: When a document is modified, its old version becomes a snapshot and its new version is treated as a new document. The log entry associated with the document is the entry of which the URL equals the document's URL with a null ExpireDate. First, it locates the entry and changes its ExpireDate to the time the document is modified. Then, it saves the old version in the Archive with URL + PublishDate as file name. Then, it adds a new entry with the same URL and the PublishDate is set to the time the document is modified. The ExpireDate and NewURL are set to null.

Consequently log entries with a non-null ExpireDate and a null NewURL may be related to snapshots or deleted documents. For such an entry, if there exists another entry with the same URL and its PublishDate equals to this entry's ExpireDate then this entry is a snapshot entry and the snapshot it associates with can be retrieved from the Archive using URL + PublishDate as its file name. The snapshot is valid from the PublishDate to the ExpireDate. Otherwise, the entry is associated with a deleted document which can be retrieved from the Archive using URL + PublishDate as its file name.

Relocated or renamed page: When a document is relocated or renamed, its old URL is expired and a new URL is created. The log entry associated with the document is an entry with the URL equal to the document's URL and with a null ExpireDate. First, it locates the entry and changes its ExpireDate to the time the document is relocated or renamed and changes its NewURL field to the document's new URL. Then, it adds a new entry with the new URL and the PublishDate is set to the time the document is relocated or renamed.

Hence, log entries with non-null NewURL field help chaining a document's log entries.

Using this log maintenance algorithm for the changes described in figure 2, the contents of the TemporalURLLog are shown in Figure 3, and there are five files in the Archive: P2T₀, P3T₀, P3T₂, P5T₁, and P3T₃.

URL	PublishDate	ExpireDate	NewURL
P1	T ₀	T ₁	P4
P2	T ₀	T ₂	Null
P3	T ₀	T ₂	Null
P4	T ₁	T ₄	P8
P5	T ₁	T ₃	Null
P3	T ₂	T ₃	Null
P3	T ₃	T ₄	Null
P5	T ₃	T ₄	P7
P6	T ₃	Null	Null
P1	T ₃	Null	Null
P8	T ₄	Null	Null
P7	T ₄	Null	Null

Figure 3: The contents of TemporalURLLog based on changes described in Figure 2.

3. Searching with TemporalURLLog

With the TemporalURLLog, a web server is capable of processing historical links involving deleted documents, out of date URLs, and document snapshots. For instance, using the log in Figure 3, it is possible to determine that:

- . A URL P2 valid between T₀ and T₁ is deleted, and the document it pointed to is in the Archive with the name P2T₀.
- . A URL P3 has been modified repeatedly and is eventually deleted. All documents associated with P3 can be found in the Archive.
- . An old URL P5 is now renamed to P7. It has been modified on T₃, and a copy of its snapshot can be found in the Archive with the name P5T₁.
- . The log is able to determine that a historical line P1 is now renamed to P8.
- . A URL P12 has never existed in the web site.

This section presents a Temporal URL scheme and algorithms for searching documents associated with historical links.

Requesting historical documents with temporal URL

A temporal URL is a URL submitted with temporal requirements of which the documents associated with the URL must meet. A typical way to submit additional information with a URL is through query strings. A query string is a set of name=value pairs appended to a URL. It is created by adding a question mark (?) immediately after a URL followed by name=value pairs

separated by ampersands (&). Two types of temporal URLs are designed:

1. The URL is not current: When the URL is not current, a keyword IsHistorical can be appended to the URL to indicate users are searching for documents associated with a historical link. The query string is:

?IsHistorical

2. The URL is current: The document associated with the URL may have gone through modifications. There are situations where users may need to access a document's snapshots at different points of time. Special keywords can be created for users to specify temporal requirements for snapshots. Some typical keywords are:

?SnapshotAsOf=date

?SnapshotsBefore=date

?SnapshotsAfter=date

?SnapshotsBetween=date1&And=date2

The ?SnapshotAsOf=date query string will retrieve a document's snapshot at the specified date; others will retrieve all snapshots that meet the date criteria. A web site may choose to implement the types of temporal query strings to fit its needs.

Algorithms for processing temporal URL are presented below.

Forward search to locate documents associated with a historical link

This algorithm processes the ?IsHistorical temporal query string submitted with a URL Px and searches the TemporalURLLog to locate all the documents related to a historical link. In the TemporalURLLog, entries for a URL may have three patterns of changes: 1. If a URL has a log entry with a non-null PublishDate and null ExpireDate field then it is a current URL; such as P6 in figure 3. 2. If all entries of a URL have a non-null PublishDate, ExpireDate and null NewURL field, then this URL is deleted from the web site; such as P3 in Figure 3. 3. If a URL has a log entry with a non-null NewURL field, then it has been renamed, and the log entries for the new URL may again have these three patterns of changes. Because a URL may be used several times in the life of a web site, such as P1, this algorithm will locate all documents associated with the historical link.

In the algorithm, SetPx is a set of records where URL equals Px. If SetPx is null then Px never existed. Otherwise, a loop is used to study change pattern. It applies a forward search that will trace down all related entries until reaching the last entry. To move forward, an entry's successor can be found and processed by the following rules:

1. If the entry has a null NewURL then its successor must have the same URL and the successor's PublishDate

Algorithm Forward Search

Inputs: TemporalURLLog, historical link Px

Outputs: Links to all documents related to Px

```

SetPx = { Select * From TemporalURLLog Where URL = Px And Not ExpireDate = Null
          Order By PublishDate }

If SetPx isNull Then
    Return Message: Document never exists
Else
    For Each Record R in SetPx
        If R.NextURL Is Null Then
            If Not Exist {Select * From TemporalURLLog Where
                          URL = R.URL And PublishDate = R.ExpireDate} Then
                Return LinkArchive(R.URL + R.PublishDate)
            End if
        Else
            PxLink = R.NextURL
            Do
                SetPxLink = { Select * From TemporalURLLog Where URL = PxLink
                              Order By PublishDate }
                NextLoop = False
                For Each Record R in SetPxLink
                    If R.ExpireDate isNull Then
                        Return LinkDocument(R.URL)
                    Exit Do
                Else
                    If R.NewURL IsNull Then
                        If Not Exist {Select * From TemporalURLLog Where
                                      URL = R.URL And PublishDate = R.ExpireDate} Then
                            Return LinkArchive(R.URL + R.PublishDate)
                        Exit Do
                    End if
                Else
                    PxLink = R.NewURL
                    NextLoop = True
                    Exit For
                End if
            End if
        End if
    Next
    If NextLoop = False Then
        Exit Do
    End if
Loop
End if
Next
End if

```

must equal the entry's ExpireDate. If no such successor is found, then this entry must have been generated due to a deletion and its archive name is created with this entry's URL and PublishDate. This algorithm returns a link referencing the archived document.

2. If the entry has a non-null NewURL then it must have a successor with a URL equal to the NewURL and the PublishDate equals to the entry's ExpireDate. Renaming or relocation must have generated the successor. When such a successor is found, a new loop is started to trace down the changes in the new URL. Although Px is not current, this new URL can be current if there exists an entry with the new URL and a null ExpireDate; a link referencing the new document is

returned. Otherwise, the new URL eventually is deleted and the algorithm returns a link referencing the archived document.

To illustrate, if P5?IsHistorical is submitted, initially SetPx contains two entries: (P5, T₁, T₃, Null), (P5, T₃, T₄, P7). The first entry's NewURL is null but the next entry's PublishDate equals the first entry's ExpireDate indicating that this is a modification. The second has a non-null NewURL indicating that it has been renamed. After processing the second entry, a new loop is started using the NewURL P7 to search. In the second loop, SetPx contains: (P7, T₄, Null, Null). Since its ExpireDate is null, this is a current URL and P7 is returned.

Algorithm Backward Search

Inputs: TemporalURLLog, valid URL Px, snapshot time T

Output: Px's snapshot at time T

```
CurrentEntry = {Select PublishDate From TemporalURLLog Where URL = Px and ExpireDate = Null}
```

```
If CurrentEntry.PublishDate <= T Then
```

```
    Return Document(URL)
```

```
Else
```

```
    Candidate.URL=CurrentEntry.URL
```

```
    Candidate.PublishDate=CurrentEntry.PublishDate
```

```
    Candidate.ExpireDate=Null
```

```
    PD=CurrentEntry.PublishDate
```

```
    Do
```

```
        PreviousEntry={Select * From TemporalURLLog Where URL=Px And ExpireDate=PD}
```

```
        If PreviousEntry Exists Then
```

```
            Candidate.URL=PreviousEntry.URL
```

```
            Candidate.PublishDate=PD
```

```
            Candidate.ExpireDate=PreviousEntry.ExpireDate
```

```
            PD=PreviousEntry.PublishDate
```

```
            If PD < =T Then
```

```
                Return Archive(Candidate.URL + Candidate.PublishDate)
```

```
            Exit Do
```

```
        End if
```

```
    Else
```

```
        PreviousEntry={Select * From TemporalURLLog Where NewURL=Px And  
                        ExpireDate=PD}
```

```
        If PreviousEntry Exists Then
```

```
            PD=PreviousEntry.PublishDate
```

```
            IF PD < =T Then
```

```
                If Candidate.ExpireDate=Null Then
```

```
                    Return Document(Candidate.URL)
```

```
                Else
```

```
                    Return Archive(Candidate.URL+ candidate.PublishDate)
```

```
                End if
```

```
            Exit Do
```

```
        Else
```

```
            Px = PreviousEntry.URL
```

```
        End if
```

```
    Else
```

```
        If PD > T Then
```

```
            Return Message: Snapshot Does not exist at T
```

```
        Else
```

```
            If Candidate.ExpireDate=Null Then
```

```
                Return Document(Candidate.URL)
```

```
            Else
```

```
                Return Archive(Candidate.URL+ candidate.PublishDate)
```

```
            End if
```

```
        End if
```

```
    Exit Do
```

```
End if
```

```
End if
```

```
Loop
```

```
End if
```

If P1?IsHistorical is submitted, initially SetPx contains only one entry: (P1, T₀, T₁, P4). Since its NewURL is non-null, a new loop is started and SetPxLink is created using P4 to search; SetPxLink contains one entry: (P4, T₁, T₄, P8). Because this entry's NewURL is non-null, a new loop is started to create a new SetPxLink with one entry: (P8, T₄, Null, Null). This indicates P8 is current and a reference to it is returned.

Backward search for a document's snapshot at a specific date. This algorithm processes the query string ?SnapshotAsOf=T submitted with a URL Px and searches for the snapshot based on the specified date T. It assumes Px is a current URL to simulate a scenario in which users who are viewing a current document would like to view the document's snapshot at a point in time. The algorithm is briefly explained below.

It processes log entries backward starting from a document's current entry to trace back its changes in order to locate the snapshot. If the current URL's PublishDate is less than T, then the current document itself is its snapshot at T. Otherwise the backward search starts. To trace back, an entry's predecessor has one of the following properties:

1. Its URL equals the current entry's URL and its ExpireDate equals the current entry's PublishDate. This indicates the predecessor is an old version of the document and it is the document's snapshot from the predecessor's PublishDate to its ExpireDate.

2. Its NewURL equals the current entry's URL and the ExpireDate equals the current entry's PublishDate. This indicates the predecessor has been renamed or relocated.

Initially, the current document is treated as a candidate for the snapshot. Before reaching past time T, whenever an old version is found it becomes the new candidate for the snapshot. Note that an old document's life may span beyond its PublishDate. If a document Y is originally derived from a document X through a series of renaming or relocation, then this document's life span is from document X's PublishDate to document Y's ExpireDate. The search reaches the last entry when its PublishDate is before T or it no longer has a predecessor. If the last entry's PublishDate is greater than T then snapshot does not exist at T.

To illustrate, if a request $P7?SnapshotAsOf=T_2$ is submitted, the backward search will pick up three entries: (P7, T₄, Null, Null), (P5, T₃, T₄, P7), and (P5, T₁, T₃, Null). They show that the document associated with P7 has been unchanged since T₃ and was originally associated with P5 and renamed to P7 at T₄. The document has been modified at T₃. Therefore, the algorithm returns Archive(P5 + T₁) as snapshot. If $P7?SnapshotAsOf=T_3$ is submitted, the backward search will pick up two entries: (P7, T₄, Null, Null) and (P5, T₃, T₄, P7) and return Document(P7) as snapshot.

If a request $P8?SnapshotAsOf=T_0$ is submitted, the backward search will pick up three entries: (P8, T₄, Null, Null), (P4, T₁, T₄, P8) and (P1, T₀, T₁, P4). These show that the document associated with P8 has been renamed at T₁ and T₄. It has not been modified since T₀. The algorithm will return Document(P8) as snapshot.

This algorithm can be modified to process ?SnapshotsBefore=date, ?SnapshotsAfter=date, and ?SnapshotsBetween=date1&And=date2 temporal query strings by modifying the temporal conditions in the algorithm.

4. Summary

The historical links of a web site include the URLs invalidated due to web site reorganization, documents' removal, renaming or relocation, plus links to document snapshots. Tracking historical links will allow users to use out-of-date URL and retrieve removed documents and snapshots. This paper has two contributions: 1. It presents a logging and archiving scheme to track a document's history of changes. These changes include a document's creation, modifications, web site reorganizations, and deletion, which are recorded in a log. The log records a URL's publication date, expiration date, and the new URL it is assigned to, if applicable. Document snapshots and deleted documents are archived to support users who need historical documents. 2. It presents a temporal URL scheme for users to submit a URL with temporal requirements of which the documents associated with the URL must meet. A URL will retrieve a current document by default. With the temporal URL users may inform the web server to treat the URL as a historical link, or request the document's snapshots. Algorithms for processing the log and the temporal URL are also presented. With the proposed schemes, a web site is able to track its historical links and provide better searching and information for its users.

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E-Governments: Utilizing Customer Relationship Management (CRM) Platforms to Serve Citizens

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Abstract

In a democracy, elected governments are expected to meet the needs of their various constituencies in order to have an opportunity to continue in power. “Citizen” or “constituent” is legitimate stand-in for the letter “C” in Customer Relationship Management, accepted in the world of business. Currently, many CRM companies are prospecting the public sector organizations to market their products. The government markets, globally, are the fastest growing market for CRM systems in the upcoming years. This paper describes the goals of e-Government implementations and applications that characterize the nature of citizen service delivery initiatives in the public sector. The paper examines the differences between applying CRM in public and private sector. The paper goes on to discuss the application of four E-Commerce based CRM implementation strategies in the public sector and their outcomes in selected cases. The second part of the paper uses publicly available empirical data to investigate scope, extent and impact of global e-Government implementations.

1. Introduction

As democracy takes hold in more of the world's nations, governments feel more compelled to recognize their ultimate accountability to the citizens. Even benevolent autocracies, and one party governments have realized that citizen satisfaction is vital to remain in power. The move to e-Government has gathered momentum as a viable platform to make progress in that direction. Using advanced information and communication technology (ICT) and the capabilities of the world wide web (WWW) governments try to implement high level of service orientation to citizens and effectively managing relationships between them and the government personnel to minimize frustration and dissatisfaction.

SAP, a leading provider of enterprise management systems to organizations identifies the e-Government market as one characterized by the need for a “integrated solution... that empowers public administrators to better communicate and collaborate with its people and employees, while facilitating cost-efficient processes.”[SAP] This focus has been characterized as the paradigm of complex and one directional systems that broadcast information to citizen customers. A complementary approach, the paradigm of “interactivity”

is the focus of administrators in Europe [EDEN]. The goal is thus to streamline the delivery of citizen services on one hand, and on the other, make the services widely available in spite of barriers imposed by location, demographics, and ability to pay [Nigeria], and make them friendly, convenient, transparent and inexpensive[World Bank].

An internet search of case studies of e-Government implementations show a tremendous diversity in scope and characteristics [Chatt and Pratt] as well as degree of success [Prattapati and Chatt].

The next section will lay out the definition of E-Government as it diverges from that of e-Commerce and also establish a framework for evaluating its scope, extent and success.

2. e-Government: Definitions

E-Government refers to the use by government agencies of information technologies that have the ability to transform relations with citizens, businesses, and other arms of government [World Bank]. E-G differs from E-Commerce and E-Business in that the former does not focus on volume, revenue or profit maximization, but instead seeks improved governance procedures to connect better with and within civil society [Nigeria].

The direct conceptual benefits that are expected outcomes of E-G implementation are: a. Re-affirming the citizen centric organization of the government, b. Deliver citizen services where they are needed/sought rather than locating them only in government agency offices, c. Making it possible to access citizen services with seamless integration rather than requiring multiple points of contact, d. Transparency and ease of access to government information, e. Ability to complete remote transactions with government agencies.

The operational tasks that can accomplish these goals are described as: a. Handling all forms of customer contact, including telephone, face to face, e-mail and internet, b. Systems integration within and across agencies that serve citizens, c. Improvement in quality, efficiency and effectiveness of service delivery, d. Unified and updated access to full citizen contact history, e. Provides single point of enquiry for all citizen, f. Empowering staff to act to resolve issues, after backing them up with all necessary information [Aniteps]. Implementation of E-G must also consider adopting appropriate open source technologies that can support diverse operating platforms and

communications equipment that may be in use.

From the citizens' perspective, the outcomes of E-G will be demonstrated through: a. Ease of access to information about governance policies, b. Timely access to information regarding safety and security from threats both natural and otherwise, c. Ease of completion of transactions with government agencies, such as registration of events, voter registration, passport application, tax filing, exercising voting rights, registration of motor vehicles, and obtaining permits/licenses for personal and business reasons, among other things.

3. Impediments to E-Government

The sustained push toward E-G notwithstanding, the results have been mixed so far. Some citizens have been "turned off" by E-G. A study conducted by the UK government found information on the system to be inaccurate and out of date. Low usage by targeted citizens pointed to the inadequacy of the implementation and inability of the system to satisfy citizens' needs. A blue ribbon commission pointed out that to be successful, the E-G had to be more than simply moving existing operations to the internet [UK MP Report].

The primary impediments to implementing E-B have been characterized as a. Institutional weakness, b. Inadequate human resource capability, c. Lack of funding for infra-structural expenditures, d. Lack of facilities and institutions to flesh out the multi-layered system of vendors and technical support necessary to keep the system running, and e. Uncertainty over the choice of competing technology (hardware and software) that will maximize citizen acceptance [UNPAN]. From the citizens' perspective, apart from ease of access and usability, the over-riding concern is with security of transactions and integrity of system in preserving privacy of participants.

As more E-G systems come online, they seek to deal with the citizens' issues with increasingly sophisticated technology and improved business processes. However, addressing the macro impediments have been more difficult in a depressed global economic environment.

4. Impact of E-Government Initiatives

The impact of E-G implementation spans participative governance, economic efficiency and social responsibility. In addition, the promise of real time availability of information is expected to benefit the cause of transparency in government affairs and decrease perceived corruption.

The UNPAN 2001 benchmark study found the following status of its member states as shown in Figure 1.

Figure 1. E-Government status of UN members [UNPAN]

UN member states (total)	190
Some govt. web presence	169
National govt. website	84

Single entry portals	36
Sub-national govt. website	84
On-line transaction capacity	17

Using an index of E-G, [UNPAN] captures the member states relative sophistication in creating a platform to deliver information and services to all sections of its society. The researchers then assigned the member states to five hierarchical stages of E-G implementation.

In the "emerging" category are states that have been able to incorporate some information content in published web pages at some point. Information in the form of notices, some downloadable forms and possibly e-mail contact is published over the web. There are no procedures in place to keep the information updated. Syria, Cyprus and Mali fall into this category.

In the category of "enhanced" E-G, the countries show increased diversity and quality of on-line content, but the focus is more on political and public affairs rather than citizen services in the areas such as health care, education, environment etc. Georgia, Nigeria and Monaco are in this category.

In the "interactive" category, the citizens are not passive recipients but instead determine the content they seek, and also may choose the time and place to some degree in actually obtaining the same. Countries such as Argentina, Israel and Thailand are in this category, providing its citizens with a wide array of quality published information on demand and at their convenience.

The "transactional" category signifies ability to support not only information needs but also the secure completion of transactions involving payments and information products. In one case, a transaction over the web is sufficient to secure an electronic visa for border crossing at a later date. Australia, Norway and Singapore are examples of this group.

The "seamless" customer -centric system where all aspects of the government's functions are virtually organized to provide integrated one stop system customized to respond to the unique needs of the querying citizen-customer. This has not happened. The CAPPS system proposed by the Department of Homeland Security to process security of airline passengers proposes such integration, and has been subject of much controversy related to privacy and proper use of information.

The stages, characteristics and distribution of the 169 member countries with some form of E-G is shown in Figure 2.

Figure 2. Stages of E-Government of UN members

Stage	Characteristics	Members
Emerging	Limited basic information presented in static views, at the initiative of individuals	32
Enhanced	Regularly updated content	65

Interactive	Possible to download content and request services interactively	55
Transactional	Ability to complete payment transactions	17
Seamless	Integration across agencies to complete one-stop shop for most if not all citizen service requests	0

World Markets Research Center and Brown University reported a Global E-Government Survey in 2001, which noted an interesting phenomenon: 72 % of the E-Gs used the English language as at least one language of use. 45% of the sites were multilingual. This indicates a definite consideration of the global integration in today's world. The same study also provided an assessment of content type provided by E-Gs. It appeared that contact information (for follow up and possible resolution of enquiry) was the most common, with many sites providing links to databases or other sites to assist with the enquiry. The main findings are provided in Figure 3.

Figure 4. WMRC Findings

Characteristic	%
Websites with one stop or govt. portal	6
Websites with online execution capability	8
Websites with Links to database	41
Websites with Access to Publications	71
Websites with Privacy policies	6
Websites with Security policy	3
Websites with disability access	2

The findings indicate that even among the high end implementers of E-G, there is significant lack of assurance to public as to the security and integrity of the query and or transactions that are even possible. The perceived safety of using on-line access to government is a factor that effects the usage of such services by the citizens.

Another area of interest to the policy makers, particularly in the context of global economic development and poverty alleviation has to do with the "digital divide." The availability of government sites providing on-line services shows a very clear geographical bias. The prosperous regions of N. America and Europe stand in sharp contrast to the poorer regions of the world.

The next section of the study is going to look at some empirical data from published sources to examine the

following relationships:

1. Citizen use of E-G and Population Internet Usage
2. Citizen use of E-G and Human Development Index (provided by UNDP)
3. Citizen use of E-G and Perceived Safety of Transaction
4. Citizen use of E-G and E-Govt. Index Provided by UNPAN
5. Citizen use of E-G and Geographic Location
6. Citizen use of E-G and Perceived Corruption Level
7. E-Government Index and Perceived Corruption Level

5. Methodology

The data for the empirical analysis was obtained from published sources.

1. Taylor Nelson Sofres (2001) report a Government On-line study that surveyed respondents from 28 countries, querying a. levels of e-government usage, b. safety issues as a barrier to internet use.
2. UNPAN (2001) conducted a global survey of E-Government that developed an E-Government index and also examined the scope and extent of E-Government implementation.
3. World Markets Research Center (2001) also conducted a Global E-Government Study that focused on the contents of national government websites.

6. Analysis of Empirical Data

The results of the analysis will be reported at the conference.

7. Implications of Study and Recommendations for Policy and Future Research

The results of the analysis will be reported at the conference.

8. References:

Note: The paper version with references is available from the CD of conference proceedings.

Towards an Electronic Commerce Growth Stage Model

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Abstract

The advent of the digital economy and Electronic Commerce (EC) can be seen not as the development of existing commerce but rather as a new commerce pattern caused by Internet technology. There are many possible definitions of EC, but in this research we consider the definition of EC as the buying and selling of information, products, and services via Internet. The application of EC is diffusing into various areas such as merchandising, finance, education, advertising, entertainment and government. To better understand the shaping process of EC and to predict the direction of further diffusion, the growth stage model of EC is required.

It is difficult to find a growth stage model in relation to EC. Therefore, in this study, we divide the EC into a series of phases, then develop a model explaining the shaping process of EC, regarding major domains of EC such as economic, social, political and technical. To provide a theoretical basis for the growth stage model of the EC, we consider existing literatures about information systems, organization and industry life cycle and then suggest a growth stage model reflecting major characteristics of EC. The growth stage model of EC developed in this research can not only predict the direction of EC growth, but can also provide a useful model as guideline to organizations in planning EC.

Key Words: Digital Economy, Electronic Commerce Growth Stage Model, Shaping Process, EC Planning

1. Introduction

The advent of Electronic Commerce (EC) can be seen not as development of existing commerce, but rather as a new commerce pattern brought about by information technology, telecommunication network infrastructure, and Internet technology [31; 24; 9]. The definition of EC may be regarded in different ways but Kalakota & Whinston [21] defined it as buying and selling goods via network. Considering the application of EC diffusing into such various areas as company, merchandising, finance, education, advertising, entertainment and government, in this research, we define EC as all kinds of commerce activities in cyber space on the network of information communication technology (ICT) with a wide viewpoint. To understand the various areas of EC and to predict the

direction of the EC diffusion, the systematic framework is required [34].

The growth theory divides the growth stage, direction and diffusion aspects into some phases suggested by the peculiar characteristics. There are familiar growth stage theories such as Nolan's growth stage model [29], Utterback's organization innovation process model [37], McFarlan and Mckenney's technology diffusion model [27], Levitt's product life cycle theory [25] and Hofer's [15] and Grant's [13] industry life cycle model. However, among the various models of growth stage theory suggested by many researchers, it is difficult to find one that applies to EC. Therefore, in this study, we define EC into a series of phases and then develop a model explaining the shaping process of EC. To provide a theoretical basis for the growth stage model of EC, we consider existing literature about information systems, organization and industry life cycle, and then suggest a growth stage model reflecting the characteristics of EC. The growth stage model of EC developed in this research can not only predict the direction of EC growth but can also provide a useful framework as guideline to organizations in planning EC.

2. Theoretical Background

2.1 Review of Previous Research

This study review previous studies relevant to the growth stage models of information systems, organization, and industry to provide the theoretical background for an EC growth stage model. The most familiar growth stage model in IS is Nolan's Growth Stage Model [29]. Nolan's Growth Stage Model is the theory explaining the unique characteristics of each phase when an information system (IS) is adopted by an organization, being diffused. This is significant in allowing each organization to predict direction and then establish guidelines about IS planning and management. Nolan's Growth Stage Model is illustrated in Figure 1.

As can be seen in Figure 1, the growth stage of IS is divided into four stages namely: initiation, expansion, formalization and maturity. In the initiation stage, the organization introduces a computer to reduce cost in functional areas. In the expansion stage, electronic data processing (EDP) facilities are connected to a wide

variety of applications. EDP function is also expanded widely and the EDP managers' responsibility is increased. In the formalization stage, organizational control is used to regulate the growth of the computer use and the rising cost. To reduce the scope of cost rising, the organization

starts to strictly control the information system. In the maturity stage, information technology is diffused and integrated into various areas. Organization and information technology become combined, and the short-term supply and the long-term investment are balanced.

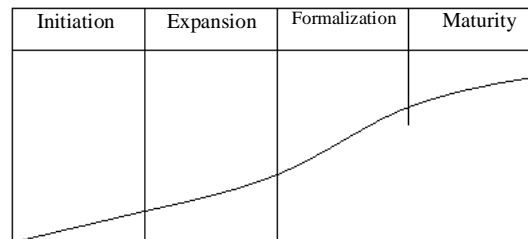


Figure1. Nolan's Growth Stage Model

Utterback [37] suggested a theory dividing the innovation process of organization into three phases: idea generation, problem solving, and implementation and diffusion. The idea generation phase is the integration of information about the consumer's need and technical methods to reduce the gap between the idea and the technical suggestions. The developing process of new products is started by acknowledging the development possibility of technology, and from this, new ideas and concepts are advanced. The problem solving phase is the process of analyzing the technical problems given in the idea generation step. In this step, the information for problem solving has to be instantly usable, and other research and development activity is required. The implementation and diffusion phase is the process of using new processes for manufacturing, the shipping of new products into the markets and the delivering of information for innovation to make economical influence. On the basis of Utterback's model, the adoption of information communication technology can be understood as being shaped through serious steps such as the general innovation process.

McFarlan and Mckenney [27] suggested a different four-step model to analyze the diffusion of new

technology in an organization. First is the technology identification and investment step. In this step, a new technology with potential profits is identified, and capital for the technology application is raised. Second is the learning and adaptation step of the technology. In this step, the user share their ideas about previous problem with the technology application. The user's experimentation in various areas is also encouraged. Third is the rationalization and management step. In this step, many techniques are developed through the effective application of the new technology to guarantee the confidence and permanency of investing in new skills. Fourth is the widespread technology transfer step. In this step the effectiveness and experience of the new technology is spread and technical basis is affirmed. The learning of the technology is also finished and the long-term strategy is established.

The product life cycle theory is generally accepted as the model that echos the human cycle being born, growing, maturing and declining, at last arriving at natural death [25]. As each product has its life cycle, industry too has also a life cycle [15], as can be seen in Figure 2.

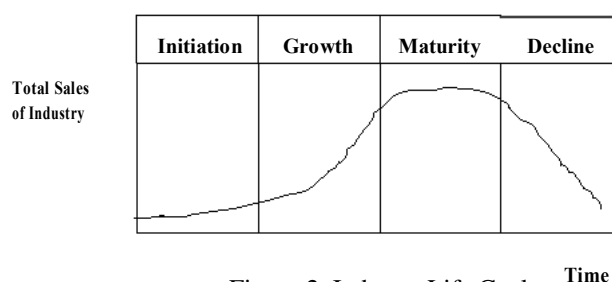


Figure 2. Industry Life Cycle

An industry grows through the initiation period. In the growth period, once a product is known to markets, the demand of the product has a tendency to rapidly increase. In the maturity period, the demand increase is slow-moving and diminishes. As it declines, the industry becomes a so-called 'decaying industry', with its scope constantly reducing. Major forces deriving industry life cycle is the pattern of demand increased. The demand

increase itself is regarded as the diffusion process of knowledge about the product. According to the progress of the industry life cycle, the demand is popularized from the high-income bracket, and the technology also becomes standardized [38]. Although, in the early stage, the product design is frequently changeable, the design becomes oriented for cost and durability, and then the difference disappears as standardization progresses.

Moreover, in the aspect of the production and distribution, at the early stage, the production is small scale. On entering the growth period, production scale becomes insufficient, but in the maturation and decaying period, over-production can cause a problem. The industry is usually a monopoly and oligopoly system of a few enterprises at the early stage. Gradually many new enterprises enter into the competition making it keen, and eventually, through the competition in price, many businesses withdraw. The major elements for the success

of each industry phase are different according to each step. For instance, in the early stage, product innovation is the major element. However, through the growth and maturation period, cost and process innovation becomes important. In the decaying period, cost reduction, the rationalization of industry facilities and the role of distribution and brand are important to take into account. On the basis of this review, Table 1 provides a summary of the previous research of the life cycle in terms of its strengths and weaknesses.

Table 1. Summary of Previous Research

Division Stage Model	Strength	Weakness
Nolan's Growth Stage Model [29]	<ul style="list-style-type: none"> ñEase of information planning ñEffective management and control of system ñPresentation of direction for MIS growth 	<ul style="list-style-type: none"> ñShortage of logical linkage between each stage ñDifficulty of verification Model limitation for the electronic commerce system
MaFarlan's Information Diffusion Model [27]	<ul style="list-style-type: none"> ñSupports long term information system planning ñEffective information planning for the whole organization 	<ul style="list-style-type: none"> ñRigidity of information system planning ñGap immanence in the adoption of information technology to organization
Utterback's Innovation Process of Organization [37]	<ul style="list-style-type: none"> ñComprehensive model for organization innovation 	<ul style="list-style-type: none"> ñShortage of detailed characteristics at each stage of innovation
Industry Life Cycle Theory [15]	<ul style="list-style-type: none"> ñIndustry change based on life cycle ñArrangement of the development of industry structure and competition 	<ul style="list-style-type: none"> ñDifferent concepts for applying to whole ICT

2.2 Previous Research of Electronic Commerce Model

This section shows the theoretical background for identifying the characteristics of EC and developing the growth stage model through a literature review about the EC model.

Nissen [28] suggested the integrated EC model. This model divides commercial activity between purchaser and seller into five functions, which are used as a framework showing the relationship in the functional process between product, information, and payment. The model describes the five functions as 1) need definition, 2) resource finding, 3) negotiation, 4) purchase, and 5) use and maintenance in the purchaser's aspect, as well as 1) the arrangement, 2) the customer finding, 3) the negotiation, 4) the order execution, and 5) customer support in the seller's aspect. Nissen's business model proposes a conceptual model focusing on the commerce process between purchaser and seller, therefore, it is somewhat limited to explain the global scope of EC.

Information Infrastructure Task Force [18] provides a global EC framework which explains the principle and policy in the aspects of the economic, legal, and business issues. The detailed explanation is as follows. First, it divides economic issue into 1) customer and tax, and 2) electronic payment systems. Second, in the legal issue, there are 3) the unified business code for EC on the Internet, 4) copyright, 5) privacy, and 6) preservation.

Finally, the business issue includes 7) network infrastructure, 8) content, and 9) technical standard. This framework divides the issue related to the EC into three aspects such as the economic issue, the legal issue, and the business issue. However, it is a limitation that this framework disregards the technical aspect, which is one of the major issues of EC.

Zwass [39] suggested a three level structure model to facilitate the complex system and the development of EC. He defined hardware, software, database, and communication technology as the infrastructure level; classified message, transmission, searching, negotiation, an agreement as the service level; finally, customers and business partners, information sharing and cooperation, and electronic markets are defined as the product and structure level. This model is meaningful for the hierarchical classification of EC in terms of the system aspect. However, it does not explain the relationship between the hierarchical levels.

Kalakota and Whinston [21] proposed an EC framework consisting of legal and public policy, standardization and protocol, the information super highway, network infrastructure, general business service infrastructure, and EC application technology. However, this framework is likely to focus on the technical aspects among the several EC elements, and does not provide major characteristics about each element.

The US government proposed a global EC framework to promote global commerce on the Internet [36]. The

framework divided the principle to guide policy development and the guidelines of essential issue about EC, and a road map for international commerce into the financial, legal, and market access issues. It sets taxes and customs, and electronic payment in the financial issue; EC code in the legal issue; information technology, communication infra, contents, and technology standards in the market access issue. This framework has tried to explain comprehensively the relevant part of EC. However, the technical issues that should be considered as important factors in the EC domain are not categorized as a separate issue.

3. EC Growth Stage Model

3.1.1 Social Aspect

In e-commerce diffusion, the most important aspect is the social aspect. Generally, people prefer business in the market place so it is necessary to expand their understanding and experience about cyber business through networking. Moreover, it is only recently that the Internet is diffused and used in various social fields. Therefore, social members' recognition and reliance on cyber business based on networks such as the Internet have a major effect on the diffusion of EC. In addition, there is social risks in the barriers to the diffusion of EC. For example, the consumer's protection, contract completion, identification problems, counterfeiting of electronic payments, personal information protection and so on. Therefore how to handle effectively the various risks from transaction through EC is a major factor for the diffusion of EC.

3.1.2 Economic Aspect

EC changes the structures and the transactions of business, the organization, market and industry. Therefore, we need to examine the influence of the economic aspect within EC diffusion. That is, it is necessary to consider the usage of electronic payment, the reduction of product circulation process [6], the curtailment of distribution process [5], and the reduction of transaction cost. Without an intermediary such as the middle distribution process, direct business transaction between the seller and buyer is possible on the network, curtailing the transaction cost [32]. Moreover, e-commerce based on information communication network infrastructure is different from traditional business in terms of product types and business transactions. It is expected that the world EC market will grow rapidly. Research agencies predict a 70-100% mean yearly growth. Therefore, it is predicted to continuously increase the portion of total sales based on e-commerce in a firm. On the basis of these, we analyze major issues in the economic aspect and then reflect them in the growth stage model of EC.

The previous EC models provide limited frameworks regarding some elements of EC. This article attempts to provide an EC growth stage model for predicting the shaping process of EC.

3.1 The Development of the Framework for the EC Analysis

This study extracts major variables to adequately explain the phenomenon of EC better than previous research EC models. We attempt to divide the various EC issues into four aspects: 1) the social aspect [18; 21], 2) the economic aspect [28; 18; 36], 3) the political aspect [18; 36], and 4) the technical aspect [39; 21; 36]. The detailed explanation of each aspect follows.

3.1.3 Political Aspect

To successively promote EC, regulations and legislation should be established. After the government establishes a general policy, actions, standards and plans for facilitating EC, they need to drive forward to a pan-government policy in line with the industry policy, the active support, and the institutions considered on government dimension. Without this preparation of policy, the continuous diffusion of EC will not happen. Therefore, the policy level and the time predicted for policy establishment are important elements for the determination of EC growth. On the other hand, e-business on the Internet is performed through different procedures from those of the off-line business [16]. Thus, it is necessary to establish new laws for the electronic signature to recognize electronic business and transaction [11]. Settling the core of the disputes and the electronic registry should be reached by the agreement. The intellectual ownership on the Internet, patent rights, trademark rights and conveyance are to be entered into in domestic and foreign agreements.

3.1.4 Technical Aspect

To facilitate e-commerce, it is necessary to develop the essential factors and subside EC technologies. EC uses various forms of information such as data, voice, and pictures between the contracting parties in a business on the basis of ICT. Because EC is in a developing state, there are many tasks to be solved technically and socially. These problems and tasks will be gradually settled. However, to make EC active, the technical issues like the network infrastructure, the security for safe deals and the electronic payment system must be seriously considered [20]. That is, the technical infrastructure should be prepared to facilitate the shaping process of EC [39]. A safe network must exist to make EC possible and then communication functions reorganized. In addition, the technical aspects need to be established the security and the standard of information sharing, the platform of software and hardware, the building of databases and the

electronic payment system to exchange products and services.

These are the major issues in the four aspects of EC in terms of society, economy, policy, technology. On the

basis of this review, we attempt to arrange the detailed variables to be analyzed in the four aspects of EC (see Table 2).

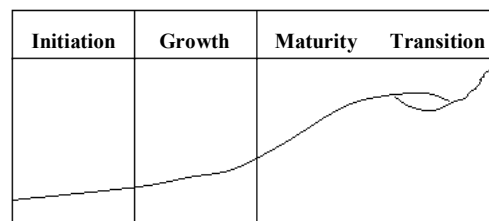
Table 2. Analysis Category of EC Growth Stage

Analysis Domain		Explanation
Aspects	Analysis Variable	
Social Aspect	Social Trust	the degree of reliance of social members accepting e-business through network [19].
	E-business Awareness	the degree of awareness of social members about the various trade through e-business [19].
	Risk degree	the degree of risk in the various trades through e-business [8].
Economic Aspect	Product	the type of products in e-business [19].
	Transaction Cost	the cost of products in e-business [19; 8].
	Gross Sales	the relative importance of sales in e-business [6].
Political Aspect	Laws & Institutions	the laws and regulations in online business [11].
	Policy & Publicity	Policy and public information for the diffusion of the e-business [22].
Technical Aspect	Technological Infrastructure	the degree of development and application in the e-business technology [30; 8].
	Standardization	the degree of Standardization for information sharing and electronics with e-business [10]
	Security	the degree of the advance of security systems in performing e-business [10]

3.2 Development of EC Growth Stage Model

We attempt to provide a growth stage model for EC on the basis of Nolan's growth stage theory and industry life cycle model. We divide EC growth into four stages: initiation, growth, maturation, and transition; we then

analyze major issues on EC according to a social aspect, a economic aspect, a political aspect and a technical aspect. The EC growth stage model applied in this study can be seen in Figure 3. We then analyse the characteristics of each step on the basis of the EC analyse category defined in Table 2.



<Figure 3> EC Growth Stage

3.2.1 Initiation Stage

In the initiation stage, enterprises try to propose the product and service to customers and buyers through e-commerce. The acknowledgment degree of social members and the reliability of EC are low, but the danger degree is high.

In addition, the demand of the product is small, but the amount of sales is increasing. The products for this stage focus generally on special products such as the books, flowers, S/Ws and CDs with low prices and simple processes for selling and buying. The number of EC users are few. That is why not only the transaction cost is somewhat high, but also the sale price of EC is low. This high transaction cost in the initiation stage will play as a factor to delay the diffusion of EC.

The institution and laws concerning EC in the initiation stage are not arranged systematically, and a preparation is made to make them legal. The policy plans of EC are mainly acted out by governments. The

education and public information for EC diffusion usually made by experts become more popular among the public. The essential technology of the technical infrastructure is developed in this stage, and unstandardized EC technologies compete with each other. They will have keen competition that leads toward standardization. The security technology is somewhat vulnerable to external infringement and hackers, because in this stage the basic technology and network infrastructure is still developing.

3.2.2 Growth Stage

In the growth stage, the competitions among many enterprises are more accelerated due to the innovation of ICT and EC diffusion. Therefore, product sales and services are diffused step by step among customers and in the company. In proportion to the understanding of social

members and the social trust for EC, the danger degree become weak.

In this stage, it is necessary to affirm the EC support system using information technology as fast as possible. This will obtain a relative advantage in the customer market by occupying the electronic market before other companies can.

In the initiation stage, the companies open their homepages, and send their information through electronic catalogs to introduce their products and service to customers. However, in the growth stage the total product selling on the Internet will be expanded and the amount of sales is increasingly enlarged. Though EC diffused, the existing intermediaries will disappear and new type of middleman will have an advent. That is, if the customer spends more time searching for a product on information, the electronic intermediary will be needed to execute it in cyber space. Through this, the transaction cost per unit will be lower and lower.

EC institution and law of the growth stage become systemic and strengthen the background for facilitation of EC use, settlement, and diffusion. EC policy and public information led by the government in the initiation stage are transferred into public organizations and companies at the growth stage. The public information and education of EC are expanded for the general users of EC.

EC technology in the growth stage become more standardized as the unstandardized technology drops out. As the technology standardizes, the technology diffusion speeds up. With this, the security technology is improved for identification and certification, approach control, alteration prevention, and auditing. In particular, the certification agency is affirmed, the form of certification is set, and the standard protocol for digital signatures is established in the growth stage.

3.2.3 Maturity Stage

Social trust and customer acknowledgement of EC become mature in this stage. As the degree of danger on the EC lowers, the market share and the revenue of the EC gradually increase.

At this point, the customers will know well the characteristics of each internet business each, and various types of internet business models will appear. As the various types of products become standardized by the high market share products, the differentiation is reduced. In addition, with the technology diffusion, imitations are easily made. That is why the EC market is being aggravated and overwhelmed with competitors.

Therefore with a mature EC market, a strategy is needed to adjust the competitive advantage from differentiation to cost. Intangible digital products such as music, software, movies, research information, and VODs are going to be transferable on a massive scale. However, with users increased through EC, the transaction costs per unit become low, the degree of the sale price of EC will be high in the total sale price.

In the previous stage, the laws for EC encouragement and EC usability were confusing due to the scattered and

systematically unmanaged legal issue. However, in the mature stage, the law will be unified. The users' acknowledgments of EC diffusion play an important role. Therefore, the education and publicity for users is to be made.

Moreover, in this mature stage, the technology base of EC will be completely standardized and then spread extensively. One of the most important technologies in EC is security. This will be completed and standardized in relation to the telecommunication security, shopping mall certification, security technology of customer data and so on.

3.2.4 Transition Stage

The transition stage is the transformation period to facilitate EC growth, re-establishing new strategies, products and ICT facing limitation in the previous growth stage. That is, the technology and knowledge accumulated during the EC growth stage get newly arranged, applied and then a new strategy of information communication technology will be provided.

Furthermore, the various business domains of EC are reviewed, arranged and unified. EC systems run loosely in the past will be newly evaluated and redeveloped according to the new information strategy. The EC laws revised by separate countries will have been unified into a law of international EC.

New technological advances to challenge technological are needed. In technology research, when standard technology is compared with research ambition for the technology, if research ambition is lower than the technology standard, it will be categorized as a technology-push. On the other hand, if higher, it will be categorized as the demand-pull [24; 9; 35].

Until now, EC research is inclined to the technology-push. However, in the transition stage, with new theory and research ambition diffused, the paradigm of technology research [23] will be changed into the demand-pull. The companies that do not grope for technical advances in the transition stage will be combed out in competition with other companies that are entered in the e-commerce market with advanced technology.

4. Conclusion

EC is regarded as a new type of business system in which a product and service are transferred to clients on the basis of the information communication technology. The rapid diffusion of Internet use and the active efforts for making networks rapid, the endeavor of the company and the financial institution for the support of EC and the advanced technology for payment system have made EC a new paradigm of the global digital economy in the 21 century. However, among the research until now, there has been no research presenting an EC growth stage model for the phenomenon of EC diffusion process, and the prediction of the further direction of EC growth.

In this paper, on the basis of the stage theory suggested by many researchers, we present an EC growth stage model. We divided EC growth into four stages: initiation, growth, maturity, and transition, and then classified major issues of EC into four categories: social, economical,

political, and technical aspects. With this, we identified the major characteristics according to EC growth stage. The characteristics of EC growth stage discussed in this study are outlined in Table 3.

Table 3. Characteristics of EC Growth Stage

Analysis Domain		Electronic commerce Growth Stage			
Aspects	Analysis Variables	Initiation	Growth	Maturity	Transition
Social Aspect	Social Trust	Low	Medium	High	Very High
	Awareness of E-business	Low	Medium	High	Very High
	Risk Degree	High	Medium	Low	Very Low
Economic Aspect	Product Type	Special	General	Digital	-
	Trade Cost	High	Medium	Low	Very Low
	Gross Sales	Low	Medium	High	Very High
Political Aspect	Laws and Institutions	Preparation	Individual EC Law	Unification of Domestic EC Low	Unification International EC Low
	Policy and Publicity	Nationally Oriented	Enterprise Oriented	Consumer	General
Technical Aspect	Network Infrastructure	Development	Standardization	Application	New Paradigm
	Standardization	Low	Medium	High	Very High
	Risk Degree	Low	Medium	High	Very High

The EC growth stage model suggested in this research will provide individuals and organizations with a useful conceptual framework for understanding the process of EC. However, in further study, the actual application of the EC growth stage model presented in this paper should be applied in practical e-commerce circumstances.

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Taxonomy of Web-Based Shopping Systems

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Abstract

This paper attempts to address a detailed understanding of the diffusion of WBSS, introducing a classification model of WBSS, analyzing the cases of four categories of WBSS, and providing a characteristics of the four types of WBSS. A model of four types of Web-based shopping systems is suggested: (1) general-direct-sales; (2) general-intermediary-sales; (3) specialized-direct-sales and (4) specialized-intermediary-sales. On the basis of these four categories of WBSS, the paper analyses the distinguishing characteristics of WBSS, which has implications for both theory and practice. We hope that this research will mark the starting point in on-going research towards many unresolved issues on Web-based shopping systems.

Key words: Web-Based Shopping Systems, Classification Model of WBSS, Characteristic Analysis.

1. Introduction

Internet technology has evolved into a dynamic source of information as well as an extraordinary business tool that is able to reach any user [6, 14]. Internet technology also allows organizations to overcome many of the physical constraints that often prevent them from doing business [21]. Therefore, time and space, the two age old limitations of human beings, can be overcome more easily than ever today [16]. There is a growing desire to understand

electronic commerce and to utilize new technology within the Internet business [6, 10, 12, 14].

However, many organizations lack a clear understanding of how to make effective use of Internet technology as a means of new business supporting global electronic commerce [4, 15, 26]. Organizations need to plan effectively before they venture into Internet business [6, 10, 19, 20]. The aim of this paper is to answer the above questions and to provide a theoretical background of further WBSS diffusion study. In order to do so, we introduce the concept of WBSS and analyze the characteristics of each type of WBSS identified, focusing a review of cases that are utilizing WBSS. Finally, we provide the major characteristics of the four types of WBSS.

2. Web-Based Shopping Systems

Web-Based Shopping Systems (WBSS) can be described as Internet-based shopping systems for selling and buying products, information, and services [2]. According to Porter [19], "the organizations that will be most successful will be those that use Internet technology to make traditional activities better and those that find and implement new combinations of virtual and physical activities that were not previously possible." Though there will be several ways to do this on the Internet, WBSS can succeed in this regard due to its particular characteristics, which we will discuss in more

detail below. There are various types of configuration of WBSS, such as those adopted by Amazon.com, eBay.com, Del.com, Tesco.com and so on. Figure 1 provides a multi-tier

architecture for WBSS, one which is adopted for the purposes of this research.

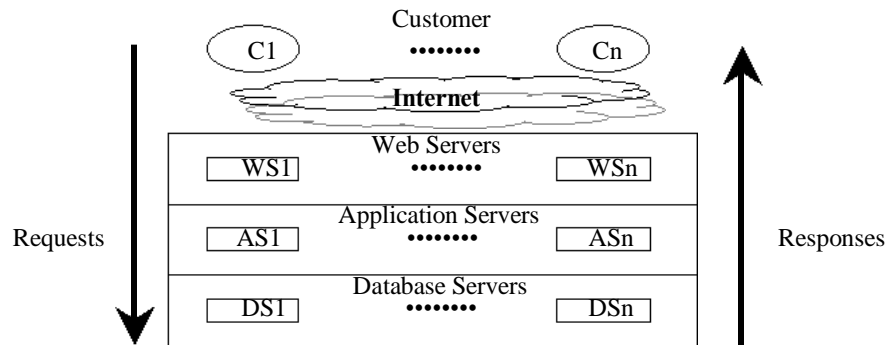


Figure 1. Multi-tier Architecture of Web-Based Shopping Systems [2]

As can be seen in Figure 1, WBSS consist of Web servers, application servers, and database servers [2]. First, Web servers support Web-based shopping between seller and buyer, merchant and customer, and manufacturer and supplier. Web servers fill the role of middleman between the back-end systems and front-end clients [12]. Second, application servers support information retrieval, personalization, transactional other management, security management, and payment management. They include shopping agents or search engine, security system, certificate system, customer relationship management (CRM) system, and payment system [2, 12]. For example, Amazon.com developed not only its Web site but also incorporates Web-based shopping applications for order processing, invoicing, payment, shipment, inventory management and procurement. Finally, database servers manage all data related Web-based shopping between WBSS and customer. For instance, eBay.com is utilizing Web and database connectivity systems to carry out its successful business process of creating a feedback and rating system for all buyers and sellers on its auction site. To sum up, Web servers, payment system in application servers and database servers are indispensable to WBSS. We might conclude that the application of WBSS promises to be a driving force for

electronic commerce by allowing organizations to create global electronic markets, increase efficiency, and lower transaction costs through digital commerce with customers and businesses around the world.

3. A Classification Model of WBSS

We can consider WBSS as a new business enabler with the potential to change the ground rules by which businesses interact with their clients [2, 12]. Carrying out global business on WBSS is becoming more important to many organizations. The purpose of this sections is to develop a classification model of WBSS, and suggest its characteristics to provide a detailed view of WBSS.

3.1 Development of a Classification Model of WBSS

According to Peppers and Rogers [18], “the core issue confronting business is how to achieve sales and which products to sell.” On the basis of this definition, in terms of a global business medium, it would appear helpful to classify various types of WBSS applications, therefore, by product type and sales type.

Firstly, the sales type of WBSS is examined. For instance, Amazon.com sells multiple products such as books, CDs,

and software as well as is directly responsible for the products sold on its WBSS (www.amazon.com), while Fastparts.com sells electronic parts, and is indirectly responsible for sales products in the role of intermediary (www.fastparts.com). On the basis of this observation, the sales types of WBSS are classified into two types: direct sales type and indirect sales type. As a real marketing channel, WBSS support two-way sales types between the seller and the customer. One is a direct-sales type, which is directly responsible for a guarantee of quality and delivery for the sales products [1, 18]. The other type related to indirect sales, and is indirectly responsible for a guarantee of quality and delivery for sales products [18]. That is, the indirect sales type relays business transactions between the manufacturer, merchant, distributor and consumer [25].

Another distinguishing factor of WBSS is the type of product being sold via this medium. In order to gain a meaningful insight for classifying the different product types sold WBSS, this study explore the products sold by some well-known dot-com companies. For example, Del.com and Amazon.com are selling products directly to global customers without any intermediaries. However, the product types are different from each other, i.e., Dell.com is selling only a single product such as a computer (www.dell.com), whilst there are multiple products such as books, CDs and software sold by Amazon.com (www.amazon.com). Based on this observation, the product types sold on WBSS are divided into two groups: single product type and multiple product type, as outlined in Table 1.

Table 1. Product Type of Web-Based Shopping Systems

Type	Definition	Examples
Single Product	• Single industry product	• Software, CD, Book etc.
	• Unified group image product	• Baby clothes, Sports equipment
Multiple Product	• More than two industrial products and products that are not unified into a group	• Department store products

Firstly, the single product type includes the product of a single industry such as a book, a CD, software, a flower, etc., as well as unified groups of products such as sports equipment, baby clothes and cars. Secondly, the multiple product type includes more than two industrial products, for example department store products, as well as products that are not part of a group of products.

On the basis of the product and the sales type of WBSS, a classification model of WBSS can be developed (see Figure 2). In the model, the horizontal axis displays the product type of WBSS, while the vertical axis displays the sales type of WBSS. This research thereby proposes a model which classifies Web-based shopping systems into the following four types: 1) General-Direct-Sales (GDS); 2)

General-Intermediary-Sales (GIS); 3) Specialized-Direct-Sales (SDS); and 4) Specialized-Intermediary-Sales (SIS). The general-direct-sales type means that this product type is multiple, and product sales are direct. The general-intermediary-sales type is the WBSS type selling multiple products indirectly. The specialized direct-sales type sells single products directly. The specialized-intermediary-sales type focuses on single products and indirect sales. However, not all WBSS conform to these four types: hybrids are possible for example. Nonetheless, this model serves primarily as a basic framework of WBSS for analytical purposes. In the next section, four cases are introduced in order to demonstrate the characteristics of each type of WBSS in more detail.

Classification Model of WBSS		Sales Type of WBSS	
Product Type	Single	Direct sales	Indirect sales
	Multiple	GDS	GIS
		SDS	SIS

Figure 2. A Classification Model of Web-Based Shopping Systems

3.2 Case Analysis of the Four Categories

This section aims to expand our view of WBSS and to explore the four categories of WBSS previously identified. In order to do this, we address four dot-com cases, derived from Web-sites, and then attempt to analyze each category. The dot-coms were selected because they are well-known dot-coms in each type (e.g., Hansolcs.com, Dell.com and Fastparts.com), and by searching Web-sites it seems to be well-matched with a GIS type (ShopNow.com).

3.2.1 General-Direct-Sales (GDS)

Hansol CSN is a cyber department store, which does not have any physical shop and sells several kinds of products that are identical to those of an actual department store. Therefore, the product prices in this category are cheap because goods can be sold directly to the customer without a salesperson, and intermediaries such as suppliers can be cut out. In doing so, Hansol CSN can reduce the transaction costs of selling products on WBSS (source: www.hansolcs.co.kr).

In addition, Hansol CSN provides one-to-one marketing, based on customer management databases that store customer information to analyze their characters, needs and preferences. Moreover, CSN carries out differentiation strategies such as one hundred percent exchange/refund, quick delivery, membership management and a variety of other services. One hundred percent exchange/refund is a customer satisfaction system that exchanges or refunds a purchase when a customer is not satisfied. Furthermore, it is claimed that this cyber department reduces traffic

congestion and avoids parking difficulties, because it does not have physical stores or car parks, so that customers are directly able to access product information and order from home (source: www.hansolcs.co.kr).

3.2.2 General-Intermediary-Sales (GIS)

ShopNow.com is a leading electronic commerce marketing company that helps businesses participate in Web-based shopping business. Based on its full suite of e-commerce solutions, ShopNow.com claims that it helps customers and merchants safely and easily buy and sell merchandise online. The ShopNow.com WBSS provides millions of products and services from more than 40,000 merchants. Customers can rapidly and efficiently search the variety of products by comparative shopping functions on ShopNow.com WBSS (source: www.stores.shopnow.com).

ShopNow.com not only supports technology and outsourcing services to retailers, manufacturers and other businesses, but also launches and manages the Web-based shopping systems on their behalf. Shoppers can purchase desired products and services from merchants located around the world. The major strategic option of ShopNow.com focuses on the global community. Hence, an International Business Division was recently established to expand ShopNow.com into Western Europe and Asia. From North America, this is led by individual divisions, each with a good knowledge of the international marketplace. By pursuing strategic alliances and partnerships in other regions of the world, ShopNow.com is hoping to accelerate its goal of becoming a pre-eminent Internet business service

provider worldwide (source: www.stores.shopnow.com).

3.3.3 Specialized-Direct-Sales (SDS)

Dell.com is one of the best examples of the specialized direct sales type of WBSS. Dell.com sells computer equipment directly to its customer on the WBSS. Dell.com currently sells more than \$14 million in PC products over WBSS each day. Its Web-based shopping business has over 25 million visits per quarter. By the year 2003, the company expects to handle half of all its business, ranging from customer inquiries to orders and follow up services, through the SDS type of WBSS (source: www.dell.com).

The chairman of Dell.com has claimed that Web-based shopping business as a new business model would facilitate a dramatic drop in costs and destroy old competitive advantages. The advantages of the Dell.com model are claimed to include near-zero inventory, less risk of obsolescence, more state-of-the-art products and a favorable cash flow [11, 18]. Since March 1999, Dell.com and Amazon.com have agreed to offer linked cyber shops and provide customized contents for their respective customers. Dell.com and Amazon.com can therefore offer mutual customer services, competitive prices, and ease of navigation (source: www.dell.com; www.amazon.com).

3.3.4 Specialized-Intermediary-Sales (SIS)

Fastparts.com trades in electronic components and equipment. Fastparts.com is an e-commerce systems provider that enables electronic manufacturers to deliver trading exchange, auction and shopping venues. The company provides an Internet based trading exchange and marketplace for the electronics manufacturing and assembly industry, as the leading business-to-business provider (source: www.fastparts.com).

Fastparts.com WBSS has sold \$140 billion in electronic parts and hundreds of millions of dollars in manufacturing

equipment. Fastparts.com serves as a 'spot market' where OEMs, contract manufacturers, distributors, and part makers buy and sell electronic parts at market-driven prices, providing franchised supply service. In addition, FastParts.com periodically offers various inventories to sell its members' products on Internet auction. Auctions are pre-announced to all members, and bidding is generally open for two or three days. Though anyone can use the FastParts.com shopping architecture to access information on parts, price and availability, the actual bidding, buying or selling of parts requires membership. There is no charge to become a member. All members must agree to abide and be bound by the FastParts.com operating rules and protocols (source: www.fastparts.com).

4. Characteristics Analysis of The Four Categories

We can analyze the distinguishing characteristics of the four categories of WBSS as follows. Firstly, the relationship between seller and WBSS is examined. For example, some sellers are themselves owners of the WBSS, whilst others are a lessee or brokerage within the WBSS [5, 14]. The second focuses on the number of sellers [24, 25]. The third considers product type [11, 18], and the fourth, the responsibility of guarantee for the product sold [25, 18]. Based on these analyses of each type of WBSS, a suitable firm that is well-matched with the four types of WBSS is suggested [11, 25]. Next, we illustrate the strength of the four types of WBSS [14]. An attempt is then made to analyze the strategy type of each WBSS, in accordance with the strategic options suggested by Wiseman [27]. These are: differentiation, cost, innovation, growth and alliance. Differentiation is defined as making a distinction between product and service in comparison to a competitor's. Cost is a competitive advantage that is achieved through an increase in competitors' costs, or a decrease in one's own

cost. Innovation is the act that renovates the product or the service. Growth is achieved through product variety, the expansion of marketing areas, and the increase in the number of business transactions. Alliance gains competitive advantage through firms joining together, inter-organizational agreements, and joint investment. Finally, we consider critical success factors to continuously maintain the competitive advantage of the four types of WBSS. Critical success factors (CSF) are defined as “the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization” [22]. According to the eight analysis domains defined above, detailed characteristics of four types of WBSS are investigated.

4.1 General-Direct-Sales (GDS)

The general-direct-sales type is applicable to direct sales and multiple products. This type uses the WBSS to sell many products that are identical to those of an actual department store. As can be seen in the Hansol CSN case, this type is itself an owner of the WBSS as well as the only seller, selling several kinds of products to multiple buyers in the world. The GDS type is therefore directly responsible for the guarantee of the product sold. As seen in the Hansol CSN case, these types of WBSS are in keen competition with each other. Therefore, a differentiation strategy will be well-matched with this type, with a new to gaining a competitive advantage through differentiation of service or product, in comparison to other competitor WBSS.

The strength of the GDS type is that it provides a cyber warehouse which needs less initial investment expense and staff requirement, in comparison to actual department stores. Therefore, the GDS type can not only make high profits due to a reduction in maintenance and other costs, but it can also solve traffic and parking problems, because customers do not need to leave home to go shopping.

The CSF of this type of WBSS are achieved by utilizing customer information and by having a creative design of WBSS [3]. Firstly, the application of consumer information increases customer satisfaction, which itself facilitates a successful competitive advantage of this type. This is because utilizing customer information can reduce a customer's search time, through a quick response of product and service based on the customer database accumulated by Web-based shopping [24]. Secondly, customers indicate that they prefer new and attractive features of WBSS, which create a feeling of shopping at a real department store. Thus, this type of WBSS needs a creative design based on the latest information communication technology (ICT); such as virtual reality, multimedia, being three dimensional and intelligent agents [24]. For example, multimedia and virtual reality types of architecture are able to present the customer with an interesting experience, somewhat similar to shopping at real department stores.

4.2 General-Intermediary-Sales (GIS)

The general-intermediary type of WBSS is suitable for indirect sales and multiple products. This type includes many shops such as book stores, computer shops, gift shops, wine stores, sports stores, and so on. This type of WBSS sells customers various kinds of products via several different cyber shops. In the case of ShopNow.com, there are many sellers dealing in several types of products for a variety of customers in the global electronic market. These sellers are lessees within the GIS. Thus, the GIS itself has an indirect responsibility for products sold, because individual sellers within the GIS are directly responsible for the products.

This type of WBSS provides a strategic opportunity to small- and medium-sized enterprises, which are faced with a shortage of funds, human resources and technical

expertise in comparison to larger companies. This is because this type of WBSS allows relatively easy and low-cost entry of small- and medium-sized enterprises into Web-based shopping business areas. Namely, those small- and medium-sized companies that have never carried out traditional online business can undertake Internet business thereby extending their marketing territory [24].

The strength of the GIS type of WBSS is that it provides various cyber malls that customers can choose according to their needs and preferences. This kind of selective buying can serve as a major attraction to customers, as compared to other types of WBSS. However, it is important for shops within GIS to maintain a high quality of products and services, because this can influence customer satisfaction, which in turn affects the successful diffusion of GIS.

Other types of WBSS cannot establish the variety of shops, nor provide the range of products that the GIS type can, due to limited capability such as systems management, operating costs and human resources. Therefore, GIS has a competitive advantage over other types of WBSS, and has a greater capacity for growth, through its ability to provide a diversity of products, a high quality service, and many kinds of shops. Thus, the most suitable strategy for the GIS would appear to be a growth strategy.

As seen in the ShopNow.com case, there are many shops and varieties of products within the GIS type. When customers visit this type of WBSS to make a purchase, they can have difficulty in finding the product best suited to their preference. Therefore, by providing a comparative shopping function based on intelligent search engines [23, 24], the GIS type of WBSS can support the customer in finding the best priced or highest quality products without spending considerable time searching for several cyber stores. Thus, the CSF of this type of WBSS is its effective comparative shopping function, which in turn will increase its advantage.

4.3 Specialized-Direct-Sales (SDS)

The specialized-direct-sales type is a specialized WBSS dealing with direct sales and single products. As can be seen in the case of Dell.com, the seller is identical to the owner of the SDS system. Thus, the seller is a single seller as well as an owner of the SDS type of WBSS. As a result, the SDS itself bears direct responsibility for the product sold.

This type of WBSS provides opportunities for global marketing to manufacturing companies and smaller shops, which have limited capital and business resources. For example, manufacturing companies can sell products directly to the customer without any intermediary. Also, this WBSS type will help smaller shops to become 'Giants of marketing', competing with giant corporations, because physical size is not an important factor in determining market strength.

The strength of the SDS type lies in its ability to provide a specialized cyber shop. Organizations that have limited resources can efficiently focus their capabilities in selling a specialized single product. The initial stage of Dell.com is a major example of this type of application. The SDS type needs to concentrate on a cost strategy, as in the case of Dell.com, since it is necessary to maintain low prices for specialized products, in comparison to other types of WBSS, which sells various kinds of products. Through the lowered cost of selling products, these kinds of WBSS will have a competitive advantage against general types of WBSS.

A CSF for the SDS type of WBSS is specialization. The focus is on one top priority out of service, cost, quality or speed related to the Web-based shopping business, in order to have a competitive advantage with other WBSS. In addition, people are under considerable time constraints in this day and age. If customers discover that this type of WBSS makes it easier to purchase the hard-to-find-products they prefer [8], customer satisfaction is likely to increase.

This is a major advantage of this type of WBSS.

4.4 Specialized-Intermediary-Sales (SIS)

This type of WBSS sells single products indirectly. This type of WBSS can be thought of as a basic level of a virtual organization that links people, assets and ideas to create and distribute products and service [13, 9]. This is because buyers and sellers can negotiate and trade products, services and information in real-time, based on a specialized-intermediary-sales shopping architecture. As can be seen in the case of Fastparts.com, there are many sellers, selling a single product, within SIS. These sellers take on the role of broker. Thus, the SIS type itself has an indirect responsibility for the product sold, because individual sellers within the SIS type of WBSS are directly responsible for the product guarantee.

The SIS architecture can offer a significant opportunity for auction market, in particular, and acts as an intermediary between seller and buyer. Therefore, the SIS type needs to be kept up-to-date to provide the most recent data on products and services, because companies may want to access the latest information related to their market. The strength of the SIS type of WBSS is that it plays the role of cyber agent, able to support business-to-business electronic commerce. Its role as cyber agent between businesses is a basic form of virtual organization, because the key attribute of a virtual organization is strategic alliances or partnering [9].

As can be seen in the Fastparts.com example, the successful diffusion of this type of WBSS will depend on alliances and tight co-ordination with various WBSS. Therefore, an alliance strategy is well matched with this type of WBSS in order to gain a competitive advantage, because firms can negotiate directly with each other and trade products and services with other types of WBSS.

The CSF at play here is risk management. For example,

this WBSS type mediates business transactions between businesses, so that the SIS type requires strong risk management against electronic fraud or theft that can occur in business-to-business transactions [17]. If the SDS type reduces the risk associated with Web-based shopping, customers will trust this architecture to provide a safe and secure service. Such trust can lead to a strong competitive advantage for the SDS type in comparison to other architectures.

5. Conclusion

In these relatively early days of electronic commerce, WBSS are offering organizations new opportunities to undertake Web-based shopping around the world. However, in spite of this, many WBSS are disappearing from the Internet business world, whilst other organizations such as eBay.com, Amazon.com, and Tesco.com, are growing in global electronic markets, providing a new business model. Successfully utilizing and upgrading WBSS to survive in the e-business world is still far from easy, apparently. Hence the need for research of the kind described here.

WBSS are diffusing rapidly across national boundaries. A growing number of companies are taking advantage of WBSS by selling products, services and information, ranging from groceries to department stores, from SMEs to large firms, and from young organizations to established organizations. WBSS not only increase the ability of organizations to trade with customers, but also offer firms a new opportunity to reach millions of global clients worldwide. In addition, WBSS have the potential to radically change the way businesses interact with their customers. The traditional roles of manufacturers, distributors and suppliers are blurring as a result of WBSS. Within the Web-based shopping environment, customers should be the ultimate winners, because they can quickly compare products and prices from a global range of seller

faster and more easily than ever before, putting them in a better bargaining position.

Given this as background, this research has attempted to develop a classification model of WBSS and to analyze the characteristics of four types of WBSS. In building this model, we have classified WBSS into the following four types: 1) general-direct-sales (GDS); 2) general-intermediary-sales (GIS); 3) specialized-direct-sales (SDS);

and 4) specialized-intermediary-sales (SIS). The classification model provides what is hoped to be a useful theoretical background for further studies of WBSS.

We have analyzed the major characteristics of the four types of WBSS utilizing appropriate examples from practice. As a result of this analysis, specific characteristics are synthesized in Table 2.

Table 2. Characteristics of the Four Types of WBSS

Analysis Domain	Types of WBSS			
	GDS	GIS	SDS	SIS
Seller Character	• Owner	• Lessee	• Host	• Brokerage
Seller Number	• Single	• Multiple	• Single	• Multiple
Product Type	• Multiple	• Multiple	• Single	• Single
Guarantee of Product Sold	• Direct	• Indirect	• Direct	• Indirect
Suitable Firm	• Department store	• Small-medium Enterprise	• Shop • Manufacture	• Auction
Strength	• Cyber Warehouse	• Cyber Malls	• Cyber Shop	• Cyber Agent
Strategy Type	• Differentiation	• Growth	• Cost	• Alliance
CSF	• Dynamic information • Creative development of WBSS	• Diversification • Support of comparative shopping	• Specialization • Easy buying of hard-to-find product	• Connection • Risk Management

As shown in Table 2, the four kinds of WBSS have different characteristics, with each having their own strengths and weaknesses as an enabler of new business. As such, the development of new business processes, strategic planning, and system architectures should be necessary for success. The characteristics of the four categories of WBSS provide insight for researchers investigating new research subjects related to Web-based shopping and Internet business, and potentially helpful guidelines for practitioners seeking ways to gain sustainable advantages over their competitors from e-business.

However, since this research is an exploratory study on WBSS, the number of cases analyzed to explain each type is limited. Therefore, it may be fruitful for further research to analyze more cases to test the utility of the proposed

model, in particular focusing on certain types of WBSS architecture. In addition, there are like to be some examples that do not fit the four types of WBSS identified. For example, Amazon.com is well known as a specialized book selling dot-com company. However, Amazon.com is actually selling other products such as CDs, software and so on. Thus, it is necessary to be cautious in applying the model.

It is hoped that this groundwork, and the subsequent results generated by this paper, can provide both theoretical and practical contributions. From the theoretical perspective, this study proposes a model of WBSS classification and characteristics of four types of WBSS. It can therefore be utilized in research related to Web-based shopping and electronic commerce by providing theoretical basis for

further study. From the practical perspective, since organizations around world are interested in the Internet business, there is hope that this study will pave potentially guidelines for organizations looking for appropriate ways of undertaking Web-based shopping business.

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An Integrative Framework for Examining Customer Loyalty in Online Environments

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Abstract

Organisations are increasingly turning to the Internet to complement their traditional brick-and-mortar businesses. In our research, we are concerned with the current challenges of customer loyalty, or rather the lack of, in online environments. This paper discusses an approach which examines the relationship between customer e-loyalty and key antecedents like trust, customer satisfaction, perceived risk and corporate image.

Insights from this study will assist marketing managers in prioritising resources on training programs, communication and promotion initiatives. This will lead to improved segmentation techniques, more targeted marketing-mix and positioning strategies and finally, better e-customer relationship management.

1. Introduction

According to market research firm Jupiter Research [27], online retail revenue is forecasted to reach \$105 billion by 2007, accounting for 5 percent of all U.S. retail spending. More significantly, the Internet medium will influence 34 percent of all U.S. retail spending by 2007. This rapid growth of e-retailing reflects the compelling advantages that it offers over conventional brick-and-mortar stores, including greater flexibility, enhanced market outreach, lower cost structures, faster transactions, broader product lines, greater convenience, and customization [64] [70].

Indeed, some recent studies reported that there might be systematic differences in customer attitudes and behaviour for products and services chosen online versus offline. For example, price sensitivity may actually be lower online than offline (e.g. [14] [41]). Perhaps this is because consumers are easily able to compare and contrast competing products and services with minimal expenditure of personal time or effort. According to Kuttner [40], "The Internet is a nearly perfect market because information is instantaneous and buyers can compare the offerings of sellers worldwide. The result is fierce price competition and vanishing brand loyalty."

Reicheld [57] asserts that the fundamental task of businesses today should be managing customer loyalty. After all, there is much agreement that building customer loyalty is a key factor in winning market share [35] and developing a sustainable competitive advantage [38]. The presence of numerous web sites means that e-retailers have a tenuous hold at best on a large number of "eyeballs" [64]. It thus does not come as a surprise that there is mounting interest to understand the determinants of customer loyalty in online environments. This would allow appropriate strategies to be implemented in order to reap the benefits of a loyal customer base.

To this end, a primary objective of this paper is to identify those managerially actionable factors that impact e-loyalty through a proposed integrative framework. This article is structured as follows. We first briefly discuss the concept of customer e-loyalty. We then introduce four focal constructs, which could potentially influence customer e-loyalty, namely trust, customer satisfaction, perceived risk and corporate image. We conclude by noting the managerial implications and limitations of this study.

2. Customer e-Loyalty

In research conducted in the 1960s and 1970s, customer loyalty was interpreted as a form of customer behavior (i.e. repeat purchasing) directed toward a particular brand over time (e.g. [68]). This is not surprising as most research originated from the field of packaged consumer goods [34]. Day [12], in particular, criticizes behavioral conceptualizations and argues that loyalty has an attitudinal component.

Attitude, which measures the degree of a consumer's disposition, was hence suggested to supplement the behavioural approach [1]. More recently, Dick and Basu [16] argued that loyalty is affected by the relative strength of the relationship between attitude and behaviour. Oliver [50] augmented this school of thought by arguing that consumers could become 'loyal' at each attitudinal phase. Specifically, consumers may become loyal in a cognitive sense first, then later in an affective sense, still later in a conative manner and, finally, in a behavioural manner, which has been described as "action inertia".

The cognitive form of service loyalty has been described to be of “shallow nature” [51] where customers “have not ceased attending to alternatives, but maintain their awareness of alternatives without “constant and frenetic testing” [21]. In addition, given that the future behaviour of customers is generally of more interest to marketers than current attitudes and/or behaviour, it is natural that the most frequently researched component of loyalty in the past decade is future intentions or conative loyalty [22] [71].

However, it is not well understood how accurately intention predicts actual purchase behavior [3] [43]. The operationalisation of future loyalty as a choice profitability for the next purchasing incidence would be subject to numerous situational factors as well, which cannot be easily monitored [73]. Hence, it is useful to conceptualise “customer e-loyalty” herein as retained preference [53] and as willingness to recommend the e-retailer to other people [31] [13].

3. Suggested Antecedents

3.1 Customer Satisfaction

Satisfaction has been identified as the driver of loyalty by some researchers [49] [52] [6] [8] [22] [3] [16] [50] and as non-significant by others [24] [36]. Reichheld [56] [57] is the flag bearer for the latter movement and suggests that loyalty, not satisfaction, should be the primary focus of a firm’s marketing activities. Perhaps the varying relationship found between satisfaction and service loyalty is due to an incomplete portrayal of loyalty in these studies [28] which by itself, is a complex phenomenon that warrants a multifaceted conceptualization [16]. Given the unequivocal debate on the satisfaction-loyalty (and its sub-components) linkage (e.g. [43] [28] [60]), the strength of that link should be tested:

H_{1a}: The greater the customer satisfaction, the greater is the customer e-loyalty.

Meanwhile, rather than driving the relationship, trust has also been argued to be reflective of the level of customer satisfaction [24]. Although trust is usually understood as a future-oriented attitude, i.e. as a state of mind that goes beyond past experience, one can hardly deny that a certain amount of positive experience with a person or organization will at least support the development of trust towards this person or organization [23] [25] [32]. We hypothesise that:

H_{1b}: The greater the customer satisfaction, the greater is the trust.

3.2 Trust

Just like customer satisfaction, trust is one of the most widely examined and confirmed constructs in relationship marketing and more recently, electronic commerce research (e.g. [37] [10] [24] [32] [45] [46]). Despite attempts to understand the construct better, it remains elusive. For example, even though studies have generally found positive effects of trust on loyalty [24] [25] [47] [69], some studies refute the effects [17] [23] [26] [46].

In this paper, we argue that the intangibility (customers have difficulty evaluating both goods and services on the web before they have been purchased and delivered) and heterogeneousness (the lack of standards, particularly for services, makes it difficult to judge quality in advance of purchase) of electronic commerce “positions trust as perhaps the single most powerful relationship marketing tool available to the e-retailer” [7]. This is mainly attributed to its ability to diminish the perceived risk and vulnerability in a relationship that leads to a higher commitment to the relationship [23]. This, in turn, reduces transaction costs, as there is less necessity to establish expensive control mechanisms.

Specifically, trust is shown to have a positive influence on relationship outcomes in electronic commerce [33]. For example, the likelihood of Internet product purchase is influenced by the amount of consumer trust regarding the delivery of goods and use of personal information [33]. Other research also shows that the fairness of a company’s website with respect to information privacy is a significant factor in building trust and in ensuring the continuation of the relationship with the e-retailer [11]. In consonance with the general school of thought (e.g. [47]), we propose that trust is an essential antecedent of loyalty:

H₂: The greater the customer trust, the greater is the customer e-loyalty.

3.3 Perceived Risk

The perceived risk construct was introduced to marketing in the 1960s by Bauer and his associates at Harvard Business School [5] [9]. It is defined by Dowling and Staelin [19] as a consumer’s perceptions of the uncertainty and adverse consequences of engaging in an activity. Consumer behavior is motivated to reduce risk [5] [67]. When consumers intend to buy a product or a service, they often hesitate to make the final decision because they can’t be sure that all of their buying goals will be accomplished with the purchase [59].

Donthu and Garcia [18] found that Internet shoppers are more less risk averse than Internet nonshoppers. According to SRI International, about 70 percent of Internet users have the risk-taker personality type. Miyazaki and Fernandez [44] further proposed that the

rate of purchasing products online is negatively related to the perceived risk of conducting online purchase. They also suggested that higher levels of Internet experience could lead to lower risk perceptions regarding online shopping and fewer specific concerns regarding system security and online retailer fraud.

The variability and the non-standardized nature of the online offerings could lead to uncertainty about cost and product performance [48] and make it difficult for a consumer to evaluate alternatives before purchase [29]. The heightened uncertainty resulting from the lack of knowledge and information implies higher perceived risk, which affects customers' decision whether or not to make that online purchase [62]. However, it is also apparent that the amount of risk a buyer perceives depends on the characteristics of the buyer and the type of product or service being considered [30] [62].

In tandem with previous studies (e.g. [65] [66]), perceived risk is viewed as the subjective expectation of a loss or sacrifice. We thus hypothesise that:

H_{3a}: The greater the perceived risk, the less is the customer satisfaction.

H_{3b}: The greater the perceived risk, the less is the customer loyalty.

3.4 Corporate Image

Many conceptualisations of image have been advanced in the past [20] [39] but generally, image has been treated as a “gestalt”, reflecting a customer's overall

impression [72] [15] or as an “idiosyncratic cognitive configuration” [42]. Importantly, a growing number of companies have tried to position themselves through the communication channel [4] with the objective of building strong corporate images in order to create relative attractiveness. The importance of corporate image is heightened in the online world because customers, are more often than not, inundated by the variety of the offerings on the Internet. An obvious choice would be to go for a name they trust, select a company they have heard of, one with a reputation for service, quality and reliability.

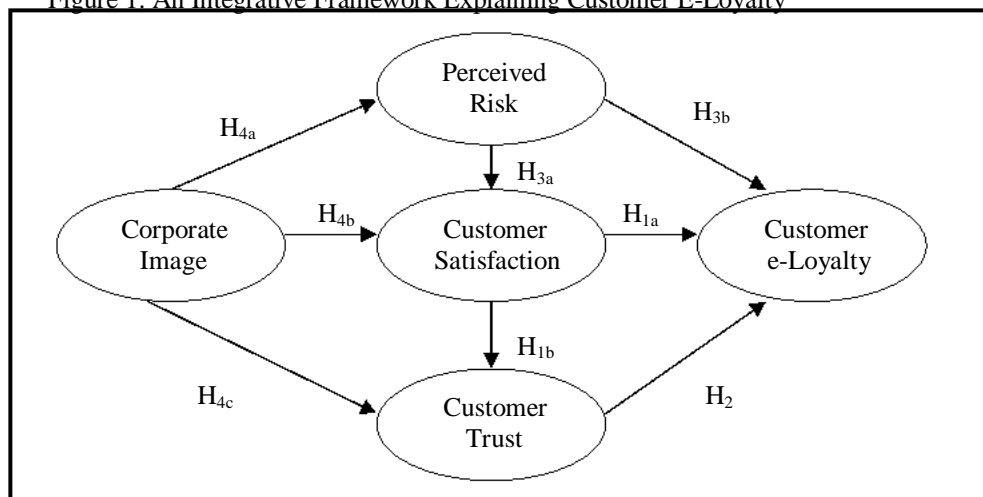
Corporate image could be treated as an outcome from accumulated attitude derived from experience and/or direct or indirect market communication [4]. As a consequence for the relationship level, it is not apparent whether corporate image should be seen as independent from perceived quality and customer satisfaction (as proposed by [4]) or as dependent (as proposed by [61]). Corporate image is defined in this study as the customer's emotional stereotypes associated with the e-commerce service provider. Given that perceived quality, trust and customer satisfaction are emotionally and holistically anchored [2], we thus hypothesize that:

H_{4a}: The better the corporate image, the lower is the perceived risk.

H_{4b}: The better the corporate image, the greater is the customer satisfaction.

H_{4c}: The better the corporate image, the greater is the customer trust.

Figure 1: An Integrative Framework Explaining Customer E-Loyalty



4. Managerial Implications & Conclusions

The antecedents of customer loyalty in the traditional brick-and-mortar marketplace have been studied in detail [63]. However, to the best of our knowledge, there have been no studies evaluating the roles of corporate image, trust, perceived risk, customer satisfaction and loyalty in online environments within a

single study. This study thus hopes to make a contribution towards this critical knowledge gap. Based on our model, more comprehensive and richer models of e-loyalty could be developed and tested.

As noted by Peterson [54], electronic markets will lead to intense price competition resulting in lower profit margins. Customer loyalty has been mooted as the only

source of sustainable competitive advantage for firms [57]. From a managerial perspective, an analysis on the underlying dimensions of elusive and difficult to operationalise constructs (e.g. corporate image) could provide insights into their relationships with loyalty, allowing marketing managers to justify expenditures on training programs and communication and promotion initiatives that contribute to higher levels of customer loyalty. Further, for compelling value propositions and effective marketing-mix strategies to be crafted, the effects of focal constructs like customer trust have been included. Such an understanding will allow companies to adapt operational variables (e.g. communication message) to increase consumers' receptiveness towards their online offerings. Finally, the study could be used to build indices to supplement measures of financial performance and market share. This, in turn, allows for the competitive benchmarking of e-marketing strategies.

There are some limitations of this research that should be considered when interpreting its findings. Our model does not take into account individual-level variables that also may have an impact. Such variables could be out of the control of the e-retailer (such as customer inertia) and other variables that are jointly determined by individual-and-business factors (such as reposed trust and satisfaction) which may also impact e-loyalty [58]. Also, the suitability of the Internet for e-retailing depends to a large extent on the characteristics of the products and services being marketed [55]. This study does not control for such differences across product & service categories. Researchers can develop richer models that capture and address these limitations.

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Contextual Criteria to Select a Framework for Enterprise

Architecture

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Selected Track

Other Research Subjects

Contextual Criteria to Select a Framework for Enterprise Architecture

Abstract

Enterprise Architecture is considered to be an efficient tool to overcome on managerial problems, especially those which come from information technology environment of the enterprise. One of the steps must to be taken to have an Enterprise Architecture is to select an appropriate Framework. Frameworks are the most important components in any Enterprise Architecture. Those are essentially needed to create an integrated Enterprise Architecture. There are many frameworks proposed for specific use in certain enterprises. However there are some more general frameworks which are applied in different situations. These general frameworks are FEAF, TEAF and C4ISR. In this paper some criteria to select a framework are introduced. These criteria are based on the context for Enterprise, Architecture and Framework. Although all of the examples here, include only these three frameworks, the provided criteria are applicable on other frameworks in the area of Enterprise Architecture.

Keywords

Framework, Selection Criteria, Enterprise Architecture, Zachman.

1. Introduction

Many of the concepts in the area of Enterprise Architecture could be found in other areas such as civilization or informatics, so it seems no further explanation is needed. Unfortunately this is not true in this area and almost all of the concepts have to be redefined. This need comes from lack of unique definitions for some of them or this fact that most of these concepts have migrated from a domain to a new completely different domain. For instance *Architecture* that is a well-known keyword for most of us, has a distinct meaning in this new area.

What is an Enterprise?

There are many definitions for the term *enterprise* which could be categorized in two broad classes. The first class includes those who see an enterprise from the viewpoint of its information systems. Mary Johnson and Larry Whitman of the University of Texas Automation & Robotics Institute, define an enterprise as a *complex system of cultural, process and*

technology components engineered to accomplish organizational goals [1].

The second class includes those who define an enterprise from an organizational viewpoint. In *TEAF* documents, an enterprise is described as *an organization supporting a defined business scope and mission. An enterprise is comprised of interdependent resources (people, organizations, and technology). These resources must coordinate their functions and share information in support of a common mission (or set of related missions)* [2].

We may categorize the views in defining an enterprise into *Systematic View* and *Organizational View*. Although the second one is in more interest in the enterprise architecture area but both views could be seen equally important. This is true specially when we notice that an architecture is the bridge connecting them to each other :



Figure 1 : Architecture maps organization into information systems.

What is an Architecture?

Originally architecture comes from civilization. It is used in the area of informatics today in some different ways but the way we deal with is *enterprise architecture*.

Zachman offers enterprise architecture to be *the set of primitive, descriptive, artifacts that constitute the knowledge infrastructure of the enterprise* [3]. However this is a general definition could be applied on many areas, there are more specific definitions such as one which presented by *CIO*¹. *EA*² is *a strategic information asset base that defines the business, information necessary to operate the business, technologies necessary to support the business operations, and transitional processes for implementing new technologies in response to the changing needs of the business.*

¹ Chief Information Officers Council in the United States

² Enterprise Architecture (will be used this point forward)

Ultimately an architecture effort will result in an IT environment for the enterprise or conforms its current IT environment to a new one. Therefore, any enterprise architecture may have up to three time-phased views [5]:

- *Baseline or Current Architecture* – Describes the current state of the environment (Often called “As-Is”).
- *Target Architecture* – Describes the future state of the environment (Often called “To-Be”).
- *Transition Architecture* – Includes: Business Improvement Efforts, Technology Migration Strategies, Project Development Initiatives and Deployment Plans which transform the enterprise architecture from its current state to a target state.

What is a Framework?

Framework is considered to play the most important role in enterprise architecture. For any architecture project it is vital to select a framework. It guarantees final products to be interoperable and supporting for business needs.

Generally speaking a framework is a comprehensive, logical structure for descriptive representations (i.e., models) of any complex objects [4]. Specifically EA framework is simply a logical structure for classifying and organizing the descriptive representations of an enterprise that are significant to the management of the enterprise as well as to the development of the enterprise's systems [6]. Frameworks steer architecture, organize architecture products and promote interoperability within the products during an EA project.

Generally, when we speak of frameworks in the area of EA, we mean Zachman framework, which is the fundamental framework in this area. It is first introduced by Zachman (1987) and then extended and formalized by Sowa & Zachman (1992).

Zachman framework is a table, consisting of six rows and six columns. There are two different ideas for rows and columns (Zachman, 1987):

1. Rows represent different perspectives of the different participants in building enterprise architecture.
2. Columns are different ways in which we describe the same product for different purposes.

There is a cell, at the cross point of each row and each column, which contains a unique model.

Figure 3 depicts Zachman framework, as it is known today. (Model names are ignored for the sake of brevity):

Scope					
Business					
System					
Technology					
Detailed Specifications					
Functional					
Enterpris					

Figure 3 : Zachman Framweork

2. EA Frameworks

One of the steps must to be taken in any enterprise architecture effort would be selecting a framework. Using a framework will ensure uniformity and standardaization when migrating and integrating information systems [9].

There are many frameworks introduced in order to build an enterprise architecture, from which those that are candidates in doing federal architectures are selected here to describe about and use as samples.

Most federal organizations (in the US) have standardized on the following three frameworks [9]:

Federal Enterprise Architecture Framework (FEAF) [4]: The Clinger-Cohen Act of 1996 mandated that Federal Agencies develop and maintain an enterprise IT architecture. The FEAF was established in 1999 by the Chief Information Officers (CIO) in response to this mandate. The purpose of the FEAF is to facilitate shared development of common processes and information among Federal Agencies and other government agencies [10].

In designing the Framework, the CIO Council identified eight components vital for developing and maintaining the Federal Enterprise Architecture, then drilled down to a further granularity of detail. These components are [10]:

- **Architecture Drivers** are external stimuli that cause the Federal Enterprise Architecture to change.

- **Strategic Direction** ensures that changes are consistent with the overall Federal direction.
- **Current Architecture** is the current state of the enterprise.
- **Target Architecture** is the target state for the enterprise within the context of the strategic direction.
- **Transitional Processes** are those processes that apply the changes from the current architecture to the target architecture, in compliance with architecture standards (such as various decision making or governance procedures, budgeting, engineering change control, etc).
- **Architectural Segments** are subsets or a smaller enterprises within the total Federal Enterprise.
- **Architectural Models** provide the documentation and the basis for managing and implementing changes in the Federal Enterprise.
- **Standards** (some of which may be made mandatory), voluntary guidelines, and best practices, all of which focus on promoting interoperability.

The FEAF consists of four levels, the first level providing a high level description of the above components, and the next three levels describing these components in increasing details [10].

More details will be gained via breaking the components into two layers : *Business* and *Design* at level II, then dividing *Design* layer into three sub-layers : *Data*, *Application* and *Technology*.

The idea of breaking components in details in a way such that mentioned above mainly comes from EAP methodology introduced by *Spewak (1992)*.

The fourth level also provides a logical structure for classifying and organizing the artifacts. This logical structure is actually a tailored version of the Zachman Framework [10] consisting its first three columns and five rows.

Treasury Enterprise Architecture Framework (TEAF) [2]: TEAF is an EA framework for the department of treasury and its agencies. It is aligned with the FEAF [11].

At the heart of the TEAF is the TEAF Matrix which provides a customized

version of Zachman table [11]. This matrix is a 4 by 4 matrix shown in figure 5 :

Planner Perspective				
Owner Perspective				
Designer Perspective				
Builder Perspective				

Figure 4 : The TEAF Matrix

Both FEAF and TEAF adapt NIST¹ model. It has been advised to be a basic model for information architecture consisting of five layers. However both of them customize this model for their specific purposes. Layers in NIST (Firstly introduced as sub-architectures in DOE² methodology) are [12]:

- **Business:** Organizations, Customers, Business Functions, Standards, Policies and Procedures.
- **Information:** Information Flow, Internal, External, Content, Format and Presentation.
- **Applications:** Automated Data Processing, Manual Systems, Procedures and Logical Data Structure
- **Data:** Physical DB Design, DB and File Structures and Data Dictionaries
- **Technology:** Computers, Facilities, Communications Network and Security Infrastructure.

Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) Framework [13]: In December 1997, the DoD³ published its C4ISR Architecture Framework. This framework applies to all branches of the armed services and includes the numerous major and subordinate commands, field organizations, and task forces within each service [9].

The framework has four main parts: definitions of three standard views; products; references; and high-level

¹ National Institute for Standards and Technologies

² Department Of Energy

³ Department Of Defence

guidance in how to use the framework to describe an architecture [15].

“View” plays a role as “Layer” in the NIST model or as “Perspective” in the Zachman framework. These three architectural views are :

- **Operational Architecture View** describes the tasks and activities, the *operational nodes* and the information flows between nodes that are required to accomplish or support an operation.
- **Systems Architecture View** translates the required degree of interoperability into a set of system capabilities needed, identifies current systems that are used in support of the operational requirements and facilitates comparison of current/postulated system implementations with the needed capabilities.
- **Technical Architecture View** articulates the criteria that govern the implementation of required system capabilities [9, 15].

These three views have explicit linkages between themselves in order to maintain consistency and integration of the architecture [9, 15].

C4ISR has this advantage that provides some *Universal Reference Resources*, which serve as sources for guidelines, and attributes that must be consulted while building architecture products [13].

Also its other advantage is a *Six-Step Architecture Process*. This is described briefly in the framework document as the fundamental steps to build architecture in accordance with the Framework [13].

3. Framework Selection

Selecting a framework must be a step in building enterprise architecture. This is specially true for those enterprises which have no architecture before. Some enterprises may have frameworks selected before. It is important to note that although having already a framework, architects must evaluate the current framework in order to understand its ability to response to the drivers forcing the enterprise to be changed.

In [9] some framework selection criteria are mentioned for federal agencies. These are:

- **Area of Policy**
 - Regularity and legislative direction.

- Agency policy.
- Compatibility needed with another Agency or joint policy

- **Enterprise**

- Context for the enterprise: e.g., subordinate to a larger enterprise, closely related to another enterprise.
- Experience with a particular framework.
- Mandates and drivers: e.g., emphasis on business versus infrastructure or operational versus technical issues

- **EA Products**

- Priorities, intended uses and desired level of detail: e.g., large-scale modernization versus stable IT environment.
- Resource and schedule constraints on modeling efforts.
- Availability of existing architecture products.

Among these criteria, the context for the enterprise is in our interest here. Also we focus on the context for architecture and show that both have some counterparts in the context for framework.

We provide four classification schemes here, first two of which are about *the Context for the Enterprise* and two last ones are about *the Context for the Architecture*.

Organizational vs. Operational: Of course each organization, have many operations to do. When we talk about operations here we don’t mean any activities an organization performs. Operations are distinct from other activities in two following ways:

1. Typically an operation is not a simple office or customer related service. It is as critical as there will be no more need to the organization if it doesn’t perform the operation.
2. An operation usually invokes many more resources than other activities. The resources might include human, machines, time, fund and etc.

Examples of operations are: Military Operations, Fire Fighting Operations, Crisis Management, Software Production Process, a Soccer Match and so on.

Regarding this definition there are two broad categories for enterprises: *Organizational Enterprise* vs. *Operational Enterprise*. Also we may name them *Structural Enterprise* vs. *Behavioral*

Enterprise respectively. Note that these two types of enterprises are often mixtured in a unique organizational unit.

In order to provide better understanding of this point, refer again to our samples of an operation and consider folowing descriptions:

- A military operation (Operational Enterprise) is done by a defense related deapartment (Organizational Enterprise).
- A software production process is done by a software engineering company.
- A fire fighting operation is done by the fire guard.

In the same way we would see that frameworks themselves could be seen as having more operational or organizational emphasis. It means that some frameworks form an architecture which shows the enterprise as an organization whereas others establish an architecture that depicts the enterprise as an operation.

Having enterprises categorized in this way, we could name frameworks as the same way. So we have *Structural (Organizational) Framework* and *Behavioral(Operational) Framework*.

The best sample of an operational framework is C4ISR. It focuses on the operational nodes and elements at the top level of its architecture and so is well organized to build architecture for an operation.

On the other hand, we have FEAF & TEAF, both accepting NIST structure as their reference architecture pattern. As we have shown before it begins with the *Organization* as its top level. These are structural frameworks.

To finalize examples, now we offer following proposals in order to build architecture:

- To build architecture for the organizations such as Department of Defense, select FEAF, and to build architecture for its military operations, select C4ISR.
- To build architecture for a software engineering company, select TEAF, and to build architecture for its projects development process, select C4ISR.

As a result we could say that if the enterprise you want to build architecture

for, is an operational one, you may choose an operational framework such as C4ISR. But what to do, in the case of organizational ones?

Nested vs. Flat: Every organization has many subunits in its structure. Some of these subunits might be seen as enterprises themselves. For example in a government there are some ministries (or departments) that are enterprises themselves such as Department of Defense or Ministry of Education. We name such enterprises as *Nested Enterprise* and we mean it includes some other enterprises.

For an enterprise to be considered as a nested one, just having other enterprises included is not enough, but also these sub-enterprises must be devised to be engaged with architecture. If sub-enterprises have not been considered in the architecture or have been seen as a simple black box with some input/output lines, we could not suppose the main enterprise as a nested one.

If any of two conditions mentioned above are not present then the enterprise may be called a *Flat Enterprise*.

Similar to the enterprises, frameworks may be *nested* or *flat*. Two of three frameworks suggested by CIO for federal organizations are good examples for these two types of frameworks: FEAF & TEAF.

FEAF is considered to be a *Nested Framework* for its *Architectural Segments* component. As it has been shown before those are sub-organizations or sub-divisions of the major business in the federal organization. These segments are considered to be other enterprises within the federal enterprise [4].

Although we could ignore segments in FEAF for a flat enterprise, there is a more appropriate framework for flat enterprises: It's TEAF. TEAF is well-matched with FEAF, but it has no architectural segments included. So we might consider the TEAF as a *Flat Framework*.

We may use C4ISR for building architecture in a flat enterprise, however, note that a flat enterprise seems to be an organizational enterprise more than an operational one.

Level of Details: When planning for architecture projects, we might decide about architectural products, for example which of them are required? And in which level of details? So architectures (after planned) are not as the same to each other in the level of details for final products.

Furthermore frameworks are not equally focused on their products either. In some frameworks such as C4ISR, there are many descriptions on how to create products? Steps to be taken? What are included in each product? There are even attributes for each product fully described. Such a framework is suitable for implementing a final IT environment. We call any framework like this a *Low-Level Framework*.

To get more familiar with this concept let us verify our three accepted frameworks in this manner. As it is said before the C4ISR is a low-level one. Not only there are a lot of descriptions about its products documented officially, but also there are many researches and work done on tools and methodologies for building architecture using C4ISR framework. TEAF could also be seen as a low-level framework but not as low-level as C4ISR. It defines attributes for its products but it has no step-by-step method to achieve them.

On the other hand we have FEAF as a high-level framework, that is not engaged with the details of products and how to produce them.

If your goal is to provide a real working IT environment you may prefer C4ISR to TEAF or FEAF even if the subject enterprise be an organizational one. In other words you as the architect should have the art of ranking these factors against each other.

States of the Architecture: This could affect the architecture effectively. Remember three states which were mentioned before for any architecture. However for an architecture it is not obligatory to have exactly those three states. It may only concern with the current (or target) state of the IT environment.

In such a way, it is not true that all of the frameworks support the three possible states of the architecture. For example C4ISR only deals with one state (current or

target). Although it has some products to keep some notes on the future technologies or activities, but obviously these are not a complete set of architectural products.

On the other side both FEAF and TEAF support the three states for any architecture as mentioned before. This is specially true for FEAF that supports any of these three states with a certain component.

So if the project is planned to check the current state and provide a migration plan to achieve an offered future state you must select each of the FEAF or TEAF.

4. Conclusion

Having classified framework selection criteria, we have reached to some properties, an enterprise or an architecture may have. As an architect you may choose the framework which its properties match with the one for the enterprise and the architecture in the best way.

As we said before in some situations we may have two or more properties occurred simultaneously, while they seem to be contradicting each other. As it was mentioned earlier, the role of the architect is very important in such cases.

However a notable point to focus is that these situations may occur rarely. This is due to the most important part of our taxonomy that describes an enterprise to be structural or behavioral.

An organization often comprises other organizations but operations included in an operation are smaller than to be seen as an enterprise. So an operational enterprise may not be seen as a nested one.

Furthermore, we are more interested in details for operations than organizations. This is because operational enterprises are often *more mission critical* than organizational enterprises. Any mistake in these enterprises could result in *immediately unpredictable crashes*.

These doesn't mean structural enterprises are not mission critical. It means their failures could be recovered more easily. While for operational ones these failures could not be recovered at all. As a consequence most of the times, low-level architectures is needed for operational enterprises not for organizational

enterprises. Table 1 summarizes all the criteria discussed in this paper:

	Enterprise				Architecture			
FEAF	√			√		√		√
TEAF	√		√		√			√
C4ISR		√	√		√		√	

So far we suggested a taxonomy of enterprises in this paper. For an enterprise, to be fitted in this taxonomy easily, we need to define an enterprise in a new manner:

An enterprise is any collection of sub-units, inter-connected to each other through the flow of information.

This seems to be a very simple definition, but it could be applied on both types of the enterprises discussed earlier as well. We may expect an enterprise to be necessarily a giant object but if we accept architectures apply on enterprises then we may notice to Zachman, Inmon and Geiger who believe that an architecture is used to describe an object [7]. Also as it was said by Zachman and Sowa (1992) the logic and rules of the framework can be used for structuring the description of any complex object.

Future Work

Many problems exist in this area, need to be solved yet. Following this work, we will consider on other framework selection criteria, trying to represent a full taxonomy of all the criteria.

Also we think about more contextual aspects of enterprises, architectures and frameworks as the selection criteria. Some of these aspects are:

- Conceptual vs. Technical
- Homogeneous vs. Heterogenous
- Dynamic vs. Static
- Single Dimension vs. Two Dimension

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The Use of Real Options to Evaluate Business-To-Business Companies

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Abstract

The purpose of this work is to show that the use of real options can contribute to a better evaluation of companies devoted to Electronic Commerce – Business-to-Business. For such, usual company-evaluation techniques are presented and the advantages and disadvantages of each one are discussed, with emphasis to the real-option technique. Additionally, the similarity between asset investment and call options is shown, and internal and external real options existing in a Business-to-Business company are identified. Finally, this work describes how to evaluate a company acting in Business-to-Business by employing the concepts of real-option theory.

1. Introduction

In recent years, the development of Internet-bound technology has yielded the extraordinary growth of Electronic Commerce among companies, called Business-to-Business (B2B), leading to the constitution of several electronic marketplaces. Transactions among companies have become faster and safer and have had their costs reduced, attracting a larger number of purchasers and suppliers into this new business environment.

Despite many successful stories of B2B companies created in the past few years, their growth has been facing difficulties due to technical, organizational, economical and legal challenges. Such uncertainty scenario has led to a significant loss in the value of such companies.

The new economy has revolutionized traditional evaluation theories. While in the old economy evaluation models were based on tangible assets, such as factories, machinery and finished products in stock, in the new economy intangible assets, such as intellectual capital or clients, have also started to be computed as company values.

The evaluation of Internet companies has been greatly affected by the uncertainty of markets. The impossibility to foresee how companies will perform in the future makes the evaluation of these companies using traditional methods inadequate because these methods do not consider managerial flexibility. A new trend in evaluation methods concentrates in the exploration of uncertainty, approaching businesses or investments as real options.

This work presents a proposal for evaluating B2B Internet companies that takes into consideration the existing uncertainties in the Internet B2B environment by applying the real-options theory.

First, we present the traditional methods for evaluating Internet companies. Then, we emphasize the positive and negative aspects of each method. Next, we present a typical configuration of the environment where B2B companies operate and the existing relationship dynamics between a given company and all other companies with which it interacts. Based on this configuration, we show the existing internal and external options that add value to that company.

2. Usual Evaluation Methods for Uncertainty Environments

The mostly used methods for evaluating companies in uncertainty environments are (Trigeorgis, 1996):

- Discounted Cash Flow
- Sensitivity Analysis
- Simulation
- Decision-Tree Analysis
- Real Options

2.1. Discounted Cash Flow

In the absence of managerial flexibility, the discounted cash flow is the best method to calculate the value of a company (Trigeorgis, 1996).

The discounted cash flow analysis – DCF – is the tool mostly used by academics and by analysts in order to evaluate investments, especially because it is a method easy to understand. However, DCF does not deal in a convenient way with strategic factors emerged from future uncertainty and the flexibility companies makes use of to respond to situations different from the ones expected (Teisberg, 1995).

A dynamic version for DCF was created by McKinsey (Desmet et al., 2000) in order to deal with future uncertainty. This version, instead of assuming a unique future cash flow deriving from a set of predetermined decisions, takes into account that the analyst initially assumes a set of future uncertainties and contingent decisions, translating them into alternative scenarios. These scenarios can be expressed together in a decision tree. Then the probability of each scenario is evaluated.

These probabilities are obtained from the analysis of similar projects or by means of macroeconomic analysis.

Both methods, static and dynamic DCF, use a unique discount rate adjusted to the perceived risk. The evaluation of the discount rate is usually based on data from projects with a similar risk – or, ideally, with identical risk. However, the use of only one discount rate has some problems. The relative risk of an enterprise can vary for each different scenario, or even for different project stages. As an example, we can observe in some exporting companies that some of their costs can have different risks if compared with revenue risks because they can be exposed to currency risks when their raw material derives from the domestic market. Therefore, it is advisable to use more than one discount rate in the analysis of this kind of project (Luerhman, 1998, p. 60).

One of the best examples of the dynamic version of DCF was created by McKinsey in order to evaluate Amazon.com (Desmet et al., 2000). In this example, McKinsey has combined the classic DCF method, microeconomic analysis and probability-weighted scenarios.

2.2. Sensitivity Analysis

The net present value of a project is a function of the forecasts of some variables: the project's life, salvage values, product prices, production costs, size and growth of the market and others.

Sensitivity analysis is the process of investigating these forecasts in order to identify the key variables and determine the impact of each of these primary variables on the net present value of the project. The sensitivity analysis is made by varying the value of the primary variable selected, holding other variables unchanged. (Trigeorgis, 1996, pg 52.)

The sensitivity analysis is important to identify the variable that contributes the most to the investment's risk. A variable can have a high variance compared with other variables (higher risk) but make an insignificant contribution to the project's risk and, thus, we can consider that investment decisions are independent from a very accurate precision in its estimate. On the other hand, if a variable has a low risk, it can demand a better estimate of its value. Therefore, if we commit errors in its estimate they can generate significant impact on the project's value. The relevance of each variable will indicate the necessity or not to spend more time or money in it to attain information in order to contribute to the reduction of the uncertainty of the project as a whole.

The sensitivity analysis also has some limitations. It considers the effects on the net present value at a time ignoring the possibility of interdependencies between variables, that is, the effects of the variation of a variable on other variables. In this case, the result might be underestimated, not corresponding to the results that would occur in practice. Another limitation is that a variable can present a dependency in time that is an error in the estimate of one year, which can spread to the following years causing great impact on the net present value.

When variables are interdependent, it is necessary to examine the project's net present value according to alternative scenarios with the simultaneous variation of a limited number of variables as a function of their interdependence.

2.3. Simulation

The simulation technique is used in the attempt to imitate managerial decisions in the real world. In order to obtain the desired results, a mathematical model is developed holding equations that represent the operations accomplished by the system being analyzed. This model must capture the most significant characteristics of the project as it evolves in time and encounters random events. The Monte Carlo method is the traditional method used in simulation. It includes the following steps:

- The project is modeled by means of a set of mathematical equations and identities contemplating the more significant primary variables;
- Probability distributions are specified for each of the above variables in a subjective way or from past empirical data;
- A random sample is then drawn from the probability distribution for each variable, allowing the calculation of the net cash flow for each period;
- The process is repeated until the average and standard deviation of the net present value can be obtained.

Although this procedure can handle sophisticated models, it has some limitations: (Trigeorgis, 1996, pg. 55):

- It is difficult to estimate the probability distribution for each significant variable.
- Even if the probabilities were determined, it is difficult to capture and shape all the interdependencies among the variables of the model.
- If the result of the simulation is a risk profile of net present value, the meaning of an outcome probability distribution of the NPV is questionable, since it is not clear what discount rate should be used.
- The management cannot easily translate the risk profile into clear decisions for action.
- Using the variability of project outcome as a measure of risk instead of the systematic risk, which would be the most appropriate risk for the company's shareholders, is dangerous.
- In some situations, the management can assume that a group of projects is viable when analyzed as a group, even when some of them are individually unacceptable.

2.4. Decision-Tree Analysis

Decision-tree analysis is a methodology that attempts to account for uncertainty and the possibility of subsequent decisions by the management. It helps the management to structure the decision problem by means of mapping all the dependent alternative courses of action. This methodology is especially applicable to analyze complex decisions of sequential investments when the uncertainty is decided in different points in time.

The decision-tree analysis is a good methodology for analyzing sequential investment decisions when uncertainty is resolved at diverse points in time. It forces the management to recognize the interdependencies between the immediate decision and subsequent ones.

Although this method is sufficiently flexible, allowing the representation of the managerial flexibility found in practice, it has practical limitations. For example, decision-tree analysis can quickly become very complex if the number of paths through the tree increases too much motivated by the number of decisions. Another problem is the difficulty to determine the appropriate discount rate.

2.5. Real Options

Options are contracts that give their holder the right, but not the obligation, to buy (call option) or to sell (put option) an asset at a predetermined price (exercise price) on or before a specified date (expiration or maturity date). For a call option, when the exercise price is above the market price of the asset, the option is said *out-of-the-money*. Conversely, if the market price of the asset is above the exercise price, the option is said *in-the-money*.

An option is called American option if it allows its owner to exert the option before the maturity date. It is called European option if it can be exercised only at the maturity date.

We can find different models to estimate a price for an option with sufficient precision. The mostly known models are the binomial model developed by Cox, Ross and Rubinstein (1979), and the Black-Scholes model (1973).

The evaluation of an option is based on the following premises (Weston, Copeland, 1992, p. 446):

- Frictionless capital markets (for actions, headings and options). This means: a) they do not have transaction costs or taxes; b) there are no restrictions on short sales; c) all shares of all securities are infinitely divisible; and d) borrowing and lending are unrestricted.
- Asset prices obey stationary stochastic processes along time.
- Risk-free rate is constant along time.
- Underlying assets pay no dividends.

Most of these premises can be relaxed without changing the basics of the option pricing model.

2.5.1. Binomial Model

The binomial option pricing model is a discrete model along time. This model starts by reducing the possible

option price modifications for the following period to two: price can move up or down from its current level. This simplification is acceptable if the period of time is very short, so that a great number of small movements is accumulated along the option's life (Brealey, Myers 1992). Thus, for a one-period model, the investor assumes that the price of the action – S – at the end of the period can have one of two values: uS with probability q or dS with probability $1 - q$. Let C be the current value of a purchase option; C_u and C_d the value of the call option at the end of the period if the option price is equal to uS and dS , respectively. In the one-period model, the option expires at the end of the period, and then the option's value in maturity date equals $C_u = \max(0, uS - X)$, X being the option's exercise price, with probability q and $C_d = \max(0, dS - X)$ with probability $1 - q$.

This procedure can be easily extended to multiple periods. If the time to the option's expiration, τ , is subdivided in n equal subintervals, each of length $h = \tau / n$, and the same valuation process is repeated starting at the expiration date and working backwards recursively, the general multiplicative binomial option-pricing price for n periods will be:

$$C = \sum_{j=0}^n \frac{n!}{j!(n-j)!} p^j (1-p)^{n-j} \max(u^j d^{n-j} S - X, 0) \frac{1}{(1+r)^n}$$

The first part, $\{ n! / [j!(n-j)!] \} p^j (1-p)^{n-j}$, is the binomial distribution formula giving the probability that the stock will take j upward jumps in n steps, each with probability p . The last part, $\max(u^j d^{n-j} S - X, 0)$, gives the value of the call option at expiration conditioned to the stock following j ups, each by $u\%$, and $n-j$ downs each by $d\%$ within n periods. The summation of all possible option values at expiration multiplied by the respective probability of occurrence ($j = 0, \dots, n$), gives the expected terminal option value, which is then discounted at the riskless rate over the n periods (Trigeorgis, 1996, p. 85).

2.5.2. Black-Scholes Model

In 1973, Black and Scholes presented a rigorous method to value stock options based on the premise of risk-free arbitrage. The term *risk-free arbitrage* means that investments which have the same risk/return rate must be equally priced. If it is possible to determine the payments of a risky investment and then to construct a portfolio with other investments that offers exactly the same payments, then the price of the two assets must be equal. If the prices are not equal, then the occurrence of arbitrage is possible, that is, purchasing an asset by a lower price and selling the same asset for a higher price.

The Black-Scholes model formula is:

$$C = S N(d_1) - X e^{-rfT} N(d_2),$$

where

$$d_1 = \frac{\ln(S/X) + rfT}{\frac{s \sqrt{T}}{2}} + \frac{1}{2} \frac{s \sqrt{T}}{2}$$

$$d_2 = d_1 - s \sqrt{T}$$

$N(d_1)$ and $N(d_2)$, respectively, are the cumulative standard normal distribution function of a unit's normal variable d_1 and d_2 ; S is the price of the asset; X is the exercise price; T is time to maturity; σ^2 is the return volatility of the asset; r_f is the risk-free rate; and e is the base of natural logarithms, constant = 2,71828...

The Black-Scholes model was developed over of some hypotheses that introduce some limitations to its use. The Black-Scholes model assumes (Copeland and Antikarov, 2001, p. 106):

- The option alone may be exercised only at maturity (European option).
- There is only one source of uncertainty.
- The option is contingent on a single underlying risky asset.
- The underlying asset pays no dividends.
- The current market price and the stochastic process followed by the underlying assets are known (observable).
- The return variance on the underlying assets is constant through time.
- The exercise price is known and constant.

The payment of dividends reduces stock price. Consequently, call options will become less valuable and, conversely, put options more valuable as dividend payments increase. Damodaran (Damodaran, 1997, p. 735) presents an adjustment for dividends when valuing short-term options and another for long-term options. He also suggests some other adjustments that allow calculating the value of an option for an early exercise.

For short-term options, that is, within a short time before expiration (less than one year):

Adjusted stock price = Current asset value - Present value of the expected dividends or

$$S' = S - S \frac{\text{Div}_t}{(1+r)^t}$$

$$C = S' N(d_1) - X e^{-rt} N(d_2)$$

where:

$$d_1 = \frac{\ln(S'/X) + rfT}{s \sqrt{T}} + \frac{1}{2} s \sqrt{T}$$

$$d_2 = d_1 - s \sqrt{T}$$

For the long-term period, assuming that the dividend yield (dividend yield = y = share/current asset value) is expected to remain constant during the option's life, the Black-Scholes model can be expressed as:

$$C = S e^{-yt} N(d_1) - X e^{-rt} N(d_2)$$

where:

$$d_1 = \frac{\ln(S/X) + (rf-y)T}{s \sqrt{T}} + \frac{1}{2} s \sqrt{T}$$

$$d_2 = d_1 - s \sqrt{T}$$

The adjustments in the Black-Scholes formula have two effects: a) the asset value is discounted back to the present at the dividend yield to take into account the expected drop in value from dividend payment; and b) the

interest rate is offset by the dividend yield to reflect the lower carrying cost from holding the stock.

2.5.3. Mapping a Project onto an Option

An investment opportunity is similar to a call option because the company has the right, but not the obligation, to acquire the asset as, for example, a new business. So, if it is possible to determine options that are similar to investment opportunities, the values of these options can be taken as reference for the value of these investments. Given the characteristics of an investment, it is very difficult to obtain a similar option. Thus, the only trustworthy way of getting the desired option is by means of the construction of an option. In order to obtain such option, it is necessary to establish a correspondence between the characteristics of the investment opportunity and the variables that determine the value of a call option (Luehrman, 1998, p. 52). Figure 1 shows the mapping of an investment opportunity onto a call option.

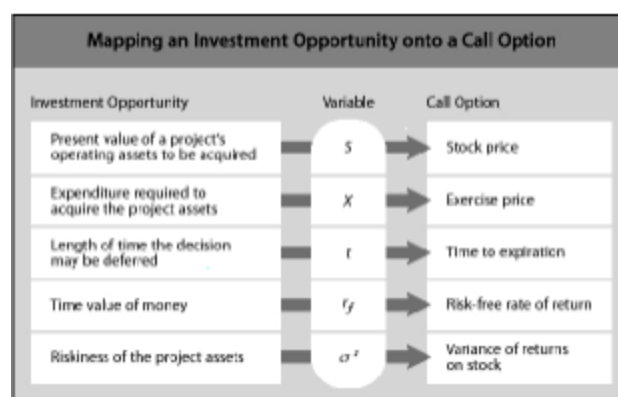


Figure 1: Mapping an investment opportunity onto a call option

Source: Investment Opportunities Real Options: Getting Started on the Numbers, Luehrman, T. A., Harvard Business Review, July-August, 1998

The net present value of an investment opportunity is the difference between its net present value S and how much it costs, $NPV = S - X$. When the NPV is positive the investment adds value to the business. Conversely, if it is negative, the company does not invest in this new opportunity, that is, $NPV = 0$. In terms of real options, this result can be expressed as being the value of the call option = $S - X$.

In the traditional methods of asset evaluation, managerial flexibility is not taken into account. Managerial flexibility is similar to a deferral option and adds value to the investment opportunity. By means of deferment the company postpones the outlay relative to the investment and, by applying this amount, it earns the value of the money in time and creates the possibility to do the investment later in case the asset value goes up. If the last alternative occurs the company can exercise the option. If, in contrast, the asset value decreases, it can either abandon the business or wait to see if its value goes up in time, avoiding loss of money with the investment.

Brealey and Myers (1992, p. 579) developed a methodology that simplifies the effort of valuing a call option using the Black-Scholes model. This methodology follows four steps:

1st step: a) let σ^2 be the variance of returns per unit of time in our project; b) multiply variance per period by the number of periods t to get cumulative variance $s^2 t$; c) take the square root of cumulative variance to change units, expressing the metric as standard deviation rather than variance. Luehrman (1998, p. 54) called this result *cumulative volatility* ($s \sqrt{t}$).

2nd step: calculate the ratio asset value to the present value of the option's exercise price. Assuming that the option's exercise occurs in t periods, the current value of the exercise price is equal to $PV(X) = X \div (1 + rf)^t$ and the desired quotient: $S \div PV(X)$.

3rd step: the option's value in function of the value of the exercise can be obtained by entering the values obtained in steps 1 and 2, above, in table 6 – *Call Option Values, percent of share prices* – presented in the appendix of the book *Principles of Enterprise Finances* (Brealey, Myers, 1992).

The value of a European put option value (kept until its expiration date) can be calculated using the following equality:

Value of put option + price of the asset = value of the call option + present value of the exercise price (X).

Using the Black-Scholes model's formula, it is possible to verify the impact of the variation of each variable on the value of a call option. Table 1 shows the impact for each variable:

Table 1: Impact of the Variation of a Variable onto the Value of a Call Option and a Put Option

Increasing	Option Value	
	Call	Put
Asset Price	↑	↓
Exercise price	↓	↑
Time to Expiration	↑	↑
Risk-free rate of return	↑	↑
Variance of Returns on Asset	↑	↓
Dividends	↓	↑

2.5.5. Relationship Between the Binomial and the Black-Scholes Methods

The results produced by binomial method approaches to the ones of Black-Scholes model when the time interval between a period and the following one is very short as the number of branches in binomial tree becomes large (Weston and Copeland, 1992, p. 454).

Figure 2 shows the evolution of an option value using the binomial model and the Black-Scholes Model. The input data in this example are: asset present value - \$100; exercise price - \$250; time to expiration - 7 years; risk-free rate of return - 10%; standard returns on asset - 40,55% and a changeable number of steps.

In the calculation of the option values we used the following tools: a) for the binomial method: *Peter*

Hoadley's Options Strategy Analysis Tools: Binomial Tree Option Calculator (<http://www.hoadley.net/options/binomialtree.aspx?tree=B>); b) for the Black-Scholes method: *Numa Option Calculator* (<http://www.numa.com/derivs/ref/calculat/option/calc-opa.htm>).

In the construction of the graph we used a maximum of 150 steps. This number is due to limitations imposed by the calculators used. We used Microsoft Excel to adjust a logarithmic curve to points obtained from the calculators.

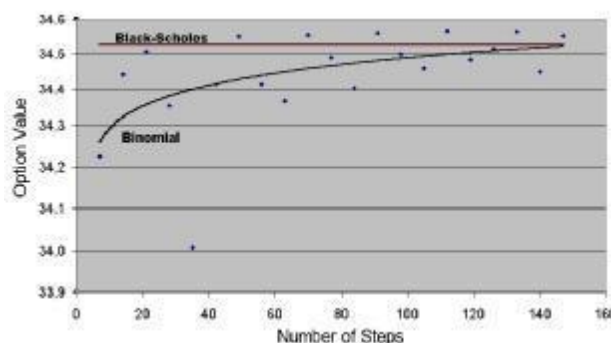


Figure 2: Relationship Between Binomial and Black-Scholes Method

2.5.6. Types of Real Options

There are eight common categories of real options (Trigeorgis, 1996, p. 2):

1. Option to defer – enables the management to defer investment for a project or one of its stages. This option can be expressed as an American call option on the gross present value of the completed project's expected operating cash flows with an exercise price equal to the required outlay.

2. Option to expand – enables the management to increase operation capacity if market conditions turn out more favorable. This option can be expressed as a call option to acquire an additional part of the base-scale project, paying an additional expansion cost as exercise price.

3. Option to contract – enables the management to operate below capacity or even reduce the scale of operations thereby saving part of the planned investment outlay. This option can be expressed as a put option where the asset price is represented by the percentage of the basic project equivalent to the reduction, being the exercise price equal to the potential saving.

4. Option to shut down and restart operations – enables the management to shut down installations if cash revenues are not sufficient to cover variable operating costs. If prices rise sufficiently, operations can be restarted. This option can be expressed as a call option to acquire that year's cash revenue and the exercise price equal to the variable cost of operating.

5. Option to abandon – enables the management to abandon the project permanently in exchange for its salvage value. This option is similar to an American put

option on the project's current value with an exercise price equal to the salvage or a best value alternative, such as selling the project to another company.

6. Option to switch – enables the management to switch from one way of operation to another, such as adopting a flexible process that allows for different technologies. It can be represented by a portfolio of options that consists of both call and put options.

7. Growth option – sets the path of future opportunities of strategic importance for the company. It can be represented by composed options where each new business opportunity is a contingent option to the previous exercise of other options.

8. Multiple interacting options – involve a collection of various options. Upward-potential-enhancing and downward-protection options are present in combination. They can be represented by composed options.

3. A Generic Model for B2b Companies

Figure 3 presents the “B2B Global Model”, a generic model proposed for the B2B environment. Components of this model can be virtual companies (pure-play dot-com), mixed companies (bricks and clicks) or, in some cases, traditional companies (bricks and mortar).

In operational terms, the B2B Company presented in the generic model offers suppliers and consumers a virtual place where they can perform transactions in an easy and safe way. The technological solutions and tools offered by the B2B Company reduce the total costs and make the transactions between suppliers and consumers more efficient. The B2B Company offers several kinds of services such as: collaborative planning, forecasting and replenishment, catalogue of products and the implementation of supply chains.

The representation of the B2B Company makes explicit the sectors in charge of Technology, Marketing, Law and Payment because of their importance to the company and its relationship with the external elements interacting with it. Such sectors have a strong integration among one another. For example: the Technological area provides support to Marketing by means of CRM tools; the Legal area provides support to the Payment area by modeling the agreements made among the diverse elements that compose the Company's internal and external environment.

To carry their transactions in the B2B environment, the companies need external support from other companies, especially those related to the areas of technology, marketing, law and payment. These companies are represented in the model by the name of e-Technology, e-Marketing, e-Law and e-Payment, respectively. Other companies that do not belong to these groups are called e-Others. These companies can be virtual companies, traditional companies or mixed companies (bricks and clicks).

Governmental institutions, market-specific entities, unions and other regulation and control institutions with which companies in the B2B environment relate are also represented in our model by e-Laws.

There are several particular cases of B2B models which are subsets of the generic model presented here, such as: (a) purchases made to Suppliers effected by a single Buyer, such as Wal Mart Stores (www.walmartstores.com); (b) sales performed by a single Supplier, such as Ford do Brasil (www.ford.com.br), which sells parts to their distributors exclusively through the Internet; or (c) company that are service providers, such as an ASP provider.

Below, the nomenclature referring to the components in the model, as presented in Figure 3, is described:

- **Co_k** – B2B Company k – k^{th} electronic-commerce solution provider, connecting Suppliers and Consumers in a virtual environment and providing Client services.
- **Su_i** – Supplier i – i^{th} goods and/or service provider.
- **Co (k , Su_i)** – relationship between the k^{th} B2B Company and the i^{th} Supplier. The same Supplier can appear in the model associated to other companies.
- **Cs_i** – Consumer i – i^{th} goods and/or service consumer.
- **Co (k , Cs_i)** – relationship between the k^{th} B2B Company and the i^{th} Consumer. The same Consumer can appear in the model associated to other companies.
- **Cl_i** – Client i – i^{th} client.
- **Co (k , Cl_i)** – relationship between the k^{th} B2B Company and the i^{th} client. The same Client can appear associated to other companies.
- **Te_j** – e-Technology j – j^{th} technology-solution provider.
- **Te (j , Co (k , Cl_i))** – support provided by the j^{th} technology-solution provider to the i^{th} client in its relationship with the k^{th} B2B Company. The same Client can be supported by the same technology-solution provider in its relationship with other companies.
- **Ma_j** – e-Marketing j – j^{th} marketing-solution provider.
- **Ma (j , Co (k , Cl_i))** – support provided by the j^{th} marketing-solution provider to the i^{th} client in its relationship with the k^{th} B2B Company.
- **La_j** – e-Law j – j^{th} legal-solution provider or regulatory agent.
- **La (j , Co (k , Cl_i))** – support provided by the j^{th} legal-solution provider or control made by the regulatory agent on the i^{th} client in its relationship with the k^{th} B2B Company.
- **Pa_j** – e-Payment j – j^{th} financial institution.

- $Pa(j, Co(k, Cl_i))$ – relationship between the j^{th} financial institution and the i^{th} client in its relationship with the k^{th} B2B Company.
- Ot_j – e-Other j – j^{th} provider of other services. An example of a company in this class could be a recruiting company of specialized personnel.
- $Ot(j, Co(k, Cl_i))$ – support provided by the j^{th} provider of other solutions to the i^{th} client in its relationship with the k^{th} B2B Company.
- $Pr(Co_i, Co_j)$ – e-Partnership – joint efforts between the i^{th} B2B Company and the j^{th} B2B Company sharing functions and expertise in order to provide their Clients excellence in technology and services.
- $SC(Co(k, Su_i), Co(k, Cl_j))$ – Supply Chain – supply chain connecting Supplier i to Consumer j in its relationship intermediated by B2B Company k .

4. Evaluating B2b Companies

The value of a B2B Company is equal to its value without managerial flexibility added by the value of its internal and external real options. The value of the company without managerial flexibility can be obtained using the traditional net present value.

Internal options are those inherent to managerial flexibility that only affect the company. Below there are some examples of internal real options:

- Option to expand – possibility of a B2B Company to expand its transactions with suppliers and consumers in case it has extra capacity or, conversely, to invest if it is economically feasible.
- Option to defer – alternative to postpone a new internal project or one of the stages of a project of the company.
- Option to contract – possibility to reduce its performance in the market, if one of its segments is not profitable.
- Option to shut down and restart operations – alternative to cancel one or more activities of the company for a certain period of time until the conditions of the market become more attractive to the company.
- Option to abandon – alternative to abandon the project permanently or permanently close the activities of the company.
- Option to shift – possibility to change the kind of activities in the market.

External options are those related to other companies, that is, suppliers, consumers, clients, solution providers, partnerships, Governmental institutions, unions and others, such as:

- Option to switch – alternative to change the technology used affecting the relationship with other companies.

- Option to expand – the partnership with an international law office can assure the extension of legal support to the Company in new geographic regions, minimizing costs and speeding up the presence of the company in new regions.
- Option to contract – the reduction of profits of certain segment of a company can force it to lock up its activities with a certain group of companies, harming them in some way. The existence of an option to contract will give the right to the company to lock up these activities without suffering any legal constraint.

We could mention many other examples of real options, but the ones presented clearly demonstrate the value of these options and how they affect the value of a company.

Using the components of the “B2B Global Model” in figure 3, we can identify the existing real options and calculate their respective values. Representing by NPV the net present value, ROV the real option value, Co_k the evaluated company and by *Modified NPV* the total value of the Company_k, then the total value of Company_k can be expressed by:

$$\begin{aligned} \text{Modified NPV}(Co_j) = & \text{NPV}(Co_j) + (\text{NPV without} \\ & \text{managerial flexibility}) \\ & \Sigma \text{ internal ROV} + (\text{Total value} \\ & \text{of internal real options}) \\ & \Sigma \text{ external ROV} \quad (\text{Total value} \\ & \text{of external real options}) \end{aligned}$$

where

$$\begin{aligned} \Sigma \text{ external ROV} = & \Sigma \text{ ROV}(Co(j, Su_i)) + \\ & i = 1..n \quad (\text{Total value of} \\ & \text{supplier options}) \\ & \Sigma \text{ ROV}(Co(j, Cs_i)) + \\ & i = 1..m \quad (\text{Total value of} \\ & \text{consumer options}) \\ & \Sigma \text{ ROV}(Co(j, Cl_i)) + \\ & i = 1..p \quad (\text{Total value of} \\ & \text{client options}) \\ & \Sigma \text{ ROV}(Co(j, Te_i)) + \\ & i = 1..o \quad (\text{Total value of} \\ & \text{technology provider option}) \\ & \Sigma \Sigma \text{ ROV}(Te(k, Co(j, Su_i))) + \\ & i = 1..n \quad k = 1..r \\ & \Sigma \Sigma \text{ ROV}(Te(k, Co(j, Cs_i))) + \\ & i = 1..m \quad k = 1..r \\ & \Sigma \Sigma \text{ ROV}(Te(k, Co(j, Cl_i))) + \\ & i = 1..p \quad k = 1..r \\ & \Sigma \text{ ROV}(Co(j, Ma_i)) + \\ & i = 1..q \quad (\text{Total value of} \\ & \text{marketing provider options}) \\ & \Sigma \Sigma \text{ ROV}(Ma(k, Co(j, Su_i))) + \\ & i = 1..n \quad k = 1..q \\ & \Sigma \Sigma \text{ ROV}(Ma(k, Co(j, Cs_i))) + \\ & i = 1..m \quad k = 1..q \\ & \Sigma \Sigma \text{ ROV}(Ma(k, Co(j, Cl_i))) + \\ & i = 1..p \quad k = 1..q \end{aligned}$$

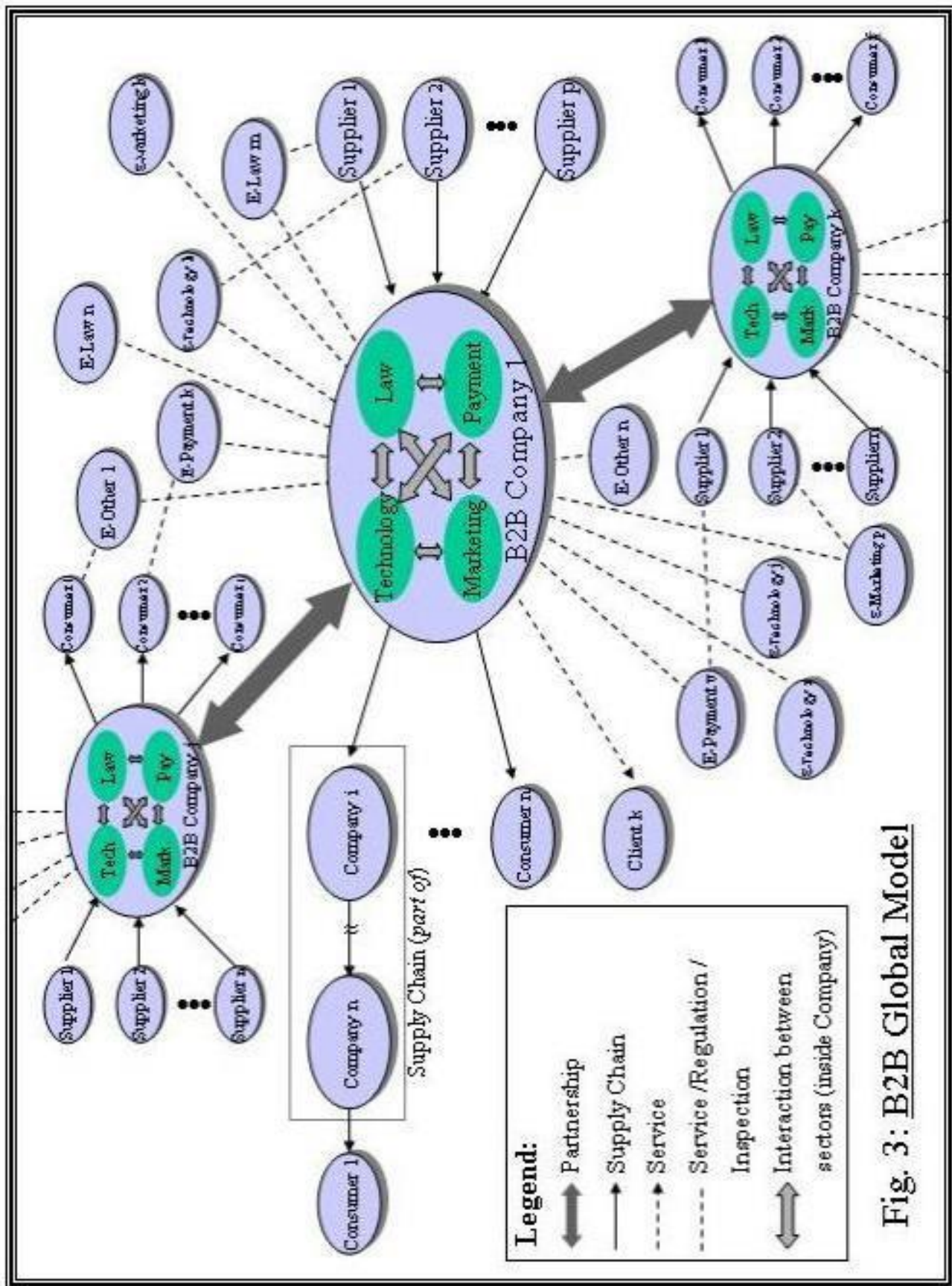


Fig. 3: B2B Global Model

$$\begin{aligned}
& \sum_{i=1..q} ROV (Co (j, La_i)) + \\
& \quad \text{(Total value of} \\
& \quad \text{law provider options)} \\
& \sum \sum_{i=1..n \ k=1..q} ROV (La (k, Co (j, Su_i))) + \\
& \sum \sum_{i=1..m \ k=1..q} ROV (La (k, Co (j, Cs_i))) + \\
& \sum \sum_{i=1..p \ k=1..q} ROV (La (k, Co (j, Cl_i))) + \\
& \sum_{i=1..r} ROV (Co (j, Pa_i)) + \\
& \quad \text{(Total value of} \\
& \quad \text{payment provider options)} \\
& \sum \sum_{i=1..n \ k=1..r} ROV (Pa (k, Co (j, Su_i))) + \\
& \sum \sum_{i=1..m \ k=1..r} ROV (Pa (k, Co (j, Cs_i))) + \\
& \sum \sum_{i=1..p \ k=1..r} ROV (Pa (k, Co (j, Cl_i))) + \\
& \sum_{i=1..s} ROV (Co (j, Ot_i)) + \\
& \quad \text{(Total value of} \\
& \quad \text{other provider options)} \\
& \sum \sum_{i=1..n \ k=1..s} ROV (Ot (k, Co (j, Su_i))) + \\
& \sum \sum_{i=1..m \ k=1..s} ROV (Ot (k, Co (j, Cs_i))) + \\
& \sum \sum_{i=1..p \ k=1..s} ROV (Ot (k, Co (j, Cl_i))) + \\
& \sum_{i=1..t} ROV (Pr (Co_i, Co_j)) + \\
& \quad \text{(Total value of} \\
& \quad \text{partner options)} \\
& \sum \sum_{i=1..m \ k=1..n} ROV (Sc (Co (j, Cs_i), Co \\
& \quad (j, Su_i))) \\
& \quad \text{(Total value of} \\
& \quad \text{existing options in supply chain)}
\end{aligned}$$

The list of real options presented above is theoretical, because it would be very expensive and it would take too much time to identify and obtain all the values of these options. In practice, we need to select the more valuable real options and work with those that are feasible to be exercised. Furthermore, interactions among real options present in combination generally make their individual values non-additive. The nature of such interactions and the conditions under which they may be small or large, as well negative or positive, may not be trivial.

5. Conclusion

This work has brought new contributions to the evaluation of Business-to-Business companies. Initially, we have examined techniques presented in the literature: discounted cash flow, sensitivity analysis, simulation, decision-tree analysis and options, discussing each one's advantages and disadvantages. We have concluded that, with the exception of real options, none of them contemplates managerial flexibility.

The use of the "Global B2B Model" in the evaluation of B2B companies is an advance because it allows the identification of the types of companies that operate in this environment: suppliers, consumers, customers and others related to the areas of Technology, Marketing, Law and Payment. This identification allows us to take into account all companies with which the company being evaluated relates to.

The identification of these companies and their characteristics allows us to collect all existing internal and external options for the company being evaluated. We have shown that the calculation of the value of any one of these options is possible by establishing a correspondence between its characteristics and those of a call option or a put option and, in some cases, of a portfolio of call and put options. The methodology presented for the calculation of each option was based on the work by Luehrman (1998).

Finally, we have concluded that the calculation of the company's value can be done taking into account the net present value (without flexibility) of the company plus the total value of the internal and external real options of the company being evaluated. It is important to emphasize that in practice, due to the existence of a great number of direct relationships and partnerships with other companies, it is necessary to verify which options are more representative for the calculation of the company's value in virtue of the effort, cost and time consumed in the calculation of each option value.

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Investigating the Influence of Learner Diversity on the E-learning Acceptance

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Abstract

University students' demographics have been changing in the past two decades. Students diversity becomes an important factor in evaluating e-learning acceptance. Using a previously validated e-learning acceptance model, the paper investigated the construct means differences among various academic departments and between nontraditional continuing education and traditional higher education students, and tested the differences in model relationships between nontraditional and traditional student groups. Inferential statistics (t tests, ANOVA) and multiple-group Structural Equation Modeling (SEM) using LISREL were performed for the data analysis. The results revealed that different needs of various learner groups for e-learning, rather than academic discipline or gender, seem to drive the differences in intention to use IT for distance education and for supplementary learning. In addition, two relationships in the path model varied between nontraditional and traditional students groups. System functionality predicted intention to use e-learning as a supplementary learning tool for traditional students, but not for nontraditional students. Perceived usefulness predicted intention to use e-learning as a supplementary learning tool more strongly for nontraditional students than for traditional students. The implications for management and practices are discussed.

1. Introduction

E-learning has become an important teaching and learning tool worldwide [1] [17]. Most noticeably, it has been used or promoted in the following four areas: corporate training, universities, government, and K-12 education.

An e-learning system is an integrated system as opposed to stand-alone, single-function systems. Recently, more advanced e-learning systems, such as WebCT (<http://www.webct.com>) and Cyber University of NSYSU (<http://cu.nsysu.edu.tw>) have been developed. These systems are specifically designed for teaching and learning purposes and can be used to integrate course development tools, course material (audio, video, and text), e-mail, live chat sessions, online discussions, forums, and the World Wide Web. With this kind of system, instructional delivery and communication between instructors and students can be conducted either synchronously or asynchronously.

In the past two decades, demographics of university students have been changing in the U. S. and Taiwan [12] [6]. The two noticeable changes are: (1) the increase of female students and (2) the increase of older, working students. In the adoption of innovation (in this case, e-learning), the factors predicting e-learning adoption may vary across demographic groups. To better address e-learning adoption problem for different demographic groups, it is necessary to study the effects of these two changing factors on the e-learning adoption. For example, gender has been reported to have influence on the adoption of e-learning [5]. Appropriate actions can then be planned separately for either female or male group to improve the acceptance. The influence of another changing factor, students diversity, therefore is worth investigating. For example, older working students have a tendency to be enrolled as nontraditional continuing education students. Comparing with traditional higher education students, these nontraditional students generally have different living schedules and needs and, therefore, may vary in their intentions to use an e-learning system. The purpose of this study then is to investigate how learner (student) diversity will influence the acceptance of an e-learning system. In particular, the following research questions guided the study:

1. Do learners of different academic departments have similar perceptions and use intentions regarding e-learning acceptance?
2. Do non-traditional and traditional learners have similar perceptions and use intentions regarding e-learning?
3. Do the relationships between learners' behavioral intentions to use an e-learning system and determinant factors differ for non-traditional and traditional learners?

2. Literature Review

2.1 Research Model

Lee and Pituch [9] proposed and empirically supported an e-learning acceptance model as shown in Figure 1. The model is derived from the Technology Acceptance Model [10] and Diffusion of Innovation (DOI) perspective [14]. This model uses behavioral intention as a surrogate for IT acceptance of novice learners. The acceptance criteria were categorized into behavioral intentions to use the e-learning system as a supplementary learning tool (IU1) and as a distance education method (IU2). Lee and Pituch

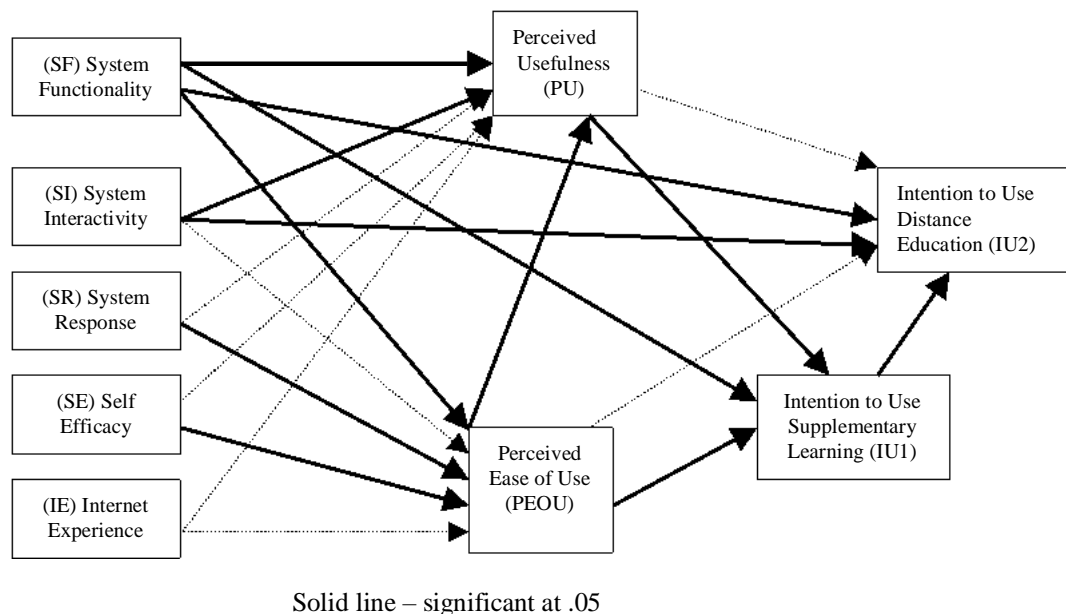


Figure 1. E-learning acceptance model (Lee & Pituch [9])

found that factors related to IT acceptance included perceived usefulness (PU), perceived ease of use (PEOU), system characteristics (functionality, interactivity, and response), and learner characteristics. The system characteristics are defined as follows. System functionality (SF) is a learner's opinion or perception of system functions related to learning and relative advantage as to time and place in learning. System interactivity (SI) is a learner's opinion or perception of the e-learning system's ability in enabling interactions between teacher and students, and among students themselves. System response (SR) is the degree to which a learner perceives whether the system response is fast/slow, consistent, and reasonable in requesting a system service [2]. For the learner characteristics, self-efficacy (SE), based on [4], is defined as one's self-confidence in his or her ability to perform certain learning tasks using an e-learning system. Internet experience (IE) is the extent to which a prospective learner uses the Internet [15].

2.2 The Influence of Learner Diversity

Human needs and behavior are related. Maslow's theory of the need hierarchy is the single most influential theory of human motivation. The theory indicates that there are five basic needs: physiological, safety, social, esteem, and self-actualization. These five needs are related to each other and are being arranged in a hierarchy of prepotency. The theory postulates that behavior is motivated biologically, culturally, and situationally to satisfy those needs.

Human needs influence their adoption behavior. Rogers [14] stated that compatibility of an innovation is an important determinant for adoption and compatibility is "the degree to which an innovation is compatible with the existing values, past experiences, and needs" (p. 224).

Various demographic groups have different values, experiences, and needs, therefore, may affect IT adoption. For example, gender, as one of the demographics, was reported to have influence on IT adoption [6] [19] and, in particular, on e-learning adoption [10].

The diversity of learner investigated in this study includes two demographic factors: academic departments and educational divisions. For example, nontraditional students are those who most likely have full-time employment, attend school in the evening, and have a family. Technology advancement has enabled this group of learners to continue their education in ways that seemed impossible before [11] [18]. That is, they have needs to use e-learning technology to achieve their educational goals. An old proverb has stated, "Necessity is the mother of invention." Similarly, different needs between nontraditional and traditional students may influence their perceptions of the e-learning system and intentions to use such system.

The e-learning acceptance model (as shown in Figure 1) has been validated by prior research. It provides a sound framework for further research to identify if the construct means differed among students in various academic departments, and between nontraditional and traditional student groups. The relationships in the model is also examined to determine if they vary for nontraditional and traditional student groups.

3. Methodology

For this study, data collected from an earlier research [9] were grouped by academic departments and educational divisions. In brief, participants in the study consisted of postsecondary students enrolled in computer classes at a college in Taiwan. Students were given a 40-minute live

demonstration of an e-learning system¹ and 30-minute to individually practice with it. A total of 259 surveys were collected from participants in the demonstration and practice. The response rate is 80.7% based on a total of 321 class members. Respondents were all in degreed programs, had ages ranging from 18 to 32 with an average of 22, and were relatively balanced between educational divisions (traditional higher education students 55.2%, non-traditional continuing education students 44.8%). The students were from several academic departments (MIS 76, Pharmacy 69, Healthcare Administration 81, others 33). The “others” category includes students from Nursing and Industrial Hygiene departments. The survey instrument was the same as the earlier study [9]. For Research Questions 1 and 2, inferential statistics such as one-way ANOVA and t tests were used to determine which factor means differed significantly among different academic departments or between educational divisions. For Research Questions 2, multi-group Structural Equation Modeling (SEM) approaches [3] [8] [16] using LISREL 8.50 were performed to determine the moderating effects of educational divisions on the research model. A measurement invariance across groups [7] is tested first. Then the differences in path coefficients between two groups are tested and identified [8].

4. Findings and Discussion

As shown in Table 1, with regard to students’ intention to use e-learning for supplementary learning (IU1) and that for distance education (IU2), there are no significant differences among students in different academic departments ($F = 0.91, 1.16; p = 0.436, 0.324$ separately), using a 0.05 significant level. But there are significant differences in factor means of perceived ease of use ($F = 3.08, p = 0.03$), system functionality ($F = 3.0, p = 0.03$), and self-efficacy ($F = 2.88; p = 0.04$) among different departments. Furthermore, Tukey’s post hoc analysis indicated that MIS students have a significantly higher perception of system functionalities than Pharmacy students, and “other” department’s students have a significantly higher self-efficacy than Healthcare Administration students. Students in the “other” category were from Industrial Hygiene and Nursing departments and were taking the computer course as an elective. Generally, they should have interests and self confidence in IT. Therefore it is not unusual for this group of students to have a significantly higher self-efficacy than average students in Healthcare Administration. Using a significance level of 0.10, there are significant differences in Internet experience among different departments’ students. As to the usefulness, system interactivity, and system response, there are no significant differences among different departments.

In the comparison between nontraditional and traditional students as shown in Table 2, nontraditional

students have significantly higher perception of usefulness ($t = 2.30, p = 0.02$) and intention to use for distance education ($t = 2.33, p = 0.02$). Using a significance level of 0.10, nontraditional students have significantly higher perception of system functionality and intention to use for supplementary learning.

Table 1. Differences in factor means based on academic departments

Factors	Academic Departments				ANOVA	
	MIS	Pharmacy	Healthcare	Other	F	Prob.
PU	5.06	4.86	4.83	5.02	0.93	.43
PEOU	5.25	4.90	4.86	5.33	3.08	.03**
IU1	5.24	5.07	4.97	5.24	0.91	.44
IU2	5.39	5.04	5.13	5.27	1.16	.32
SF	5.91	5.43	5.69	5.82	3.00	.03**
SI	4.94	4.87	4.75	5.00	0.58	.63
SR	4.73	4.78	4.89	4.76	0.39	.76
SE	4.84	4.72	4.44	5.06	2.88	.04**
IE	5.32	5.10	4.83	5.32	2.35	.07*

Note. * $p < .10$. ** $p < .05$.

Table 2. Differences in factor means between nontraditional and traditional students groups

Factors	Non-traditional		Traditional		<i>t</i> value	Prob.
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
PU	5.08	0.93	4.80	1.00	2.30	.02**
PEOU	5.16	1.06	4.95	1.12	1.55	.12
IU1	5.26	1.10	5.00	1.14	1.87	.06*
IU2	5.39	1.10	5.04	1.28	2.33	.02**
SF	5.84	1.02	5.60	0.97	1.92	.06*
SI	4.97	1.09	4.79	1.13	1.26	.21
SR	4.91	1.00	4.71	0.99	1.58	.12
SE	4.66	1.21	4.75	1.10	0.59	.56
IE	5.05	1.40	5.15	1.18	0.61	.54

Note. * $p < .10$. ** $p < .05$.

An examination of the mean differences for the constructs between the nontraditional and traditional students through the path model ($SE \rightarrow PEOU \rightarrow PU \rightarrow IU1 \rightarrow IU2$) indicates that the difference is small for self-efficacy and generally increases on the path to IU2 as shown in Figure 2. The p value for the t -test of these difference decreases from .559 to .02. These results show that the educational division differences are in the latter part of the path model. Comparing with the gender study [10], the differences occurred at the opposing end of the path model.

The findings suggest that, although there is no difference in learners’ confidence in using the e-learning technology, nontraditional students have higher beliefs of technology usefulness and higher intentions to use such technology for distance education than do the traditional learners. One possible explanation for these findings is that they may be driven by actual needs. Generally,

¹ The e-learning system used is the Cyber University at National Sun Yat-sen University (Taiwan). It provides Internet users with a guest account.

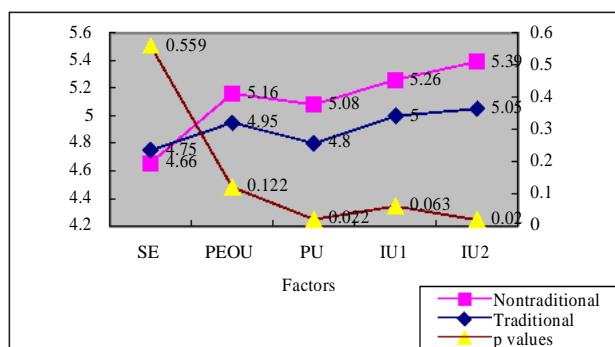


Figure 2. Trend of the differences in factor means between nontraditional and traditional groups

nontraditional students work full-time during the day, attend classes at night, and struggle with the responsibilities of work, family, and school. The e-learning technology provides a relative advantage in learning over a face-to-face class as to time and place independence and many-to-many communication. Using this technology as a distance education method would be more compatible with their living schedule and needs. Therefore, nontraditional learners perceive the technology more useful and have higher intention to use the technology as a distance education method. This is consistent with the compatibility characteristics of the innovation adoption theory [14]. Based on the same rationale, different academic departments' students may not have varying needs, therefore, their intentions to use the technology for either supplementary learning or distance education are indifferent. The same rationale can be applied to explain the indifference in the intentions to use between male and female students [10].

A multi-sample SEM was performed to compare the structural equation model over nontraditional and traditional students groups. The purpose of this analysis was to understand whether educational division had a moderating effect on the research model. Prior to testing the differences in model path estimates between non-traditional and traditional students, measurement models were tested for each group separately. Table 3 shows that the measurement models for both non-traditional and traditional students had adequate model fit. In addition, the difference in fit between a baseline model that allowed all factor loadings to vary across the two groups and a factor loading invariance model that constrained the factor loadings to be the same for these groups provides support for the more restrictive model. As presented in Table 3, the difference in the fit of these models is not statistically significant, $\chi^2_{\text{difference}} (41, N = 259) = 49.69, p > .05$. In addition, since the overall fit indicators provide support for the invariant factor loading model, this measurement model was used to test the difference in the relationships among constructs for the non-traditional and traditional learners.

Following the establishment of a common measurement model, multi-sample SEMs across

educational divisions were performed. The first model tested path invariance by constraining all structural paths, reflecting the relationships among constructs, to be the same across both academic divisions. The model indicated an acceptable model fit, $\chi^2/df = 1.39$, CFI = .962, NNFI = .956. However, the modification indices indicated that the chi-square would decrease 7.636 if the path from SF to IU1 were estimated separately for both groups. A second model was specified accordingly and tested. The fit of this model was acceptable, $\chi^2/df = 1.37$, CFI = .963, NNFI = .957, and this model was more consistent with the data than the initial model, $\chi^2_{\text{difference}} (1, N = 259) = 7.96, p < .05$. For this second model, the modification indices indicated that the chi-square would decrease 6.895 if the path from PU to IU1 were estimated separately for each group. This third model was specified and tested. The model fit was acceptable, $\chi^2/df = 1.37$, CFI = .964, NNFI = .958, and this third model had better overall fit than the second model, $\chi^2_{\text{difference}} (1, N = 259) = 3.84, p = .05$. Finally, the modification indices for this third model were all small and did not suggest any further refinements to the model.

The moderating effects of educational division on the relationships in the path model are presented in Table 4. The direct effects found to be the same across educational divisions are shown in the common metric column. The values shown in the nontraditional and traditional columns are the standardized path coefficients estimated separately for each group. In particular, system functionality predicted intention to use IT for supplementary learning for traditional students (0.504, significant) but not for nontraditional students (0.110, insignificant). Perceived usefulness predicted intention to use for supplementary learning more strongly for nontraditional students (0.511, significant) than for traditional students (0.287, significant). The multi-sample SEM path model for educational divisions is illustrated in Figure 3. One possible explanation is that the reason for having the intention to use the technology for supplementary learning might be different for nontraditional and traditional learners. Nontraditional learners generally have a higher tendency to miss some face-to-face classes due to family or work reasons. Thus, they may be more apt to rely on the technology to make up instruction time at home. The time and place flexibility in learning provided by system functionality, the many-to-many communication provided by system interactivity, all supported by a consistent and fast system response would enable them to do that. Therefore, belief of technology usefulness which is impacted by system functionality, system interactivity, and system response would have more influence in intention to use for supplementary learning for nontraditional than for traditional learners. But for traditional learners, most of them are full-time students, have a lower tendency to miss classes, and have more time to meet with instructors and other students. Therefore, system interactivity and system response are not as important. Instead, system functionality has more influence in their intention to use e-learning for supplementary learning.

5. Conclusions

Theoretically, this study further identifies some of the differences in the factor means of the e-learning acceptance model among students in different academic departments (MIS, Pharmacy, Healthcare Administration, and other), and between nontraditional and traditional student groups. An initial conclusion can be drawn from this research together with prior study [10] that different needs of various learner groups, rather than academic discipline or gender, seem to drive the differences in intention to use IT for distance education and for supplementary learning. Therefore, in practice, faculty members or educational administrators should promote or implement e-learning for student groups such as nontraditional students who have greater needs for the technology and are more likely to have higher intentions to use it.

In addition, two relationships in the path model varied for nontraditional and traditional student groups. Enhancing the usefulness of an e-learning system may substantially increase the likelihood that non-traditional

students, especially, may use the system for supplementary learning purposes. That is, the overall system functionalities, interactivity, response, and ease of use need to be improved. In order to enhance traditional learners' intention to use the technology as a supplementary learning tool, improvements in system functionality would produce the most significant results. The implication is that faculty members or educational administrators can take different actions for various learner groups to improve their intention to use for supplementary learning purpose.

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Note: The full paper is available from the CD of conference proceedings.

Table 3. Test results of multi-group SEMs nontraditional and traditional students

Model	<i>N</i>	χ^2	<i>df</i>	χ^2/df	χ^2_{diff}	<i>df</i> _{diff}	CFI	NNFI
				< 3.0 ^a			> .90 ^a	> .90 ^a
Single Group CFA								
Traditional students	143	317.58*	216	1.47			0.963	0.953
Nontraditional students	116	292.63*	216	1.35			0.963	0.953
Multiple Group CFA								
Baseline (no constraints)	259	610.21*	432	1.41			0.963	0.953
Factor Loading Invariance	259	659.90*	473	1.40	49.69	41	0.961	0.955
Multiple Group SEM								
1. Paths Invariance	259	665.16*	480	1.39			0.962	0.956
2. Free SF->IU1	259	657.20*	479	1.37	7.96*	1	0.963	0.957
3. Free PU->IU1	259	653.36*	478	1.37	3.84*	1	0.964	0.958

^a Recommended values. * *p* < .05.

Table 4. The moderating effects of nontraditional versus traditional students

Outcome	Determinant	Common Metric	Standardized Direct Effects	
			Nontraditional 1	Traditional 1
Perceived Ease of Use	System Functionality	0.133*		
	System Interactivity	0.112		
	System Response	0.276*		
	Self-efficacy	0.358*		
	Internet Experience	0.083		
Perceived Usefulness	Perceived Ease of Use	0.229*		
	System Functionality	0.089		
	System Interactivity	0.369*		
	System Response	0.127		
	Self-efficacy	-0.117		
	Internet Experience	0.138		
Intention to Use 1 (Supplementary tool)	Perceived Usefulness		0.511*	0.287*
	Perceived Ease of Use	0.254*		
	System Functionality		0.110	0.504*
Intention to Use 2 (Distance Education)	Intention to Use 1	0.426*		
	Perceived Usefulness	0.076		
	Perceived Ease of Use	0.075		
	System Functionality	0.226*		
	System Interactivity	0.151*		

Note. $N = 259$. * $p < .05$.

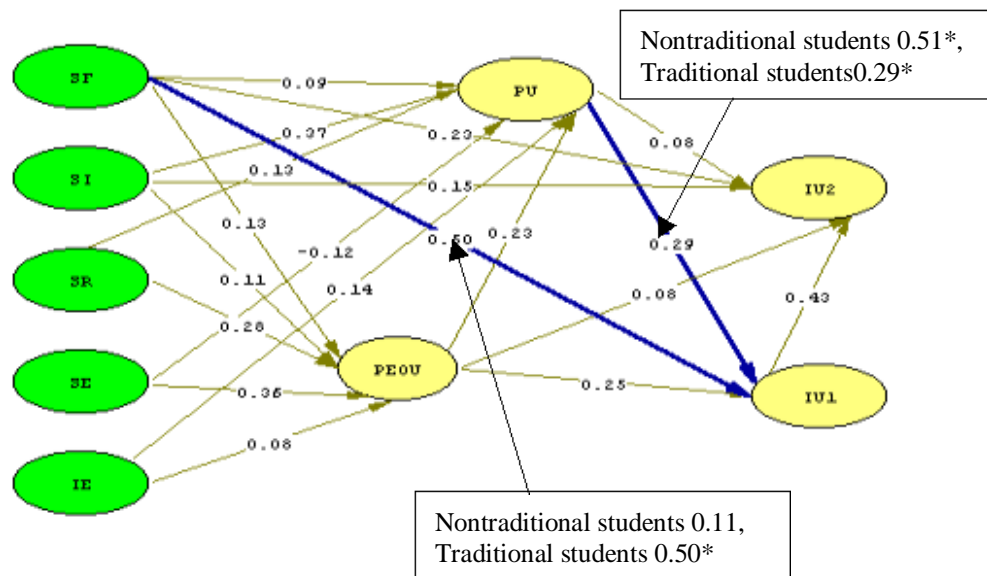


Figure 3. Multi-group SEM results for nontraditional versus traditional learners

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A Fuzzy Selection Model of Microwave System Procurement

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Abstract

In order to cope with the coming of future digital television broadcasting, terrestrial broadcast companies have started to upgrade their program transmission relay devices from analog to digital. Although well-defined specifications can be referenced from all manufactures, with all the intricate factors such as functionalities, features, pricing, operation cost, and after service, it becomes a heavy burden as far as how to choose the most appropriate equipment in the procurement of digital microwave relay system. The goal of this report is to set up all kinds of evaluation items utilizing hierarchical structure model, and to choose the most appropriate digital microwave equipment using fuzzy assessment method.

1. Introduction

The digital microwave relay system plays an important role in the future digital television broadcasting system and can be used for more than ten years. Therefore, the chosen microwave machine needs not only to meet the standards of product specifications and features but also to consider the future expansion capability such as most up to date functionalities, adequate spare parts, inexpensive long-term operation cost, and business opportunities.

This study presents a real case for evaluation. The north-south bound microwave

relay system in the west of Taiwan has 8 stations and 7 sections; total up to 14 sections back and forth (Refer to Fig. 1). Average

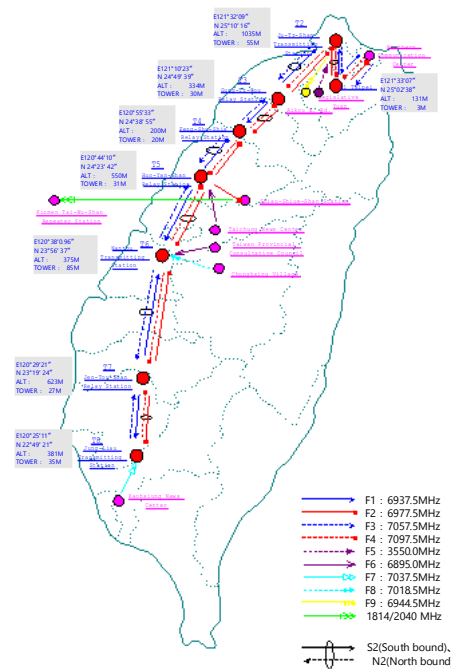


Fig.1 Western digital microwave relay system map

distance between each section is about 30 kilometers and above. In order to meet the system reliabilities and basic function requirements, project specifications are published in advance for vendor's reference. Three machines from two manufactures are selected for consideration, to comply with the basic requirements. Therefore, other criteria need to be used on top of the basic requirements and specifications in the assessment process.

2. Theory Exploration

2.1 Fundamental Requirements of Digital

Microwave Relay System

Digital microwave transmission channel in this project requires one route for DS3 (44.736Mbps—program transmission) and one route DS1 (1.544Mbps —enterprise intranet), system reliability is set for 99.975 % and above (with disconnection rate 21.6 second per day).

2.2 Factors contribute to System Reliability

System reliability involves microwave machine transmission power, receiving threshold, FEC (forward error correction) function, hot stand-by architecture and adoption of space diversity, etc. (Please refer to Table 1). Although the three machines from the two manufactures do achieve more than 99.975 % system reliability, they retain the leading position in some areas of the system architecture. Especially when all figures are derived from theoretical computation rather than reality, this increases difficulty during the assessment.

System gain, which is one of the system reliability elements, includes transmission power (dBm) and receiving threshold (dB). Therefore, the higher the transmission power and the lower receiving threshold are, the larger the system gain will be. (Please refer to Table 1) System reliability is also relatively increased. Among other items; factors such as FEC function can increase system gain 2 ~ 2.5dB and hot stand-by function increases overall system reliability 50 % should not be neglected. In additional, machine with lower transmission power tends to have less long-term operation cost. Cost saving can be used to acquire additional receiving antenna to increase the system reliability through space diversity

technology. The resulting effect is far better than increasing output power.

Table 1 General function comparison

Brand	A	B	C
Model	MDR-XXXX	DVR-XXXX	C-XXXX
Frequency Band(GHz)	6.425~7.125	6.875~7.125	U6
Modulation(QAM)	16	64	32
FEC	N/A	Single-Lee	Reed-Solomon
Capacity	DS3+DS1	DS3+DS1	DS3+4XDS1
System Reliability	99.9841	99.977	99.99
Frequency Stability	0.001%	0.001%	0.0003%
TX BW (MHz)	15	10	14
TX Power (dBm)	30,33	29,31	29
T/I Ratio Cochannel 32dB(dB@10 ⁻⁶ BER)	27(dB@10 ⁻³ BER)	30(dB@10 ⁻³ BER)	30(dB@10 ⁻⁶ BER)
T/I Ratio Adjacent channel 3dB(dB@10 ⁻⁶ BER)	-4(dB@10 ⁻³ BER)	-8(dB@10 ⁻³ BER)	-22(dB@10 ⁻⁶ BER)
Dispersive Fade Margin (dB@10 ⁻⁶ BER)	57(dB@10 ⁻³ BER)	59(dB@10 ⁻³ BER)	60(dB@10 ⁻⁶ BER) 61(dB@10 ⁻³ BER)
RX Threshold (dBm)	-78.5	-76	-76
Network Management	Non-SNM P Architecture	Non-SNM P Architecture	Starview/SNMP
Hot Stand-By	SouthBound-Yes, NorthBound-No	SouthBound-Yes, NorthBound-No	SouthBound-Yes, NorthBound-Yes
Prices	NT \$: 29192256	NT \$: 34565321	NT \$: 30001290

2.3 Wave Usage Charge

Wave usage charge calculation formula published by Ministry of Transportation and Communication in 1990 is as follow:

Formula: $(BW \div 1\text{MHz}) \times (W \div 1\text{Watt}) \times 14000 \times 0.4$
Identical bandwidth, Power 2W, 1W are used for comparison.

$$2W: (15\text{MHz} \div 1\text{MHz}) \times (2W \div 1W) \times 14000 \times 0.4 \\ = 168000 \text{ dollars/year.}$$

$$1W: (15\text{MHz} \div 1\text{MHz}) \times (1W \div 1W) \times 14000 \times 0.4 \\ = 84000 \text{ dollars/year.}$$

Price difference for the 14 sections of the

entire system is 1176000 dollars per year. Annual saving of 1.17 million would be adequate for the purchase of two receiving antennas (RFS UXA12-65A one unit costs 665176 dollars). Using space diversity technology can increase system reliability.

2.4 Transmission Channel Capacity

Capacity of DS3 and DS1, even though all three machines fulfill the basic requirements, one of the machines has one route for DS3 plus 4 routes for DS1. As the commercial value of DS1 channel declines with the opening of the three major fixed-network communication companies, the utilization of the enterprise intranet and the enhancement of efficiency cannot be quantified by dollar figures. This item is, therefore, included as one of the important elements.

3. Fuzzy Assessment Model

3.1 Hierarchical Structure Model

Due to the wide range of areas covered by selection criteria, there are a lot of items need to be considered. A hierarchical structure model as shown in Fig. 2 is used in order to take into equal consideration of all areas to build an assessment architecture model.

3.2 Grade of Evaluation and Grade of Importance of the Evaluated Items

Different items are evaluated in the selection process. Each item has its own grade of evaluation and grade of importance as shown in Table 2 [1]. Each grade of evaluation and grade of importance is further divided into 11 linguistic variables.

Great deal of uncertainty and fuzzy occur when using linguistic variables in many circumstances.

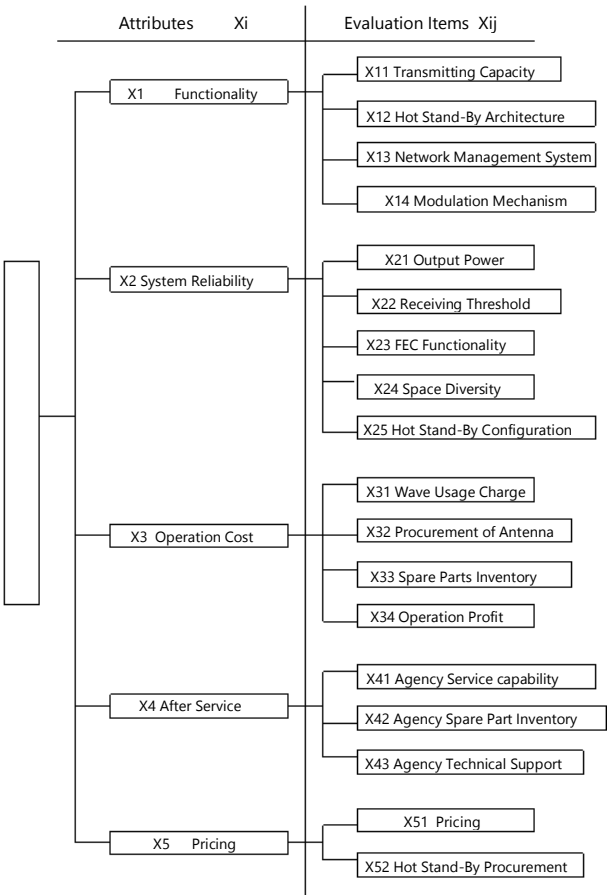


Fig. 2 A hierarchical structure model

Therefore, ambiguous linguistic variables are represented by triangular fuzzy numbers as shown in Table 3 [1].

3.3 Evaluating the Aggregative Rate Method

Let w_i represent the weight of the attribute X_i , and w_{ik} denote the weight of the item X_{ik} as shown in Fig. 1, $g(a_{ij}, b_j)$ represent the value [1] which is derived by the defuzzified method after multiplying the grade of evaluation (a_{ij}) and grade of importance (b_j) .

In referencing the Lee et al. [2] algorithm, calculation steps are as follows:

Step 1. Let

$$R2(k) = \frac{\sum_{j=1}^{n(k)} W_{kj} * g(r_{kj}, i_{kj})}{\sum_{j=1}^{n(k)} W_{kj}}$$

$$= \sum_{j=1}^{n(k)} W_{kj} * g(r_{kj}, i_{kj}) \quad (1)$$

for $k=1, 2, \dots, 5$, where $n(k)$ is the number of evaluation items for attribute X_k , then we have $n(1)=4, n(2)=5, n(3)=4, n(4)=3, n(5)=2$; $g(r_{kj}, i_{kj})$ is the rate of pair (k, j) for each evaluation item X_{kj} ; W_{kj} is the weight of the item X_{kj} .

Step 2. The final rate of aggregative evaluation is by the centroid method as follows:

$$\text{Let } R1 = \frac{\sum_{k=1}^5 W_k * R2(k)}{\sum_{k=1}^5 W_k}$$

$$= \sum_{k=1}^5 W_k * R2(k) \quad (2)$$

Then, the value of R1 is the rate of aggregative evaluation.

3.4 Data Example

Assume there are 3 sets of actual data representing selected machines A, B and C. Other company may assign different weight values to each attribute and evaluation item according to actual demand. Fixed Weight Value and Grade of Importance are used in the selection process. The values do not affect by different machine model. Evaluation Rate and Grade of Importance of each item are shown in Table 4.

Final evaluation result can be obtained after calculation through above mentioned fuzzy assessment algorithm. As shown in Table 5, the

result after sorting is $B > A$.

Table 2 Linguistic variables of grade of Evaluation and grade of importance [1]

11 Evaluation Rate Sequence	11 Grade of Importance Sequence
1: 11th Grade	1: Extremely Unimportant
2: 10th Grade	2: Especially Unimportant
3: 9th Grade	3: Very Unimportant
4: 8th Grade	4: Unimportant
5: 7th Grade	5: Somewhat Unimportant
6: 6th Grade	6: Ordinary
7: 5th Grade	7: Somewhat Important
8: 4th Grade	8: Important
9: 3rd Grade	9: Very Important
10: 2nd Grade	10: Especially Important
11: 1st Grade	11: Extremely Important

Table 3 Fuzzy numbers of grade of valuation and grade of importance [1]

Grade of evaluation	Fuzzy Numbers	Grade of Importance	Fuzzy Numbers
1	(0.0,0.0,0.1)	1	(0.0,0.0,0.1)
2	(0.0,0.1,0.2)	2	(0.0,0.1,0.2)
3	(0.1,0.2,0.3)	3	(0.1,0.2,0.3)
4	(0.2,0.3,0.4)	4	(0.2,0.3,0.4)
5	(0.3,0.4,0.5)	5	(0.3,0.4,0.5)
6	(0.4,0.5,0.6)	6	(0.4,0.5,0.6)
7	(0.5,0.6,0.7)	7	(0.5,0.6,0.7)
8	(0.6,0.7,0.8)	8	(0.6,0.7,0.8)
9	(0.7,0.8,0.9)	9	(0.7,0.8,0.9)
10	(0.8,0.9,1.0)	10	(0.8,0.9,1.0)
11	(0.9,1.0,1.0)	11	(0.9,1.0,1.0)

4. Conclusion

This study attempts to assess the most appropriate digital microwave system from the perspective of fuzzy theory. Weight values, evaluation items and grade of importance, which can be adjusted according to real situations in order to fulfill company's requirements.

Reference

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Table 4 Sample data

Attributes	X1				X2					X3				X4			X5	
Weight(W_i)	0.25				0.3					0.25				0.1			0.1	
Items	X11	X12	X13	X14	X21	X22	X23	X24	X25	X31	X32	X33	X34	X41	X42	X43	X51	X52
Weight(W_j)	0.30	0.30	0.25	0.15	0.20	0.20	0.20	0.20	0.20	0.30	0.30	0.20	0.20	0.30	0.40	0.30	0.60	0.40
Grade of Importance	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Machine A (MDR-XXXX)																		
Grade of evaluation	5	4	3	3	7	6	4	1	2	5	6	5	5	4	2	3	4	2
$g(s_i)$	0.2430	0.1830	0.1230	0.1250	0.3630	0.3050	0.1830	0.0228	0.0650	0.2430	0.3050	0.2430	0.2430	0.1830	0.0630	0.1230	0.1830	0.0630
Machine B (DVR-XXXX)																		
Grade of evaluation	5	4	3	4	6	4	5	1	2	7	5	6	5	3	2	2	2	2
$g(s_i)$	0.2430	0.1830	0.1230	0.1850	0.3030	0.1850	0.2430	0.0228	0.0650	0.3630	0.2450	0.3030	0.2430	0.1230	0.0630	0.0630	0.0630	0.0630

Table 5 Final evaluation values of selected machines

Machine A	Machine B
0.192668	0.222668

The Effects on Workers in the Privatization Process in Taiwan

A case study: An empirical Analysis of privatizing SOEs

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Abstract

This research aims at empirical analysis the effects on workers in the privatization process from a broad range of perspectives including employees, managers and representatives of labor union. Also of interest is the relationship between these variables and six measures of the effects on workers in the privatization process, such as gender, age, salary, level of education, level of position and years of experience.

The results had rejected our hypothesis (H1) of independence. It has noted that part of variables significant a relationship were observed on six measures of the effects of workers with these variables: gender, age, level of education, level of position, years of experience and salary.

Finally, the research suggests that the government, when implementing privatization policy, should consult the useful measures of industrialized countries and consider the effects on workers. Six useful strategies should be developed to enhance communication with workers and publicity, so as to adjust the resistance mentality of working for the implementation of the privatization policy.

1.1 Motivation

As the state-owned enterprises (SOEs) in Taiwan now face the great impacts and organizational change (OC) brought by privatization, liberalization and globalization, this time can be considered wartime. Following privatization of SOEs, management style and working environment have been changed rapidly. The change of the working environment has made a noTable 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, promotion of privatization can easily incur strong resistance from workers. During this period of transition, the author has found leadership crises exist within the enterprise. The relationship between leadership style and worker commitment has examined by Blau (1985). A consideration leadership style was found to have a greater influence than a concern for structure leadership style (or task-oriented style) on commitment. Also, Williams and Hazer (1986) included consideration leadership style as one of their antecedents to commitment.[1][2]

It is necessary to develop an effective measure and to establish new leadership style between organization and workers through communication so as to transform

resistance into assistance. The research aims at exploring the effects on workers in the privatization and to provide leaders with useful leadership strategies as reference.

1.2 Objective

The main aim of this study is to investigate the effects on workers in the privatization process. Also 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.

Hypothesis 1 (H1)

There is statistically significant no difference in the these variables with six measures of the effects on workers such as gender, age, salary, level of education, level of position and years of experience.

2. Research Methodology

2.1 Sampling Plan

The sampling included workers, managers and representatives of labor union of a large scale SOEs selected in Taiwan (omit).

Questionnaires will be mailed or emailed to workers, managers and representatives of labor union of the sampled SOEs. The sampling characters of questionnaires survey were shown in Table 1.

A Chi-square goodness of fit test on sampling and population was carried out to test gender, age and level of position as shown in Table 2. For the item of gender, the respondent of statistics ($\chi^2=2.428 < 3.841$, at the 0.05 level of significance) was accepted. For the item of age, the respondent of statistics ($\chi^2=12.472 < 15.507$, at the 0.05 level of significance) was accepted. For the item of level of position, the respondent of statistics ($\chi^2=12.472 < 15.507$, at the 0.05 level of significance) was accepted.

Table 1 Sampling Characters

Item	Variety	Sample(N)	Sample(%)
Gender	Male	792	91.7
	Female	73	8.3
Age	25 below	4	0.5
	25-34	123	13.9
	35-44	328	37.5
	45-55	305	34.7
	55 above	117	13.4
Level of education	Junior school	45	5.2
	Senior school	278	31.7
	Polytechnic Diploma	356	40.6
	University	160	18.3

	Post graduate above	37	4.2
Level of position	Top manager	11	1.3
	Mid manager	27	4.2
	Grass-roots cadre	115	13.1
	Worker	713	81.4
Years of experience	5 below	54	6.2
	5-15	132	15.3
	15-20	244	27.9
	20 above	446	50.9
Salary (per month)	NT\$30000 Below	3	0.3
	NT\$30000-50000	194	22.1
	NT\$50000-70000	589	67.2
	NT\$70000-90000	64	7.3
	NT\$90000 Above	26	3.0

Table 2 Chi-square goodness of fit test on Sampling

Item	Variety	Sample(%)	P(%)	Chi-square test
Gender	Male	91.7	89.3	Statistics ($\chi^2=2.428$) is lower than the value (3.841) at the (0.05) level of significance.
	Female	8.3	10.7	
Age	25 below	0.5	1.2	Statistics ($\chi^2=12.472$) is lower than the value (15.507) at the (0.05) level of significance.
	25-34	13.9	15.2	
	35-44	37.5	39.2	
	45-55	34.7	31.8	
	55 above	13.4	112.6	
Level of position	Top manager	1.3	1.3	Statistics ($\chi^2=7.644$) is lower than the value (7.815) at the (0.05) level of significance.
	Mid manager	4.2	3.4	
	Grass-roots cadre	13.1	12.7	
	Worker	81.4	82.4	

2.2 Data-gathering instruments

A survey questionnaire was developed to measure the responses for the six constructs of the effects on workers. Some of six constructs were refined by deleting a few items from the original list of items. Thus, using a rigorous statistical scale validation technique, the survey instrument, consisting of the refined six constructs shown in Table 3 (Chen, 2002, 2003), was developed.[3][4]

One instrument used in this study was a 25-item questionnaire adapted from Chen (2002, 2003). The questionnaire consisted of 25 items on 5-point Likert scale. On each of the 25 items workers were asked to indicate from 1 (strongly disagree) to 5 (strongly agree).[3][4]

2.3 Respond

Questionnaires were mailed or e-mailed to workers and managers of the sampled SOEs with a request to forward these to workers and manager in the department of the sampled SOEs. The survey will be conducted in three waves, spaced six weeks apart. Of the total 1450 questionnaires mailed or e-mailed, the author will expect about 865 completed and usable questionnaires were returned, yielding a 59.6 per cent response rate.

3. Data Analysis and Finding

3.1 Foreword

In this section, for each of the six measures, a Chi-squared test was carried to test the workers commitment and classification. It is interesting to examine the factors on workers in privatisation which it is felt have contributed significantly to workers and SOEs. A brief analysis of the six measures follows.

3.2 The analysis of the effects of workers on Six Factors

Chi-square test on safeguard of workers' rights and interests

With respect to Chi-square test on safeguard of workers' rights and interests represented by the items shown in Table 5. Through the analysis of Chi-square test, results showed that only the variable of years in experience in the personal condition had obvious variation at the (0.008) level of significance. The larger proportion significant, there were workers of the lower level of position stressed the importance of safeguard of workers' rights and interests.

Chi-square test on compensation of potential loss

With respect to Chi-square test on compensation of potential loss represented by the items shown in Table 7. Through the analysis of Chi-square test, results showed that 3 variables: age, years in experience and salary of per month in the personal condition had obvious variation. The item of age showed workers (55 above) having the highest commitment and workers (25 below) having the lowest commitment. The item of years of experience, at the (0.007) level of significance, indicated workers' agreement with the years of experience increasing however increasing. The item of salary of per month, at the (0.001) level of significance, indicated workers' agreement with salary increasing however increasing.

Chi-square test on education and communication

With respect to Chi-square test on education and communication represented by the items shown in Table 9. Through the analysis of Chi-square test, results showed which 4 variables: age, level of position, level of education and salary of per month in the personal condition had obvious variation. The item of level of education indicated that almost 70 per cent workers agree to factor 3, but only 60 per cent workers (post graduate above) agree to factor 3. The item of age showed workers' commitment with age decreasing however increasing. The item of level of position indicated workers' commitment with position decreasing however increasing. The item of salary of per month indicated workers' commitment with salary increasing however decreasing.

Chi-square test on leadership trusts and employee

consultation

With respect to Chi-square test on leadership trusts and employee consultation represented by the items shown in Table 11. Through the analysis of Chi-square test, results showed that 2 variables: level of education and years in experience in the personal condition had obvious variation. The item of level of education indicated that workers' disagreed to education increasing however increasing; over 70 per cent workers (post graduate above) disagree to factor 4. The item of level of position indicated mid manager having higher disagree and worker having lower disagree.

Chi-square test on participation of employees and the labor union

With respect to Chi-square test on participation of employees and the labor union represented by the items shown in Table 13. Through the analysis of Chi-square test, results showed that 3 variables: age, level of position and salary of per month in the personal condition had obvious variation. The item of age showed workers (45-55) having the lowest agreement and workers (25 below and 55 above) having the highest agree. The item of level of position indicated workers' agreement with position increasing however increasing. The item of salary of per month indicated workers' agreement with salary increasing

Chi-square test on encourage the employees to learn and to cultivate a second specialty

With respect to Chi-square test on encourage the employees to learn and to cultivate a second specialty represented by the items shown in Table 14. Through the analysis of Chi-square test, results showed which 4 variables: age, level of position, level of education and salary of per month in the personal condition had obvious variation. The item of level of education indicated that workers (senior school) is the higher agreement than workers (junior school) on factor 6. The item of age showed workers (25 below) are the lower agreement. The item of level of position indicated workers' commitment with position increasing however increasing. The item of salary of per month indicated workers' commitment with salary increasing however increasing.

4. Discussions and Suggestions

4.1 Discussions

The effects on workers in the privatization process, the analysis of six factors is presented from Table 3 to Table 15. The relationship of these variables with workers commitment on six measures, such as gender, age, salary, level of education, level of position and years of experience are shown in Table 5, 7, 9, 11, 13 and 15. Years of experience in the personal condition have a significant relationship on safeguard of workers' rights (see Table 5). Age, years in experience and salary of per month in the personal condition had obvious variation on compensation of

potential loss (see Table 7). Age, level of position, level of education and salary of per month in the personal condition had obvious variation on education and communication (see Table 9). Level of education and years in experience in the personal condition had obvious variation on leadership trusts and employee consultation (see Table 11). Age, level of position and salary of per month in the personal condition had obvious variation on participation of employees and the labor union represented (see Table 13). Age, level of position, level of education and salary of per month in the personal condition have a significant relationship on encourage the employees to learn and to cultivate a second specialty (see Table 15).

The results had rejected our hypothesis (H1). It has noted that part of variables significant difference were observed on six measures of the effects of workers in these variables: gender, age, level of education, level of position, years of experience and salary of per month.

4.2 Suggestions

The research has found various issues and impacts on workers in SOEs selected. Moreover, the research has worked out six effective measures for the government and decision-makers of the company to help them conduct successful communication with the staff, transform resistance into assistance and promote the policy of privatization.

During the process of privatization, workers' rights and interests staff ought to be taken into account and full communication should be ensured to reduce resistance. In the past, it is relatively easy to deal with substantial reforms of technology while analysis is needed to understand the reasons why workers reject reform.

Following lack of communication during the process of privatization, which leads to lack of consensus and resistance from workers. The labor union and workers are also against the company in the privatization process. Future decision-makers should prevent the labor union from political zing the issue of privatization, which will be delayed the promotion of privatization.

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Table 3 six measures of the effects on workers in privatization

Six factors	Sample Size N (%)	Strongly Agree N (%)	Agree N (%)	Neutral N (%)	Disagree N (%)	Strongly Disagree N (%)	M ₀	$\overline{X^2}$	S
Safeguard of workers' rights and interests (factor 1)	865 (100)	208 (24.0)	481 (55.6)	92 (10.6)	71 (8.2)	13 (1.5)	2	2.09	0.89
Compensation of potential loss (factor 2)	865 (100)	203 (23.2)	440 (50.3)	151 (17.3)	68 (7.8)	13 (1.5)	2	2.13	0.91
Education and communication (factor 3)	865 (100)	91 (10.5)	325 (37.4)	3029 (34.8)	117 (13.5)	34 (3.9)	2	2.63	0.97
Leadership trust and Employee Consultation (factor 4)	865 (100)	24 (2.9)	99 (11.8)	185 (22.0)	343 (40.8)	190 (22.6)	4	3.73	0.99
Participation of employees and the labor union ((factor 5))	865 (100)	96 (11.1)	383 (44.3)	157 (18.2)	186 (21.5)	45 (5.2)	2	2.66	1.09
Encourage the employees to learn and to cultivate a second specialty (factor 6)	865 (100)	209 (24.1)	479 (55.1)	149 (17.1)	19 (2.2)	13 (1.5)	2	2.02	0.79

Table 4 Measures on Safeguard of workers' rights and interests

Questions	Sample Size N (%)	Strongly Agree N (%)	Agree N (%)	Neutral N (%)	Disagree N (%)	Strongly Disagree N (%)	M ₀	$\overline{X^2}$	S
1. The employees who wish to remain in the work place will be guarantee for work	865 (100)	209 (24.0)	479 (55.6)	93 (10.6)	72 (8.2)	12 (1.4)	2	2.08	0.88
2. The employees would be influenced due to the privatization even with hard working	865 (100)	255 (29.4)	424 (48.6)	90 (10.3)	91 (10.3)	12 (1.4)	2	2.06	0.96
3. After privatization, the state share will be lower gradually; thus it would not influence the working rights	865 (100)	96 (11.0)	232 (26.7)	237 (27.3)	250 (28.7)	55 (6.3)	4	2.93	1.11
4. The employees will be benefit with reasonable protection due the stock options condition	865 (100)	119 (13.7)	325 (37.4)	164 (18.9)	211 (24.3)	30 (3.5)	2	2.68	1.10
5. The stock options condition will enable to boost the loyalty among employees and ease of promoting of the privatization	865 (100)	96 (11.1)	383 (44.3)	157 (18.2)	186 (21.5)	45 (5.2)	2	2.66	1.09
12. You agree the employees' working right will be reasonably guarantee by company after privatization	865 (100)	19 (2.2)	47 (5.4)	172 (19.9)	485 (52.9)	160 (18.5)	4	3.80	0.87

Table 5 Safeguard of workers' rights and interests (Chi-square test)

Item	Variety	Sample N (%)	Strongly Agree N (%)	Agree N (%)	Neutral N (%)	Disagree N (%)	Strongly Disagree N (%)	χ^2	p-value
Gender	Male Female	792(100) 73(100)	197(24.9) 11(15.1)	430(54.3) 51(69.9)	87(11.0) 5(6.8)	65(8.2) 6(8.2)	13(1.6) 0(0.0)	7.46	0.113
Age	25 below 25-34 35-44 45-55 55 above	3(100) 120(100) 323(100) 301(100) 115(100)	0(0.0) 26(21.6) 87(26.9) 69(22.9) 26(22.6)	3(100) 71(59.2) 159(49.2) 170(56.5) 76(66.1)	0(0.0) 12(10.0) 38(31.7) 32(11.0) 9(7.8)	0(0.0) 7(5.8) 36(11.1) 23(7.6) 4(3.5)	0(0.0) 4(3.3) 3(0.9) 6(2.0) 0(0.0)	43.12	0.091
Level of education	Junior school Senior school Polytechnic Diploma University Post graduate above	43(100) 271(100) 355(100) 158(100) 36(100)	15(34.9) 65(24.0) 82(23.1) 39(24.7) 7(19.4)	16(37.2) 146(53.9) 209(58.9) 87(55.1) 21(58.3)	9(20.1) 34(12.5) 33(9.3) 12(7.6) 4(11.1)	1(2.3) 20(7.4) 30(8.5) 16(10.1) 4(11.1)	2(4.6) 6(2.2) 1(0.3) 4(2.5) 0(0.0)	30.09	0.068
Level of position	Top manager Mid manager Grass-roots cadre Worker	11(100) 37(100) 115(100) 702(100)	2(18.2) 5(13.5) 38(33.0) 168(24.0)	9(81.8) 27(73.0) 48(41.7) 380(54.1)	0(0.0) 2(5.4) 16(13.9) 88(12.5)	0(0.0) 3(8.1) 12(10.4) 53(7.5)	0(0.0) 0(0.0) 1(0.9) 13(1.9)	12.82	0.382
Years of experience	5 below 5-15 15-20 20 above	52(100) 132(100) 243(100) 446(100)	12(23.1) 35(26.5) 56(23.0) 106(23.8)	28(53.8) 71(53.8) 119(49.0) 380(54.1)	10(19.2) 10(7.6) 34(14.0) 88(12.5)	2(3.8) 8(6.1) 30(12.3) 53(7.5)	0(0.0) 4(3.0) 4(1.6) 13(1.9)	38.34	** 0.008
Salary (per month)	NT\$30000 Below NT\$30000-50000 NT\$50000-70000 NT\$70000-90000 NT\$90000 Above	2(100) 189(100) 586(100) 64(100) 23(100)	1(50.0) 44(23.3) 144(24.6) 14(21.9) 5(21.7)	1(50.0) 94(49.7) 327(55.8) 42(65.6) 16(69.6)	0(0.0) 32(16.9) 59(10.1) 3(4.7) 0(0.0)	0(0.0) 15(7.9) 47(8.0) 5(7.8) 2(8.7)	0(0.0) 4(2.1) 9(1.5) 0(0.0) 0(0.0)	23.97	0.463
Level of significance *** P<0.001 ** P<0.01 * P<0.05									

Table 6 Measures on Compensation of potential loss

Questions	Sample Size N (%)	Strongly Agree N (%)	Agree N (%)	Neutral N (%)	Disagree N (%)	Strongly Disagree N (%)	M ₀	$\overline{X^2}$	S
6. After privatization, the company shall calculate "the year of service" according to the superannuation from the Labor regulations, also ease of promoting of the privatization	865 (100)	94 (10.8)	251 (29.0)	143 (16.5)	278 (32.1)	101 (11.6)	4	3.05	1.23
7. It is reasonable to offer the severance pay (6+1 months) to its ex-employees	865 (100)	86 (9.9)	229 (26.3)	269 (30.9)	230 (26.4)	56 (6.4)	3	2.93	1.08
8. According to the compensation, all the workers' right shall be appropriately protected.	865 (100)	91 (10.5)	325 (37.4)	302 (34.8)	117 (13.5)	34 (3.9)	2	2.63	0.97
30. According to the current regulations, when privatize a state enterprise, government shall be liable for compensation if employees lose their "years of service", superannuation, other applicable allowance	865 (100)	277 (32.1)	507 (58.7)	61 (7.1)	11 (1.3)	8 (1.0)	2	1.79	0.67

Table 7 Compensation of potential loss (Chi-square test)

Item	Variety	Sample N (%)	Strongly Agree N (%)	Agree N (%)	Neutral N (%)	Disagree N (%)	Strongly Disagree N (%)	X^2	p-value
Gender	Male Female	792(100) 73(100)	89(11.2) 2(2.7)	289(36.3) 36(49.3)	275(34.5) 27(37.0)	109(13.7) 8(11.0)	34(4.3) 0(0.0)	7.66	0.105
Age	25 below 25-34 35-44 45-55 55 above	3(100) 120(100) 324(100) 302(100) 116(100)	0(0.0) 17(14.2) 35(10.8) 24(8.0) 13(11.3)	1(33.3) 56(46.7) 115(35.6) 96(31.9) 58(50.4)	2(66.7) 32(26.7) 113(35.0) 123(40.9) 32(27.8)	0(0.0) 10(8.3) 46(14.2) 49(16.3) 10(8.7)	0(0.0) 5(4.2) 75(4.6) 11(3.7) 2(1.7)	55.08	*** 0.007
Level of education	Junior school Senior school Polytechnic Diploma University Post graduate above	43(100) 272(100) 356(100) 158(100) 36(100)	7(16.3) 27(9.9) 32(9.0) 19(11.0) 6(10.7)	10(23.3) 92(33.8) 138(38.8) 67(42.1) 17(47.2)	17(39.5) 108(39.7) 120(33.7) 47(29.6) 10(27.8)	6(14.0) 31(11.4) 55(15.4) 20(12.6) 3(8.3)	3(7.0) 14(5.1) 11(3.1) 6(3.8) 0(0.0)	23.08	0.285
Level of position	Top manager Mid manager Grass-roots cadre Worker	11(100) 37(100) 115(100) 702(100)	1(9.1) 7(18.9) 8(7.0) 75(10.6)	6(54.5) 20(54.1) 51(44.3) 248(35.1)	4(36.4) 6(16.2) 43(37.4) 249(35.3)	0(0.0) 4(10.8) 14(12.2) 99(14.0)	0(0.0) 0(0.0) 0(0.0) 34(4.8)	22.82	0.029
Years of experience	5 below 5-15 15-20 20 above	52(100) 132(100) 245(100) 446(100)	13(25.0) 13(9.8) 26(10.7) 39(8.7)	26(50.0) 55(41.7) 71(29.1) 174(39.0)	9(17.3) 43(32.6) 97(39.8) 154(34.5)	2(3.8) 10(7.6) 36(14.8) 68(15.2)	2(3.8) 7(5.3) 14(5.7) 11(2.5)	55.49	*** 0.000
Salary (per month)	NT\$30000 Below NT\$30000-50000 NT\$50000-70000 NT\$70000-90000 NT\$90000 Above	2(100) 189(100) 587(100) 64(100) 23(100)	0(0.0) 21(11.1) 60(10.2) 6(9.4) 4(16.0)	0(0.0) 60(31.7) 221(37.7) 36(56.3) 9(36.0)	2(100.0) 76(40.2) 199(34.0) 18(28.1) 9(36.0)	0(0.0) 22(11.6) 85(14.5) 4(6.3) 2(8.0)	0(0.0) 11(5.8) 22(3.7) 0(0.0) 1(4.0)	42.78	* 0.010
Level of significance *** P<0.001 ** P<0.01 * P<0.05									

Table 8 Measures on Education and communication

Questions	Sample Size N (%)	Strongly Agree N (%)	Agree N (%)	Neutral N (%)	Disagree N (%)	Strongly Disagree N (%)	M ₀	$\overline{X^2}$	S
13. It is necessary to counsel with workers' union with the privatization's transform measures	865 (100)	227 (26.1)	550 (63.3)	69 (7.9)	19 (2.2)	4 (0.5)	2	1.87	0.67
16. You agree that the current promotion method and contents is sufficient to perform.	865 (100)	81 (9.4)	253 (29.2)	111 (12.8)	308 (35.6)	113 (13.0)	2	3.13	1.23
17. You agree that the company shall arrange the communication seminars to boost the communication between both parties.	865 (100)	87 (10.0)	229 (26.2)	270 (30.9)	230 (26.3)	57 (6.5)	3	2.93	1.08
15. The privatization policy is lack of communication from employees	865 (100)	11 (1.3)	80 (9.2)	238 (27.2)	379 (43.4)	166 (19.0)	4	3.71	0.91

Table 9 Education and communication (Chi-square test)

Item	Variety	Sample N (%)	Strongly Agree N (%)	Agree N (%)	Neutral N (%)	Disagree N (%)	Strongly Disagree N (%)	χ^2	p-value
Gender	Male Female	792(100) 73(100)	287(23.3) 16(21.9)	401(50.0) 29(53.4)	138(17.2) 13(17.8)	64(8.0) 4(5.5)	12(1.5) 1(1.4)	1.37	0.850
Age	25 below 25-34 35-44 45-55 55 above	3(100) 120(100) 324(100) 302(100) 116(100)	0(0.0) 38(30.9) 88(26.8) 63(20.7) 16(13.7)	2(66.7) 55(44.7) 165(50.3) 159(52.1) 56(47.9)	1(33.3) 16(13.0) 47(14.3) 54(17.7) 28(23.9)	0(0.0) 8(6.5) 20(6.1) 22(7.2) 15(12.8)	0(0.0) 3(2.4) 6(1.8) 6(2.0) 0(0.0)	61.97	** 0.001
Level of education	Junior school Senior school Polytechnic Diploma University Post graduate above	43(100) 272(100) 356(100) 158(100) 36(100)	13(28.9) 70(25.2) 75(21.1) 37(23.4) 9(25.0)	19(42.2) 149(53.6) 183(51.4) 75(47.5) 13(36.1)	7(15.6) 40(14.4) 61(17.1) 29(18.4) 11(30.6)	3(6.7) 14(5.0) 32(9.0) 17(10.8) 2(5.6)	3(6.7) 5(1.8) 5(1.4) 0(0.0) 1(2.8)	34.03	* 0.026
Level of position	Top manager Mid manager Grass-roots cadre Worker	11(100) 37(100) 115(100) 702(100)	1(8.3) 5(13.5) 32(27.8) 165(23.2)	7(58.3) 22(59.5) 60(52.2) 352(49.5)	1(8.3) 8(21.6) 17(14.8) 125(17.6)	3(25.0) 2(5.4) 4(3.5) 60(8.4)	0(0.0) 0(0.0) 2(1.7) 11(1.5)	42.61	*** 0.000
Years of experience	5 below 5-15 15-20 20 above	52(100) 132(100) 245(100) 446(100)	15(27.8) 40(30.3) 62(25.2) 86(19.5)	22(40.7) 61(46.2) 119(49.2) 236(52.8)	11(20.4) 16(12.1) 43(17.8) 79(17.7)	2(3.7) 10(7.6) 13(5.4) 41(9.2)	1(1.9) 2(1.5) 6(2.5) 4(0.9)	26.01	0.165
Salary (per month)	NT\$30000 Below NT\$30000-50000 NT\$50000-70000 NT\$70000-90000 NT\$90000 Above	2(100) 189(100) 587(100) 64(100) 23(100)	0(0.0) 62(32.0) 133(22.6) 6(9.2) 1(4.3)	1(50.0) 91(46.9) 302(51.3) 32(50.8) 10(43.5)	1(50.0) 21(10.8) 104(17.6) 17(26.2) 5(21.7)	0(0.0) 8(4.1) 43(7.3) 9(13.8) 6(26.1)	0(0.0) 8(4.1) 5(0.8) 0(0.0) 1(4.3)	11.51	*** 0.000
Level of significance *** P<0.001 ** P<0.01 * P<0.05									

Table 10 Measures on Leadership trust and Employee Consultation

Questions	Sample Size N (%)	Strongly Agree N (%)	Agree N (%)	Neutral N (%)	Disagree N (%)	Strongly Disagree N (%)	M ₀	$\overline{X^2}$	S
19. Top manager has explained the procedures of reform and regulations to workers to build up their trust	865 (100)	81 (9.4)	253 (29.2)	111 (12.8)	308 (35.6)	113 (13.0)	2	3.13	1.23
20. Management worker relations in this company are satisfactory	865 (100)	94 (10.8)	251 (29.0)	143 (16.5)	278 (32.1)	101 (11.6)	4	3.05	1.23
18. Workers are satisfied with leadership of top manager	865 (100)	87 (10.0)	229 (26.2)	270 (30.9)	230 (26.3)	57 (6.5)	3	2.93	1.08
21. Top manager has pay attention to understand the feelings of workers and reduce unnecessary fear	865 (100)	19 (2.2)	47 (5.4)	172 (19.9)	485 (52.9)	160 (18.5)	4	3.79	0.88

Table 11 Leadership trust and Employee Consultation (Chi-square test)

Item	Variety	Sample N (%)	Strongly Agree N (%)	Agree N (%)	Neutral N (%)	Disagree N (%)	Strongly Disagree N (%)	χ^2	p-value
Gender	Male Female	792(100) 73(100)	24(3.1) 0(0.0)	95(12.3) 4(5.6)	165(21.5) 20(21.8)	309(40.1) 34(47.2)	176(22.9) 14(19.4)	5.71	0.222
Age	25 below 25-34 35-44 45-55 55 above	3(100) 120(100) 324(100) 302(100) 116(100)	0(0.0) 4(3.3) 11(33.5) 8(2.6) 1(0.9)	0(0.0) 16(13.0) 32(9.7) 36(11.8) 15(12.8)	2(66.7) 25(20.3) 66(20.1) 67(22.0) 25(21.4)	0(0.0) 36(29.3) 122(37.2) 139(45.6) 46(39.3)	1(33.3) 32(26.0) 85(25.9) 55(18.0) 17(14.5)	41.56	0.120
Level of education	Junior school Senior school Polytechnic Diploma University Post graduate above	43(100) 272(100) 356(100) 158(100) 36(100)	3(6.7) 8(2.9) 10(3.0) 3(1.9) 0(0.0)	10(22.2) 39(14.2) 32(9.6) 13(8.3) 4(11.4)	9(20.0) 62(22.6) 69(20.8) 40(25.6) 5(14.3)	15(33.3) 108(39.4) 135(40.7) 66(42.3) 17(48.6)	4(8.9) 57(20.8) 86(25.9) 34(21.8) 9(25.7)	35.51	* 0.018
Level of position	Top manager Mid manager Grass-roots cadre Worker	11(100) 37(100) 115(100) 702(100)	0(0.0) 0(0.0) 4(3.5) 20(2.9)	0(0.0) 3(8.1) 10(8.8) 86(12.6)	4(36.4) 4(10.8) 26(23.0) 15(22.2)	4(36.4) 27(73.0) 45(39.8) 267(39.3)	3(27.3) 3(8.1) 28(24.8) 156(22.2)	24.51	* 0.017
Years of experience	5 below 5-15 15-20 20 above	52(100) 132(100) 245(100) 446(100)	2(3.7) 4(3.0) 9(3.7) 9(2.1)	7(13.0) 17(12.9) 29(11.9) 46(10.9)	12(22.2) 30(22.7) 49(20.2) 96(22.7)	14(25.9) 42(31.8) 99(40.9) 188(44.4)	15(27.8) 34(25.7) 57(23.5) 84(19.9)	19.13	0.513
Salary (per month)	NT\$30000 Below NT\$30000-50000 NT\$50000-70000 NT\$70000-90000 NT\$90000 Above	2(100) 189(100) 587(100) 64(100) 23(100)	0(0.0) 8(4.1) 15(2.5) 1(1.6) 0(0.0)	1(50.0) 27(13.9) 63(10.7) 6(9.8) 1(5.3)	1(50.0) 46(23.7) 123(20.9) 12(19.7) 4(21.1)	0(0.0) 61(31.4) 237(40.2) 35(57.4) 10(52.6)	0(0.0) 44(22.7) 134(22.7) 7(11.5) 4(21.1)	32.50	0.115
Level of significance *** P<0.001 ** P<0.01 * P<0.05									

Table 12 Measures on Participation of employees and the labor union (team decision)

Questions	Sample Size N (%)	Strongly Agree N (%)	Agree N (%)	Neutral N (%)	Disagree N (%)	Strongly Disagree N (%)	M_0	$\overline{X^2}$	S
14. It is necessary to counsel with workers' union with the privatization's transform measures	865 (100)	203 (23.2)	440 (50.3)	151 (17.3)	68 (7.8)	13 (1.5)	2	2.14	0.91
22. Workers' union and workers' suggestions have been accepted	865 (100)	11 (1.3)	80 (9.2)	238 (27.2)	379 (43.4)	166 (19.0)	4	3.70	0.90
23. Top manager with their workers to resolve problems	865 (100)	81 (9.4)	253 (29.2)	111 (12.8)	308 (35.6)	113 (13.0)	3	2.93	1.09

Table 13 Participation of employees and the labor union (Chi-square test)

Table 13-1 Participation of employees and the labor union (Chi-square test)									
Item	Variety	Sample N (%)	Strongly Agree N (%)	Agree N (%)	Neutral N (%)	Disagree N (%)	Strongly Disagree N (%)	X^2	p-value
Gender	Male Female	792(100) 73(100)	87(11.0) 6(8.2)	342(43.2) 41(56.2)	142(18.0) 15(30.5)	175(22.1) 11(15.1)	45(5.7) 0(0.0)	8.45	0.076
Age	25 below 25-34 35-44 45-55 55 above	3(100) 120(100) 324(100) 302(100) 116(100)	0(0.0) 15(12.2) 37(11.3) 27(8.9) 13(11.1)	0(0.0) 55(44.7) 130(39.6) 131(42.9) 65(55.5)	3(100.0) 16(13.0) 65(19.8) 54(18.7) 19(16.2)	0(0.0) 27(21.9) 68(20.7) 77(25.2) 15(12.8)	0(0.0) 7(5.7) 26(7.9) 10(3.3) 1(0.9)	61.89	** 0.001
Level of education	Junior school Senior school Polytechnic Diploma University Post graduate above	43(100) 272(100) 356(100) 158(100) 36(100)	3(6.7) 32(11.9) 37(10.4) 16(10.2) 5(13.9)	21(46.7) 118(43.7) 149(42.0) 73(46.5) 20(55.6)	8(17.8) 45(16.7) 67(18.9) 32(20.4) 5(13.9)	5(11.1) 58(21.5) 89(25.1) 28(17.8) 5(13.9)	5(11.1) 17(6.3) 13(3.7) 8(5.1) 1(2.8)	22.41	0.318
Level of position	Top manager Mid manager Grass-roots cadre Worker	11(100) 37(100) 115(100) 702(100)	0(0.0) 6(16.2) 10(8.8) 76(10.8)	9(81.8) 19(51.4) 58(50.9) 290(41.7)	2(18.2) 7(18.9) 23(20.2) 122(17.6)	0(0.0) 5(13.5) 22(19.3) 161(23.1)	0(0.0) 0(0.0) 1(0.9) 48(6.9)	23.88	* 0.021
Years of experience	5 below 5-15 15-20 20 above	52(100) 132(100) 245(100) 446(100)	6(11.1) 16(12.1) 23(9.5) 48(10.9)	24(44.4) 55(41.6) 95(39.1) 208(47.2)	10(18.5) 23(17.4) 54(22.2) 72(16.3)	9(16.7) 28(21.2) 48(19.8) 101(22.9)	3(5.5) 7(5.3) 23(9.5) 12(2.7)	24.84	0.208
Salary (per month)	NT\$30000 Below NT\$30000-50000 NT\$50000-70000 NT\$70000-90000 NT\$90000 Above	2(100) 189(100) 587(100) 64(100) 23(100)	0(0.0) 24(12.4) 58(9.8) 7(10.9) 3(13.0)	2(100.0) 72(37.1) 260(44.1) 36(60.9) 9(39.1)	0(0.0) 36(18.5) 106(18.0) 10(15.6) 7(30.4)	0(0.0) 42(21.6) 130(22.1) 8(12.5) 4(17.4)	0(0.0) 26(13.4) 29(4.9) 0(0.0) 0(0.0)	41.91	* 0.013
Level of significance *** P<0.001 ** P<0.01 * P<0.05									

Table 14 Measures on Encourage the employees to learn and to cultivate a second specialty

Questions	Sample Size N (%)	Strongly Agree N (%)	Agree N (%)	Neutral N (%)	Disagree N (%)	Strongly Disagree N (%)	M ₀	$\overline{X^2}$	S
9. After privatization, the company shall offer training and re-employment towards to those who wish to leave.	865 (100)	209 (24.1)	479 (55.1)	149 (17.1)	19 (2.2)	13 (1.5)	2	2.02	0.79
10. During the progress of the privatization, the company shall try arrange or transfer to other work	865 (100)	176 (20.2)	404 (46.4)	102 (11.7)	142 (16.3)	46 (5.3)	3	3.11	0.92
11. The switching training and re-employment counseling will assist to progress the privatization	865 (100)	116 (13.3)	381 (43.8)	89 (10.2)	216 (24.9)	67 (7.7)	2	2.07	1.21
24. Workers have received formal second specialty training	865 (100)	19 (2.3)	150 (18.2)	175 (21.5)	306 (37.4)	168 (20.5)	3	3.56	1.07

Table 15 encourage the employees to learn and to cultivate a second specialty (Chi-square test)

Item	Variety	Sample N (%)	Strongly Agree N (%)	Agree N (%)	Neutral N (%)	Disagree N (%)	Strongly Disagree N (%)	χ^2	P-value
Gender	Male Female	792(100) 73(100)	107(13.4) 9(12.3)	344(43.2) 37(50.7)	78(9.8) 11(15.1)	200(25.1) 16(22.0)	67(8.4) 0(0.0)	6.87	0.143
Age	25 below 25-34 35-44 45-55 55 above	3(100) 120(100) 324(100) 302(100) 116(100)	0(0.0) 14(11.4) 45(13.7) 38(12.4) 18(15.4)	0(0.0) 56(45.5) 125(38.1) 136(44.6) 64(54.7)	1(33.3) 13(10.6) 29(8.8) 34(11.1) 11(9.4)	2(66.7) 28(22.7) 100(30.5) 74(24.3) 12(10.2)	0(0.0) 9(7.3) 27(8.2) 20(6.6) 9(7.7)	51.12	* 0.017
Level of education	Junior school Senior school Polytechnic Diploma University Post graduate above	43(100) 272(100) 356(100) 158(100) 36(100)	4(8.9) 38(14.0) 43(12.1) 26(16.4) 5(13.9)	11(24.4) 122(44.9) 162(45.5) 68(42.8) 16(44.4)	7(15.5) 22(8.1) 43(12.1) 14(8.8) 3(8.3)	9(20.0) 69(25.4) 87(24.4) 40(25.2) 10(27.8)	11(24.4) 21(7.9) 21(5.9) 11(6.9) 2(5.6)	36.51	* 0.013
Level of position	Top manager Mid manager Grass-roots cadre Worker	11(100) 37(100) 115(100) 702(100)	2(18.2) 9(24.3) 15(13.0) 90(12.7)	8(72.7) 16(43.2) 60(52.2) 297(42.1)	0(0.0) 1(2.7) 11(9.6) 77(10.9)	1(9.0) 9(24.3) 24(20.9) 182(25.8)	0(0.0) 2(5.4) 5(4.3) 60(8.5)	23.49	* 0.024
Years of experience	5 below 5-15 15-20 20 above	52(100) 132(100) 245(100) 446(100)	8(14.8) 12(9.1) 32(13.2) 64(14.3)	22(40.7) 62(47.0) 87(25.8) 210(47.1)	6(11.1) 15(11.3) 24(9.9) 45(10.1)	13(24.1) 28(21.2) 79(32.5) 96(21.5)	3(5.6) 12(9.1) 21(8.6) 31(7.0)	22.74	0.302
Salary (per month)	NT\$30000 Below NT\$30000-50000 NT\$50000-70000 NT\$70000-90000 NT\$90000 Above	2(100) 189(100) 587(100) 64(100) 23(100)	0(0.0) 15(7.7) 81(13.7) 11(18.5) 17(30.4)	1(50.0) 75(38.6) 258(43.8) 35(53.8) 11(47.8)	1(50.0) 28(14.4) 57(9.6) 4(6.2) 0(0.0)	0(0.0) 51(26.3) 148(25.1) 13(20.0) 3(13.0)	0(0.0) 21(10.8) 42(7.1) 1(1.5) 2(8.7)	52.68	** 0.001
Level of significance *** P<0.001 ** P<0.01 * P<0.05									

Focusing On The High-End Or Low-End? Local Attacking With Network Externalities

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Abstract

Network externalities can encourage adoption when a network is growing in size. Network externalities, however, can also encourage abandoning when a network is getting small. Therefore, the challenger's action focusing on persuading a part of the market can eventually affect the whole market when network externalities are at work.

This paper discusses two local attacking strategies, namely, "focusing on the high-end" and "focusing on the low-end", and compares their effects. The conclusions show that the former strategy generally exhibits stronger eventual effects than the latter. Although direct effects are local, the eventual effects could be global when network externalities are strong and/or consumers have small differences in their reservation prices.

Based on our results, the incumbent should set a price keeping all installed users away from being stranded. If any installed user gives up the incumbent's technology, he or she may be the fuse to trigger the chain reaction. Thus, a better approach is to "make the fuse wet". To the challenger, local attacking strategies work better when network externalities are strong and/or reservation prices of installed users are nearly the same.

Keyword: Network Externalities, Attacking Strategies, Targeting

1. Introduction

Network externalities is the phenomenon that adopters' utility increases with the number of equivalent adopters [5] [6] [7] [14] [20]. Network externalities have proven themselves as a hot topic in the fields of economics and management. Moreover, it manifests undoubted relevance in information economies. Telephone, email [3] and computer operation systems are the most representative products characterized by network externalities. It also exhibits the property of increasing return [2] [18], and various inefficiencies [8] [11] therefore shaping a new business model in information economies.

Applicable are conventional and classic strategic thinking: building alliance, taking first-mover advantages, and managing consumers' expectation [19]. However, various counter-intuitive but insightful strategies are proposed and analyzed in the context of network externalities. For instance, allowing piracy in software markets [9], planned obsolescence [13], introducing

"clones" [10], predatory pricing under some conditions [4], and providing an adapter [1]. Analyzing the characteristics and influences of network externalities can help managers apply economic principles to improve on their decisions such as product line design, pricing strategies, property rights and taking advantage of lock-in effect [18].

We follow the research [21] that explained why challenger firm can win over incumbent firm in industries characterized by network externalities. Theoretically, network externalities stand on the incumbent's side and create enormous switching costs for installed users, or namely, the installed base. Based on the work [12], challengers have little chance to successfully penetrate into industries characterized by network externalities. However, it is interesting to note that in the history of industry this theoretical inference is not followed. The phenomenon that challengers win over incumbents takes place again and again. [21] successfully explained the phenomenon existed in growing markets. By contrast, attacking strategies in this paper can explain the same phenomenon even when markets do not grow in sizes.

One of the competitive strategies is seeking for sponsorship. Sponsorship can help one of the oligopolists to offer a lower price than marginal cost and thus gain competitive edge against the rival [15].

Another frequently cited research [17] showed that firms might race excessively and incompatibly in research and development. The government can take on the "force licensing" policy to slow down this race to improve social welfare. Our paper, on the other hand, proposes that the challenger firm can use local attacking strategies without interventions of governments.

Before we introduce this paper's purpose, we first come to the precise definition of "local attacking strategies". Marketing activities can be utilized to target the whole market or to target at a specific segment. Marketing activities, such as advertising or promotional campaign, utilized to target the whole market can be very expensive and lost of focus. On the other hand, marketing activities can be utilized to target at a specific segment. We name these marketing activities "local attacking strategies" because they do not attempt to persuade the whole market, by contrast, a particular part of the market. We will show that focusing on a rather small segment can affect the choice of the whole market in the context of network externalities.

Briefly, the purpose of this paper is to illustrate that attacking strategies by the challenger can destruct the

incumbent's installed base. In this paper, the effects of two local attacking strategies are analyzed and compared. One strategy is "focusing on the high-end" and the other is "focusing on the low-end". This paper will show that local attacking strategies not only have local direct effect, but also have global eventual effect on the number of the incumbent's installed users.

The attempt of this paper is new in the fields of industrial organization and management science. Firstly, this paper shows that network externality can amplify the effect of a challenger's attacking strategies. Although the direct effect of attacking strategies is local, the strategic effect amplified by network externality could be enormous.

Explaining the similar phenomenon, this paper attempts to extend [21] to explain the challenger's victory even without a growing market. The increasing return property of network externality is well known but, however, network externality also makes a network more vulnerable when a network is under attack.

This paper is organized as follows. The current section describes this paper's purpose, importance and status in the literature. The next section describes the model. The third section solves the problem and discusses the results. Finally, the conclusion is drawn.

2. Model

The model consists of one incumbent firm, one challenger firm and a number (M) of users. The incumbent possesses a technology and set a price for usage right in a specific time period, for instance a year. Every user in the market is assumed to have paid for the technology in the previous time period but needs to decide whether to pay the incumbent again for the coming year's usage. That is, the incumbent firm occupies the market in the beginning of the model.

This paper does not analyze the dynamic and competitive issues between the incumbent and the challenger. The focus is put on the one-shot effect of the challenger's attacking strategies and network externality between technology adopters. The analysis is limited to the scope in which the challenger takes one strategy and the incumbent is not ready to notice or react to the challenger's attack. Thus, the game theoretical view is not applied on the interactions of the incumbent and the challenger, but applied on the interactions between technology adopters.

Since the challenger is new in the market, he/she may concentrate his/her marketing resources to attract some (locally), but not all (globally), of the consumers in the market. Intuitively, "focusing on the high-end" and "focusing on the low-end" are two candidate strategies. The only decision to be made in this model is challenger's strategy.

Let us first elaborate these strategies. The term "high-end" refers to consumers, who may have higher income or wealth, possessing higher reservation prices. By contrast, the other term "low-end" refers to consumers possessing lower reservation prices. Moreover, "focusing

on the high-end" strategy is concentrating marketing resources to target consumers with higher reservation prices. On the other hand, "focusing on the low-end" strategy is concentrating marketing resources to target consumers with lower reservation prices for the incumbent's technology.

It is hard to judge which of these two strategies is better. The former, "focusing on the high-end", may lead the challenger to seize a higher-margin segment as a niche. On the other hand, "focusing on the low-end" may help the challenger expand its market share in a higher speed.

To reflect the direct effects of these two strategies, we model the former strategy, "focusing on the high-end", in a way that a challenger moves the consumer with the highest reservation price out of the incumbent's installed base. Similarly, we model the latter strategy, "focusing on the low-end", in a way that a challenger moves the consumer with the lowest reservation price out of the incumbent's installed base. The consumer, who is "targeted" by a challenger, "uninstall" the incumbent's system and stops using the incumbent's technology, and consequently leave no value to other consumers and the incumbent.

The incumbent charges a price at the end of the model to every consumer who decides to renew the contract with the incumbent. One must notice that in this paper the incumbent is assumed to set a price maximizing his/her short-term profit without considering the competition. Thus, the incumbent's price is fixed when consumer reservation prices and the strength of network externality are given. In other words, the incumbent does not expect the emergence of the challenger. Accordingly, this paper does not attempt to provide any equilibrium but the optimal move (the optimal local attacking strategy) for the challenger.

To clearly identify every consumer and his or her reservation price, we next sort and give subscript "i" to consumers by their reservation prices. Moreover, consumer Q 's reservation price is called P . Accordingly, The consumer with the lowest reservation price, P_1 , is called G_1 in this paper and correspondingly the consumer with the highest reservation price, P_M , is indexed as G_M .

Consumers decide in a sequence of C_1, C_2, \dots, C_M . Therefore, we set that there are M periods and M consumers. In the first period, the consumer (C_1 or C_M) who is targeted by the challenger refuses to pay the incumbent again. In the following $M - 1$ periods, consumers decide in a sequence (C_2, C_3, \dots, C_M or C_1, C_2, \dots, C_{M-1}) and just one consumer decides in each period, respectively. The sequence may reflect the reality well because the consumer with a lower reservation price is more sensitive to market change such as the challenger's strategic actions. On the contrary, the consumer with a higher reservation price is more satisfied with the incumbent's system thus less willing to search for alternatives.

The distribution of consumers' reservation prices indeed matters. We assume that distribution follows a

linear pattern of $P_i = a + b + r(n - 1)$, where “n” represents the number of consumers who still are installed users of the incumbent’s technology. That is, P_1 equals $a + b + r(n - 1)$ and P_M equals $a + b + r(n - 1)$. The parameter “a” thus represents the reservation price difference between consumers. On the other hand, the parameter “r” therefore represents the strength of network externality.

The linear pattern of reservation prices of consumers is a approximation of uniform distribution setting [14]. On the other hand, the linearity of network utility on the number of adopters is following the model of [21] and similar to the setting [16].

The incumbent’s price, P , also plays an important role in the effectiveness of a challenger’s attacking strategies. Intuitively, a higher price without losing any consumer can generate the maximal short-term profit. How much can the incumbent charge? In order to retain all of consumers in the system, the price cannot exceed the lowest reservation price P_1 with $n = M$. Moreover, any price beneath P_1 , statically, does not attract more consumers but only directly reduce the profit. To focus on the effect of a challenger’s attacking strategies, the price set by the incumbent is modeled to be $P = a + b + r(n - 1)$. The price set by the incumbent is modeled as a constant in this paper. The only decision is made by the challenger to choose one of the two attacking strategies.

The model operates as follows. The incumbent sets a price equal to $P = a + b + r(n - 1)$, equivalently $a + b + r(M - 1)$. Next, the challenger decides to target at C_M , the consumer with the highest reservation price, or C_1 , the consumer with the lowest reservation price. These two approaches are named “focusing on the high-end” and “focusing on the low-end”, respectively. In the mean time, the consumer targeted by a challenger does not pay the incumbent again. Finally, the remaining consumers decide whether to renew the contract with the incumbent and pay the price in a sequence specified above. The number of consumers who do not pay the incumbent again measures the effectiveness of attacking strategies.

For easy reference, we list notations used throughout this paper in the following.

C_i : the consumer with the i^{th} low reservation price

P_i : the reservation price of C_i consumer

a : the reservation price difference between consumers C_k and C_{k+1} , where k is an integer between 1 and $M - 1$

r : the strength of two-way network externality between any pair of consumers

n : the number of consumers who still use the incumbent’s technology in the current period

M : the total number of consumers in the market

P : the price set by the incumbent which is equal to P_1 with $n = M$, that is, $P = a + b + r(n - 1)$

3. Analysis

Now we start to analyze the first targeting strategy: “focusing on the high-end”. A challenger concentrates his or her marketing resources to target the consumer with the highest reservation price. The effects of such attacking strategy are shown as Figure 1.

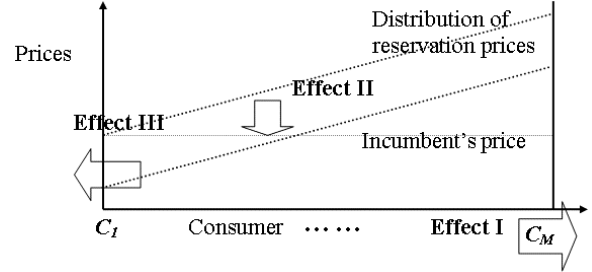


Figure 1: Effects of “focusing on the high-end” strategy

Firstly, the targeted consumer does not pay for the incumbent’s technology (Effect I), that is the direct effect. Since consumers’ reservation prices are constructed upon other consumers’ equivalent adoptions, the reservation prices of remaining consumers all drop an amount of r (Effect II). Consequently, the reservation prices of some consumers may fall beneath the incumbent’s price and refuse to pay it (Effect III). Moreover, some other consumers abandon the incumbent’s technology and the reservation prices drop more. Those effects (Effects II and III) form a self-reinforcing loop, which is triggered by the “focusing on the high-end” strategy (Effect I). Although only one consumer is affected initially by the challenger’s strategy, more than one consumer is eventually affected. The argument is proved more rigorously in the following.

Proposition 1 :

When the challenger uses the “focusing on the high-end” strategy and $\frac{a}{r} \geq 2$, eventually 2 consumers will not pay for the incumbent’s technology.

Proof:

When consumer C_M is targeted and does not pay the incumbent again, all consumers’ reservation prices drop an amount of r . Consumer C_1 ’s reservation price now becomes $a + b + (M - 2)r$, which is below the price, $a + b + (M - 1)r$, set by the incumbent. Consumer C_1 refuses to pay the incumbent again. Next, consumer C_2 ’s reservation price thereafter becomes $2a + b + (M - 3)r$, which is above the price, $a + b + (M - 1)r$, set by the incumbent when $\frac{a}{r} \geq 2$. Consumer C_2 pays the price and stays as an installed user and the stop-point of the chain reaction of abandoning. The consumers ($C_3 \sim C_{M-1}$) with a higher reservation price than C_2 deservedly pay the

price for the incumbent's technology. Only G_I and G_M are affected by the challenger's strategy. Proposition 1 is proved.

Under another condition, $\frac{k}{k-1} \leq \frac{a}{r} < \frac{k-1}{k-2}$, the effect of "focusing on the high-end" strategy would be stronger.

Proposition 2 :

When the challenger uses the "focusing on the high-end" strategy and $\frac{k}{k-1} \leq \frac{a}{r} < \frac{k-1}{k-2}$, eventually k consumers will not pay for the incumbent's technology, where k is a positive integer between 3 and $M-1$.

Proposition 3 :

When the challenger uses the "focusing on the high-end" strategy and $\frac{a}{r} < \frac{M-1}{M-2}$, eventually all (M of) consumers will not pay for the incumbent's technology.

Proposition 4 :

When the challenger uses the "focusing on the high-end" strategy and $\frac{a}{r} < 1$, eventually all (M of) consumers will not pay for the incumbent's technology.

When the four propositions are proved, we observe that the incumbent's installed base is more "fragile" when reservation price difference between consumers (a) is smaller and/or network externality (r) is stronger. The more "fragile" the incumbent's installed base is, the higher the incentive for the challenger to launch an attacking action.

To the incumbent, what are the ways to make the installed base more "solid"? The reservation price difference between consumers (a) is a characteristic of the market and may be hard to change. On the other hand, network externality (r) can be strengthened by technical functions facilitating consumers' interactions or providing convenience to interact with friends by the incumbent's technology.

Intuitively, the incumbent shall enhance consumers' value (r) from interactions. The installed base, however, becomes more fragile when network externality (r) gets stronger. Therefore, the incremental value from interactions is double-edged to the incumbent. Its advantage is that it helps the incumbent to achieve higher performance in terms of consumer satisfaction or profits. On the other side, it makes the incumbent's installed base more vulnerable. The double edge traps the incumbent into a dilemma whether to add consumer's value from interactions.

To the challenger, the values of " a " and " r " can help to estimate the effect of "focusing on the high-end"

strategy. When " a " is relatively small and " r " is relatively large, the "focusing on the high-end" strategy can be expected to have a larger effect on the incumbent's installed base.

For instance, players in online games interact frequently and closely, that represents a stronger network externality, namely larger " r ". Players in online game industry mainly consist of students. They can be considered to have similar reservation prices. A challenger may concentrate his or her marketing resources to offer attractive deals such as free usage or cash rebate. According to the propositions above, the challenger uses the "focusing on the high-end" strategy and the remaining players lose contact to players who refuse to pay the incumbent again and lose value from communication with them. Some of remaining players may feel dissatisfied and do not repurchase the incumbent's service. As more players switch their choice, the remaining players will tend to switch also. Those may form a self-reinforcing loop and make the "focusing on the high-end" strategy very powerful to destruct the incumbent's installed base.

Now let us analyze the second targeting strategy: "focusing on the low-end". A challenger concentrates his or her marketing resources to attract the consumer with the lowest reservation price. The effect of such attacking strategy is shown as Figure 2.

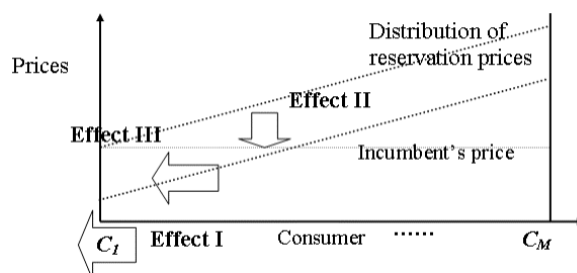


Figure 2: Effects of "focusing on the low-end" strategy

First, the targeted consumer (C_1) refuse to pay the incumbent again (Effect I), that is the direct effect. Other remaining consumers' reservation prices drop an amount of " r " (Effect II). Consequently, the reservation prices of some consumers may fall beneath the incumbent's price and refuse to pay it (Effect III). Accordingly, more consumers leave and the reservation prices drop more. Those (Effects II and III) form a self-reinforcing loop, which is triggered by the "focusing on the low-end" strategy (Effect I). Although only one consumer is affected, more than one consumers will eventually be affected. The argument is proved more rigorously in the following.

Proposition 5 :

When the challenger uses the “focusing on the low-end” strategy and $\frac{a}{r} \geq 1$, eventually only 1 consumer will not pay for the incumbent’s technology.

Proposition 6 :

When the challenger uses the “focusing on the low-end” and $\frac{a}{r} < 1$, eventually all (M of) consumers will not pay for the incumbent’s technology.

Similar to propositions 1 to 4, propositions 5 and 6 also indicate that the incumbent’s installed base is more “fragile” when reservation difference between consumers (a) is smaller or network externality (r) is stronger. The incumbent faces the same dilemma whether to facilitate consumers’ interactions and add some value to consumers via more convenient communication.

One may notice that the incumbent in this model set a price that makes one consumer (C_1) on the threshold of paying for the incumbent’s technology or not. The pricing rationale is most profitable in the short run or without competitors. The single on-the-threshold consumer, however, can be a fuse triggering the chain reaction of abandoning due to network externality. One intelligent way is to lower the price to take all consumers away from the threshold point, that is, “make the fuse wet”. Once the incumbent adopts such defensive strategy, the challenger may face difficulties to trigger the chain reaction by local attacking strategies.

Again we turn back to the challenger. The values of “ a ” and “ r ” can help to estimate the effect of “focusing on the low-end” strategy. When “ a ” is relatively small and “ r ” is relatively large, the “focusing on the low-end” strategy can be expected to have a larger effect on the incumbent’s installed base.

For instance, word processing software (such as MS Word) may be one of the markets consisting of diversifying consumers. Students, professionals and administrators may have different reservation prices. In the model, the difference of consumer reservation prices may be large. On the other hand, network externality may be low to medium, that is, the value of “ r ” may be small. Based on propositions 5 and 6, we have the theoretical result that the challenger’s “focusing on the low-end” strategy only has a limited effect.

When two local attacking strategies are analyzed, we are on the position to compare their effects.

Proposition 7 :

The “focusing on the high-end” strategy is more effective than the “focusing on the low-end” strategy when $\frac{a}{r} \geq 1$.

Proposition 8 :

The “focusing on the high-end” and “focusing on the low-end” strategies are the same effective when $\frac{a}{r} < 1$.

To be clear, proposition 1 to 8 are summarized in Table 1.

Table 1: Comparison of two local attacking strategies

Number of consumers switch Scenario	Strategy	Focusing on the high-end	Focusing on the low-end
$2 \leq \frac{a}{N_j}$		2	1
$\frac{k}{k-1} \leq \frac{a}{N_j} < \frac{k-1}{k-2}$		$k (3 \leq k \leq M-1)$	1
$1 \leq \frac{a}{N_j} < \frac{M-1}{M-2}$		M	1
$\frac{a}{N_j} < 1$		M	M

According to Table 1, we find that “focusing on the high-end” strategy is superior to the “focusing on the low-end” strategy in some cases however only the same effective in other cases. To sum up, “focusing on the high-end” strategy weakly dominates “focusing on the low-end” strategy in the context of network externality.

4. Conclusion

This paper analyzes the effects of two local attacking strategies by a challenger. The “focusing on the high-end” strategy is found superior to “focusing on the low-end” strategy in some industry scenarios.

Two local attacking strategies are shown to have larger eventual effects than the direct effects in the context of network externality. That is, local attacking strategies although only have limited direct effects but can trigger the chain reaction, which results in larger eventual effects.

By analysis of this paper, a challenger can estimate the effect of his or her local attacking strategies. When consumers have same similar reservation prices, the chain reaction is easier to be triggered and local attacking strategies have significant effects. On the contrary, local attacking strategies only have limited or local effects when consumers are very distinct in their reservation prices. The reason is that chain reaction is harder to be triggered.

In addition to consumers’ heterogeneity in reservation price, the strength of network externality should be considered when estimating effects of local attacking strategies. Strong network externality represents larger value via communication between the consumers. The power to strengthen and facilitate chain reaction is stronger when network externality is stronger. Accordingly, effects of local attacking strategies arise with network externality.

On the contrary, weak network externality hardly pushes the chain reaction to go on. Therefore, the effects of local attacking strategies become weaker in the context

of weaker network externality.

From the incumbent's point of view, it is unwise to take over as much as consumers' surplus in the industries characterized by network externality. One consumer, who is stranded or stand on the threshold of abandoning or not, can be the fuse to trigger a scale of chain reaction. A better approach is to adequately lower the price to leave more surplus to consumers, that can be regarded as "make the fuse wet" approach. Although that approach reduces the short-run profit, it can effectively retain the installed base stable and subsequently the seat of incumbent.

The strategic implication to the challenger is to find the "fuse", the consumer(s) who are least satisfied with the incumbent's current offering. "To light the fuse" can effectively take advantage of network externality. The better fuse is the high-end consumer(s) because of stronger eventual effects theoretically guaranteed by network externality. Practical targeting strategies are offering "rebate when old exchanged for new" or "special deal", or concentrating advertising and channel efforts to target at the better fuse.

Future researches extending or improving this paper can: (1) analyze the value of the timeliness of incumbent to stop the chain reaction, (2) provide defensive strategies and analyze their effects, (3) form a sequential attacking-defending game for an incumbent and challenger, and (4) consider the cost factors and subsequently provide a decision support model.

In addition, network externality between consumers may not always be anonymous, but local with identities. That is, a research may extend this paper by considering local network externality and find differences in results. Another natural extension of this paper is to consider different distributions of consumers' reservation prices. The form of distribution can indeed affect the effects of attacking strategies.

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Note:

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Prioritizing Service Quality Dimensions

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Abstract

Researchers all over have discussed and debated the contents of service quality. Multi-dimensionality of the service quality construct has been proposed. Further, researchers have attempted to prioritize the service quality dimensions. Authors have, as a part of a larger research initiative have made an attempt to analyze the prioritization among different service dimensions across different services types based on nature of service act and target of service act. Authors have concluded that a generalization of priority across all service types is not admissible. They also suggest different weights for different service quality dimensions depending upon the service types.

1. Introduction

In the 'age of customer', delivering quality service is considered an essential for success and survival [12], [18], [22] and [28]. What constitutes service quality has attracted the attention of researchers all over the world. The debate continues.

Johnston [14] suggests that one of the pressing issues before services research concerns the identification of the determinants of service quality. This should be a central concern for service management academics and practitioners, as the identification of the determinants of service quality is necessary in order to be able to specify, measure, control, and improve customer perceived service quality.

Early studies during 1980s focused on determining what service quality meant to customers and developing strategies to meet customer expectations [18]. The early pioneers of services marketing in Europe, especially the Nordic School, argued that service quality consists of two or three underlying dimensions. Lehtinen and Lehtinen [16] referred to physical and interactive quality while Christian Gronroos [13] identified a technical dimension, a

functional dimension and the firm's image as a third dimension. In later years, Parasuraman, Zeithaml and Berry [18] published empirical evidence from five service industries that suggested that five dimensions more appropriately capture the perceived service quality construct. Building on the pioneering work of the Nordic School of services management and particularly Christian Gronroos, they established service quality as the core of services marketing. Their landmark article in 1985 conceptualized service quality as a gap between consumers' expectations and perceptions [18] inspired many other researchers to examine the services quality construct within a marketing premise [2]. However, their contribution has not gone unchallenged. Much of this interest has centered on the controversy generated by their Service Quality Gaps Model [18], and particularly the SERVQUAL instrument developed to measure service quality [19]. Many researchers who have used the SERVQUAL instrument have been critical of its paradigmatic foundation, its convergent and discriminant validity, the use of difference scores and the use of negatively phrased items [5], [1], [21] and [4].

Variations from unidimensionality [11] to two, three, four, six and eight factor structures have been reported [1], [3], [5], [10], and [25]. Spreng and Singh [26] have hinted at the possible combination of some of the five dimensions due to high inter-correlations. Johnston and Silvestro [15] went on to add the customer's perspective to the 12 service quality characteristics. This led to the identification of an additional five service quality determinants: attentiveness/ helpfulness, care, commitment, functionality, integrity; it also led to a refining of some of the other definitions.

A number of other authors have also postulated their own determinants of service quality, though in some cases they appear to

have been based on Berry et al.'s [2] well-publicized work.

Lately even the developers of the instrument have produced evidence confirming the doubts expressed about the five-dimensional configuration. Thus, despite the 'many' studies which have analysed the dimensions measured by SERVQUAL, 'there is no clear consensus on the number of dimensions and their interrelationships'. This uncertainty hampers our understanding of service quality and casts doubts over the use of the SERVQUAL instrument in future research. It also shows that a considerable amount of research still needs to be done concerning the dimensionality of perceived service quality in general and SERVQUAL in particular, as called for by its developers [20].

Chowdhary and Prakash [9] have suggested a two factors' theory -that a more detailed approach is required wherein each factor needs to be considered independently and not as an aggregate dimension. They report evidence to support two-factor theory for services that was discarded by earlier researchers. They argue to differentiate between the factors and the outcome of performance along these factors. The study describes the two factors as 'vantage factors' and 'qualifying factors'. Marketers need to be selective in that certain factors behave as vantage factors while others as qualifying factors. The two are different in nature and require a differential treatment.

2. Relative importance of dimensions

Parasuraman et al. [19] have observed that their instrument (SERVQUAL) can be used to evaluate the relative importance of the dimensions of quality in influencing customers' overall perceptions of a service. The relative weight that customers seem to give to each quality dimension can be determined. One of the important result that has been reported in the early studies of relative importance is that customers are quite consistent in both their imputed and their direct rankings of the importance of the service quality attributes. In this key study, reliability was demonstrated to be the most important dimension and empathy (a composite of understanding and access) the least important across a seemingly wide array of service types. Zeithaml et al. [28] also report, using a variation of SERVQUAL that tangibles proves to be consistently unimportant. A pertinent question here is that whether such a generalization is possible. Chowdhary [8] suggest that generalizations are difficult to make

because of variation in the basic nature of services (labor or capital intensity) and that the type of industry affect the design of service. It was seen that *empathy* and *responsiveness* were found to be more important for labor intensive industry while *tangibles* and *reliability* affected the assessment of quality dimensions in case of capital intensive services. This was also confirmed by the results from a similar study done for 'Management Education' where the single most important dimension was the knowledge of the teacher (assurance).

Services USP (unique selling proposition) can be woven around different criteria (tangibility, customization, labor intensity, etc.). This criterion in turn could be the KPD (key performance dimension). Different user groups can see each type of service in turn as performing on a number of factors across different dimensions. From among these factors, some are the *key factors* and are relatively more important for the consumer. A number of these KFs could be simultaneously important for these user groups, though the relative importance of these dimensions may vary from one user group to another. There may also be a general shift in consumer preference for a dimension for example from 'medical-care' through 'patient-care' to 'hospital-care', in case of the consumers of healthcare. Their importance may also vary from one consumer to another.

3. Service types

Service classifications have been offered since early 1980s. Different authors have suggested different taxonomies based on different criterions. Of these four are noteworthy- Chase [6], Chase and Tansik [7], Schmenner [24], Wemmerlov [27] and Lovelock [17]. Chase segments by the extent of customer contact in the delivery of the **service**. Schmenner classifies **services** using two dimensions, with the degrees of interaction (generalized from "contact") and customization on one axis and the degree of labour intensity on the other. Wemmerlov [27] more recently proposed a classification scheme where the variables of differentiation are the degree of routinization of the process, the "object" of the **service** process, and customer contact. His operationalization of contact differs from both Chase and Schmenner in that he redefines it to be "direct", "indirect" or "no" contact with the customer, rather than simply as "high" or "low". Lovelock [17] has suggested categorizing services into four distinctive categories based on what a service

organisation is actually processing and how does it perform that task. A service organisation may be servicing individual customers or alternatively it may be servicing their possessions. Further the servicing may be physical as in case of hair cutting or a travel by train. Alternatively, the servicing may be intangible as in case of education, entertainment or consultancy. He therefore suggests a 2X2 classification of service processes.

Table 1: Population for Study			
		Who or what is the recipient of the service?	
		People	Possessions
		People Processing <ul style="list-style-type: none"> Hospitals and nursing homes Hotels Beauty saloons Fitness Centers 	Possession Processing <ul style="list-style-type: none"> Freight transportation Repair shops Retail outlets Laundry and dry cleaning
		Mental Stimuli Processing <ul style="list-style-type: none"> Telephone companies Management consulting MBA Education Cable operators 	Information Processing <ul style="list-style-type: none"> Accounting firms Banks Insurance Legal services

4. Research issue

The above cited literature review has discussed the service dimension and the tools to evaluate service quality. Yet it is insufficient in establishing any generic relative importance of service dimensions. Researcher believes that such a generalization may not be possible across all service types. This study seeks to make out whether some generalization is possible within service types and does that vary with classification variables. For the purpose of investigation, researcher has used Lovelock's classification.

The pertinent research question was whether the different categories of service processes show a pattern vis-à-vis the importance of different determinants of service quality (the five dimensions suggested by Parasuraman, et al.). The objective was to identify the relative importance of service quality dimensions for different service processes. For each category, four different services were identified. Thus in all sixteen services were identified. Respondents were asked to free list what they felt was important and added value to their consumption

of a particular service type. A survey of 356 respondents returned a 989 free-list items shown in table 2.

In the next phase of analysis, the free list items were classified using the five dimensions of Parasuraman et al. It was observed the price with reference to cost, fees, charges, discounts, etc. figured repeatedly and so it was categorized separately as the sixth dimension and was called 'fees'. For a list for any particular service type, we could now generate the relative importance matrix using tally marks. These were then converted into percentile scores. Thus, we could get a score for each dimension for each service type. Similarly, the score were calculated for each service process category.

5. Discussion

First, the six service quality dimensions corresponding to each of the service types were ranked based on the mean scores for the subset of four services comprising each group.

If any the ranks of service dimensions across each service type were similar, some kind of generalization of relative importance of dimensions was possible. It was decided to test the following hypothesis.

H₀: $\rho_s = 0$

Null Hypothesis: There is no rank correlation in the population; that is, different types of services have dimensions (tangibility, reliability, responsiveness, assurance, empathy, and fees) having different priorities (ranks).

H₀: $\rho_s \neq 0$

Alternative Hypothesis: There is population rank correlation; that is, irrespective of the service types, dimensions have similar priorities (ranks).

Table 2a: Spearman's rank correlation (r_s) test				
People Processing	1.00	-0.03	-0.47	-0.31
Possession Processing		1.00	0.56	0.26
Mental Stimuli Processing			1.00	0.53
Information Processing				1.00

For small values of n ($n=6$), we use Spearman's rank correlation test tables that give values for combined areas in both tails.

Table 2b: Spearman's rank correlation test tables					
N	0.02	0.10	0.05	0.02	0.01
6	0.600	0.771	0.829	0.886	0.943

Thus, null hypothesis was accepted at all the abovementioned levels of significance. It can therefore be concluded that for different service types, consumers rate service quality dimensions differently. This supports Rosen and Karwan's study [23] that the proposition that one can generically order the quality dimensions (in terms of relative importance as suggested by Parasuraman, et al [20]) for any firm is appealing, but is not likely to be supportable. The reasons for this are intuitive from a strategic operations perspective and are observable when conducting the tests for 'relative importance' across a truly broad sample of service types.

Subsequently, two-step cluster analysis procedure was deployed to reveal natural grouping (or clusters) within a data set for each service quality dimension that would otherwise not be apparent. Similarity between clusters was computed on the basis of log-likelihood method. The likelihood measure places a probability distribution on the variables. Continuous variables (tangibility, reliability, responsiveness, assurance, empathy and fees) were assumed to be normally distributed, while categorical variable (service type) are assumed multinomial.

Further, all variables are assumed to be independent. Empirical internal testing indicates that the procedure is fairly robust to violations of both the assumption of independence and the distributional assumptions. One important observation is that two-way cluster analysis in almost all cases (5 out of 6, barring reliability) resulted in 2 X 2 distributions of service types.

Once the clusters were obtained, based on Euclidean measure of distance test of differences between cluster means for small sample sizes was applied to ensure if the difference in cluster-means is significant or not at $\alpha = 0.05$.

Tangibility is clearly an important issue with services that require a more visible action that is people-processing (A) and possession-processing (B) services. Perhaps tangible cues buttress tangible actions for these cases. Customers need more tangibility to identify with services where value is created in their physical presence on the service process. Since the presence of customer is not a concern in case of services with an intangible action, customers of mental-stimuli (C) and information processing (D) have rated tangibles as low on expectations. Still it must be noted that need for tangibility is higher as we move from services targeted at possessions to services those are targeted at people (39.64 (A) > 19.758 (B); 8.34 (C) > 6.19 (D)). Tangibility, therefore, is more important an issue for universities and cinema halls than for insurance companies and accounting firms. Thus tangibility is most important for people processing services followed by possession processing, mental-stimuli processing and information processing services in that order.

Respondents from the services selected for the study rated reliability as the most important service dimension. As in most cases of services, only a post purchase evaluation is possible, customers expect service processes to be reliable to match their expectations. In case of this dimension two-step cluster analysis resulted into two clusters with people processing services as one cluster and the other three being included in the second cluster. Respondents for cluster one, are relatively less concerned about reliability perhaps because tangibility serves as a surrogate for it. All the others in cluster two rate it as quite important (Mean = 34.22 , s.d. = 7.12). Further, as we move towards services that are targeted at possessions of customers, whereby the presence of customer on the process is not necessary and the services are carried out largely in back-offices, there is a greater need for reliability of service process. More reliability is expected as

services include intangible actions. Thus, reliability is very important for information processing services (ATM-deposit, or ability of your lawyer) followed by possession processing, mental-stimuli processing and least important in case of people processing services.

Cluster analysis clubbed people-processing and information-processing as one cluster; and possession-processing and mental-stimuli-processing as the second cluster, for “assurance” dimension. Test of difference between means of two clusters was administered to ascertain if there was a significant difference in the means of two clusters. Analysis suggested null hypothesis to be accepted, that is there was no significant difference in the means. Subsequently, two clusters ((A, C) and (B, D)) based on distance of mean values of four service-types were formed and the test for differences was applied. A t-value of 2.38 (> 2.145 the critical value) was obtained and the alternate hypothesis was accepted. The difference in means was significant at $\alpha = 0.05$ for one tailed test.

Assurance, the knowledge and courtesy of employees and their ability to convey trust and confidence (competence, courtesy, credibility, security) was important for services targeted at the individual customers necessitating considerable contact between the employees and customers ((A=22.33) and (C=28.42)). Further, as the nature of service act grows more intangible the need for greater assurance was felt (C (28.42) $>$ A (22.33) and D (19.36) $>$ B (17.43)) to reinforce the confidence of customer. Thus customers of mental-stimuli-processing services (C) that require meaningful customer contact and are largely intangible (MBA teaching, management consulting, etc.), expect greater assurance from service providers. Subsequently, the importance of assurance decreases in the order: people-processing, information processing and last the possession processing.

Test of difference of means based on both, the two-step cluster analysis and distance, for responsiveness, suggested accepting null hypothesis. That is no grouping of service types was available that results into significant difference to suggest that responsiveness was more important in any one of service types or groups. In fact, responsiveness was uniformly considered as less important service dimension by respondents of all service types. In these times of transition, ours is still a deficit market economy. The customers are less expectants and waiting time is often not a big consideration. The

customer therefore accepts less spontaneity and slothfulness in service delivery. This may change as markets mature over time and customers need to be lured and pampered.

Two-step cluster analysis identified people-processing (A= 16.71) and information-processing (D= 23.19) services as one cluster (Mean = 19.95, s.d. = 6.5) where empathy is considered important. In people-processing services the presence of customer is substantial that requires service providers to make an extra effort to understand his/ her needs and make the stay pleasant. At the other extreme is a largely intangible service (information processing) to be carried out in back-office away from the customer. The customer’s concern is higher-that service be explained to him/ her, and he/she may be understood well before the provider sets out to create the service. A tangible (visible) service is more certain. Further, if it is targeted at a customer’s possession the trepidation is less. A video repair service engineer may be less empathic than a lawyer who must appreciate a customer’s concern and viewpoint. Similarly, an hotelier must be more conscious of a customer’s preferences as he/ she stays with him. Thus, empathy is least with possession-processing services (B=8.43). Mental-stimuli-processing (C= 11.67) occupies an intermediate position.

In absence of risk of personal well being (people-processing) or the risk of information processing the other services are generally available in standardized modes in near perfect markets (cable operators, telephone companies, retail outlets, dry cleaning etc.) The choice of provider therefore gets associated with the monetary cost of obtaining the service. Prices for information-processing services are very competitive (bank rates or insurance premium) and therefore the prices of these have a limited affect on purchase decision making (A= 9.06). On the other hand, the concern for well-being of self is paramount in case of people-processing services and so the cost of contentment takes a low priority (D= 5.4).

6. Deduction

Though certain trends are visible, yet the researcher would like to draw attention to some of the precincts of this study. In most cases, the notions of most of the concepts vary. Different respondents had different connotation of the same word. Say- safety/ security; reliability, credibility and assurance; location, accessibility; etc. were often used interchangeably. Ranking of dimensions also depended on the current state of

the competition in a particular industry and varied from industry to industry within a service type. While markets have matured for some industries, they are not very competitive for others. Some for example the cable operators, telephony and insurance till recently, have monopolistic tendencies.

Given the state of competition and market within the different service industries, following can be concluded:

- Tangibility is more important for services with more tangible actions. Further, the importance reduces as one shifts from services targeted at people to service targeted at possessions.
- Need for reliability is more for services with intangible nature of service act. Services targeted at possessions of the customers will also require more reliability.
- Services targeted at the individual of the customer requires more assurance than those targeted at the possessions. Further more assurance will be needed for services with intangible act.
- Responsiveness did not allow for any kind of clustering. Customers ranked it last on priority across different service types. Perhaps they are less expectant for this service dimension.
- Information-processing and people-processing services require more empathy as compared to other two types.
- Prices were considered relatively more important by consumers of possession-processing and mental-stimuli processing services.

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**Business-to-business relational bonding over the internet:
some evidence from Australian service industry**

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Extended Abstract

Internet marketing and relationship marketing are becoming prevalent in Australian firms. The advent of the internet has created numerous opportunities for marketing professionals to enhance current marketing practices, including relationship marketing. However, the investigation of marketing relationships in an internet environment is scant. Further, there appears to be no investigation of this phenomenon within the context of Australian service industries. Given these gaps in the literature, the research problem investigated in this research is: How does B2B internet use affect inter-firm relationships in service industries?

Thus this paper addresses the problem: How does B2B internet use affect inter-firm relationships in Australia service industries? Essentially, I argue that internet use does not hinder exchange relationships and effective internet use may enhance exchange relationships in the long run, with the internet directly affecting communication in an exchange relationship. Therefore this research constructs a comprehensive theoretical model that summarise the relationship facilitating aspects of the internet in a B2B context. The literature does not investigate this research problem in any depth. However, a framework about internet-facilitated marketing relationship in the extant literature was integrated and synthesised with literature about internet marketing and relationship marketing to arrive at two research issues:

RI 1: How are the relational bonds in an inter-firm relationship influenced by internet use?

RI 2: How do these relational bonds interact in an internet environment?

To investigate these three research issues, a combination of qualitative and quantitative two-stage methodological approach was used. The first stage was eleven convergent interviews to build on the extant literature and to further confirm and refine the theoretical framework. In the second stage, a survey methodology was used to test the model about internet-facilitated inter-firm relationships in Australian business internet banking users. Data was analysed and the hypotheses specified in the main model were tested using structural equation modelling techniques. Thus this research involved both theory building and theory testing.

The findings of this research have implications for the two research issues. The results for the first research issue showed that the internet has little negative impact on relational bonding in the B2B context. That is, technology-mediated transactions in financial services may not be detrimental to established relationships because trade efficiencies are more of a concern for

businesses rather than the social aspects. Moreover, the impact of internet use on relational bonds of trust and dependence is moderated by the length of B2B internet use. The findings for the second research issue were that most interrelationships between structural and social bonds in an internet environment are in line with the generic literature. In addition, the findings of this research highlight some important issues in relationship marketing research. That is, inter-relationships of the relational constructs depend on the context in which the relationship exists.

The main contribution of this theory building research is the development and confirmation of a final theoretical framework about internet-facilitated inter-firm relationships. This research has both theoretical and practical implications in the area of internet marketing and relationship marketing. The framework was built from theory and empirical research to represent this process and provides a foundation for further research.

List of references available upon request

A Preprocessing Method for Improving Effectiveness of Collaborative Filtering

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Abstract*

Collaborative filtering uses information about customers' preferences to make personal product recommendations and is achieving widespread success in e-Commerce. However, the traditional collaborative filtering algorithms do not response accurately to customers' needs. The quality of the recommendation needs to be improved in order to support personalized service to each customer. In this paper, we present novel method to improve the accuracy of the collaborative filtering algorithm. We borrow vector space model from information retrieval theory and use it to effectively discriminate the preference weights on the items for each customer. The proposed method achieves more accurate recommendations for customers who purchase similar types of products repeatedly. Our experimental evaluation on the well-known MovieLens data set shows that our method does result in a better accuracy.

1. Introduction

The explosive growth of the world-wide-web and emergence of e-Commerce has led to the development of automatic item recommendation systems. A recommendation system is based on a personalized information filtering technology, and is used to predict whether a particular user will like a particular item. Personalization service of a good quality to customer will control the success and failure of customer relationship management and e-Commerce as a whole. Many research efforts have given birth to various algorithms for such personalization services. The most representative among them is collaborative filtering. In recent years, many researches for the performance enhance of collaborative filtering have been proposed. As results, various recommendation algorithms have been proposed.

Among them, a user based recommendation system works as follows. For each user, it uses historical information to identify a neighborhood of people that in

the past have exhibited similar behavior and then analyze the neighborhood to identify new pieces of information that will be liked by the user. Despite its success, GroupLens, and other similar collaborative-filtering based recommendation systems suffer from major problems [1][2][3][4].

Collaborative Filtering treats customers with different buying patterns identically. For example, customers who purchase many products evenly and others who purchase only a few products repeatedly, obviously have different buying patterns and these patterns may be used as valuable information for recommendation systems. In our work, we propose a preprocessing method in which we take into account those buying patterns and turn them into weight calculation to derive and differentiate users from one another. We show, through experiments, that our preprocessing method indeed works better than conventional collaborative-filtering based recommendation systems.

Section 2 introduces related work about collaborative filtering. In section 3, we explain our proposed method. In section 4, we evaluate our approach on the well-known MovieLens dataset. The paper ends with a conclusion.

2. RELATED WORK

Tapestry[5] is one of the earliest implementations of collaborative filtering based recommender systems. This system relied on the explicit opinions of people from a close-knit community, such as an office workgroup. However, the case which the user does not put the comment to treat on the document is difficult be achieved for the accuracy recommendation. Later, several ratings-based automated recommender systems were developed. The GroupLens research system[1][2][6] uses a nearest-neighbor approach to find a subset of all users that have the most similar preference history as the active user. When this neighborhood is found, the similarity between the active user and a neighbor determines how much the neighbor influences the prediction for the active user. If the similarity is high, the neighbors have high influence on the final prediction. Thus, the final prediction is a weighted combination of the neighbor preferences. The above two way directly use the preference about the item of the customer. According to this reason, it's drawback that they don't recommend accuracy.

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Our work, which uses the vector space model, a class of method to assign weights to each data object, is able to solve these problems.

3. Preprocessing Method

The traditional collaborative filtering algorithms directly use the preference about the item of the customer for recommend item to customer. But in this paper we associate weight showing the preference on item of each customer.

We use the vector space model[7][8] as follows. Let C be an $m \times n$ customer-item matrix containing historical purchasing information of m customers on n items. In this matrix, C_{ij} is one if the i th customer has purchased the j th item.

3.1. Vector Space Model

The following matrix $C(m \times n)$ is used to express to the preference about the item n of the customer m .

$$C = \begin{bmatrix} C_{11} & C_{12} & \dots & C_{1(n-1)} & C_{1n} \\ C_{21} & C_{22} & \dots & C_{2(n-1)} & C_{2n} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ C_{m1} & C_{m2} & \dots & C_{m(n-1)} & C_{mn} \end{bmatrix}$$

- m : Customer
- n : item
- C_{ij} : The preference about the item j of the customer i

Element C_{ij} of matrix C is the preference of the customer i to item j . $\max[C_{i1}, C_{i2}, \dots, C_{ij}, \dots, C_{in}]$ expresses the largest preference value among items of the customer i , and thus $cf_{i,j}$ of (1) is normalized preference value by the maximum.

$$cf_{i,j} = \frac{C_{i,j}}{\max[C_{i1}, C_{i2}, \dots, C_{ij}, \dots, C_{in}]} \quad (1)$$

(2) gives the customers who purchase many products evenly a low value, and gives the customers who purchase a specific product many times a high value. In (2), N represents total number of items and n_i represents the distinct number of items purchase by the customer i .

$$icf_i = \log \frac{N}{n_i} \quad (2)$$

The weight calculation of the matrix $C(m \times n)$ is done as shown in (3).

$$w_{ij} = cf_{i,j} \times icf_i \quad (3)$$

3.2. User Similarity Computation

This general formulation of collaborative filtering first appeared in the published literature in the context of the GroupLens project. The basic idea in similarity computation between set of items rated by both customers (C_1 and C_2).

There are a number of different ways to compute the

similarity between customers. Here we present two such methods. These are cosine-based similarity(4), correlation-based similarity(5).

$$sim(C_1, C_2) = \cos(\vec{C_1}, \vec{C_2}) = \frac{\vec{C_1} \cdot \vec{C_2}}{\|\vec{C_1}\| \|\vec{C_2}\|} \quad (4)$$

$$w(C_1, C_2) = \frac{\sum_{j \in I_{C_1 C_2}} (C_{1,j} - \bar{C_1})(C_{2,j} - \bar{C_2})}{\sqrt{\sum_{j \in I_{C_1 C_2}} (C_{1,j} - \bar{C_1})^2} \sqrt{\sum_{j \in I_{C_1 C_2}} (C_{2,j} - \bar{C_2})^2}} \quad (5)$$

$I_{C_1 C_2}$: set of items rated by both customers (C_1 and C_2)

3.3. Prediction Computation

The prediction $p_{1,j}$ is the prediction for customer G for item j

$$p_{c1,j} = \bar{C_1} + \frac{\sum_{i \in U_{cj}} w_{c1,i} \times (C_{i,j} - \bar{C_1})}{\sum_{i \in U_{cj}} |w_{c1,i}|} \quad (6)$$

U_{cj} : set of users who rated item j

3.3. Proposed Method

We use a vector space model for our preprocessing method. The following matrix is to add expression (3) with matrix $C(m \times n)$. It is used to computation the prediction $p_{1,j}$ of customer G on item j . ($C+W=CW$)

$$\begin{bmatrix} C_{11} & C_{12} & \dots & C_{1(n-1)} & C_{1n} \\ C_{21} & C_{22} & \dots & C_{2(n-1)} & C_{2n} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ C_{m1} & C_{m2} & \dots & C_{m(n-1)} & C_{mn} \end{bmatrix} + \begin{bmatrix} W_{11} & W_{12} & \dots & W_{1(n-1)} & W_{1n} \\ W_{21} & W_{22} & \dots & W_{2(n-1)} & W_{2n} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ W_{m1} & W_{m2} & \dots & W_{m(n-1)} & W_{mn} \end{bmatrix} = \begin{bmatrix} CW_{11} & CW_{12} & \dots & CW_{1(n-1)} & CW_{1n} \\ CW_{21} & CW_{22} & \dots & CW_{2(n-1)} & CW_{2n} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ CW_{m1} & CW_{m2} & \dots & CW_{m(n-1)} & CW_{mn} \end{bmatrix}$$

(7) is similarity measure of customer G and G

$$w(C_1, C_2) = \frac{\sum_{j \in I_{C_1 C_2}} (CW_{1,j} - \bar{CW_1})(CW_{2,j} - \bar{CW_2})}{\sqrt{\sum_{j \in I_{C_1 C_2}} (CW_{1,j} - \bar{CW_1})^2} \sqrt{\sum_{j \in I_{C_1 C_2}} (CW_{2,j} - \bar{CW_2})^2}} \quad (7)$$

(8) is the prediction $p_{1,j}$ is the prediction for customer C_1 for item j

$$p_{c1,j} = \bar{CW_1} + \frac{\sum_{i \in U_{cj}} CW_{c1,i} \times (CW_{i,j} - \bar{CW_i})}{\sum_{i \in U_{cj}} |CW_{c1,i}|} \quad (8)$$

4. Experimental Evaluation

4.1 MovieLens Database

We use the MovieLens dataset[9]. The database contains ratings from 6,040 users on 3,900 movies. User ratings are recorded on a numeric five-point scale. We divide the data set into a training set and test set in the ratio of 8:2. We use MAE(Mean Absolute Error) to evaluate the precision of the forecasting.

$$|\bar{E}| = \frac{\sum_{i=1}^N |e_i|}{N} \quad (7)$$

4.2 Experimental Result

We implemented two different similarity algorithms pure cosine, correlations and tested them on our data sets. For each similarity algorithms, we implemented the algorithm to compute the neighborhood and used weighted sum to generate the prediction. We ran these experiments on our training data and used test set to compute Mean Absolute Error(MAE).

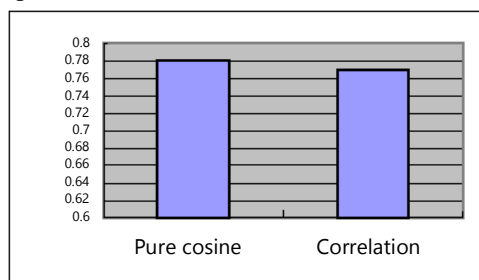


Figure 1 Impact of the similarity computation measure on user-based collaborative filtering algorithm. (No preprocessing data)

Figure 1 shows the experimental results with no preprocessing dataset. Figure 2 shows the experimental result with preprocessing dataset. It can be observed from the results that correlation computation for preprocessing method has advantage, as the MAE is significantly lower in this case. Hence, we select the adjusted preprocessing method for the rest of our experiments. Figure 3 shows experimental result that MAE of customers who purchased only a few categories of products repeatedly is lower than customers who purchased many different types of products evenly. Many customers in e-Commerce environment have tendencies to repeatedly purchase similar group of products over and over again.

5. Conclusion

Recommender systems provide powerful new technology for extracting additional value for a business. These systems benefit users by enabling them to find items they like. Conversely, they help the business by generating more sales. Recommender systems are rapidly becoming an indispensable tool in e-Commerce and need for innovative technologies are overwhelming especially,

for improvement of accuracy of recommender systems.

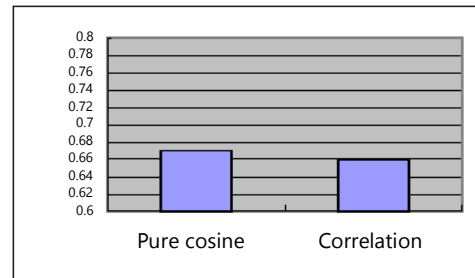


Figure 2 Impact of the similarity computation measure on user-based collaborative filtering algorithm (preprocessing data)

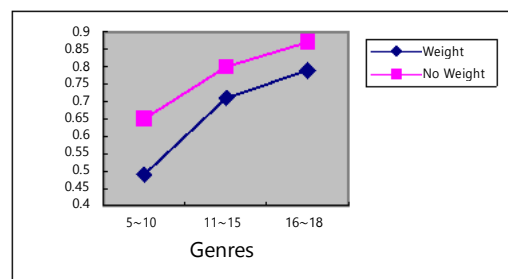


Figure 3 Sensitivity of the genres size on user-based collaborative filtering algorithm

In this paper we presented and experimentally evaluated a new preprocessing method for a user-based recommendation system. Experimental result showed that our weight calculation method provides more accurate recommendation than those provided by traditional user-based collaborative filtering techniques.

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"Note: The full paper is available from the CD of conference proceedings"

Future Strategies for a Click-and-Mortar Bank: A Case Study of the Nordea Group

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Abstract

The case study describes one of the most ambitious and successful attempts of creating a Nordic based large international financial service company, capable of spearheading the transition to the digital economy. Nordea is in the midst of various transformation processes across the organisation due to several years of multiple cross boarder mergers and acquisitions, new composition of the group executive management, increasing thrives towards automation of business processes to reduce costs, and different innovations involving a change of the roles of value network partners.

The focus of the study is on the future e-business challenges to the Nordea Group internally, in its collaboration with network partners, in its utilization of the largest number of on-line customers of any bank (3,1 million in 2002), and the implications for the value proposition of the Nordea Group customers.

1. Introduction

A networked world entails entirely new ways for the financial sector to generate and protect customer value. This is a case study of the largest financial services group, Nordea, in the region of the Baltic Sea with approximately EUR 251 billion in total assets. The case focuses on the changing role of business partners and the customer value proposition of the Nordea Group.

Nordea (short for Nordic Ideas) has a very large customer base containing 9,7 million private customers, 1 million corporate customers and 500 large corporate customers. The distribution network of Nordea is the most comprehensive in the region entailing 1,245 bank branch offices in 22 countries, and 40.000 employees.

2. The History – An Ongoing Process of Mergers and Acquisitions

A brief historic outline of the Nordea Group reveals an ongoing process of mergers and acquisitions. The Nordea Group was established in March 2000. The merger of the two groups MeritaNordbanken and Unidanmark (parent company of Unibank) resulted in the creation of the Nordea Group, which in 2002 was the leading financial services group in the Nordic and Baltic region. The group is listed on the stock exchange in Copenhagen, Helsinki and Stockholm, and had a market capitalisation of EUR

15.6bn at that time.

The MeritaNordbanken-Unidanmark merger and the acquisition of Norwegian Christiania Bank og Kreditkasse was expected by top-management to create annual synergies of EUR 360m when fully realised by the end of 2003. To ensure the further improved efficiency of the Group, a second wave of integration process had been initiated. This second wave was expected to create annual synergies of the same magnitude when fully realised by the end of 2004.

An overview of the many M&A's is shown in the following figure.

Ten Years of Nordea's History

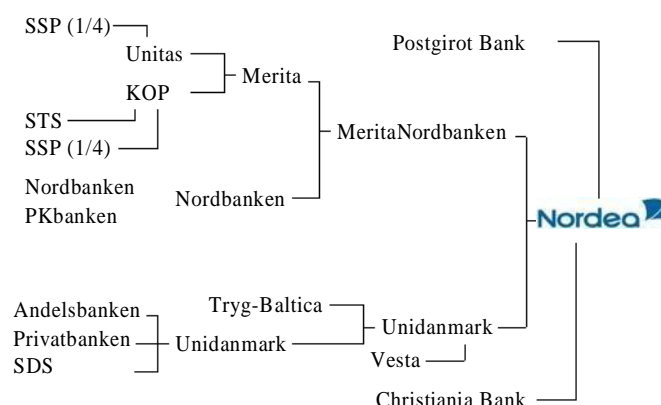


Figure 1: Ten Years of Nordea's history.

3. The Market and Strategic Focus

The Nordic countries (Denmark, Finland, Norway and Sweden) are the home market of Nordea. The three Baltic states of Estonia, Latvia, and Lithuania as well as Poland are seen as emerging markets for Nordea. The proportion of Nordea's loan portfolio provided to customers in the Nordic countries at the end of 2001 was 88% of the total loan portfolio.

Nordea has significant positions in Nordic banking markets, i.e. 40 per cent market share in Finland, 25 per cent in Denmark, 20 per cent in Sweden and 15 per cent in Norway. Also, in the Nordic insurance market Nordea has significant positions. In life insurance the figures are: Finland 35%, Denmark 10%, Norway 9% and Sweden 6%. Furthermore, Nordea is a leading asset manager in the Nordic financial market with EUR 100 billion (including

private banking) under management.

Nordea also operates on an international basis. The Group has a network of international branches and representative offices to support its Nordic and international customers.

Nordea wants to be the preferred partner of Nordic and international medium-sized companies, large corporate customers and institutional customers in this region. Outside the Nordic and Baltic Sea region, Nordea operates to support core customers and competencies through its own units or partners. Nordea is also a leading international shipping bank. Nordic and selected European asset management products and services are offered to international institutional customers, and private banking products are offered to high net worth individuals in selected European countries.

The strategic direction of Nordea is market leadership and growth, which are closely linked. Nordea has a clear strategy for growth. Nordea will work to further deepen the customer relationship and increase customer loyalty and thereby business volumes with existing home market customers. In the Baltic Sea region, Nordea will grow through increasing market shares achieved by organic growth as well as acquisitions. Being a universal bank and bancassurer, Nordea offers a broad range of financial solutions and advisory services, focusing on opportunities for cross-selling and up-selling. The role of branch offices is changing into focused service, advisory centres and sales offices along with the intensified use of the Internet, call centres and mobile banking. Nordea is and aims to remain a world e-leader in e-based financial solutions.

4. New Composition of Group Executive Management and the Organisation in Nordea

Following the appointment in summer of 2002 of Lars G Nordström as new Group CEO, the composition of and the responsibilities within Nordea's Group Executive Management was changed from 1 October 2002.

A new organisational unit, Group Processing and Technology, was established with the responsibility of central production and processing as well as coordination of Group-wide integration projects. According to the news release, "The new unit will speed up consolidation and integration and free up resources in business areas, thus enabling an even stronger customer and business focus". The new unit will consist of Group IT, Electronic Banking, Global Operations Services and Production & Productivity. The focus on Group Processing and Technology chaired by the deputy group CEO underlines that information technology continuously maintained its key role as the most important business enabler.

The new Group Executive Management team announced a plan to speed up and complete the transformation of Nordea into a fully integrated Nordic financial services group. "We will act as a team and each of us will take on Group responsibility for implementation of our Nordic strategy. We will concentrate on our strengths, compete and continuously improve

performance to create value for shareholders and customers", says Lars G Nordström, Group CEO of Nordea.

Nordea operates in three business areas: Retail Banking, Corporate & Institutional Banking, and Asset Management & Life. Each business area is responsible for financial results, customer relations, distribution, products and business development and support. In 2001 the revenue split between the different business areas was approximately: Retail Banking 71%, CIB 21%, Asset Management 4.1%, Life 1.3% and General Insurance 6.4%.

Nordea has three vital support functions, i.e.

- *Group Processing and Technology* includes Group IT, Electronic Banking, Global Operations Services and Production and Productivity.
- *Group Corporate Centre* includes Group Credit and Risk Control, Group Treasury, Group Planning and Control, Group Finance, Investor Relations and Group Corporate Development.
- *Group Staffs* includes Group Support and Procurement, Group Human Resources, Group Identity and Communications, Group Legal and Group Compliance.

The organisational chart of the Nordea Group is shown in figure 2.

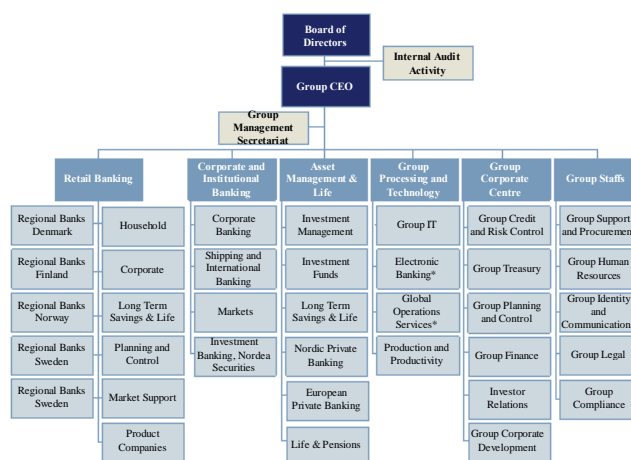


Figure 2: The organisational chart of the Nordea Group.

4.1 The Nordea Group Mission and Vision

The **mission** of the Nordea group is: "Making it possible. By providing a broad set of seamless and easily accessible financial solutions and competitive advisory services, Nordea helps customers where we operate to reach their objectives".

The **vision** of the Nordea group is: "We will be valued as the leading financial services group in the Nordic and Baltic financial markets with a substantial growth potential. We will be number one or number two or show superior profitable growth in every market and product

area in which we choose to compete. We will have the leading multi-channel distribution with a top world ranking in e-based financial solutions.”

4.2 The Nordea Group Values and Performance

The **values** of Nordea are:

- “We create value. We thoroughly understand our customers and anticipate their financial needs and we always try to generate added value for each customer. We learn from our colleagues and share Nordic ideas.
- We are innovative. We explore our competencies and try out new ideas to improve existing services, create new solutions or meet new needs. We embrace new technology and are committed to excel through continuous improvement.
- We are empowering. We respect our customers and proactively offer financial solutions and services making their lives and business activities easier. We make decisions close to our customers and exercise leadership through clear guidelines, objectives and follow-up and transparent information.
- In our operations, we are committed to a Nordic heritage of freedom, equal opportunities, care for the environment and good citizenship including ethics, honesty and sincerity.

The Nordea Group considers **performance** as:

- “We will create value for our shareholders measured by total shareholder return in the top five of our peer group of European listed financial services companies.
- We will enhance value through concentration on core business, stable and broadly based growth of revenue, operational excellence and an optimal use of capital combined with balanced risk-taking.
- We will rank among the best financial services companies in measurements of customer satisfaction and brand loyalty.
- We will attract, develop and retain highly motivated, competent and empowered employees. Measurements of Nordea employee expertise and motivation are to show continuous high levels of employee satisfaction.
- We are committed to always improve but never claim to be perfect.”

5. Financial Status and Changes in Market Capitalisation

On August 22, 2002, Nordea released their Interim Report for the Second Quarter 2002 concluding: “Stable development in our core earnings and a satisfactory credit quality form a strong basis for our business. The divestment of the General Insurance activities will further increase our earnings stability. While maintaining a sharp

focus on cost control we are investing in future growth and increased efficiency”, says Thorleif Krarup, (the former Group CEO of Nordea). Furthermore, the interim report explained:

“Operating profit before investment earnings is EUR 409m, and unchanged compared to first quarter. Total income is EUR 1,513m, which is up 1% on first quarter, supported by growth in loans and deposits, net interest income is up 2%, and strong commission income is up 4%. Total expenses are EUR 1,065m, and are up 3% on first quarter, reflecting investments in the second wave of integration. Satisfactory credit quality is maintained. Loan losses are down to EUR 56m (EUR 63m) corresponding to 0.16% of loans, annualised. Operating profit is EUR 315m.

Weak equity markets resulting in investment earnings of EUR -50m. The financial buffers in Life operations were satisfactory. Pension fund allocation is EUR 152m, which reduced pre-tax profit correspondingly. Integration and focus on core areas were stressed. Sale of General Insurance was concluded by the end of September 2002. Finally, the second wave programme consolidated into 15 main projects”.

Figure 3 presents the share performance and the value creation in Nordea compared with Nordic peers until week 39 of 2002.

	Absolute performance since YE 2001, %	Absolute performance last 12 months, %	Absolute performance 5 days, %	Total shareholder return ⁽¹⁾ since YE 2001, %	Total shareholder return ⁽¹⁾ last 12 months, %	Market capitalisation, EUR million
Danske Bank	-11.6	-0.4	-2.1	-8.2	3.3	11,677
DnB	-17.6	-2.6	0.6	-13.1	2.7	3,539
Sampo	-25.6	-21.0	-0.2	-19.3	-14.3	3,616
SEB	-10.5	21.3	4.3	-6.9	26.2	6,557
SHB	-19.8	-9.2	-0.4	-17.4	-6.5	9,600
Swedbank	-23.8	-8.3	-0.5	-20.4	-4.1	5,705
Nordea	-29.7	-24.3	-1.5	-27.0	-21.4	12,707
BEBANKS Index⁽²⁾	-30.0	-17.1	-0.9	N.A	N.A	N.A

Source: Bloomberg

Note: Last closing prices as of September 26, 2002

(1) Total shareholder return is defined as growth in the value of a shareholding over a specified period, assuming that dividends are reinvested to purchase additional units of equity at the closing price applicable on the ex-dividend date.

(2) BEBANKS Index = The Bloomberg Europe Banks and Financial Services Index is a capitalisation-weighted index of all companies involved in the bank and financial sector of the Bloomberg Europe 500 Index. The index contains of today 73 shares. The index was developed with a base of 100 as of December 31, 1996.

Figure 3: Share performance and the value creation in Nordea compared with Nordic peers.

In his comments on the financial performance, Nordea Group CEO Lars G Nordström says in an interview with the Danish paper Jyllands-Posten: “Not only must Nordea employees run faster and face tough cost-cutting measures, they must also learn to hate to lose to their competitors”, “Our asset management must be better than that of Den Norske Bank, and our payment service must be better than Danske Bank's”. And he went on, “As a branch manager in Nordea I must hate that you as a branch manager in Danske Bank is better than me!”.

6. The IT Situation of Nordea

Nordea increases efficiency and integration through consolidation of IT production. The current IT operations in all four Nordic countries will be merged into a common IT platform to support increased productivity and higher cost efficiency. Consolidation of IT production is a major initiative in the ongoing second wave of integration

programme. The aim of the programme is to simplify, unify, speed up and re-engineer internal processes and to consolidate and share group infrastructure across borders and business areas in order to benefit from the scale of Nordea.

The IT production comprised some 1050 employees and had a cost base in 2002 of around EUR 330m mid 2002. According to the plan this would have to be consolidated and incorporated with contractual obligations for delivery, quality etc to the customers in the business areas and group functions. However, due to the many mergers, and a very business oriented IT-strategy, the architecture was extraordinary complex. Nordea had any type of software and operating system found in any bank in the Nordic region. It was believed that a policy of reducing the number of technological platforms each of which was to be consolidated into one single location, standardised network and desktops would have a significant impact on the Group's future cost development.

The committed cost saving potential is approximately 20 per cent of the future overall production costs without executing the planned consolidation process. The effect will be gradually increasing with full-year sustainable effect after 4 years estimated at EUR 70m. The largest cost reductions emerge from centralised and standardised hardware and software and reduced costs for licences. Expected investments of EUR 60m will be accounted for in 2002-2004 resulting in a positive cash flow from 2004, among other things resulting in downsizing by around 250 employees over the period

The in-house solution was expected to create large cost savings while maintaining control and future flexibility. This has been chosen after thorough analyses of several possible solutions including outsourcing.

7. e-Business Achievements

Nordea pursues a Multi-Channel strategy, where customers can combine their use of channels and select the most convenient channel at any given moment. With high accessibility, integration and efficient business processes in all channels, Nordea wants to ensure the highest customer satisfaction and services that meet customer's expectations. Knowledge about the customers is seen as the focal point for the development of integrated e-solutions. Accordingly, Nordea aims to develop similar system for customers and employees in order to provide consistent customer experiences and support the Multi-Channel strategy.

Customer satisfaction and retention will be further improved with the integration of e-solutions throughout all business processes of Nordea. Increased internal and external use of electronic channels/e-solutions/internet technologies shall further improve the supporting of the relationship between Nordea customers and employees.

Nordea offers a variety of eBusiness solutions to their B2C as well as their B2B customers. Some of the most important examples are presented below:

E-payment and Solo Market. Net customers can make secure online purchases using e-payment. In 2002 Nordea had over 1,800 e-payment agreements with vendors who accept e-payment and more than 600 are represented at the electronic marketplace Solo Market, accessible from the national web site in Denmark, Finland, Norway and Sweden. Online buyers thus have convenient access to a wide range of goods and services - including customers using WAP and GPRS phones.

For e-commerce vendors, net customers are an ideal target group, sufficiently large in number, with modern attitudes and purchasing power, familiar with online operations. By accepting e-payments, vendors eliminate invoicing and credit risks. This is particularly important with a large number of small transactions.

Furthermore, via Solo Market, vendors get access to buyers in market places in Denmark, Finland, Norway and Sweden. Nordea's local home pages (www.nordea.dk, www.nordea.fi, www.nordea.no and www.nordea.se) have become important portals, as online customer typically visits the e-banking services 4 to 5 times on average a month via these portals.

E-invoice. E-invoice is a kind of semi-direct debit - an e-invoice sent to the customer's or buyer's computer rather than printed on paper. A company that uses online invoicing saves on postage costs and can provide better service in an interactive online customer relationship. A customer using e-invoice can receive an invoice directly to his computer, and approve payment without having to retype the details. Via this online invoice, the customer can also link to the online service of the vendor in order to obtain more information. The main emphasis has been put on consumer invoicing. B-2-B invoicing is going to be the next step.

E-identification and E-signature. Many enterprises and public sector institutions need to be able to identify their online customers/clients. As early as 1992 the insurance companies in Finland began to use bank delivered e-identification. In dealing with authorities, this service can be used for example to send information to the corporate register maintained by the National Board of Patents and Registration of Trademarks. Net customers can also sign agreements with third parties using their electronic IDs as a signature. There is also significant potential for an electronic signature of contracts.

E-salary. E-salary is a service designed to enable employees to browse through their monthly salary data electronically via e-Banking services. Thus, the sending of a pay slip on paper will no longer be necessary. A substantial benefit is also that the pay slip details are saved in files thereby providing the user access to earlier salary data.

CoinClick (www.coinclick.dk) is a micro-payment system allowing service providers to charge for small amounts in a very easy, secure way. It was developed and launched in August 2002 by the two largest banks in Denmark, i.e. Danske Bank and Nordea, in corporation with the association of regional banks, the electronic payment processing company PBS, and the largest Danish

telecom operator TDC (Tele Denmark Communication). Among them these organisations have 1,5 million Internet bank customers and 1,9 million users of mobile services.

CoinClick is an Internet account - a type of 'web wallet' - for the payment of small sums ranging from approximately 8 cents to 8 Euro. Users can establish an account on Coin Click's home page or via their net bank. By using CoinClick customers can easily pay for digital services (music files, invoices, financial advice and sports news, etc. using Internet and mobile phones.

CoinClick offers two types of accounts: Payment in advance and payment in arrears. While the former is free, payment in arrears accounts cost only one DKK per month for the buyer. For vendors, fees depends on sales volume, but will typically be around 10%.

Identrus™ LLC and SWIFT on TrustAct. Identrus is a provider of global e-commerce trust systems that delivers validation and warranty protection for B2B eCommerce.

SWIFT (www.swift.com) and Identrus™ LLC (www.identrus.com) have entered into an alliance to offer a joint solution to facilitate business-to-business (B2B) trusted communication and give financial institutions. Based on Identrus' identity trust services and Swift's messaging capability, financial institutions all over the world can help their corporate customers identify trading partners, trust their communications implicitly and protect themselves in the event of a dispute.

Swift's internet-based messaging service, TrustAct, enables banks to provide secure delivery and receipt of messages that businesses exchange on the Internet. In addition, TrustAct keeps a log of business-to-corporate business messages and provides full non-repudiation. This non-repudiable evidence, together with the Identrus system non-repudiation of digital signatures, is essential for audit trails or dispute resolution.

In June 2002, Nordea agreed with the e-market place for the forest industry, PapiNet (www.papinet.org), to use TrustAct. Hereby, Nordea integrates banking into e-business flows of the global forest industry. PapiNet was initiated by the forest industry to facilitate standards of communication and commerce.

PapiNet is the global initiative to develop, maintain and promote the implementation of global electronic transaction standards for the paper industry. The purpose is to facilitate the flow of information and facilitate computer-to-computer communications among all parties engaged in the buying, selling, and distribution of forest, paper and wood products. The set of standards is referred to as the PapiNet standard. The standards include common terminology and standard business documents (e.g. purchase orders, shipping notices, and invoices).

Nordea and PapiNet have modelled a solution to integrate security and banking services into the business-process messaging of the global paper industry. The joint solution provides cost reduction potential for PapiNet members due to integrated financial and business-process messaging, simplified dispute resolution and global Internet-initiated payments provided by the

banks of their choice. The solution builds on Identrus PKI security and Swift's TrustAct messaging infrastructure. It covers the entire value chain from order to settlement.

The various e-business initiatives are a proven success as illustrated in the following numbers:

- 3.100.000 e-customers of the 9,7 million private customers
- 110 million Internet log-on per year
- 125 million Internet payments per year
- 5+ million calls per month - and 85% of the calls stay in the IVR

Also, the numbers show that Nordea is well ahead in the transformation from a traditional bank to a click-and-mortar bank.

8. The Role of Banks in Mobile Payment Systems

Mobey Forum is a global, financial industry-driven forum with over 30 members. Mobey Forum's mission is to encourage the use of mobile technology in financial services. Nordea is one of the founders of Mobey Forum. The common denominator for all Mobey Forum members is their commitment to accelerating the take-off of user-friendly mobile financial services by promoting open, non-proprietary technology standards for services like payment, remote banking and brokerage.

Nordea believes that mobile net-terminals will play an increasing role because it is personal and trusted. Everyone will have one, it is always near and it is always on. It will eventually be connected to the Internet - all the time. It can be a card reader for one-hand operated e-bank-logons and card payments. Blue tooth and similar technology make it ideal for machine-to-machine interaction.

There is divergence of opinions on Telco's future interest in, and ability to provide efficient payment services in competition with banks. Never the less, it is an increasing threat for banks that value network partners as Telco's previously only providing all types of communication access, etc. now are engaging in providing payment solutions to customers - a threat that is not only prevailing on the B2C market, but also on the B2B market.

Payment methods related to mobile phones can broadly be classified into two categories: e-money (pre-paid cards as well as network-based electronic money) and "conventional" electronic payment systems (e.g. bank accounts transfers) through wireless access, where new electronic access to otherwise conventional payment mechanisms is provided. Payments by mobile phone further contribute to blurring the distinctions between the participants in payment systems (banks, non-bank financial institutions, telephone companies, internet access providers), cf. Arbussá (2000).

To conclude, although nowadays banks continue to be at the centre of the retail payments system in Europe, the role of financial intermediaries in the provision of

payments systems is changing. Since electronic payment technologies require large fixed investments and often networks that exhibit significant economies of scale, we are witnessing a process of alliances among firms that intervene in payment systems. These alliances are not confined to banks or other financial institutions, but include technology vendors and telecom operators as major participants.

9. Redefining the Value Proposition?

The head of E-banking in Denmark Jens Galatius was looking through his office window at the water in Copenhagen Harbour and the skyline of Copenhagen city on the other side of the water.

“It is clear that the overall strategy of moving the banking business from traditional cash and asset management to a net-centric click-and-mortar financial institution was going to increase the need for new e-business systems. But it is not quite clear what would be the most urgent agenda”.

Furthermore, he was wondering how Nordea better could leverage upon its large customer base in the Nordic and Baltic countries. But the water reflecting the skyline did not provide an answer.

Moreover, he considered the future role of banks in the relationship with customers and partners. He started sketching a “diamond” (see the figure below) in order to better focus on the individual relationships between the actors. The worrying scenario was that telecom companies could be providers of network services as well as transaction payment services. This clearly represented a challenge that banks in general and The Nordea Group in particular should be aware of.

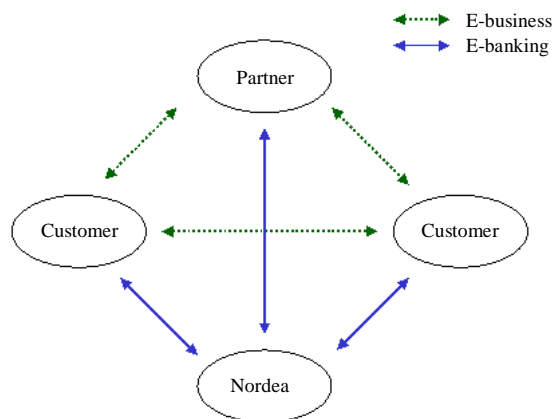


Figure 4: Nordea's relationships with customers and partners.

As other players were likely to enter the competitive arena, a re-examination of the value proposition might be relevant. The race is set on keeping and moving products (and customer segments) from business partners as Telco's in a profitable way. Hence, a question that needs to be addressed from the Nordea Group is: “What kind of

services will be demanded from the customers - and to what extent may Nordea have the possibility of being the preferred business partner?”

More considerations went through the mind of the e-banking director and he started listing different challenges, focus areas and initiatives. The list contained the following (non-prioritised) items:

1. Further develop multi channel distribution - online, offline and interfaces. Attractiveness and difficulties.
2. Increased emphasis on business process automation, like straight through processing (STP) between the ERP-system and the customers.
3. What would customer orientation entail in the future?.
4. Data mining for increased customer intimacy.
5. Increased digitalisation of customer service introducing more self-service and making it more attractive.
6. Integration of systems with those of corporate customers - such as development and deployment of Identrus and TrustAct to other industries than the forest industry
7. Establish collaboration with key corporate customers on R&D
8. How can Nordea create an enhanced value proposition to its corporate customers from being present in all Nordic and Baltic countries?
9. ...

You are a consultant trying to facilitate the Nordea Group pursuing their goals – what do you recommend – and why?

10. Discussion

In this section, the questions for the students are presented. Also, possible models applicable for analysis of the case are presented. Finally, some reflections upon the first teaching experiences are presented.

10.1 Questions to the Nordea Case

The list of questions to be addressed is:

- [Q1] How would you assess the e-business status of Nordea compared to other banks, in the B2B area as well as in the B2C area?
- [Q2] To what extent does the financial situation and market capitalisation of Nordea compared to Nordic peers constitute a “burning platform”?
- [Q3] What do you regards as the major value proposition of Solo Market?
- [Q4] How would you assess the key strategic options of the Nordea Group?
- [Q5] (Please refer to the list in the last section of the case for a list of possible strategic initiatives. Which of these do you find most appropriate? Would you

suggest others? Formulate a vision for the chosen ones, and argue why).

- [Q6] Nordea holds the largest customer base among the Nordic Banks, but the market shares is not the same in the different countries.. When developing new e-services, Nordea wants to exploit the large customer base and the fact, that the bank covers all the Nordic and Baltic countries. What advice could you provide the top management?

The questions are aimed at students studying for a Masters of Science in business administration related to information technology and/or e-business. Moreover, the questions should be appropriate irrespectively of whether the students are in the beginning of a MBA-program or in the end of a strategy course.

10.2 Models Applicable for Analysis

The case study invites to discuss an array of challenges at the financial institution Nordea. Several strategy-related models may be applied to the analysis of the case study, e.g. Hax & Wilde (1999), Hamel (2000), Hackbarth & Kettinger (2000) and Porter (2001).

The attractiveness of the industry may be analysed based on Hackbarth & Kettinger (2000) and Porter (2001) highlighting the e-business imperative of the industry analysis, and in particular stressing the e-banking bargaining power of multi channels, offline and online, and end users (B2B as well as B2C).

Hamel (2000) framework for business concept innovation building upon the resource-based view and the core competences tradition, is especially relevant in evaluating the development and deployment opportunities of Identrus and TrustAct in other industries than the forest industry, emphasising customer interfaces and the value network.

The Delta model proposed by Hax & Wilde (1999) provides several possibilities for analysis including product strategy, data mining for increased customer intimacy, collaboration with key corporate customers on R&D, and "System Lock-In" through partnership and standardised relations with selected actors in the business value network.

10.3 Reflections from First Test-Run

The Nordea teaching case has successfully been used at an introductory seminar of the 18 month part-time EMBA Global e-Management www.gem.cbs.dk offered at Copenhagen Business School. The learning goals were partly to introduce the students to strategic analysis and decision-making in a complex business world, partly to emphasise e-business challenges and solutions in a particular industry. The students had two hours to analyse the case in groups after having read it. Further, they had to present the answers to the questions before the e-banking director of Nordea Denmark at their domicile. After the presentation, the questions and answers were discussed facilitated by the e-strategy professor and program

director. Although the students had only just started at the MBA-program, their analysis pin-pointed the key-strategic issues.

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Firm Performance and IT Investment Relative to E-Business in Rubber Industry

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Abstract

USA small and medium firms facing a more competitive environment in the Internet era have no choice but to rely more on IT to improve the quality of their products and management practices. IT seems already to play a crucial role in the development of new opportunities including E-Business. The growth in IT investment indicates an increased awareness of the importance of adopting new technologies to remain competitive and take new challenges.

The main research hypotheses stipulate that the investment in IT will have a direct impact on firm's performance that certain organizational and personal factors will interact to affect the overall performance. This study cited Regress, Factor Analysis, Discriminant Validity Analysis, Skewed, Path Coefficients and Varimax Rotation to test hypothesis.

The results of this study, besides testing the instrument for assessing IS variables in the context of a developing economy, lend support to prior research findings. User satisfaction with IS had a significant impact on performance. The direct impact of IT investment on performance was not detected. This study found an indirect effect of investment in IT on performance. Many other IS variables did affect performance.

1. Introduction

E-Business is expected to experience fast growth over the next several years. Forrester Research, Inc. of Cambridge, Mass., forecasts that revenues generated by e-Business will be as much as \$6.9 trillion by 2003. By 2002, e-tailing, a category of e-Business that involves the purchasing of consumer goods and services online, will be a \$41 billion business, compared to a forecasted \$12 billion in revenues at the end of 2000, according to Jupiter Communications, Inc., a New York market research firm [1]. A study done by the University of Texas revealed sales revenue over the Internet in 1998 was more than \$300 billion and employed more than 1.2 million workers [2]. These figures are increasing rapidly. Figures from Forrester, Gartner, IDC, Jupiter and others all predict that worldwide business-to-business (B2B) e-Business will exceed \$13 trillion by the year 2003 [3].

The expanding literature on electronic commerce is primarily focused on business-to-consumer (B2C) e-Business, although business-to-business (B2B) e-Business has a larger potential impact on the economy

[4,5]. Predictions for worldwide e-Business exceed \$3 trillion in 2003 with growth rates exceeding 100% per year. GartherGoup estimates that worldwide B2B e-Business will surpass \$7.29 trillion in 2004, close to 7% of the forecasted total global sales transactions [6]. Vennat (2000) says, "The beauty of e-commerce is that a business does not have to be big to win big. Information technology allows companies of all sizes to improve productivity and extend their reach to a broad customer base; innovation is the name of the game". It is crucial to study the efficiency and effectiveness of investing in Information Technology (IT), specially focusing on e-Business in selected industries.

1.1 Theoretical Foundation

To examine the contribution of IT to output, it is helpful to work within the well-defined framework of the theory of economic production. This theory postulates that the output of a firm is related to its inputs (one of which will be IT) via a production function and predicts that each input should make a positive contribution to output. Also, the marginal cost of each input should, on balance, be offset with production of at least equal benefit.

1.2 Definition of Terms

1.2.1 E-Business

Numerous definitions have emerged since the introduction of e-Business. Experts define e-Business as the integration of business processes; enterprise applications, relationships and organizational structure to create a high-performance business model, capable of delivering differentiated business value [7,8,9,10]. The implementation of e-Business applications includes the reengineering of business processes and the use of the Internet technology to disseminate information electronically [8]. Wigand [11] views e-Business as the seamless application of Internet technology alone the entire value chain of business processes, enabling the accomplishment of business goals.

1.2.2 Small Business

The U.S. Small Business Administration (SBA) guidelines use annual sales volume and/or number of employee, depending on the industry, for classifying businesses as to size. Under the SBA guidelines, a small business could have fewer than 100 to as many as 1500 employees, or annual sales from \$2.5 to \$17 million, depending on the industry [12]. The standard most often cited by the SBA's Office of Advocacy for the public at large is fewer than 100 employee [12]. Weinstein [13] used \$10 million as the sales breakpoint for small business. In some studies, a small or medium size firm in

the manufacturing or service sector is defined as having between 20 and 100 employees [14,15]. The definition was based on Miller and Toulouse (1990) where companies with fewer than 100 employees were included in their study. Jones [16] combined employee and sales limits to define a small business as one with annual sales of no more than \$10 million and fewer than 100 employees. That is the definition used in this study.

2. Research Questions

Several researchers [17,18,19,20], some of whom did not explicitly address the "Productivity Paradox", reported that investment in IT did not produce expected gains in productivity. However, several other researchers [21,22,23,24,25,26,27,28,29,30,31] have noted the existence of a relationship between IT investment and an increase in productivity. Thus, the author has conflicting findings. Clearly, the business value of computers is an

area where many unanswered questions and ambiguous results exist. It is hoped that this study will be a small step towards remedying this situation by attempting to answer two questions. The first question will address the "Productivity Paradox". The second question will attempt to identify areas of IT investment that are associated with corporate productivity.

3. Results and Analysis

Approach of this paper could be qualified as an effectiveness-oriented approach [32] since this study concerned with issues of information content quality, IT support, use of systems, and impact on user and organizational performance. The rubber industry composition of the SMEs, which were included as potential respondents, is provided in the following table. Table 1 also shows the industry composition of the responding and the non-responding factions in the survey.

Table 1: Industry composition of sample population and respondent population

Industry/Rubber	Number in Sample	%	Number of Respondents	%	Number of Non-Respondents	%
Local	231	66.9	126	61.7	105	74.5
Export	114	33.1	77	38.3	37	25.5
Totals	345	100.0	204	100.0	141	100.0

A t-test was run to determine whether there was a statistically difference between the respondent population with in each group. For each case the hypotheses can be stated as:

$$H_0: u_1 = u_2$$

$$H_1: u_1 \neq u_2$$

The test run is a two-tailed t-test, which tests the null hypothesis that there is no difference in the mean scores of the two groups. Controlling the type I error at $\alpha = 0.05$, with $n_1 + n_2 - 2$ degrees of freedom, the critical t for both groups (with more than 120 member each) is 1.96. The corresponding decision rules are:

$$\text{If } t < |1.96|, \text{ conclude } H_0$$

$$\text{If } t > |1.96|, \text{ conclude } H_1$$

The respondent population is statistically not different from the non-respondent population on the characteristic used to select companies within the rubber industry. Not surprising since this study had a response rate of more than 50%. Based on the results of these tests, it seems unlikely that the study conclusions project any significant bias due to non-response.

3.1 The Rubber Industry: Descriptive Statistics

Based on the rate of return recorded by the surveyed companies the performance of the company statistics from 1997 to 2001 are shown in the Table 2.

The investment in IT in 2001 was increased to new levels. The average investment was approximately USD\$52,640 with a maximum reaching USD\$100,000.

More statistics will be shown as the author studied each individual variable in the context of its relations with other study variables.

3.2 Assessment of the Measurement Model

To assess company performance, the author used two measures: the first, perceptual, based on the assessment of company's performance in comparison to its competitors as perceived by the respondent. The second, financial-oriented, was based on the rate of return over a five-year period. In order to generate one measure the author loaded the variables into one factor as reported in table 4. Based on previous research [33] only measures with loadings higher than .70 were included in the final measure. This is considered to be high loading since the item explains almost 50% of the variance in a particular measure.

To the question: compared to your closest competitor how do you evaluate the performance of your company? The answers in Table 4 show that the respondents had a skewed perception in compared to their closest competitors.

The majority of respondents (94%) perceived their company performance as the same or higher than that of their closest competitor. This perception couldn't be supported by the measure of performance based on the financial information provided by the same respondents.

3.3 Investment in IT Relative to E-Business

Investment in IT for 2001 ranged from USD\$3,000 to USD\$540,000. The majority of investment was made for the acquisition of inexpensive components to maintain or improve existing systems. On the other hand, 25% of the surveyed companies invested more than USD\$23,000 each in IS. This is a significant amount and indicates that the management expects an improvement in the business functions of the company.

Table 2: Average firm performance (financial statement in USD\$1000)

	N	Minimum	Maximum	Mean	Std. Deviation
Financial Information (Performance 1997)	78	3.00	550.00	50.1231	145.30674
Financial Information (Performance 1998)	90	.14	650.00	51.4960	160.94306
Financial Information (Performance 1999)	96	1.10	590.00	45.5375	141.43396
Financial Information (Performance 2000)	96	2.30	580.00	45.8931	138.79276
Financial Information (Performance 2001)	96	2.60	540.00	43.1188	129.15950
Valid N (listwise)	78				

Table 3 summarizes investment in IT for 1997-2001.

Table 3: Average firm IT investment relative to e-business (USD\$1000)

	N	Minimum	Maximum	Mean	Std. Deviation
Investment in Computer Technology (Cut Operating Costs)	132	0	80	24.86	20.392
Investment in Computer Technology (Increase Sales or Market Share)	132	0	75	22.50	20.005
Investment in Computer Technology (Do Other Functions)	132	10	100	52.64	25.700
Valid N (listwise)	132				

Table 4: Perceived performance (compared with competitors in robber industry)

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 3	12	5.9	6.9	6.9
4	24	11.8	13.8	20.7
5	60	29.4	34.5	55.2
6	42	20.6	24.1	79.3
7(Superior)	36	17.6	20.7	100.0
Total	174	85.3	100.0	
Missing System	30	14.7		
Total	204	100.0		

3.3.1 IT Use by Business Function

Table 5 reports that administrative use of IT is most common with more than 60% of moderate or extensive use of computers to generate reports, manage data, and control activities. The electronic communications, mainly e-mail, was used with 76% of the companies reporting an extensive use of this communication tool while e-Business was used with only 20%.

3.4 Correlation Between IT Investment and Performance Relative to E-Business

There is not a strong correlation between the independent study variables, which indicates that they measure different attributes. All correlations indicated are significant at $p = 0.1$.

3.5 Hypothesis Testing

The statistical analysis, as indicated above, followed a two-step procedure. The path coefficients for the model were calculated. Second, path coefficients that were not

statistically significant were removed where theoretically justified. Because coefficients change when a variable is deleted from an equation, it was sometimes necessary to repeat the second step in order to delete new coefficients that had become non-significant. Following Pedhazur [34], this second step was performed until an optimal model was obtained. In other words, a model in which no path coefficients could be deleted without significantly losing to the data. The procedure was applied first to the whole sample, then to each of the sub-samples. The final models along with direct, indirect and total effects coefficients are presented in the following figures and tables.

Hypothesis 1: Investment in IT has a significant and positive impact on:

H_{0-1a} -- user satisfaction

H_{0-1b} -- perceived ease of use

H_{0-1c} -- perceived usefulness

Total effect of Information Technology Investment on:

Table 5: Use by function

Task	Almost Never		Moderate		Almost Always	
	Count	%	Count	%	Count	%
1. Report Production	24	12	60	29	120	59
2. Letters & Memos	31	15	89	44	84	41
3. Data Mgmt	12	6	31	15	161	79
4. Decision Making	78	38	78	38	48	24
5. Trend Analysis	90	44	37	18	77	38
6. Planning/Forecasting	69	34	49	24	86	42
7. Problem Solving	79	39	60	29	65	32
8. Budgeting	76	37	54	27	74	36
9. Activities Control	65	32	42	21	97	47
10. Electronic Communications	30	15	18	9	156	76
11. E-Business	132	65	30	15	42	20

Table 6: Correlation among study variables

	Usage	Utilization	Ease of Use	Usefulness	ISupport	ESupport	ITraining	ETraining	Satisfaction	Attitude	IT Investment	Performance
Usage	1											
Utilization	0.331	1										
Ease of Use	0.215	0.2392	1									
Usefulness		0.2609	0.3268	1								
ISupport			0.3004	0.3035	1							
ESupport	0.455	0.2221	-	-	-0.3944	1						
ITraining	0.163		0.2481	0.3659	0.4005	-0.1128	1					
ETraining	0.298	0.2747	0.3005	0.2601	0.1515	0.3401	0.1522	1				
Satisfaction	0.251		0.3637	0.4131	0.2059	0.1767	0.1931	0.2462	1			
Attitude	0.191		0.1542	0.2057	0.1440	0.2145	0.1969	0.4083	0.2233	1		
IT Investment	-0.33	-0.098			0.3296	-0.400				-0.2803	1	
Performance	0.327		0.2352		-0.2607	0.2084	-0.2233		0.3295	0.1675	-0.1776	1

Table 7: Effect of information technology investment on satisfaction, ease of use and usefulness

	Total effect = Direct effect + Indirect effect			T	P
User Satisfaction	2.05074998	2.002637	0.048112975	2.219	0.0568
Ease of Use	0.454284	0.454284	-	1.455	0.1726
Usefulness	0.081744	0.081744	-	0.178	0.8948

Table 7 presents the results for the Path Analysis of the effect of IT Investment. The data support the first proposition, that is the investment in IT has a significant and positive impact on user satisfaction ($t = 2.22$, $p = .06$). The data also support the second proposition that investment in IT will positively affect perceived ease of use. However data do not support the third proposition which implies that the perceived usefulness will increase with the increase of IT investment. When the data are analyzed using the whole sample there is a negative relationship between investment in IT and the perceived ease of use. However, a more detailed analysis produced

some additional and interesting results. Indeed, when the author looked at the overall relationship between the IT investment and the perceived ease of use the author found that there was a slightly positive relationship though not significant.

Hypothesis 2: Training has a significant and positive impact on:

H_{0-2a} -- users satisfaction

H_{0-2b} -- perceived ease of use

H_{0-2c} -- perceived usefulness

Total effect of Training on:

Table 8: Total effect of training

	Total effect = Direct effect + Indirect effect			T	P
User Satisfaction	0.99506758	0.819548	0.175519583	4.952	0.000
Ease of Use	1.033253	1.033253	-	5.554	0.000
Usefulness	1.13409516	1.038476	0.095619158	5.475	0.000

The data provide support for Hypothesis 2, which stated that training will affect positively and significantly user satisfaction, perceived ease of use and usefulness. In fact, a direct positive and significant effect of training was found in the three variables. There was, however, no significant indirect effect of training on the perceived ease of use.

Hypothesis 3: User satisfaction, Perceived ease of use, and Perceived usefulness will have a significant and positive impact on:

a- IT utilization

b- Organizational usage

H_{0-3a-a} -- User satisfaction will have a direct positive impact on IT utilization.

H_{0-3a-b} -- User satisfaction will have a direct positive impact on organizational usage of IT.

Total effect on Utilization of:

Table 9: Total effect on utilization

	Total effect = Direct effect + Indirect effect			T	P
User Satisfaction	-0.349955	-0.349955	0	5.875	0.0000
Ease of Use	0.28600735	0.19454	0.091467352	3.003	0.0231
Usefulness	0.44549908	0.361929	0.083570079	5.905	0.0000

The data do not support the first proposition, which stated that users satisfaction will impact positively the utilization of computers. However, it showed that ease of use and usefulness, as hypothesized, will impact positively and significantly the utilization of IS. Moreover, positive indirect effects were also detected in the case of ease of use and usefulness.

H_{0-3b-a} -- Perceived ease of use will have a direct positive impact on IT utilization.

H_{0-3b-b} -- Perceived ease of use will have a direct positive impact on organizational usage of IT.

H_{0-3c-a} -- Perceived usefulness will have a direct positive impact on IT utilization.

H_{0-3c-b} -- Perceived usefulness will have a direct positive impact on organizational usage of IT.

Total effect on Usage of:

Table 10: Total effect on usage

	Total effect = Direct effect + Indirect effect			T	P
User Satisfaction	0.251258	0.251258	-	3.621	0.0204
Ease of Use	0.25042154	0.180112	0.070309538	2.451	0.0358
Usefulness	0.14951917	-0.119122	0.049602827	-2.141	0.0000

The level of IT usage was significantly related to user satisfaction and the perceived ease of use that provides partial support for hypothesis 3. However, usefulness did have the positive impact expected on usage. It rather had a 'mild' negative impact at -0.1495. Therefore indicating

that perceived usefulness doesn't play the expected role found in previous studies.

Hypothesis 4: IS support will have a significant and positive impact on IT Utilization

Total effect of IS Support on:

Table 11: Total effect of IS support

	Total effect = Direct effect + Indirect effect			T	P
IT Utilization	0.12507037	0.160289	-0.205359373	2.273	0.0451

Data do not provide support for Hypothesis 4. On the contrary, it shows a negative impact of support on IT utilization (t = 2.27, p = .05). The degree of influence is not important but is significant.

Hypothesis 5: Users attitude will have a significant impact on organizational usage.

Total effect of Users Attitudes on:

Table 12: Total effect of users attitudes

	Total effect = Direct effect + Indirect effect			T	P
Organizational Usage of IT	0.189115	0.189115	-	2.749	0.0268

Data provide support for the proposition that user attitudes have a positive impact on IT usage.

Hypothesis 6: IT utilization will have a significant and positive impact on performance.

Total effect of IT Utilization on:

Table 13: Total effect of IT utilization

	Total effect = Direct effect + Indirect effect			T	P
Performance	0.13015271	-	0.130152706	2.614	0.0238

IT utilization did not have a significant direct effect on performance. But, the author could not reject the hypothesis that there is a significant and positive impact of IT utilization on performance since there is an indirect and positive impact of utilization on overall performance. Thus, the author could safely confirm that the data support Hypothesis 6.

Hypothesis 7: Usage will have a significant and positive impact on performance.

Results in Table 14 support total effect of organizational usage on performance.

Data support the proposition linking usage to performance. The results in Table 29 provide additional support, where User Satisfaction was linked to usage that, in fact, could indicate a relationship between satisfaction and performance. The relationship confirmed in the overall model.

Hypothesis 8: Performance is positively correlated with the degree of investment in IT.

Total effect of Information Technology Investment on:

Table 14: Total effect of organizational usage

	Total effect = Direct effect + Indirect effect			T	P
Performance	0.983211	-		3.185	0.0217

Table 15: Total effect of information technology investment

	Total effect = Direct effect + Indirect effect			T	P
Performance	0.02446	-	0.02446	2.771	0.0245

Data do not provide a strong support for the hypothesis. There is a weak relationship that wasn't significant between the investment in IT and the performance.

3.6 Overall Model

Table 16 summaries the results reported above for the relationship of independent variables to performance.

Table 16: Total effect on performance relative to e-business

	Total effect = Direct effect + Indirect effect			T	P
Investment in IT	0.02446	-	0.02446	-	-
Training	0.16610886	-0.250544	0.164435142	-3.741	0.0201
Experience	0.16958303	0.201633	-0.03204997	3.178	0.0218
Support	0.30099592	-0.30418	0.08318408	-4.489	0
Ease of Use	0.36050275	0.227269	0.133233752	3.163	0.0219
Usefulness	0.06342629	-	0.06342629	-	-
Satisfaction	0.37255624	0.285189	0.087367239	3.947	0.0001
Attitudes	0.28629	0.28629	-	3.939	0.0001
IT Utilization	0.13015271	-	0.130152706	-	-
Organizational Usage	0.39377	0.39377	-	5.811	0

4. Limitations and Assumptions

A limitation involves the external validity. While the respondent companies surveyed were adequate in number and presumably representative of the population of interest, generalizability is limited to only SMEs in the rubber industry. Since the population sampled was SMEs in the rubber sector, very limited conclusions can be made about SMEs in general.

The findings of the study, thus, apply only to SMEs in the rubber sector. To improve the quality of the data collected where possible measurements should be taken from users as the computers are introduced and then take additional measures as they use the computers more extensively.

5. Findings of the Study

5.1 IT Investment

Investment in IT in the rubber industry is limited both in absolute and relative terms. The average investment over a period of five year was USD\$52,640. The trend seems to be an increased investment, however, it cannot be statistically confirmed. A strong relationship was found between the investment in IT and the perceived usefulness. The direct effect, at 0.192787 ($p < 0.005$), indicates that users perception is affected by the investments made in a particular year. This could in turn have an effect on performance through and increased use of IS. In fact, the author found that there is a significant relationship between the perceived usefulness and IT utilization, which corroborates prior findings. Furthermore, the negative relationship, found between the investment in IT and the ease of use, could be explained by the fact that users are resisting change. Thus, perceiving that the new systems will be more complicated and add to their daily tasks a new task: learning how to use the new tools. Another explanation could originate from accounting reporting rules where, due to investment, the overall results of the company, especially on the year of investment, could be affected negatively. This in turn will affect the attitudes of the users toward the source of the sub-performance e.g. the investments made in IT.

The author cannot compare the investment made in other industries, but the author could affirm that even within the rubber industry there were many differences between companies. There should be guidelines of the minimum investment made in IT as a proportion of the revenue if this sector is to become more competitive. On the other hand, the investment in IT is more restricted than expected. No major investments in a production related IT were reported.

5.2 Organizational Performance

A measure such as ROA, the ratio of profit to total assets, may be limited in several instances. Large investments in technology may have a negative impact in a particular year. Knowing the year in which the investment was made is crucial. If profits do improve measurably, changes are not expected to be detected until the system is fully operational, which presumably occurs in the period following the implementation of the system.

Support, contrary to what the author hypothesized, had a negative impact on performance. This could be explained by the fact that companies performing poorly would push strongly the introduction or the use of IT as a way to improve their performance. This additional effort would be perceived by the users as an indicator of poor performance rather than a tool to improve performance.

5.3 Perceptual Variables

The findings indicate that the perceived ease of use is a key variable linking the exogenous variable such as IT investment and computer usage. The importance of the perceived ease of use is further illustrated by its direct effect on the perceived usefulness that in turn affects satisfaction, which has a direct effect on system usage. Moreover, the direct positive effect that training has on the perceived ease of use suggests that training enhances a user's self-efficacy and help un-thwart the use of computers. This encompasses the importance of training and suggests that those programs should emphasize individual's self-confidence and perception regarding an information system. Experience in using computers has a positive impact on system utilization indication that it is important that users gain experience, through training for example, to be inclined to use more adequately the IT available. Nonetheless, experience didn't affect the perceived ease of use, which could be interpreted that experience, with a direct effect on the perceived

usefulness, does not affect the perception of how easy it is to use IT.

The total effect of the perceived ease of use is greater than that of perceived usefulness on usage. This supports the findings of Igbaria et al., [33] that were inconsistent with prior research. This may indicate that users in SMEs are inclined to accept IT based on the ease of use rather than the usefulness. These findings corroborate the fact that the perceived ease of use has a direct impact on computer usage that was greater than that of the perceived usefulness. A plausible interpretation of these results is that users are ready to face some difficulties to get the information they need. But if the difficulties they have to face are high, or perceived so for that matter, they will seek other sources to meet their information needs regardless of the perceived usefulness of the system. This emphasizes the importance of perceived ease of use in developing new systems for SMEs.

Following Igbaria et al. [33], the author suggest that a possible explanation for the importance of the perceived ease of use is the lack of experience on the part of the users. Our survey indicates no significant relationship between experience and ease of use. Furthermore, experience had a negative direct impact on usage. Suggest that usage of the system decreases with experience though utilization was positively affected. This could be explained by the fact that users become more efficient, know exactly what information they need and how to get it without spending much time using the system. The effect of the perceived ease of use is that early in the use of the system, especially in a SME environment, its effect becomes non-significant after a prolonged exposure [33].

Consistent with most prior research [33], a positive relationship was found between support and perceived ease of use. This could be explained by the fact that users in a developed environment are more inclined to accept the technological innovation and introduction. The fact

that management supports, or provides the support for, the use of IT makes that technology to become perceived as easy to use.

DeLone (1988) found that the availability of technical support, mainly for training purposes, did not result in greater IS success in a small firm context. Since most of the companies in the present study didn't have internal support for their information systems, it may be the external support did not meet their specific needs. This indicates the importance of having and developing an adequate information systems support for SMEs. It remains that, consistent with our hypothesis 4 support of the IS function has a positive and direct effect on computer utilization.

5.4 Time Lag between IT Investment and Performance Relative to E-Business

In general, the findings of this research, if limited to being a cross-sectional, demonstrate a lack of direct relationship between the investment in information technology and company performance. It was found however a positive relationship, though statistically weak, that indicates the possibility of a causal relationship. As Weill [31] suggested, the author performed an analysis of the expected relationship using a time lag of 1 year to 5 years. Following Weill [31] regression analyses were performed.

$$RP_n = b + b_1X_n + b_2X_{n-1} + \dots + b_6X_{n-5}$$

Where RP_n = Rate of return for year n ; b_j = regression coefficients; X = investment in IT (predictor variable).

The results are indicated in the following table:

Table 17: Results of regression analyses for rate of return

Dependent	Independent Variables						R^2	P
	IT Invt 01	IT Invt 00	IT Invt 99	IT Invt 98	IT Invt 97	IT Invt 96		
RR01	0.00403					-0.0017	0.21	0
RR00		-0.00081					0.05	0.006
RR99			0.00373				0.03	0.0023
RR98								

*Non-significant coefficients were not indicated.

The five possible outcomes were tested as well as interaction between different year investments. The results of the five regression analyses are presented in Table 17. The standardized b , R^2 , and p value were reported. All interaction terms were not significant, which could indicate or be explained by the absence of a coherent IT strategy with in the sampled SMEs. Moreover, the results of the regressions were not satisfactory. Limited effects were found as resulting from IT investment. In the sample firms, most of the significant coefficients indicated a negative relationship between the investment in IT and the performance measured by the rate of return.. The time lag for detecting any effects

didn't show any significant changes in the results. Actually, most results indicated that the effects were perceived the same year the investments were made. The effects faded away or were non-significant in the subsequent year.

Investment in IT, or any combination of it thereof, did not appear to have any significant direct influence on the performance. To understand the reason for the negative correlation between investment in IT and performance one can infer that respondents' high awareness of financial performance hampers their assessment of the effects of IT investment. This high level of emphasis on

financial performance may affect the perception of the benefits that result from investing in IT and the use of IS.

6. Recommendations

6.1 Recommendations to Managers

The research model has a number of implications for the managers in the rubber industry. The results confirmed that computer usage has a significant impact on company performance relative to e-Business. This suggests that practical steps should be taken to increase the use of the IT to both make those investments profitable and increase the efficiency in the data processing. Training was found to have an important impact on both the perceived ease of use and usefulness suggesting that users should have access to adequate if not extensive training before being introduced to new systems. Researchers can help define training programs aimed at increasing the awareness of the importance of the IS in general and the particular software introduced. Ease of use has a direct effect on usage, as well an indirect effect via usefulness and satisfaction. This suggests that efforts to improve the perceived ease of use should be deployed through training and familiarization sessions.

A possible strategy could involve the creation of an IT training center for all the rubber industry under the auspices of their federation. This will allow for the sector to have its own center that will respond to the needs of the member companies. This center could be created with the cooperation of the vendors and suppliers of the technology used in the industry. Training, through attitudes, will have a positive impact on performance.

Finally, investment in IT had a significant influence on perceived usefulness. This was the only significant link through which IT investment positively influenced the company performance. This suggests that efforts to improve perceived usefulness have a strong impact on firm performance in SMEs. This could be achieved through extensive training which could be used to influence the perceived usefulness by increasing the possible uses of IT and the ease with which the IT will be used [33].

The fact that the investment in IT has a negative impact suggests that either the respondents were reporting the year where such investment occurred, which could have put some strains on the finances of the company, or that the investment in IT implied the introduction of new procedures yet to prove their efficiency.

6.2 Towards an Understanding of IT Investment Relative to E-Business

Investing in IT is seen more and more as a necessity to keep the organization afloat and competitive. What are the implications of such investment? One should caution that those implications resulting from the study findings could not apply to all organizations across the industrial spectrum. Thus, the author would outline the following implications:

- Investment in IT should be considered in enhancing efficiency and usefulness.
- To improve organizational performance, IT investment should include training for users of the IS.
- When evaluating the impact of IT investment on organizational performance, performance measures such as return on investment, sales by total assets, and return on sales, should be considered. Subjective measures of performance such as comparisons to competition performance should be limited.
- Measures, such as IT budget as percentage of revenue, percentage of IT spent on training, should be considered as measures of IT investment.

Previous studies have commented on the relationship between IT investment and organizational performance, but none, to our knowledge, has provided evaluation of this relationship.

7. Conclusion

This study represents a careful and systematic effort to examine the impact of IT investment and other technology related variables on company performance relative to e-Business. It incorporates a number of features including behavioral variables and behavioral intention variables, and a relatively large sample size, which lends significant strength to the study.

The research model was built based on an extensive review of relevant literature. The study is among the few that addressed the issue of use of IT in the context of small business. It extended the existing research by including the company performance in the model. The author did not limit the study to the technology acceptance or the success of the use of IS but the author went beyond to explore the effects of the IT investment on performance.

In conclusion, the main contribution of this study was to highlight the complexity of the IT investment question and hopefully reveal the shortcomings of many of the far reaching statements found in the decision-makers circles. A second implication is that new insights may be found by approaching the question of returns to IT expenditure from another perspective. This may help us understand what factors influence firm benefits from IT expenditure. SMEs appear to use IT mainly to increase efficiency rather than for strategic development in e-Business.

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Distribution Network Design and Customer Service

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Abstract

In distribution network design, it is implicit that transportation costs, travel distances, and transit times are tightly correlated. Therefore, one can argue that models directing at minimizing travel distances not only minimizes transportation costs, but also minimizes transit times. The center of gravity, and its various extensions, is an example of such a model. Quantitative analyses such as mathematical programming and stochastic models, the transportation costs are often the only factors of interest.

A universal metric for customer service is the customer's lead time – the time it takes to get the right quantity of the right product to the right place. If the right quantity of the right product is available, then the lead-time is the time it takes to take the goods to the right place. For example, when inventory is available, the time to get the product from the warehouse to the customer consists of the time to process the order plus the time it takes to transport it to the customer. These times do not vary much. Moreover, customers generally are aware of and accustomed to them.

If the required quantity of a product is not available, the lead-time is based on two components - inventory availability and product acquisition time. Product acquisition time is the time to get the product back in stock. This is the time to process and ship the product from some other location such as another warehouse, a manufacturing plant or a supplier.

In this paper, we examine the impact of distribution network design on customer's lead time. We conclude that the number of shipping locations may have some effect on customer's lead time. However, the effect of outbound transportation on lead-time can be small relative to product acquisition time. Acquisition time is the time to get the product back in stock. Production-inventory management determines this component of the lead-time, not distribution management.

1. Introduction

It is said that about every five years, large business organizations undertake a distribution network design project to determine if their facilities are properly positioned and located. Changes to the distribution system, e.g., opening/closing warehouses/plants involve major capital expenditure. Invariably, the analyses center

on the cost of doing business, rather than how distribution network design affects customer service.

1.1 Decision Variables

Distribution system design is a complex combinatorial problem. The complexity arises from the fact that there are so many interdependent decision variables.

Oftentimes, one or more decision variables set the constraints for other decision variable. For example, plant production capacities warehouse capacities are constraints that must be satisfied in deciding on which shipping location should service which customers, or how each plant's output should be allocated among distribution points for each product. The decision variables include:

1.11 Distribution facility planning.

Distribution facilities include depots, warehouses, consolidation centers, logistic platforms, and distribution centers. Design issues include location (distance between a distribution center and a market area served by it), handling capacities (throughput at each distribution center), storage capacities, processing and storage costs, and utilization costs.

1.12 Production facility planning.

Production facilities are the plants for fabrication, transformation, and assembly. Deciding what and how much to produce at each plant depends on location, production and storage capacities, costs (production and storage costs), and utilization level.

1.13 Sourcing strategy.

In distribution system design, selecting the supplier(s) for each purchased item usually depends on location, price, quality, and availability.

1.14 Distribution channels design –

Which shipping location should service which customers? How should each plant's output be allocated among distribution points for each product?

1.15 Selection of Transportation modes, routes and rates.

For long-haul movements, business organizations usually outsource the transportation of goods to a third party logistics provider. However, many businesses opt to maintain its own fleet for local pickup and delivery. Decisions on mode of transportation (by air, land, or sea), capacity (e.g., how many trucks in the fleet), route, shipment quantities and frequencies (e.g., to split or not to split shipments), schedule, etc., have impact on cost, availability, service quality and reliability (delivery time, variability/punctuality, reputation, etc.).

1.16 Production-Inventory decisions

Major decisions in distribution system design include what and how much to produce at each plant; which inventory control system to implement, etc.

The complexity increases with the number of decision variables.

1.2 Objectives

The goal of supply chain management is to fulfill customers' need for the 4 R's – to get the right quality of product in the right quantity at the right time to the right place. In distribution system design, deciding how best to fulfill the customers' need for the 4 R's depend on location, forecasted demand of each customer for each product, delivery time windows and frequencies, etc.

What is the 'best' way to fulfill the customers' need for the 4 R's? To know what is 'best,' one must first understand the objectives of distribution network design, from the vantage point of the business organization making the decision.

First, we must assume that we know what the 4 R's are, i.e., we know what quantities of which product our customers need, and we know when and where our customers want them. (Of course, we can not simply assume that we know what the 4 R's are. But this is beyond the scope of this paper.) Then, design objectives can be summed up by two words: service and cost.

What is customer service? A universal metric for customer service is the customer's lead time – the time it takes to get the right quantity of the right product to the right place. A way to operationalize this conceptual measure of customer service is to look at what constitutes customer's lead time.

2. The Cost Objective

Decisions on distribution system design are customarily based on forecasted demand (for each product at each customer zone), dimensions and weights of the goods flowing through the network, handling requirements (Fragile and/or perishable versus durable and/or robust), packaging, and costs (production, inventory, etc.).

In modeling, it is implicit that transportation costs, travel distances, and transit times are tightly correlated. Therefore, one can argue that models directing at minimizing travel distances not only minimizes transportation costs, but also minimizes transit times. The center of gravity, and its various extensions, is an example of such a model. Quantitative analyses such as mathematical programming and stochastic models, the transportation costs are often the only location factor of interest.

Network design affects the cost of doing business, and the flow of goods and services. The faster the flow of goods and service in one direction, the lower the inventory, and the quicker funds (\$\$\$) flow back in the reverse direction.

Decisions are either demand-pulled, supply-pushed, or more frequently, both demand-pulled and supply pushed. By demand-pulled, we mean market-related factors such as the profile of customers, the profile of the competition, the need for room for expansion, etc.

Supply-pushed location factors are based on the cost of doing business. The cost of doing business includes the cost of acquiring and operating plants, distribution centers, warehouses, transportation facilities, communications equipment, data processing means, etc. Inbound and outbound transportation costs depend on the number, and the location of various components of the distribution network.

Figure 1, based on an illustration in [3] shows the relationship between various cost categories and the number of shipping location.

Inbound transportation cost increases with the number of shipping locations because there are more locations to receive shipments from the suppliers.

Outbound transportation cost, however, decreases with the number of shipping locations because with more shipping locations to serve the customers, each shipping location serves its nearest customers.

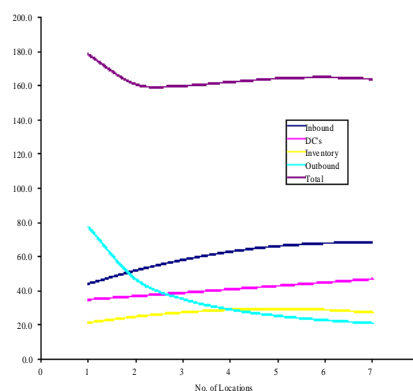


Figure 1. Cost vs. Number of Shipping Locations

More shipping locations means more inventory because each location has to maintain an adequate level of inventory. The operating cost (labeled DC's) also increases with the number of shipping locations.

Let:

N = number of shipping locations.

C_{Inbound} = Inbound transportation cost
 $= a_1 + b_{11} N + b_{12} N^2$

C_{DC} = Distribution-center operating cost
 $= a_2 + b_{21} N + b_{22} N^2$

$C_{\text{Inventory}}$ = Inventory-holding cost
 $= a_3 + b_{31} N + b_{32} N^2$

C_{Outbound} = Outbound transportation cost
 $= a_4 + b_{41} /N + b_{42} /N^2$

Let $\alpha = a_1 + a_2 + a_3 + a_4$, $\beta_1 = b_{11} + b_{21} + b_{31}$, $\beta_2 = b_{12} + b_{22} + b_{32}$, $\beta_3 = b_{41}$, $\beta_4 = b_{42}$, then the total cost =

$$C = \alpha + \beta_1 N + \beta_2 N^2 + \beta_3 /N + \beta_4 /N^2 \quad (1)$$

For example,

$$\begin{array}{llll} a_1 = 35.00 & a_2 = 33.00 & a_3 = 17.00 & a_4 = 10.00 \\ b_{11} = 10.00 & b_{21} = 2.00 & b_{31} = 5.00 & b_{41} = 80.00 \\ b_{12} = -0.75 & b_{22} = 0.00 & b_{32} = -0.50 & b_{42} = -12.50 \end{array}$$

Then

$$\begin{array}{ll} \alpha = 95.00 \\ \beta_1 = 17.00 & \beta_3 = 80.00 \\ \beta_2 = -1.25 & \beta_4 = -12.50 \end{array}$$

Solving the unconstrained integer programming problem in (1) yields the optimal solution of $N = 3$.

3. The Time Objective

The customer's lead time is a source of competitive advantage, and is a constraint that must be satisfied. This constraint may be stated in terms of "service level." In inventory theory, the "service level" is probability (likelihood) of meeting a customer's required lead time. For example, a "service level" of 99% means that 99% of the time, the right quality of product in the right quantity is delivered to the right place at the right time.

3.1 If item is available in inventory

If the right quantity of the right product is available, then the lead-time is the time it takes to take the goods to the right place. Outbound transportation lead time decreases with the number of shipping locations because with more shipping locations to serve the customers, each shipping location serves its nearest customers.

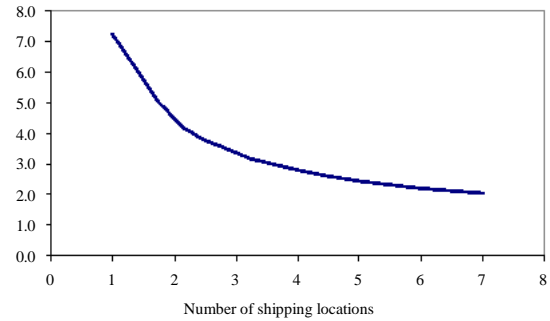


Figure 2. Outbound Lead-Time vs. No. of Shipping Locations

When inventory is available, the time to get the product from the warehouse to the customer is almost always fixed. It consists of the time to process the order plus the time it takes to transport it to the customer.

Figure 2 shows the relationship between outbound lead-time and the number of shipping location. With one shipping location, the lead-time is about 1 week. With two shipping locations, the lead-times drops to approximately 4.5 days, and with three shipping locations, the lead-times drops to about 3.5 days, etc. With 5 or more shipping locations, the lead-time is about 2 days.

Evidently, when inventory is available, lead-times normally do not vary much. More importantly, customers generally are aware of and accustomed to them.

3.2 If item is not available

Now, if the required quantity of a product is not available, then the lead-time is based on two components: inventory availability and product acquisition time. Indeed, the acquisition time is only relevant when the inventory is unavailable.

Acquisition time is the time to get the product back in stock. This is the time to process and ship the product from some other location such as another warehouse, a manufacturing plant or a supplier.

Suppose a warehouse processes all the orders for which it has inventory in t_1 days and the outbound transportation lead-time $t_2 = a + b_1/N + b_2/N^2$, where N is the number of shipping locations. If inventory is available, the customer's lead time = $t_1 + t_2$ days.

Let p = probability that the item is available. If the item is not available from inventory, the average time to acquire out-of-stock product is t_3 days.

The expected customer's lead time = $t_1 + t_2$ days + $(1-p) * t_3 = (t_1 + t_2 + t_3) - pt_3$ days. For example, suppose $t_1 = 1$, $t_2 = 1.0 + 7.5/N - 1.25/N^2$, and $t_3 = 10$. Figures 3a and 3b show the lead-time as a function of N and p .

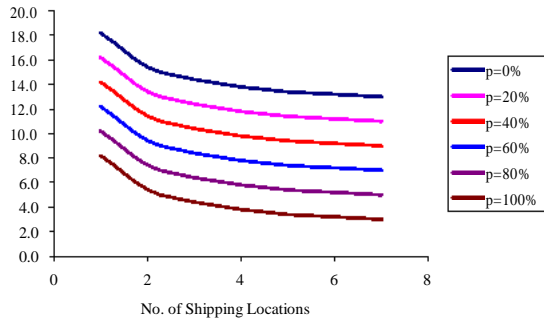


Figure 3a. Lead-time as a function of N

What determines the customer's lead-time? The customer's lead-time depends on the transit time (t_2 is about 3.5 days for $N=3$, the minimum cost solution found in Section 2.), the order processing time (one day), the probability that inventory is available, and the acquisition time (10 days).

Notice that in Figure 3b, the lead-time curve is a steep linear function of p . On the other hand, beyond $N=3$ (in our example), the lead-time curve shown in Figure 3a is rather flat with respect to the number of shipping locations N .

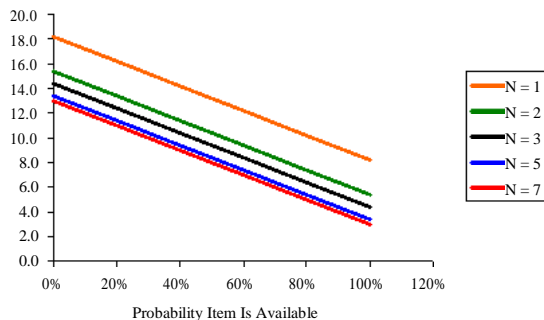


Figure 3b. Lead-time as a function of p

4. Number of shipping locations

Now, which of the components of lead-time is dependent on the number of shipping locations? Clearly, the number of shipping locations impacts only one of these elements: the outbound transit time to the customer. This transit time generally depends on the distance from the warehouse to the customer. In most supply chains the average distance decreases as shipping locations are added to the network.

Suppose the product is available 90% of the time. For $N=3$ (the minimum cost solution in Section 2.), t_2 is about 3.5 days. The expected customer's lead time = $(1 + 3.5 + 10) \cdot 90\% \cdot 10 = 5\frac{1}{2}$ days. Outbound transportation impacts 3.5 days of the customer lead time. That's 65% of the total!

Think about the capability of the network to decrease

transit times by adding more shipping locations. However, as seen in Figure 3a, the lead-time curve is rather flat with respect to the number of shipping locations N . In a 3-shipping location network, for example, the transit time is reduced by about half a day by adding a 4th shipping location. Adding a 5th shipping location further reduces the transit time by about 1/3 of a day, etc.

Figure 3b tells us a very different story. At $N=3$, and $p = 90\%$, we see that the total lead time is about $5\frac{1}{2}$ days. The linear curves in Figure 3b tell us that every 10% drop in probability that the item is available, will add a day to the customers' expected lead-time. For example, if p drops to 80%, the expected lead-time is about 6 $\frac{1}{2}$ days, if $p = 70\%$, the expected lead-time is about 7 $\frac{1}{2}$ days, etc.

Figures 3a and 3b assume that, when the item is not available from inventory, the average time to acquire out-of-stock product is 10 days. If the item has to be sourced from abroad, the acquisition time may take 3 weeks. This case is illustrated in Figures 4a and 4b below:

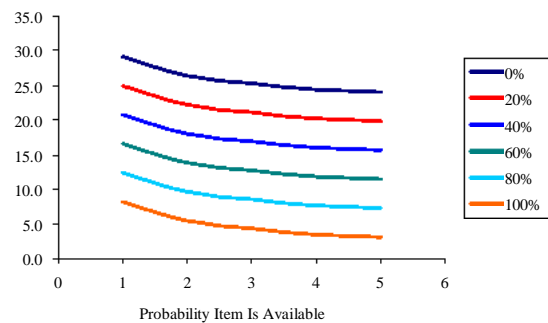


Figure 4a. Lead-time as a function of N ($t_3 = 21$)

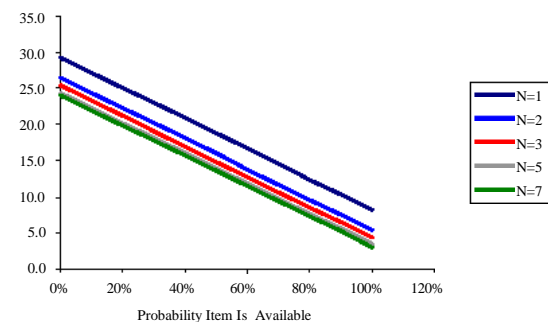


Figure 4b. Lead-time as a function of p ($t_3 = 21$)

Figure 4a shows the lead-time to be flat, with respect to the no. of shipping locations. Facility location may have some effect on customer's lead time. However, the effect of outbound transportation on lead-time can be small relative to product acquisition time (see Figure 4a). Acquisition time is the time to get the product back in stock. Production-inventory management determines this component of the lead-time, not distribution management.

The goal of supply chain management is to fulfill customers' need for the 4 R's – to get the right quality of product in the right quantity at the right time to the right place. The next section presents some real world examples illustrating the consequences of (a) not having the right quantity, (b) not having the right product, and (c) not knowing where the right quantities of the right products are. In each case, the failure was nothing short of spectacular.

5. Product, Quantity, Time, Place

5.1 Not having the right quantity

During the Internet boom of the late 1990's, networking gear (routers, switches) was hard to get. Desperate customers resorted to placing duplicate orders with multiple equipment vendors.

Each vendor, like Cisco, forecast robust growth and, to "lock in supplies", solicited long-term bids from multiple contract manufacturers. Each contract manufacturer wanted to lock in its supplies and started negotiation for long-term deliveries from chipmakers.

For the few chipmakers in the world, it all added up to an extraordinary surge in demand for their products. They promptly raised their prices or rationed their output, which frightened buyers so much they decided to hedge by placing still more orders, which re-enforced the vicious cycle.

However, customers intended to acquire only a fraction of this stupendous production – from whoever delivers first among their many orders. The whole pyramid, bloated with phantom demand, eventually imploded – the bubble burst. In 2001, Cisco was forced to write down \$2.2 billion worth of obsolete inventory, victim of a pernicious pathology in its supply chain [4].

5.2 Not having the right product

Nike went live in June 2000, with its much-ballyhooed demand forecasting application, acquired from i2 for \$400 million.

Nine months later, the inaccurate forecasts produced by the new systems had led Nike to write-off \$90 million in inventory of unsellable shoes, on top of an estimate of \$100 million in lost sales, due to shortage of sneakers in high demand [5].

5.3 Not knowing where the right quantities of the right products are

In August, 1999, Hershey announced that its IT teams had just completed its R/3 implementation — a \$112 million project which includes ERP from SAP, CRM from Siebel, and supply chain software from Manugistics.

A month later, Kenneth L. Wolfe, then CEO and

Chairman of Hershey Foods, told Wall Street analysts that the company was having problems with their new SAP implementation, and that the problems were going to keep Hershey from delivering \$100 million worth of Kisses and Jolly Ranchers for Halloween that year [2].

That year, order management and fulfillment processes broke down, causing the company to fail to meet many retailers' orders. The immediate impact was about \$150 million in lost sales for the year. Hershey's stock price fell more than 8 percent on that day.

Who is to blame for Hershey's dilemma in 1999? The new ERP system did not know where the right quantities of the right products are. According to Carr [1], Hershey had informal mechanisms for dealing with the tremendous buildup of inventory to prepare for the holiday rush. Hershey had rented warehouse space on a temporary basis, and spare rooms within factory buildings to store inventory. Unfortunately, these locations hadn't been recorded as storage points in the SAP data model!

Before SAP fulfills a customer order, it first checks its records of available inventory, and in this case a significant amount of inventory was not where the official records said it was [1].

In short, Hershey might have the right product, at the right quantity, at the right place. Unfortunately, their new ERP system did not where the inventory was, and \$100 million worth of candies were not delivered to right place in time for the Halloween and Christmas holidays.

6. Summary

A universal metric for customer service is the customer's lead time – the time it takes to get the right quantity of the right product to the right place.

In this paper, we examine the impact of distribution network design on customer's lead time. We conclude that the number of shipping locations may have some effect on customer's lead time. However, the effect of outbound transportation on lead-time can be small relative to product acquisition time. Moreover, customers generally are aware of and accustomed to outbound lead-times.

Acquisition time is the time to get the product back in stock. Production-inventory management determines this component of the lead-time, not distribution management.

Thus, the objective of facility planning should be focused on minimizing cost, i.e., find a minimal-annual-cost configuration of the distribution network that satisfies product demands at specified customer service levels.

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Examining the contribution of internal customer service to improved e-procurement performance: A Case Study investigation

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Abstract

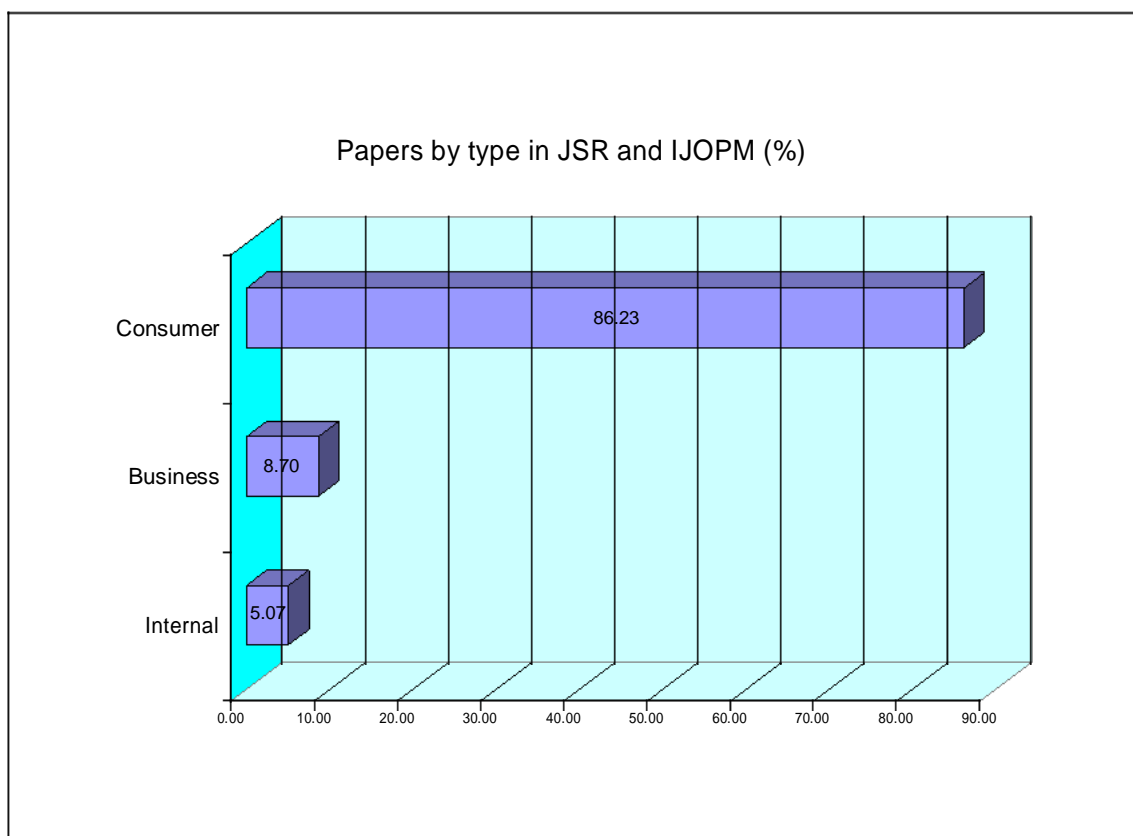
Much of the existing published research into the impact of electronic procurement has focused on the cost efficiency or implementation issues of its adoption. Issues relating to the significance of improved compliance on procurement performance were noted in our earlier paper [7], yet little if any research has so far set out to quantify the impact of electronic procurement on internal customers' perceptions of service quality. This paper provides an examination of the impact of e-procurement adoption on internal users' perceptions of service quality. Employing Johnston's [15] 15 service quality criteria, we compared users' perceptions of pre- and post-electronic procurement processes for two categories of supply: computer consumables and stationery. Using an online survey (appendix 1) a pilot study was conducted in a single organisation that has employed 'supply-side' electronic procurement for 18 months. We found that users expressed 'delight' in many aspects of the service provision relating to the design characteristics of the e-procurement system, but dissatisfaction with issues concerning the actual system delivery (particularly related to IT infrastructure and networks).

This paper only provides early results from the pilot study, so further conclusions from our research must be deferred until a more significant sample of responses have been analysed.

1. Introduction

Over the last 20 years a significant body of literature has developed on service quality and customer satisfaction. It is generally accepted that customer satisfaction has a significant impact on customer retention and loyalty (see for example [2], [18], [25]) on customer attraction (see for example [25]), staff satisfaction (see for example [13], [26]) and therefore on an organisation's financial performance (see for example [23], [10]).

Most service research however has been predominantly concerned with business to consumer (B2C) services; in particular retail services and banking. Few papers deal with business to business (B2B) or internal service issues. Indeed a analysis of 15 back issues of the *Journal of Service Research* and the *International Journal of Service Industry Management* reveals that over 80 per cent of recent papers are concerned with B2C services (see figure 1).



Furthermore, despite the recent rise in web based delivery channels and the rise in interest in e-business it is surprising that few research papers have so far been published in this area. Recent publications such as [32], [20], [28], [31] and [34], for example, have all been concerned with, in the main B2C service and, exclusively, external customers.

Data from research organisations such as Forrester Research and Gartner, has demonstrated that the greatest potential from e-business will be in B2B and internal services. It is interesting to note that research in the manufacturing area has been predominantly focused on internal activities (see for example [1], [9], and [12]).

Although the notion of internal service is not new (see for example [5], [11], [17]), there are few papers on e-service applied to internal services (notably [30], [3], [29] and [6]).

The purpose of this paper, which results from an ongoing research project into e-business, is to build on an earlier paper concerned with the application of e-service in internal services and continue to try to add some knowledge to this important but largely neglected area. We focus in this paper on an investigation of internal

customers' perceptions of the impact on service quality of e-procurement.

2. The Impact of E-Service on Internal Customer Satisfaction

The purchasing and supply (procurement) activity of organisations is an important internal service found in all organisations, public, private, governmental and charities and can be responsible for a large amount of spending on, for example materials components, facilities, subcontract capacity, IT equipment and supplies, consumables, stationery, travel and insurance. Indeed most organisations spend at least one third of their turnover/income on the purchase of goods and services ([33]; [16]).

Procurement is traditionally an internal service provided by a dedicated team of professionals. The function is usually responsible for the identification of (internal) customer's needs, translation of those needs into specifications, management of the delivery of goods and services and an assessment of the (internal) customer's satisfaction with those goods and services. The other elements of the process involve communication with suppliers –

sourcing, requests for tenders, price negotiation, ordering receipt and invoicing.

Electronic procurement systems in essence mirror the procurement process through the provision of two distinct, but connected, infrastructures - internal processing (via, for example, corporate intranet) and external communication with the supply base (via, for example, Internet-based platforms) [8]. The critical difference is that such systems allow individual employees to order goods and services directly from their own PCs through the web. Requests and orders are channeled through various forms of 'hub' or database which acts as an online catalogue of specifications, prices and often, authorisation rules. Such systems allow individual employees to search for items, check availability, place and track orders and initiate payment on delivery.

In our earlier paper we investigated the impact of changing internal services into e-services, concentrating on the evolution of procurement processes to e-procurement. Whilst there are numerous e-procurement system platforms in use, our study took a broad definition of e-procurement as "the use of internet protocol systems to support both the internal and external stages of the traditional purchasing process". Our initial study was exploratory in nature, consisting of a study across 97 organisations investigating the impact of the change from traditional procurement functions

to electronic procurement (e-procurement) on internal service quality.

Based on surveys, telephone interviews and site visits and observations of IT and Purchasing executives and manager, as well as managers in a number of user departments across a total of 97 organisations we reached three main conclusions, that e-procurement led to significant reductions in costs, an improvement in reliability of the procurement processes and an improvement in internal customer satisfaction.

In terms of internal customer satisfaction in particular, respondents reported that the replacement of bureaucratic requisition and approval process with rapid IT-based systems enhanced customers' perceptions of service availability, speed, responsiveness, flexibility in particular. Customers also expressed satisfaction over their greater ability to exercise more control over their budgets. The increased levels of satisfaction were reported despite the fact that e-procurement systems usually required much greater personal intervention by the users themselves.

We concluded our initial paper with a proposed causal map of the relationships between the quality of internal service delivery, staff satisfaction, the level of compliance and the consequent results from e-procurement use. Figure 1 below shows this posited causal relationship.

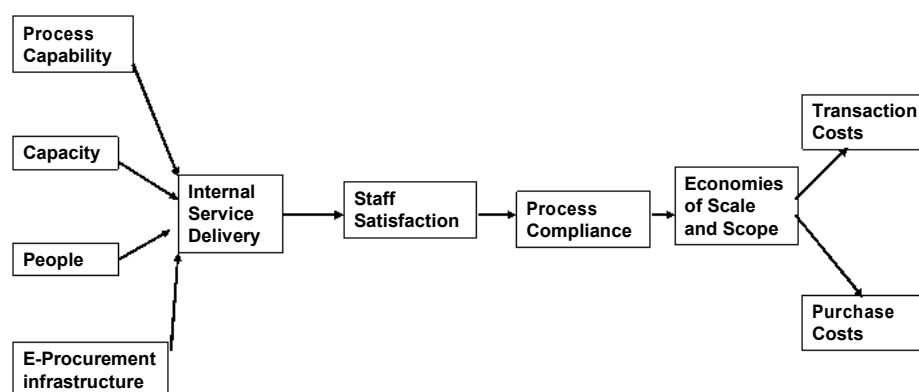


Figure 1: A Causal Relationship between Internal Customer Satisfaction, E-Procurement Compliance and Procurement Costs [7].

Whilst our earlier exploratory research [7] gave an indication that internal service quality was considered by managers in the providing functions (I.T. and Purchasing) to be a significant factor in supporting the performance benefits e-procurement performance, we had little evidence of internal end users' perceptions. In particular, since our study only included managers of user/internal customer departments rather than the operatives who regularly placed orders using the e-procurement system, we recognized that

opportunities to adopt a 'gap model' approach could offer further insights into the internal service dynamics associated with electronic procurement deployment. Utilising Slack et al's [27] interpretation of the Parasuraman et al's ServQual model, we amended the model to focus on *internal* customer service by highlighting the comparison internal users makes between different processes for placing orders and the potential for 'communications' to include policy statements and directives, figure 2 below.

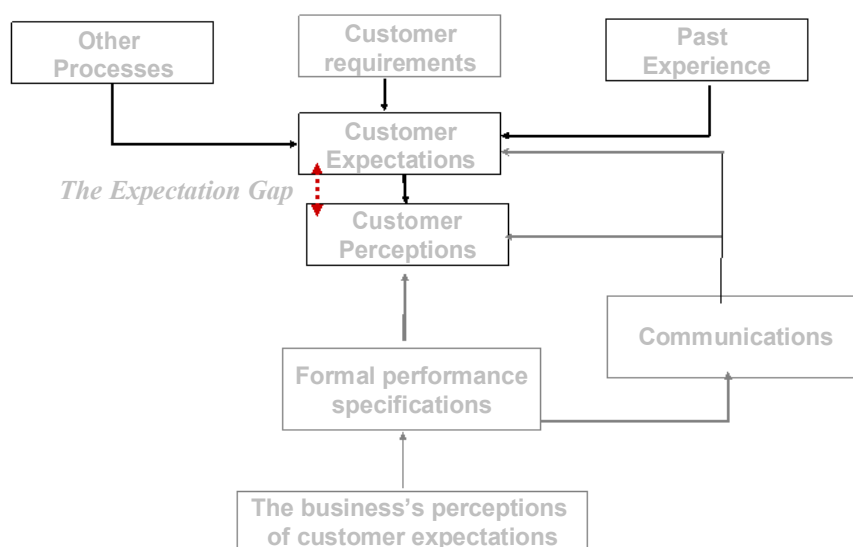


Figure 2: Modified Internal Service Quality Gap Model
(Adapted from Slack, Chambers & Johnston, 2001)

As our previous paper noted [7] much of the existing literature on e-procurement has concentrated on issues relating to the *implementation* of e-procurement – benefits, costs, returns and rollout strategies. Little research to date exists relating to the *operation* of e-procurement systems. In our previous paper we examined the *implementation* issues surrounding the impact of internal service on process compliance (and consequently on process performance). In this paper we concentrate on an *operational* issue by examining the 'expectation gap' of internal customers (encompassing administrators, administrative assistants, secretaries, finance department staff and technical staff) who carried out the day to day ordering of supplies using an electronic procurement system. Our focus is to identify the characteristics and scale

of the impact of e-procurement on internal service quality.

3. Method

The initial contention motivating this study is that enhanced internal service quality leads to greater compliance with an organization's desired procurement procedures. We thus set out to investigate internal users perceptions of the performance of e-procurement in a single case organization (Company A) for two categories of supply, stationery and computer consumables, since these are now solely purchased using e-procurement. Company A introduced e-procurement approximately 12 months before the date of this study, so respondents had recent experience of non-

electronic procurement. The process for both categories of supply is described as 'supply-side' e-procurement, that is, the catalogue and ordering process is hosted on the supplier's servers. Most users surveyed also had responsibility for other categories of supply that were not available via the e-procurement system. Thus we contest that comparison between 'e' and 'non-e' procurement is valid given the users experiences of both scenarios.

In line with our earlier research [7] we again used Johnston's [15] 15 service quality criteria to investigate internal service relationships. A questionnaire was developed (Appendix 1) in which respondents were invited to contrast their perceptions of the performance of the e-procurement system with their previous (non-electronic) method of procurement. Data collection was via on-line delivery of the survey instrument to all active users of the organization's e-procurement *intranet*. Results were transmitted to us directly via email for each respondent, all responses were anonymous. The raw data was entered onto an Excel spreadsheet to facilitate data manipulation and analysis.

As with previous research into service quality (see for example [13], [22], [19]) we used a Likert scale to assess customers' perceptions of their experiences. We chose a 9-point semantic scale (as used in the second

generation SERVQUAL instrument [21], with 1 meaning completely unacceptable and 9 meaning always exceeds my requirements (see appendix 1). We plotted a simple difference score between the e-procurement and previous system. Three potential outcomes naturally exist – 'delighted' (i.e. the e-procurement process is perceived to offer greater service quality), 'satisfied' (i.e. there is no perceived difference between the previous system and current e-procurement process) and 'dissatisfied' (i.e. the previous process offered a greater perceived level of service quality). In evaluating the results from our survey we adopted Johnston's [14] notion of the 'zone of tolerance' to delineate between the three outcomes.

At the time of writing we had completed our pilot investigation of 12 primary users. The survey is ongoing and we therefore anticipate presenting analysis of a larger sample during the conference.

4. Findings

We found that each of the three outcomes was evidenced across the service quality criteria. Figure 3 provides a bar chart summarizing the sum of differences between the e-procurement system and the previous (non-electronic) system, identifying the three 'zones' of delighted, satisfied and dissatisfied perceptions relating to the e-procurement system.

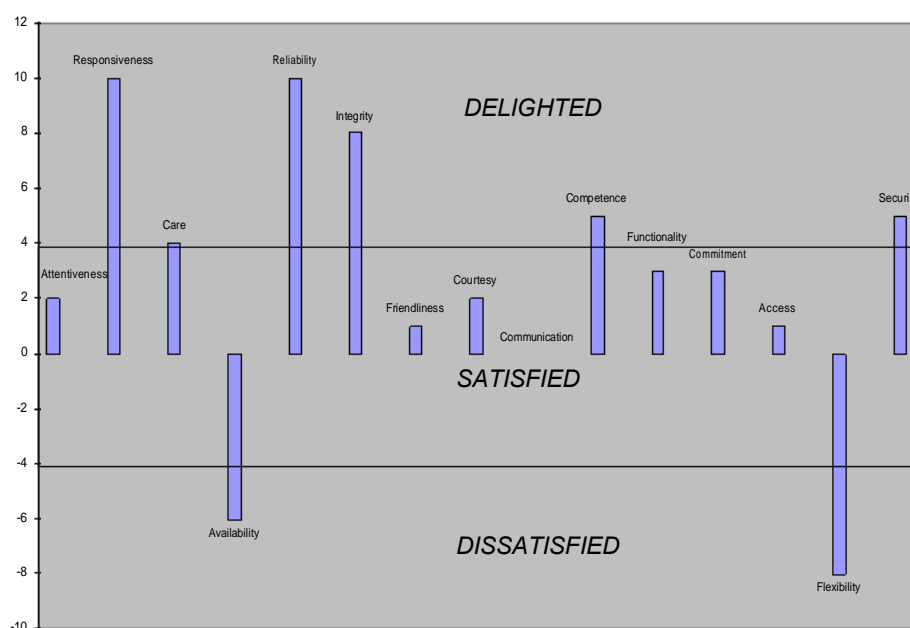


Figure 3 Service Criteria Sum of Differences

From figure 3 we see that the advent of e-procurement adoption had impacted on users perceptions of service quality in the following manner:

‘Delighted’

The e-procurement system was found to ‘delight’ users in five specific criteria of e-service delivery: responsiveness, reliability, integrity, compliance, and security.

‘Satisfied’

Seven criteria showed little if any difference between the old and e-procurement processes. Users were found to be ‘satisfied’ in the characteristics of: attentiveness, care, friendliness, courtesy, communication, commitment and access.

‘Dissatisfied’

The e-procurement system was found to have led to dissatisfaction in users in two criteria of e-service quality: availability and flexibility.

5. Discussion

This paper set out to explore the impact of electronic procurement on end users perceptions of internal e-service quality. Little if any prior research has examined this aspect of e-service and we thus based this preliminary study on an analysis of the gap between pre and post-e-procurement *operation* on Johnston’s 15 service quality criteria. We concluded by setting out three categories of criteria according to the impact on users’ perceptions of the change to e-procurement operation: Delight, Satisfaction and Dissatisfaction.

The advent of e-procurement had improved perceptions of internal customer service quality to ‘delight’ users in the attributes directly related to the fundamental process capability of the system. Responsiveness, reliability, integrity, compliance and security may all be considered to reflect the design of the procurement process. The e-procurement system is perceived to be quick, easy to use, accurate and confidential.

Users were ‘satisfied’ with seven criteria reflecting high contact aspects of the procurement process. Where interaction with a

provider (including purchasing officer, supplier or system administrator) is necessary, there appears to be little discernable difference between the e-procurement system and previous process. In essence the high contact service criteria are ‘system neutral’.

Users were ‘dissatisfied’ in two respects. Firstly, due to problems associated with server downtime and system reliability, the e-procurement system was perceived to be more likely to be unavailable to users than the previous system. This concern with the e-procurement infrastructure, particularly network downtime, is compounded by the lack of flexibility – the e-procurement system provides ‘only one way’ to order items.

Once a user has gained access to the system, the e-procurement process offers a significant improvement in their perceptions of service quality related to the design aspects of the process. Service quality in the high contact elements of the e-procurement process do not appear to offer any significant advantage or disadvantage over the previous non-e procurement process. However, users find the performance of the network and communications infrastructure to be significant dissatisfiers.

6. Summary

This study has indicated that e-procurement influences internal customers’ perceptions of the service quality they receive. However, this study so far is limited by the fact that the study is merely a pilot study and further data collection is necessary before we can posit statistically significant conclusions. However, at this stage in the research our initial indications are that e-procurement enhances internal customer service satisfaction in those aspects of service quality directly related to the *design* of the system – the ‘functionality’ of the system as it is often described in practitioner literature. Internal customers expressed dissatisfaction in aspects of the *delivery* of the process, i.e. network and communications infrastructure reliability.

This research is ongoing and further data collection is anticipated to provide a far larger data sample base.

7. Appendix

Survey of Purchasing Processes at Company A

Stationery and Computer Consumables Supplies

Professor Robert Johnston and Dr Simon Croom of Warwick Business School are conducting a study into the nature and quality of the service offered by electronic and non-electronic purchasing processes for two categories of purchase – stationery and computer consumables. We wish to contrast the current process for buying stationery and computer consumables using the online system with how you used to purchase these two categories of supplies before the introduction of the online system.

The questionnaire contains 15 questions. Each is posed in the form of a statement about the processes and we would like you to use the 1 – 9 scale shown to reflect your opinion, based on your own experiences, of the current online process and the previous purchasing process you used **for stationery and computer consumables supplies only**.

In answering all of the questions please use the following 9 point scale, to rate each statement based on your experiences where:

- 1 = Completely unacceptable
- 2 = Very poor
- 3 = Poor
- 4 = Slightly below my requirements
- 5 = Meets my requirements
- 6 = Slightly exceeds my requirements
- 7 = Sometimes exceeds my requirements
- 8 = Often exceeds my requirements
- 9 = Always exceeds my requirements

Your participation in this study is greatly appreciated.

Question	The Current On-Line Procurement Process									Your Previous Ordering Process								
1. The helpfulness of any personal service provided by the process when it is needed.																		
2. The speed and punctuality of total purchasing process from order to delivery.																		
3. Your satisfaction with the care, concern and patience shown throughout the ordering process																		
4. The availability of the ordering process																		
5. The frequency with which the total purchasing process meets your required levels of performance																		
6. The respect and fairness with which you are treated																		
7. The extent to which you are made to feel welcome																		
8. The politeness with which you are treated																		
9. The frequency and quality of all communications you receive																		
10. The accuracy with which the total purchasing process is carried out																		
11. That the ordering process achieves what it is meant to achieve																		
12. The degree of commitment of all the staff involved in responding to you																		
13. The ease of completion of the ordering process																		
14. The flexibility of the ordering process in meeting different requirements																		

15. The level of confidentiality possible in the process																			
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A Study of Effective Regulation Model in Privatizing the Public Enterprises

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Abstract

The privatization seems to be an important policy towards the solutions of public ownership faults. However, the privatizing a monopoly industry could not damage the consumers' interests inevitably. Thus, it is necessary to introduce the government regulation towards the privatized monopoly industry. The premises of the privatization combined with regulation model are: controlling the privatization of a monopoly industry shall increase the efficiency, improved service quality and lower the costs to consumers.

The method for this research is to review existing literature and study the regulations and the regulation in the developed nations comparing their variations and to find out the most efficient regulation models to design or amend for other nations. The objective of this study is to study the privatization experiences from the existing nations and convert to those nations may need for reference.

At the end, this paper also found that the effective regulation model may not only bring down the costs of the public services, but also improved the efficiency to a near market competition standard.

1. Introduction

This research paper looks at price capping theory and considers a case study, which explores incentives and relevant financial and technical points of price capping regulation. The paper will explore the optimal regulation framework which endorsed the price capping regulation framework (Laffont & Tirole, 1993); it will explore the Productivity Measurement with Adjustments for Variations in Capacity Utilization in price capping regulation theory and consider some conclusions and implications.

In 1994, research in the UK power industry found that privatization was not directly related to the improvement of productivity in the post-privatization era. (Burns and Weyman-Jones, 1994). Significantly, the research study on which these findings were based ended in 1993, before the introduction of price capping regulation and before the intensification of industry competition occurred. It missed the valuable opportunity to measure and compare productivity performance under

price capping reduction, versus market competition.

In contrast, recent studies from the electricity association of UK found: that privatization has almost doubled the productivity of the electricity industry. (Electricity Association, 1998, p.55). In the electricity industry, effective price regulation and more fierce market competition have resulted in a lowering of profit margins after peaking in 1989-90 and further resulted in an improvement of service quality. Household electricity costs have fallen at a rate of approximately 2.5% per annum after the privatization of the electricity industry. Commercial users experienced similar discounts and the prices are further negotiable subject to usage. The privatization of local electricity distributors has generally achieved higher profit margins and reduced the need to recruit employees.

The privatization of the gas corporations also achieved similar results. Once profit margins peaked in 1990~1991, prices have continued to fall, reflecting effective price regulation and intense competition in the gas industry. Actual prices for average households have fallen by 2.6% per annum. Commercial and industrial gas prices have also fallen at a rate of 5% per annum. At the same time, service quality has also improved significantly, including the discounted rate of gas pipes, improved safety records, and improved usage of gas pipes. While UK gas corporations have lowered their pipeline buildup and grown their services gradually, new entrants into the gas industry have expanded their business more aggressively to maintain the growth of the total service quantity supplied.

On the whole, consumers only increased their actual expenses in water and sewerage services, especially those consumers who were charged according to the sizes of their properties. However, water and sewerage price increases were supported by industry regulation offices (but the growth rate remained within a permissible range) because suppliers had to meet the European Union criteria and make new investments in infrastructure. Today, water quality and certain service items have greatly improved.

The struggle however, to meet these criteria is reflected by 25% of the sewerage industry which cannot meet the government requirement. The frequency of interrupted

water supply has grown and water pipe leakage has also become a public concern. This is especially problematic as water companies continue to enjoy high profit margins.

As such, the water supply regulator has instructed water companies to implement certain actions to lower the rate of water pipe leakage. The water supply regulator has raised the issues and its intention to tighten regulation and to lower the actual water prices in their next review in 1999-2000. While the regulator may intervene in the case of extraordinary price increases, the UK regulator remains committed to prices which reflect the real cost of supply.

From the perspective of employment, it is clear that total employment opportunities did not suffer from privatization. While privatization may lower employment opportunities in existing firms and organizations, new entrants still require new employees to compete with existing State-Owned-Enterprises (S.O.E.). In the telecommunication industry for example, British Telecom has conducted a few large scale redundancies over the years, but total employee numbers have actually increased. In addition, redundancies are frequently voluntarily and with generous severance packages.

The experience of privatization indicates that, effective regulation can increase productivity, lower prices, and improve quality producing greater economic benefit. Furthermore, the profit margin of privatized enterprises also tends to fall in the longer term. Newly privatized enterprises normally achieve higher surplus as a result of better costs control and less stringent governmental regulations in the initial stages of privatization. The main reason for softer regulations is that this will help gain support from investors in the privatization effort. Upon completion of the privatization, the regulator begins to tighten the conditions of price increases and provides incentives to introduce greater competition.

The Internal Rate of Return (IRR) is also an effective index which deems future profits as zero investment capital while converted into monetary terms. The IRR is being adopted as an instrument of comparison with the Return on Investment (ROI) or the profit margin. Thus, we can compare the ROI with capital costs in privatized enterprises which are regulated. Under competition, the normal ROI will tend to reflect or be close to capital costs. While capital costs are based on lending costs, the proprietor's weighted average is based on equity. In the UK, the capital costs of a privatized enterprise can be viewed as more valuable than government bonds, but in general enterprises it is considered less than the proprietor's equity.

The main reason for this is that while privatized enterprises remained dominant in the market, the regulator must ensure that they possess sufficient

financial capability. This lowers the risk of investing in privatized industries compared to other general enterprises, where capital costs or ROI are also lower. For example, the telecommunication regulation office set nominal capital costs between 8.4% - 13.4% for the telecommunication industry in the UK when actual capital costs are between 5.2%-8.8%. Generally it is true to say that the regulator sets the price capping based on actual capital costs to enable regulated enterprises to achieve 7% of actual ROI.

In some cases in the UK, for example with the British Gas Company and with British Telecom, investors do not receive the pro-normal ROI from investing in privatized enterprises until after an extended period. The reasons for privatized enterprises achieving pro-normal ROI include the government wishing to privatize enterprises successfully by underestimate the share price and the regulator getting involved with the regulation of pay increases.

2. Literature Review

Comparison between price capping regulation vs. rate of return regulation

Price capping regulation is closely related to inflation. Price capping is modified based on inflation and *the efficiency factor*. *The efficiency factor* is used to reflect the scale of productivity progress and in the UK, is symbolized as X. Price capping regulation is reviewed every 4-5 years. For instance, the price cap for British Telecom was initially set at RPI 3; then reduced to RPI 4.5 in 1989; adjusted to RPI 6.25 in 1991 and RPI 7.5 in 1993.

The objectives of price capping regulation are to amend or simplify the rate of return, which involved the "agreed rate of return" (Littlechild, 1989).

At the start of the privatization of British Telecom, services were 60% under the price capping regulation. Services have currently been lowered to 25%. This has illustrated the maturing of market competition.

Price capping, however, is under attack from many areas. This type of regulation has two major flaws. The first is the lack of motivation to lower the operation costs because increased costs can be transferred to consumers. The second is the ease of over-expanding investment because the profit is expressed as a rate of return on assets and new assets normally achieve a better rate of return (Averch and Johnson, 1962).

At the opposite end, high costs may not be passed on to its customers. Enterprises generate revenue when the cost-down rate is significant lower than efficiency factors. Thus, enterprises commonly improve performance regardless of operations or capital. However, costs and price may move in opposite directions after a period of time which may cause inefficient distribution of resources, (P?MC). Moreover, the public will question the effectiveness of

governmental regulations as high profits continue to be generated

For these reasons, the methods of calculation of price caps are reviewed every 4-5 years to maximize the results of the regulation. Governments have encouraged enterprises to raise prices within the set and acceptable range as happened in water companies. Government would also permit regulators to adjust the price capping calculation methods in unusual circumstances as in the case of British Telecom in 1991. Governments, however, refrain from intervening with prices once price capping calculations are formalized. Any inappropriate intervention in regulated enterprises would substantially affect internal performance.

Although one research study pointed out that price capping regulation is simpler than the rate of return regulation (Littlechild, 1988, P.56), price capping regulations have more complexity and are dispute in terms of manipulation. For instance, in the case of applying the rate of return regulation, there is much complex data involved such as enterprises assets, finance and forecasts of costs and revenue. For price capping regulation to work, complex enterprises and industry data are needed. However, price capping regulation requires almost as much data as the rate of return regulation. Currently, the regulation office requires more and more complex financial models to forecast the financial status of the regulated enterprise. An effective forecast model would require for instance, a nationwide forecast of demand; a model of costs and productivity relationships; future production costs (e.g. labor costs) and advanced price allocation efficiency in relation to fixed assets.

The objective of the modeling process is to establish a price regulation model. The price regulation model is aimed at assisting regulated enterprises achieve above normal return owing to industry uniqueness or monopoly unless the cost-down margin is lower than the efficiency factors. However, the normal rate of return is very difficult to calculate and requires precise capital costs. The calculation formula always raises disputes between the relevant parties. This also happens with the rate of return regulation law in the US. Apart from capital costs, the size of the asset radix and the methods of amortization are also controversial in both the UK and the US. While price capping regulation in the UK model aims to avoid the flaws in the US model, there remain many questions in the UK model.

The experience in the UK has shown that pricing variables are subject to the asset radix and the negotiated rate of return regardless of price capping regulation or the rate of return regulation. Since assets are sold at a discounted value during privatization, many concerns have been raised in areas such as purchasing costs, replacement costs and book values. For instance, the water company was sold at 90% of its actual

replacement value while the gas corporation was sold at 60% of its replacement value. In this case, it is crucial to evaluate the asset radix of the price capping regulation. Generally speaking, investors should not receive extraordinary profit from their investment amount which should include purchase costs. (Vass, 1997).

In proposing the X factors, the regulators compromised on the method of calculation. They decided on the cash flow model over the short term, which can allow a larger tolerance in net asset evaluation. The objective of the pricing formulae is to provide the regulated enterprises sufficient financial capability to fulfill the current and future public demand for investment.

In this model, the asset value is calculated based on its net book value or current value. The return to investors is over-valued during the privatization. However, if the asset value were calculated during the progress of privatization, for example when the purchase costs are, frequently under valued, more accurate values would result. Although, this may lower windfall gains from the price variation between the actual asset value and its purchase values, this would enable another variation between investors' rate of return and the return rate in the corporate accounting system. Thus, the practice accounts not support a model which went against accounting theory.

After many years of privatization, the regulation office finally took contingency actions to address the issues within privatization. For instance, with Transco (the former pipeline and storage department of the UK Gas Corporation), the monopoly and acquirer association included the asset purchase costs during the process of privatization as part of the index figures. The result of such action caused the windfall gain of investors to disappear and a price fall for its consumers. However when asset replacement is required, this means higher replacement values and service costs would rise dramatically (Fulwood, 1997; Newbery, 1997; Vass, 1997). This would enable a wealth distribution opportunity for customers although this calculation would also enable customers not to pay for actual costs. Asset evaluation became a good case study. Simpler regulation was insufficient as the situation turned complicated and controversial. Also, the UK regulator frequently intervened without following its review schedule when any consumers' disputes arose or new competitors entered the market. These actions caused many disputes and complaints between the regulator and the regulated enterprise. For instance, the telecommunication regulation office intervenes more times in British Telecom than when it was a State-Owned-Enterprise. The regulation office intervened in pricing, quality control, the rates equilibrium control and in consumer satisfaction matters (Souter, 1994:p.109). The CEO of British Telecom, Sir Valence, criticized the regulation environment in the UK

as hostile and unpredictable (Lapsley and Kilpatrick, 1997:p.81).

This also occurred in other industries. The relationships between the gas regulation office and its regulated enterprises were on the edge of rupture. The water regulation office intervened twice during the first five-year regulation period. The regulation office forced water enterprises to lower prices so as to share profits with its customers and even intervened in the bonus scheme of the enterprise. As a general rule in price capping regulation, bonus schemes of the regulated enterprises should not be an issue for the regulation office.

The regulator may amend the code of an unpredictable game. In this way the regulator and the regulated enterprises shall establish a stricter “regulation contract” or negotiate a clear code of conduct between two parties (European Policy Forum, 1996, Parker, 1997b). The price capping regulation since 1983 was designed by Professor Littlechild to minimize unnecessary and detailed governmental intervention. While it failed to minimize governmental interventions, it is highly efficient in encouraging corporate management to reduce internal inefficiency and lower service costs. The results of all types of governmental interventions in corporate strategies and economic behavior remain questionable but it is clear that negative effects have resulted.

Unexpected regulation intervention may lower the motivation for enterprises to improve efficiency because the improvement rate must exceed the X-factor to generate short term profits for shareholders. The major motivation for the regulator to pursue better efficiency is for short term profit and to be able to use this as an important index for corporate improvements in efficiency. However, regulated interventions aim to redistribute profits generated from this efficiency improvement to customers rather than shareholders. Regulated enterprises may lower efficiencies and waste resources to minimize profit and therefore avoid its prices being reviewed by the regulator. Similarly, there is a likelihood of wasted resources and lower efficiencies if the regulator intervenes in bonus distributions to shareholders.

The valuable experience of the UK regulation model that other nations can take on board is that price capping regulation is not simpler than rate of return regulation and does not use less information. In fact, both regulation models required the same amount of information. Furthermore, the regulator should amend regulations according to the review schedule and should not attempt to intervene to enhance operational efficiency. The regulator may intervene in regulated enterprises when there are pressures from governments, consumers and market competitors.

Regulators feel intervention is necessary to protect consumers from the high profiteering of regulated enterprises. Price capping regulation should introduce reforms to replace an annual bonus system or the profit sharing system (Burns, Turvey and Weyman—Jones, 1995). Profit sharing methods have caused a high level of concern in the UK and worldwide, as the design and costs incurred by the profit sharing system were disputed and not discussed revealing the intention of some enterprises to hide profits.

The profit sharing system is based on the price capping regulation but may be misunderstood and seen to be another system altogether. In fact, price capping regulation includes the profit sharing system. High profits are designed to show in following review periods, and do not reflect annual systems of profit sharing system.

We can prove the theory in the following case. Assume £1 per annum was generated from efficiency improvement. We assume an 8% conversion rate and that the cost-down would reflect in higher profits. If all things remained equal, the final benefits would be distributed as 32% to investors while 68% would be distributed to consumers.

The detail calculation per below:

$$\text{PV of } \pounds 1 \text{ for 5 years @ } 8\% / \text{PV of } \pounds 1 \text{ in perpetuity @ } 8\% = 3.99/12.49 = 31.95\%$$

The premise of this formula is that the net value of the efficiency improvement per £1 (assume 8%) would be returned to enterprise investors per five-year review period. After the five-year period, the net value of the efficiency improvement per £1 would be returned to consumers. Furthermore, the X-factor requires that 32% efficiency improvement benefits be distributed to enterprises investors while the rest of the 68% is distributed at a lower price to all consumers. The above 32/68 proportion is based on the assumption that the regulated enterprise shows improvement in the first year of the five-year period. If the improvement takes place after a few years, consumers enjoy greater benefits after the distribution. If the premise of the above calculation did not change till the fifth year, then the proportion between consumers and investors would be as high as 7/93. Therefore, price capping regulation is a profit sharing system where the timing of the benefit distribution is disputed. In price capping regulation, the consumers could be awarded their share of the profits ahead of the Investors.

3. The theory of incentive regulation

The theoretical foundation of incentive regulation in public utilities is the notion of optimal regulation. At present, there are two performance evaluation directions of the incentive regulation theory - the price capping regulation and the yardstick regulation. The Incentive regulation aims to induce regulated enterprises to improve efficiency, quality and the overall performance. The regulator adopts an intervention strategy to encourage the industry to embrace competition, to award those who uphold the regulation and punish those violating the regulation. Incentive regulation in public utilities adopts a framework of principle-agent relationships, where the regulator is the principle and regulated enterprises are the agents. Both parties tend to maximize its effective functions; where the regulators aim to maximize the social welfare function while regulated enterprises aim to maximize profits.

The economic incentives of price capping regulation have forced telecommunication network operators to increase or maintain service quality. According to one case study on telecommunication network operators, a substitution relationship was found between effectiveness and quality (Northworthy & MacDonald, 1994). The substitution relationship literally means consumers still pay the same prices even though service quality is down graded. Therefore the quality index should be incorporated as a contingency method for the calculation of total productivity. Thus, as service quality decreases, total productivity should fall accordingly. For instance, there are 18 states in USA which include 'service quality' as an item in its call rate evaluation. There are three states which include 'service quality' in price capping regulation schemes. Quality index data was collected from the open data of ARMIS (Automated Reporting Management Information System). However at present, there is not any reputable open data available in Taiwan.

Incentive regulations which aim to be successful in the telecommunication industry should include a thorough price index. A price index should incorporate significant indices and performance criteria such as the total turnover of the telecommunication services, customers groups, total demand, a telecommunication quality index, capital costs and a measure for efficiency. Performance measurement indices play a significant role in total productivity, marginal costs, quality and technical improvement (Northworthy and Tsai, 1999: p?). Performance indices enhance price capping regulations and the implementation of incentive regulation by maximizing the function of economic incentives.

4. The foreign regulation experience

This section explores the advantages and disadvantages of the public utilities privatization model in the UK. This model is now becoming the worldwide privatization template.

The most significant advantage has been to enable former state-owned enterprises (now privatized enterprise) to improve efficiency and to increase benefits for investors and consumers. In general, consumers benefit in two ways - from lower service costs and higher service quality, except in water and sewerage services. In the case of water and sewerage services, low levels of investment prior to privatization resulted in the need for the investment of large funds to improve service quality. These investment costs were transferred onto the consumers. Investors have benefited from privatization regulation laws, sometimes with extraordinary profits. These huge profits have frequently raised much public concern.

On the downside, price capping regulation law did not work as easily as formulated in 1983. Price capping regulation must incorporate operational costs, capital costs and demand growth into the calculation model. The regulated enterprises must also agree to the capital costs, and asset evaluation as per the requirement of the price capping regulation. Asset evaluation is an area of dispute because of the huge variance among the share price, net value and replacement value. This is commonly regarded as if the enterprise privatized at discounted values.

It seems that privatization under regulation achieves better performance, especially when a more appropriate system is still in the making. The regulator and the regulated enterprises should learn from the mistakes of regulation failures. A significant phenomenon was the reduction in high profitability at the early stage of privatization after tighter regulation was introduced and competition was intensified. Those nations interested in privatization and the privatization regulation may look to the UK experience.

In particular, the following points may be noted:

- (1) The direct intervention of government departments into privatized enterprises may not offer the best solution and incentive for efficient and effective regulation. In privatized monopoly enterprises, a regulation office with a detailed plan and review mechanism would offer more effective economic performance and improvement and would benefit both investors and consumers.
- (2) The positioning of the regulation as an opposing force between the regulator and the regulated enterprise is another point for consideration. While business aims to make profits for its investors, the regulator aims to minimize the profits from the regulated enterprises in order to benefit the consumers. This conflict can be seen to strengthen the relationship between the regulator and the regulated enterprise. The relationship is optimal at a certain level of opposition. Conversely, concerns are raised if both parties have close and steady relationships. This leaves room for unethical exchanges of information and even lobbying on the part of privatized enterprises to receive favorable treatment

and weakening the protection of consumers.

(3) Price capping regulation may not be easy to implement as it requires planning and as much information as the rate of return regulation. However, price capping regulation can lead to lower supply costs if spot regulation interventions were not allowed prior to the set review date. In the long term, the benefits resulting from lower costs would benefit consumers. The only problem is the presence of high profits in the short term, which would attract public criticism.

(4) Huge profits generated by regulated enterprises raise public concern and complaints are targeted at monopolized enterprises. Regulators are often pressured by the public to intervene in regulated enterprises that enjoy high profits. However such intervention lowers the efficiency motivation of the price capping regulation within the regulated enterprise. The difference between the price capping regulation and the rate of return regulation would diminish within the term of the review as the huge profits are removed.

(5) Regulation simulates or serves as a substitution for competition in the marketplace to enable the regulated enterprises to improve its performance. However unlike the true competition, man-made regulation cannot fully stimulate performance improvement and further raises some public concern. Thus, the regulator is likely to introduce more competition as long as this leads to improved economic performance. Prior to 1999, the telecommunication, gas and power generation industries remained State-Owned-Enterprises. The water supply industry remained monopolized even though the UK government tried to aggressively introduce competition into the industry (DOE, 1996; Robinson, 1997). Regulations should enable and encourage newcomers rather than acting as a hurdle into the industry.

(6) In the UK, the regulator must report to the related minister and the parliament regarding all regulatory actions. At the same time, the independent regulation must take place from the substance mode of the regulation rather than the formality mode. The work of the regulator lies in its expert opinion in its area of jurisdiction and the continuity of its policies rather than its reporting function. The work of the regulator should also be less concerned with social and political issues such as income redistribution. The balance between independence and public accountability could be threatened if the regulator is required to report its activities to the general public and if political interventions overwhelm its independence. In some nations, an over-centralized, single regulator is less acceptable than a regulator with open and democratic procedures. Furthermore, a committee-style or panel-type of regulation organization is replacing the existing single regulator model and public hearings and juridical examinations are added to enforce the regulations.

The UK experience has shown that effective regulation and privatization can energize a lethargic S.O.E., and can benefit consumers. It is important to note that the UK model is built on a specific political and economic system. Thus, the UK regulation model cannot simply be transferred to other political systems or nations but must be adapted and modified to the local environment.

The experience of price capping regulation in both the UK and the US

There are two methods of price capping regulation in both the UK and the US. The first is gain-sharing price capping regulation and the second is the sliding-scale price capping regulation. (Need more information on these 2 types of regulation. How does this relate to the next paragraph?)

In the telecommunication industry, network operators can benefit from the huge economic incentives brought about by regulation and can share these benefits with their customers. This can occur if price cap menus take into account the distribution mechanisms needed when setting the range of the X-factors. As the X-factors increase, the lower proportion of productivity profits is shared with customers. For instance, in 1995 in setting the federal price capping menus, the FCC (the Federal Communication Commission, of USA) raised its X-factors from 3.3% to 4.0%. In this case, if the telecommunication network operators chose the smallest X-factors, then they would have to distribute all the targeted productivity profits to their customers. If the network operators chose the largest X-factors, then they would not have to distribute any of the targeted productivity profits to their customers. Furthermore, if the network operators chose the median X-factors, then they would have to distribute the targeted productivity profits to their customers proportionally.

This scenario has led to five out of the seven Regional Bell Operating Companies (R.B.O.C.s) choosing the maximum X-factors while claiming that average productivity growth was not expected to exceed 3%. It is obvious that there are issues regarding asymmetrical data existing between the regulation office and the regulated enterprises. Telecommunication network operators tend to partially hide costing information in order to seek higher prices which then justify the higher X-factor target.

Therefore, in such cases, selective price cap menu regulation can more clearly reveal the cost structure information in regulated enterprises and would add to the amount of information held by the regulator. This type of regulation would resolve cases of asymmetrical data.

Price capping regulation and the X-factor has played a significant role in economic incentives. Apart from being an index for costing structure and operational

performance for telecommunication network operators, it is also an entry point for incentive regulation by the regulator.

In the US, the process of outlining and finalizing the regulation was open and consultative. The FCC organized many open conferences in order to gather information and opinions across the board. This led to the development of a strategy to support the telecommunication network operators. The FCC, however, decided on the final version of the price capping regulation.

The key points in the regulation included the calculation of X-factor, the amendment method of the X-factors, the sharing system and the linkage of X-factor, and regulation for external costs. Thus, the procedure was justified as conscientious but without being aggressive.

In the US, however, the FCC was empowered to legislate its own regulation which is not the case in other nations, such as Taiwan. If Taiwan adopted the same kind of regulation, for example, it would probably cost more to implement. The Department of General Telecommunication (DGT) may encounter costs from lengthy time delays as parties with vested interests attempt to intervene in the regulation by lodging relevant proposals to parliament for auditing. Unlike the UK experience, where the regulator negotiates the price capping formula with network operators directly and proposes all necessary indexes, such as the X-factor, the DGT in Taiwan does not possess the necessary power and may be further undermined by public skepticism.

5. The regulation experience in Taiwan

In general, the telecommunication industry has begun to experience liberalization due to breakthrough technologies, a booming service industry and government awareness of the need for global competitiveness. The US began its liberalization of the telecommunication industry from the 1980's, and this trend was followed by many other nations including the UK, Japan, Australia, New Zealand and members of the EU..

In Taiwan, the government has not been able to ignore global trends of liberalization and faces strong demands from local business and foreign Telco investors alike. This has enabled Taiwan to increase its competitiveness in a couple of ways. Firstly Taiwan has been able to transform itself into a regional transit center and secondly, it has been able to join the WTO and thus meet the demands of liberalization from local business and foreign investors.

In Taiwan, the telecommunication industry underwent a fundamental transformation based on two factors. The first factor was the speed of breakthrough technology

which dynamically transformed and made possible the liberalization of the domestic industry. The second factor was the liberalization and deregulation of the telecommunication industry worldwide. The liberalization of the telecommunication industry in Taiwan was based on fair competition enabling new market entrants to compete with the existing monopolized operator. This further increased competitiveness among the worldwide telecommunication industry.

Structural and legal reform began in Taiwan in January, 1996 when three telecommunication laws were legislated. The monopolized industry was privatized into Chung-Hwa Telecom, separating operational and administrative functions. In 1997, the telecommunication industry was further classified into two categories of business operations - the mobile networks and international direct dial business (IDD). The market continued to be liberalized.

By the end of 1997, the mobile network carriers had been liberalized. By 1999, the satellite carrier's network had been liberalized. By 2001, the telecommunication industry had liberalized all its services to all its licensed service carriers including the local exchange, long distance calls, international direct dials, broadband exchange and data exchange.

In May, 1997, the regulator of the telecommunication industry in Taiwan, the DGT, announced that it intended to replace the existing remuneration regulation rate with price capping regulation. The objectives of price capping regulation were to enable telecommunication network operators to have greater flexibility with pricing and profit while battling in the fierce competition environment under liberalization. In order to achieve the objectives, the price capping regulations included the incentive of costs reduction, and limited the previous monopolized advantages of Chung-Hwa Telecom in the market.

This research study looks at the process of legislating the price capping regulation which is economically oriented and based on economic and technical considerations. It further discusses the directions of governmental regulations and the process of formulating a more optimal regulation which is productive, rewarding and innovative.

According to the 26th Clause of the telecommunication (where is this from? Is it a charter, is it a piece of regulation? Please define): price capping regulation is only suited to the 1st type of telecommunication business and stands as the general code for the industry (Mao, 1998). At the moment, currently the Department of Transportation has amended this clause.

Price capping regulation was first presented by Littlechild in 1983 and then adopted to implement the

privatization of British Telecom in 1984. Price capping regulation was further adopted by the Federal Communication Commission (FCC) in the US during the early nineties. Currently, the theory of price capping regulation is widely adopted in telecommunication liberalization around the world, in countries including the USA, the UK, Canada and many European nations. The main reasons for the wide adoption of the theory are the incentive for economic efficiency and performance regulation. The most distinguishing characteristics of price capping regulation are that telecommunication network operators must achieve productivity goals set by regulations and that the rewards may be greater than under the previous remuneration rate regulation.

The idea of price capping theory with the X-factor of the price capping regulation was based on the goal of growing productivity. This concept also reflected if the telecommunication network operators had achieved the productivity goal, and then formulated the price within a maximum price range. If a telecom network operator achieved the productivity goal of the designated period, they were entitled to keep the super profit after deducting all operational costs and normal profit margins. The regulator would then reset the price capping maximum for the next period based on the performance of the previous period.

The productivity growth rate (the X-factor) is a significant factor in the study of price capping regulation which is used to set productivity growth targets for telecommunication network operators. Price capping formulae need to achieve effective economic efficiency incentives and performance regulation. From the point of view of consumers, higher productivity growth targets mean higher economic performance and higher economic returns could easily be achieved. In the longer term, price caps would be adjusted downwards by telecommunication network operators. The lower productivity growth target would cause a higher price capping goal. Thus, the network operators would achieve a higher rate of return and after-tax profit with costs-down operational policies and an improvement of service quality.

The incentive mechanism of price capping theory is derived from asymmetric data in an optimal regulation framework. Under price capping regulation, the regulator cannot easily predict the real costs of every type of telecommunication service and may not be able to accurately forecast cost savings due to managerial and technical improvements. However, the regulatory office may be able to design price capping formulae or various regulation contracts to induce telecommunication network operators to pursue maximum profit and cost reduction strategies. The regulation office may be able to design optimal price capping formulae or suitable regulation contracts which encourage telecommunication network operators to pursue profits, by selecting the best cost-down measures

which reflect actual costs.

When formulating the incentive mechanism of price capping regulation, the regulatory office must take into account two factors. The first factor is that network operators may reduce service quality to achieve cost-down results and the second factor is that network operators previously achieved profits from cross subsidization by operating both regulated and non-regulated telecom businesses.

For instance, in the U.S, local exchange carriers (L.E.C.s) operating in the local distance call market had to compete against inter-exchange carriers (I.X.C.), which were permitted to operate a local exchange service to compete with existing LECs. When there is cross subsidization, the long distance exchange and local exchange may not compete as fiercely as expected. Moreover, the improvement in the service quality of the LEC would be very limited if there were no real market competition.

6. Conclusion and its implications

This paper discusses the direction of governmental regulation in the area of price capping regulation and how to formulate optimal regulations prioritizing productivity, incentive investment and innovation. Laffont & Tirole (1993), endorsed optimal regulation as the goal of any price capping regulation framework. Price capping regulation and the method to induce more cost effective productivity and quality was further explored.

After the WTO classified the telecommunication industry as a global trading system and liberalization led to a maturing of the telecommunication industry, it was seen that price capping regulation would be better suited to a competitive market structure. Therefore this research is based on a new type of dynamic economic model with capital input. It has explored the incentives of price capping regulation and illustrated the measurement of total productivity in price capping regulation. It has looked at price capping regulation and sliding scale regulation from both economic and technical viewpoints during the process of liberalization in the telecommunication industry.

In the US, price capping regulation in 1991 and the Telecommunication Act of 1996 achieved several outcomes. Some phone users enjoyed the benefits of updated technology and there was competition among local exchange carriers. Furthermore proposed production growth goals were achieved despite fierce competition.

Many economic and finance regulation theories are based on asymmetric information. Incentive mechanisms of price capping regulation are based on telecommunication network operators having a sound

knowledge of costs and know-how in order to setup the incentive contract. Telecommunication network operators claim that price capping regulation has caused a drop in productivity, but in the case of the UK and the US, it has been shown that telecommunication enterprises can achieve high profitability from efficiency and increase benefits to customers. To ensure success of selective price capping regulation in the US, telecommunication network operators were allowed to choose preferred contracts in authorized business categories.

To enable the general public to benefit from increased productivity and quality, and lower prices from competition, price capping regulation formulae must incorporate a design of the optimal service index which includes measurement of service quality. While the substitution relationship between productivity and service quality has been proven in the US, in an emerging market, like Taiwan, the measurement of service quality methods and research methods must be linked to the index of price capping regulation.

Current accounting procedures do not offer the best information-gathering system for the telecommunication industry. Telecommunication network operators are frequently not called on to demonstrate the performance of the industry and pricing is not based on individual costs. In Taiwan, the DGT and Chung-Hwa Telecom came under public attack with complaints of unfairness, sloppy administrative procedures and lack of openness, when they tried to implement the call rate rationalization by addressing the telecommunication rate adjustment scheme. Public criticism also focused on the lack of detailed information for example in the case of the method for calculating the amortization of personnel costs. The difficulty was that the system did not distinguish between each type of business costs in the amortization of costs. In Taiwan, the accounting system for the telecommunication industry is based on the unified accounting procedures of the auditing department of the Executive Yuan, which is calculated based on departmental rather than on the rate of specific services or amortization.

It is clear that the research and control of the costing structure is very important. Thus it is crucial to establish a cost accounting system as a first priority. Telecommunication network operators must comply with the accounting procedures of the governmental auditing system and with corporate costs analysis and operating income accounting.

The findings of this paper indicate that regulation issues in the telecommunication industry are not simply domestic issues, but are a global phenomenon. In the future, the telecommunication industry will be faced with domestic and international competition. Therefore, consideration must be given to foreign competitors when formulating regulations. In this regard, the WTO has

played a significant role in the telecommunication industry by regulating competition and by acting as a major influence on the liberalization of the fundamental structure of telecommunication services and the direction of operations. As a result, Taiwan has adopted the new regulation model more quickly in order to improve operational performance by domestic telecommunication companies. In addition, the government is paying closer attention to the WTO conferences and decisions which help align the domestic telecommunication industry in Taiwan with international competition.

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The Mathematical Programming and the Rule Extraction from Layered Feed-forward Neural Networks

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Abstract

We propose a mathematical programming methodology for identifying and examining regression rules extracted from layered feed-forward neural networks. The area depicted in the rule premise covers a convex polyhedron in the input space, and the adopted approximation function for the output value is a multivariate polynomial function of x , the outside stimulus input. The mathematical programming analysis, instead of a data analysis, is proposed for identifying the convex polyhedron associated with each rule. Moreover, the mathematical programming analysis is proposed for examining the extracted rules to explore features. An implementation test on bond pricing rule extraction lends support to the proposed methodology.

Keywords: Rule extraction, Neural Networks, Mathematical programming, Bond-pricing

1. Extracting Regression Rules from Neural Networks

Rumelhart and his colleagues in [3] proposed a learning algorithm, named the Back-Propagation learning algorithm, for training layered feed-forward neural networks. Since then, varieties of Artificial Neural Networks (ANN) have been widely used in many fields. However, in many applications, it is desirable to extract knowledge or rules from the trained ANN for the purpose of exhibiting a high degree of comprehensibility of ANN and gaining a better understanding of the problem domain. More precisely, it is desirable to have a solid way of extracting rules from a well-known ANN, like layered feed-forward neural networks, and then examining these extracted rules to gain more information about the problem domain.

In literature, there are some recent studies related to extracting rules from the trained ANN. For instance, [7], [8] and [10] extract rules from a trained ANN for classification problems; [6] and [5] from a trained ANN for regression problems. In their paper [5, p.1279], Saito and Nakano state "one future direction for knowledge-extraction technique is enabling to deal with neural networks of real-valued outputs." Thus, in this study we focus upon developing a solid way of extracting and analyzing regression rules that deal with the real-valued outputs.

From the literature, the rules extracted from the

trained ANN for regression problem most typically take the following syntax:

If (premise), then (action). (1)

The premise is a Boolean expression that must be evaluated as true for the rule to be applied. For example, a rule premise is $x \in \{x: 0.2 \leq x_1 + 2x_2 \leq 10.2\}$, where x is the outside input vector. The action clause consists of a statement or a series of statements, and is executed only when the premise is true. For example, a rule action is that the output value y is approximated by $g(x)$. The approximation function $g(x)$ can be a piece-wise linear function (cf. [6].) or a multivariate polynomial function whose power values could not be restricted to integers (cf. [5].). Specifically, the regression rules take the following syntax:

If ($x \in$ the i^{th} Area), then ($y' = g_i(x)$), (2)

where y' is the approximation of the output value y . The Area depicted in the premise covers a region in the input space. This type of rules is acceptable because of its similarity to the traditional statistical approach of parametric regression. The treatment of many topics using traditional statistical approach aims to strip away nonessential details and to reveal the fundamental assumptions and the structure of reasoning.

To identify the premise of a single rule, [6] and [5] focus on a way of data analysis on the training sample set or the generated sample set. The generated sample set contains data instances yielded from the trained ANN. With either training or generated sample set for extracting rules, the amount of data instances is finite, and the premise of a resulted rule covers merely discrete points, instead of an area. Impractically, to really catch the rules embedded in the trained ANN, the size of the data set should reach infinity. Besides, [6] and [5] have not provided a solid way of examining the extracted rules to gain useful information for the problem domain.

Here we propose the mathematical programming methodology for not only identifying regression rules extracted from layered feed-forward neural networks, but also examining the extracted rules to gain useful information. The Area depicted in the rule premise covers a convex polyhedron in the input space, and the adopted approximation function $g(x)$ is a multivariate polynomial function of x . The mathematical programming analysis, instead of a data analysis, is suggested for identifying the convex polyhedron associated with each rule. The mathematical programming analysis is also used to examine the extracted rules to explore features.

This paper is organized as follows. Section 2 gives details of the proposed method. Section 3 presents a study of applying the proposed method to the bond-pricing. Finally, Section 4 offers some conclusions and future work.

2. The Proposed Mathematical Programming methodology

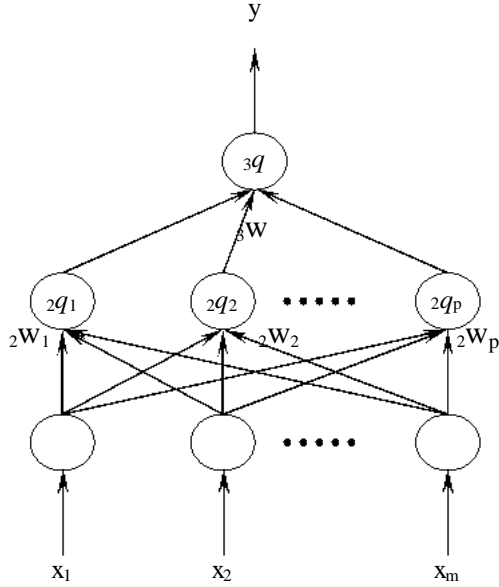


Figure 1: The feed-forward neural network with one hidden layer and one output node.

Without losing the generality, we take the network shown in Figure 1 as an illustration of the proposed methodology. The network is a three-layer feed-forward neural network with one output node. In Figure 1, y denotes the output value of the neural network, and $x^t = (x_1, x_2, \dots, x_m)$ whereas x_i denotes the i -th outside stimulus input, with i from 1 to m , where m is the amount of stimulus input. ${}_2w_j^t = ({}_2w_{j1}, {}_2w_{j2}, \dots, {}_2w_{jm})$ stands for the weights between the j -th hidden node and the input layer, with j from 1 to p , where p is the amount of used hidden nodes, and ${}_3w^t = ({}_3w_1, {}_3w_2, \dots, {}_3w_p)$ stands for the weights between the output node and all hidden nodes. ${}_2q_j$ is the bias of the j -th hidden node and ${}_3q$ is the bias of the output node. The activation function

$\tanh(t) = \frac{e^t - e^{-t}}{e^t + e^{-t}}$ is used in all hidden nodes and the

linear activation function is used in the output node. That is, for the c -th input ${}_cx$, the activation value of the j -th hidden node ${}_ch_j$ and the output value ${}_cy$ are computed as in equations (3) and (4).

$${}_ch_j = \tanh\left(\sum_{i=1}^m {}_2w_{ji} {}_cx_i + {}_2q_j\right) \quad (3)$$

$${}_cy = \sum_{j=1}^p {}_3w_j {}_ch_j + {}_3q \quad (4)$$

To extract comprehensible multivariate polynomial rules from the layered feed-forward neural network with the $\tanh(t)$ activation function, an approximation of the

$\tanh(t)$ function is necessary. The following way of approximation is proposed. Assume that we are interested in the first and second ordered differential information. Then, the following function $g(t)$ is proposed to approximate $\tanh(t)$:

$$g(t) = \begin{cases} 1 & \text{if } t \geq k \\ b_1 t + b_2 t^2 & \text{if } 0 \leq t < k \\ b_1 t + b_2 t^2 & \text{if } -k \leq t < 0 \\ 0 & \text{if } t < -k \end{cases} \quad (5)$$

where $(b_1, b_2, k) = \arg(\min_{b_1, b_2, k} \int_{-k}^k (\tanh(t) - g(t))^2 dt)$, subject to $b_1 k + b_2 k^2 = 1$. $g(t)$ is continuous at boundaries of four polyhedrons ($t = k, t = 0, t = -k$), because $\lim_{t \rightarrow k^-} b_1 t + b_2 t^2 = 1, \lim_{t \rightarrow 0^+} b_1 t + b_2 t^2 = 0, \lim_{t \rightarrow 0^-} b_1 t - b_2 t^2 = 0$, and $\lim_{t \rightarrow -k^+} b_1 t - b_2 t^2 = -1$.

With the numerical analysis of Sequential Quadratic Programming (cf. [9].), we obtain $b_1 = 1.0020101308531$, $b_2 = -0.251006075157012$, $k = 1.99607103795966$, and

$$\min_{b_1, b_2, k} \int_{-k}^k (\tanh(t) - g(t))^2 dt = 0.00329781871956464.$$

$$g(t_j + {}_2q_j) = \begin{cases} 1 & \text{if } t_j \geq k - {}_2q_j \\ (b_1 {}_2q_j + b_2 {}_2q_j^2) & \text{if } 0 \leq t_j < k - {}_2q_j \\ (b_1 - 2b_2 {}_2q_j) t_j & \text{if } -k - {}_2q_j \leq t_j < 0 \\ b_2 t_j^2 & \text{if } t_j < -k - {}_2q_j \\ (b_1 {}_2q_j + b_2 {}_2q_j^2) & \text{if } t_j \geq k - {}_2q_j \\ (b_1 - 2b_2 {}_2q_j) t_j & \text{if } -k - {}_2q_j \leq t_j < 0 \\ b_2 t_j^2 & \text{if } t_j < -k - {}_2q_j \\ 0 & \text{if } t_j < -k - {}_2q_j \end{cases} \quad (6)$$

For the j -th hidden node, let ${}_2w_j^t x$. Thus $\tanh({}_2w_j^t x + {}_2q_j)$ can be approximated with $g(t + {}_2q_j)$, which is defined in equation (6). In other words, for the j -th hidden node, the activation value is approximated with a polynomial form of single variable t_j in each of four separate polyhedrons in the x space. For example, if $x = \{x: -{}_2q_j \leq {}_2w_j^t x \leq k - {}_2q_j\}$, then $\tanh({}_2w_j^t x + {}_2q_j)$ is approximated with $b_1 {}_2q_j + b_2 {}_2q_j^2 + (b_1 + 2b_2 {}_2q_j) t_j + b_2 t_j^2$. Thus, a comprehensible regression rule associated with a trained feed-forward neural network with p hidden nodes is like:

$$\text{If } x = \{x: -{}_2q_j \leq {}_2w_j^t x \leq k - {}_2q_j \text{ for all } j\}, \text{ then } y' = {}_3q + \sum_{j=1}^p {}_3w_j (b_1 {}_2q_j + b_2 {}_2q_j^2 + (b_1 + 2b_2 {}_2q_j) t_j + b_2 t_j^2).$$

To have a better representation of the area depicted in the rule premise, let us further introduce some notations. For the j -th hidden node, set i_j be 1 when the situation $k - {}_2q_j \leq t_j$ holds; 2 when $-{}_2q_j \leq t_j < k - {}_2q_j$ holds; 3 when $-k - {}_2q_j \leq t_j < -{}_2q_j$ holds; or 4 when $t_j < -k - {}_2q_j$ holds. Also,

$$\text{set } {}_2w_{j1} = {}_2w_j^t, {}_2w_{j2} = \begin{cases} {}_2w_j^t & \text{if } i_j = 1 \\ -{}_2w_j^t & \text{if } i_j = 2 \end{cases}, {}_2w_{j3} = \begin{cases} {}_2w_j^t & \text{if } i_j = 3 \\ -{}_2w_j^t & \text{if } i_j = 4 \end{cases}, {}_2w_{j4} = {}_2w_j^t, \\ {}_2u_{j1} = k - {}_2q_j, {}_2u_{j2} = (-{}_2q_j, {}_2q_j - k), {}_2u_{j3} = (-{}_2q_j - k, {}_2q_j), {}_2u_{j4} = k$$

$+ 2q_j, g_{j1}(t_j) \square 1, g_{j2}(t_j) \square \square_1 b_1 q_{j2} + b_{22} 2q_j + (b_1 + 2b_{22} 2q_j) t_j$
 $+ b_{22} t_j^2, g_{j3}(t_j) \square \square_1 b_1 q_{j3} - b_{22} 2q_j + (b_1 - 2b_{22} 2q_j) t_j - b_{22} t_j^2,$
and $g_{j4}(t_j) \square \square - 1$. Let $i \square (i_1, \dots, i_p)$ with $i_j \square \{1, 2, 3, 4\}$

for every $j, {}_1A_i \square \begin{bmatrix} w_{i1} \\ w_{i2} \\ M \\ w_{ip} \end{bmatrix}$, and ${}_1b_i \square (u_{i1}, u_{i2}, \dots, u_{ip})^t$.

Thus, for example, the premise $x \square \{x: -2q_j \leq {}_2w_j^t x \leq k - 2q_j \mid j = 1, 2, \dots, p\}$ can be expressed as $x \square \{x: {}_1A_i x \leq {}_1b_i \text{ with } i_j = 2 \text{ for every } j\}$.

In practice, the independent variables may have some constraints, and they are usually linear as shown in equation (7), where a_{ij} and ${}_2b_i$ are given constants. Let

$${}_2A \square \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1m} \\ a_{21} & a_{22} & \dots & a_{2m} \\ M & M & O & M \\ a_{n1} & a_{n2} & \dots & a_{nm} \end{bmatrix} \text{ and } {}_2b \square (b_1, b_2, \dots, b_n)^t.$$

Thus equation (7) can be expressed as ${}_2A x \leq {}_2b$.

$$a_{i1} x_1 + a_{i2} x_2 + \dots + a_{im} x_m \leq {}_2b_i, i = 1, 2, \dots, n \quad (7)$$

In sum, there are 4^p polyhedrons in the input space where the corresponding output value y is approximated with a multivariate polynomial function. The potential rule associated with the i -th polyhedron $\{x: A_i x \leq b_i\}$ in the input space is similar to the one shown in equation

$$(8), \text{ where } A_i \square \begin{bmatrix} {}_1A_i \\ {}_2A \end{bmatrix}, b_i \square \begin{bmatrix} {}_1b_i \\ {}_2b \end{bmatrix}.$$

$$\text{If } x \square \{x: A_i x \leq b_i\} \text{ then } y' = 3q + \sum_{j=1}^p {}_3w_j g_{ji}(t_j) \quad (8)$$

However, some of these 4^p potential rules are null. The Simplex algorithm (cf. [2].) can be applied to identify the null rules. If $\{x: A_i x \leq b_i\}$ is empty, the rule associated with the i -th polyhedron is null. $\{x: A_i x \leq b_i\}$ is a convex polyhedral set in the input space because $A_i x \leq b_i$ consists of linear inequality constraints. Furthermore, $\{x: A_i x \leq b_i\}$ is non-empty if the linear programming (LP) problem (9) has an optimal solution. In other words, if LP problem (9) has an optimal solution, then the rule associated with the i -th polyhedron $\{x: A_i x \leq b_i\}$ exists. Otherwise, that rule fails to exist. The process of extracting existing rules is summarized in Table 1.

$$\begin{aligned} &\text{Minimize: constant} \\ &\text{Subject to: } A_i x \leq b_i \end{aligned} \quad (9)$$

Table 1: The process of rule extraction.

- Step 1: Input all weights and biases of the trained feed-forward neural network to form ${}_1A_i$ and ${}_1b_i$.
- Step 2: Input the constraints associated with the independent variables to form ${}_2A$ and ${}_2b$.

Step 3: For each of the 4^p potential rules, says

$$\text{If } A_i x \leq b_i, \text{ then } y' = 3q + \sum_{j=1}^p {}_3w_j g_{ji}(t_j)$$

where $A_i \square \begin{bmatrix} {}_1A_i \\ {}_2A \end{bmatrix}$ and $b_i \square \begin{bmatrix} {}_1b_i \\ {}_2b \end{bmatrix}$, examine

whether the corresponding LP problem has an optimal solution. If the corresponding LP problem has an optimal solution, then the rule exists. Otherwise, that rule fails to exist.

$$\text{Minimize: } \frac{y}{x_k}$$

$$\text{Subject to: } A_i x \leq b_i \quad (10)$$

$$\text{Maximize: } \frac{y}{x_k}$$

$$\text{Subject to: } A_i x \leq b_i \quad (11)$$

Features embedded in the feed-forward neural network can be explored via further analyzing the existing rules. Take as an illustration the exploration of the relation between y' and the k -th independent variable x_k . The null hypothesis H_0 states there is no relation between y' and x_k while an alternative hypothesis H_1 argues $\frac{y'}{x_k} > 0$, and another alternative hypothesis H_2 is

that $\frac{y'}{x_k} < 0$. For the i -th polyhedron $\{x: A_i x \leq b_i\}$,

$\left. \frac{y'}{x_k} \right|_{x \square \{x: A_i x \leq b_i\}} > 0$ if the minimal solution to the optimization problem (10) is greater than zero, and $\left. \frac{y'}{x_k} \right|_{x \square \{x: A_i x \leq b_i\}} < 0$ if the maximal solution to the optimization problem (11) is less than zero. Because of the approximation stated in equation (5), $\frac{y}{x_k} =$

$$\sum_{j=1}^p {}_3w_j \frac{g_j(t_j)}{x_k} \text{ and}$$

$$\frac{g_j(t_j)}{x_k} = \begin{cases} 0 & \text{if } t_j \leq k - 2q_j \\ {}_2w_{jk}(b_1 - 2b_{22} 2q_j) & \text{if } {}_2q_j \leq t_j \leq k - 2q_j \\ {}_2w_{jk} b_{22} t_j & \text{if } k - 2q_j \leq t_j \leq {}_2q_j \\ {}_2w_{jk}(b_1 - 2b_{22} 2q_j) & \text{if } k \leq {}_2q_j \leq t_j \leq {}_2q_j \\ {}_2w_{jk} b_{22} t_j & \text{if } t_j \leq k - 2q_j \end{cases} \quad (12)$$

Thus, the optimization problems (10) and (11) are LP problems, and accordingly, they can be solved via the Simplex algorithm.

As for identifying features such as

$$\frac{y'^2}{x_k^2} \square 0 \text{ if } x_i \square x_j, \text{ the proposed method is as follows. For instance, let } \frac{y'^2}{x_k^2} \text{ be a negative constant at}$$

the [3,3,3,3]-th polyhedron. Thus “ $\frac{\partial^2 y'}{\partial x_k^2} > 0$ if $x_i < x_j$ ”

is not true at the [3,3,3,3]-th polyhedron, and “ $\frac{\partial^2 y'}{\partial x_k^2} < 0$

if $x > x^*$ ” is true at the [3,3,3,3]-th polyhedron if and only if the LP problem (13) has an optimal solution.

Minimize: constant

$$\text{Subject to: } A_{[3,3,3,3]} x^3 b_{[3,3,3,3]}, x_i > x_j \quad (13)$$

3. The Rule Extraction in the Bond-Pricing Application

This section adopts a case of bond-pricing to examine the proposed methodology. The domain knowledge with respect to the bond pricing model has been well established and thus serves to help investigating the learning process. In equation (14), bond price at time t , denoted by P_t , is governed by four factors: (1) r_t the market rate of interest at time t ; (2) F , the face value of the bond, which generally equals 100; (3) T_t term to maturity at time $t = 0$; and (4) C , periodic coupon payment, which equals $F r_c$.

$$P_t = \sum_{k=1}^{T_0} \frac{C}{(1+r_t)^{k \Delta t}} + \frac{F}{(1+r_t)^{T_0 \Delta t}} \quad (14)$$

By assuming one coupon payment per year (that is, coupon payments are made every 12 months), there are five well-known theorems with respect to bond prices which have been derived as follows: [3]

1. If a bond's market price increases, then its yield must decrease; conversely, if a bond's market price decreases, then its yield must increase. That is, $\frac{\partial P_t}{\partial r_t} < 0$.

2. If a bond's yield does not change over its life, then its discount or premium will decrease as its life gets shorter. That is, $\frac{\partial^2 P_t}{\partial T_t \partial r_t} < 0$, where $T_t = T_0 - t$ is the term to maturity at time t .

3. If a bond's yield does not change over its life, then the size of its discount or premium will decrease at an increasing rate as its life gets shorter. That is,

$$\frac{\partial^2 P_t}{\partial T_t^2} < 0 \quad \text{if } r_c < r_t$$

$$\frac{\partial^2 P_t}{\partial T_t^2} > 0 \quad \text{if } r_c > r_t$$

4. A decrease in a bond's yield will raise the bond's price by an amount which is greater in size than the corresponding fall in the bond's price, and the fall will occur if there is an equal-sized increase in the bond's yield. That is, $\frac{\partial^2 P_t}{\partial r_t^2} > 0$.

5. The amount change in a bond's price due to a change in its yield will be higher if its coupon rate is higher.

That is, $\frac{\partial^2 P_t}{\partial r_c \partial r_t} < 0$. (Note: This theorem does not

apply to bonds with a life of one year or to bonds that have no maturity date, known as consols, or perpetuities.)

We generate the training samples from a hypothetical period of 80 trading days, during which we derive r from a normal random number generator of $N(2\%, (0.1\%)^2)$. Then we use six hypothetical combinations of terms to maturity and contractual interest rate as depicted in Table 2, and generate the data with eighty measures of t , with $t = 1/80, 2/80, \dots, 80/80$ via equation (14). Thus we have 480 training samples with input variables T_t, r_c and r_t , and the desired output value of P_t , where $T_t = T_0 - t$ is the term to maturity at time t . The constraints of these input variables are listed in equation (15).

$$(1 \leq T_t \leq 4) \text{ AND } (0 \leq r_c \leq 0.030) \text{ AND } (0.016 \leq r_t \leq 0.023) \quad (15)$$

Table 2: Six hypothetical short-term bonds. Assume coupon payments are made annually.

Term to maturity (T_0)	Contractual interest rate (r_c)
2	0.0%
4	1.5%
2	3.0%
4	0.0%
2	1.5%
4	3.0%

We adopt the Back Propagation learning algorithm to train 100 feed-forward neural networks, each of which has 4 hidden nodes and different initial weights and biases. The final weights and biases of the feed-forward neural network with the minimum sum of square error are as follows: ${}_3q = 98.571$, ${}_2q_1 = -1.565$, ${}_2q_2 = 0.335$, ${}_2q_3 = -1.310$, ${}_2q_4 = -2.341$, ${}_3w^1 = (-5.531, -1.995, 4.625, -0.871)$, ${}_2w_1^1 = (0.393, -36.344, 15.955)$, ${}_2w_2^1 = (0.145, -40.733, -36.784)$, ${}_2w_3^1 = (0.409, 45.318, -62.477)$, and ${}_2w_4^1 = (0.027, 50.463, 100.840)$. We take this neural network as an illustration. Thus

$$t_1 = 0.393 T_t - 36.344 r_c + 15.955 r_t \quad (16)$$

$$t_2 = 0.145 T_t - 40.733 r_c - 36.784 r_t \quad (17)$$

$$t_3 = 0.409 T_t + 45.318 r_c - 62.477 r_t \quad (18)$$

$$t_4 = 0.027 T_t + 50.463 r_c + 100.840 r_t \quad (19)$$

$$\begin{aligned} g_{11}(t_1) &= 1.000 & \text{if } t_1 &\leq 3.561 \\ g_{12}(t_1) &= 2.183 - 1.788 t_1 + 0.251 t_1^2 & \text{if } 1.561 < t_1 < 3.561 \\ g_{13}(t_1) &= 0.953 - 0.216 t_1 + 0.251 t_1^2 & \text{if } 0.431 < t_1 < 1.561 \\ g_{14}(t_1) &= 1.000 & \text{if } t_1 > 0.431 \end{aligned} \quad (20)$$

$$\begin{aligned} g_{21}(t_2) &= 1.000 & \text{if } t_2 &\leq 1.661 \\ g_{22}(t_2) &= 0.307 - 0.834 t_2 + 0.251 t_2^2 & \text{if } -0.335 < t_2 < 1.661 \\ g_{23}(t_2) &= 0.363 - 1.170 t_2 + 0.251 t_2^2 & \text{if } 2.331 < t_2 < 0.335 \\ g_{24}(t_2) &= 1.000 & \text{if } t_2 > 2.331 \end{aligned} \quad (21)$$

$$\begin{aligned} g_{31}(t_3) &= 1.000 & \text{if } t_3 \leq 3.306 \\ g_{32}(t_3) &= 1.744 - 1.660t_3 + 0.25t_3^2 & \text{if } 1.310 \leq t_3 \leq 3.306 \\ g_{33}(t_3) &= 0.882 - 0.344t_3 + 0.25t_3^2 & \text{if } 0.686 \leq t_3 \leq 1.310 \\ g_{34}(t_3) &= 1.000 & \text{if } t_3 \leq 0.686 \end{aligned}$$

(22)

$$\begin{aligned} g_{41}(t_4) &= 1.000 & \text{if } t_4 \leq 4.337 \\ g_{42}(t_4) &= 3.721 - 2.177t_4 + 0.25t_4^2 & \text{if } 2.341 \leq t_4 \leq 4.337 \\ g_{43}(t_4) &= 0.970 - 0.173t_4 + 0.25t_4^2 & \text{if } 0.345 \leq t_4 \leq 2.341 \\ g_{44}(t_4) &= 1.000 & \text{if } t_4 \leq 0.345 \end{aligned}$$

(23)

$$\begin{aligned} y' &= 98.571 - 5.531 g_{1i_1}(t_1) - 1.995 g_{2i_2}(t_2) \\ &\quad + 4.625 g_{3i_3}(t_3) - 0.871 g_{4i_4}(t_4) \end{aligned} \quad (24)$$

Among the 256 (4^4) potential rules associated with this neural network, there are only eleven existing rules shown in Table 3. Namely, the other 245 potential rules are null. In Table 3, two polyhedrons are adjacent if they have adjacent values in one index and same values in the other indexes. Table 4 displays the amount of training samples contained in the corresponding polyhedron of each existing rule. Rules 3, 4, 5, 9, 10, and 11 provide the information of y in polyhedrons which contain no training samples.

In practice, we may be interested in features of first and second order differentiations of bond price; namely, the general principles about $\frac{y}{r_c}$, $\frac{y}{r_t}$, $\frac{y}{T_t}$, $\frac{y^2}{T_t r_c}$, $\frac{y^2}{r_c^2}$, $\frac{y^2}{r_t^2}$, $\frac{y^2}{T_t r_t}$, $\frac{y^2}{r_c r_t}$, $\frac{y^2}{T_t^2}$, $\frac{y^2}{r_c^2}$, and $\frac{y^2}{r_t^2}$.

$\frac{y^2}{T_t r_c}$, $\frac{y^2}{r_c r_t}$, $\frac{y^2}{T_t^2}$, $\frac{y^2}{r_c^2}$ and $\frac{y^2}{r_t^2}$. Then, from the eleven existing rules, we can examine the corresponding features embedded in the feed-forward neural network. Table 5 reports the result of such examination, indicating that $\frac{y}{r_c} > 0$ and $\frac{y}{r_t} < 0$ are true in all polyhedrons. Namely, the result lends support to the two rules. The rules of $\frac{y^2}{T_t r_c} > 0$, $\frac{y^2}{T_t r_t} < 0$, $\frac{y^2}{r_c^2} < 0$ and $\frac{y^2}{r_t^2} > 0$ are true in almost all polyhedrons.

The above learning process, nevertheless, is subject to a Type I error [1] for $\frac{y^2}{T_t r_c} > 0$. Specifically, $\frac{y^2}{T_t r_c} > 0$ is not unequivocal in the bond-pricing field. There are some relationships between T_t and r_c by intuition; for example, the price increases if T_t and r_c both increase and the price decreases if T_t and r_c both decrease. But we do not know exactly whether the price increases or decreases when T_t decrease while r_c increases, or vice versa. Thus $\frac{y^2}{T_t r_c} > 0$ is not an unequivocal characteristic in the bond-pricing field.

Table 3: The coefficients in each multivariate polynomial associated with each existing rule.

Rule No.	<i>i</i>				Coefficients									
	<i>i</i> ₁	<i>i</i> ₂	<i>i</i> ₃	<i>i</i> ₄	Constant	T _t	r _c	r _t	T _t r _c	T _t r _t	r _c r _t	T _t ²	r _c ²	r _t ²
R1	2	2	3	2	109.193	-3.526	403.598	-387.214	-1.955	-46.049	-4459.398	0.419	5605.512	7785.223
R2	2	2	3	3	106.798	-3.470	506.882	-180.822	-3.154	-48.446	-8908.414	0.418	4492.314	3339.985
R3	2	3	3	2	109.081	-3.623	430.899	-362.559	9.905	-35.338	-7460.240	0.398	3944.009	6430.268
R4	2	3	3	3	106.686	-3.568	534.183	-156.168	8.706	-37.735	-11909.255	0.397	2830.810	1985.030
R5	3	2	3	3	99.997	-0.057	191.007	-42.152	76.108	-83.242	-5688.151	-0.010	824.626	2633.130
R6	3	3	2	2	98.294	2.277	390.772	-604.042	3.154	48.446	8908.414	-0.418	-4492.314	-3339.985
R7	3	3	3	2	102.280	-0.210	115.025	-223.889	89.168	-70.135	-4239.977	-0.031	276.322	5723.413
R8	3	3	3	3	99.885	-0.154	218.308	-17.498	87.968	-72.532	-8688.992	-0.031	-836.877	1278.175
R9	3	3	4	2	101.734	-0.861	42.876	-124.422	46.161	-10.845	2334.218	-0.225	-2107.996	1191.714
R10	3	3	4	3	99.339	-0.805	146.159	81.969	44.962	-13.241	-2114.797	-0.225	-3221.195	-3253.524
R11	4	3	3	2	102.538	0.260	71.541	-204.800	49.537	-52.737	-5850.108	0.184	2110.166	6076.841

Table 4: The amount of training samples in the corresponding polyhedron of each rule.

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11
Amount of training samples	1	79	0	0	0	80	240	80	0	0	0

Table 5: The explored features.

Characteristic	$\frac{y}{r_t}$		$\frac{y}{r_c}$		$\frac{y}{r_t}$		$\frac{y^2}{r_t r_c}$		$\frac{y^2}{r_t r_t}$		$\frac{y^2}{r_c r_t}$		$\frac{y^2}{r_t^2}$		$\frac{y^2}{r_c^2}$		$\frac{y^2}{r_t^2}$	
	>0	<0	>0	<0	>0	<0	>0	<0	>0	<0	>0	<0	>0	<0	>0	<0	>0	<0
R1	No	Yes	Yes	No	No	Yes	No	Yes	No	Yes	No	Yes	Yes	No	Yes	No	Yes	No
R2	No	Yes	Yes	No	No	Yes	No	Yes	No	Yes	No	Yes	Yes	No	Yes	No	Yes	No
R3	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	No	Yes	Yes	No	Yes	No	Yes	No
R4	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	No	Yes	Yes	No	Yes	No	Yes	No
R5	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	No	Yes	No	Yes	Yes	No	Yes	No
R6	No	No	Yes	No	No	Yes	Yes	No	Yes	No	Yes	No	No	Yes	No	Yes	No	Yes
R7	No	No	Yes	No	No	Yes	Yes	No	No	Yes	No	Yes	No	Yes	Yes	No	Yes	No
R8	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	No	Yes	No	Yes	No	Yes	Yes	No
R9	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	No	Yes	Yes	No
R10	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
R11	Yes	No	Yes	No	No	Yes	Yes	No	No	Yes	No	Yes	Yes	No	Yes	No	Yes	No

Table 6: The results of the examining rules

Rule Characteristic	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	Ratio(%) ¹
$\frac{y}{r_c} > 0$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100.00
$\frac{y}{r_t} < 0$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100.00
$\frac{y^2}{r_t r_c} < 0$	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	90.91
$\frac{y^2}{r_c r_t} < 0$	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	81.82
$\frac{y^2}{r_t^2} > 0$, if $r_c > r_t$	- ³	-	-	-	-	Yes	Yes	-	-	-	No	66.67
$\frac{y^2}{r_t^2} > 0$, if $r_c < r_t$	Yes	Yes	Yes	Yes	No	No	No	No	No	No	-	40.00
$\frac{y^2}{r_c^2} > 0$	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	81.82
Ratio ²	100	100	100	100	83.33	42.86	85.72	83.33	66.67	66.67	83.33	-

1. (The number of "Yes") / (The total number of "Yes" and "No") in one characteristic.
2. (The number of "Yes") / (The total number of "Yes" and "No") in one rule.
3. There is not a polyhedron that $r_c > r_t$ or $r_c < r_t$.

The corresponding features extracted from the trained neural network can be compared with the ones derived from the well-known bond pricing theorems. Such a comparison can help us gain out knowledge about the bond-pricing, and also investigate whether the learning is effective.

Table 6 shows the result of comparing features embedded in the neural networks with the ones derived from these well-known theorems. This table demonstrates that these rules have a mean of 100.00%

((100.00+100.00)/2) in satisfaction of both features $\frac{y}{r_c}$

> 0 and $\frac{y}{r_t} < 0$, and a mean of 72.24%

((90.91+81.82+66.67+40.00+81.82)/5) in satisfaction of

other four features. Moreover, each rule has an average satisfaction of 82.90 % on these six features. The results of the extracted rules are proved positive.

4. Conclusions and Future Work

In this study, we propose a mathematical programming methodology for extracting and examining regression rules from layered feed-forward neural networks. The mathematical programming analysis, instead of a data analysis, is proposed for identifying the premises of multivariate polynomial rules. Also, the mathematical programming analysis is claimed with the aim to explore features from the extracted rules. The proposed methodology can provide regression rules and features not only in the polyhedrons with data instances, but also in the polyhedrons without data instances.

Furthermore, the proposed method can be applied to any non-linear rules and features, as long as the adopted approximating function holds the proper nonlinear information. The approximating function $g(x)$ used in equation (5) here is designed as a piece-wise second order nonlinear function due to the assumption that we are interested in only the first and second order differential information. With respect to the bond-pricing application, features with the first and second ordered characteristics can be explored from extracted rules. Generally, $g(x)$ can be a piece-wise higher order nonlinear function, and the proposed method can be applied to the new $g(x)$.

In contrast with Setiono et al. [6], the approximating function used in equation (5) has a better total absolute error than the one associated with the approximating function proposed in Setiono et al. [6]. With the dataset used to extract rules approaches infinity, our total absolute error almost equals 0.124056, while theirs almost equals 0.142338 [6].

Issues worthy of future studies include the application of the proposed methodology to real world data, how to delete redundant constraints from the premise of a rule, and how to integrate extracted rules.

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The Role of Components of Data Flow Diagram in Software Size

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Abstract

Managing and estimating a good software is not an easy task. Because software estimation activities are concerned not only with time and effort scheduling, but also with specifying work activities, skill levels and scheduling of necessary resources. With duration, effort and other factors overlooked, poor reliability and functionality of software may occur. Furthermore, inaccurate estimation will lead to high pressure for the working team, and poor quality of final development. Hence, designing a right software metric is an important task. Due to these reasons, a software size model is being developed using a sample consisting of 122 student projects. This model takes several advantages: (1) there tends to be fewer counting problems than other software metrics, because this model is based upon simple counts; (2) the predicted software projects were calibrated to specific local environments rather than being based upon industry weights; (3) basic size components can be identified easily at the early stage of the development life cycle; (4) the model provides clues to project designers in planning and scheduling the development of new information systems.

1. Introduction

Software size models have become quite sophisticated since their introduction during the early 1970s. At that time, software development cost models were only based on a single parameter such as program size. These models were not accurate and reliable, as they were usually developed from a limited database, both in number of programs and a variety of applications. Furthermore, according to Boehm [2], these early models varied widely in their underlying assumptions and definitions of size, so the cost equations differed substantially.

Software size is a key factor to all software cost models, however, as late as the early 1980s, a few size estimation models were developed. Bozoki [4] developed a well-known expert judgment sizing model, a variant of which is now incorporated into the SEER family of models as SEER-SSM. PRICE Systems added a parametric sizing model. This model considers about twenty factors, including size calibration factor to estimate lines of code (LOC). Unfortunately, LOC is only restricted to using one particular language to estimate the software size.

Upon the introduction of Function Points Analysis by Albrecht [1], it is used to measure the functionality delivered by software and a measure about the functionality that the software delivers to the users [7] [13]. An extension of Albrecht method is known as Mark II

function points [13]. This model considers a system consisting of some logical transactions. Each transaction consists of inputs that are received, data stores that are referenced, updated and outputs that are generated. Based on the number of transactions in an information system, each transaction is individually sized and the total counts are obtained toward the overall information processing size for the whole system. In both of these two metrics, although significant effort has been devoted to strengthening the counting practices, but questions of subjectivity and measure interdependence remains. Function point method is a complex process that required a degree of training [11] [3]. While Mark II function point uses industry average weights as a measurement for construction. It is unclear how representative the systems contributing to the average are, and how stable the averages are over time. In addition, it is also unclear such weights are appropriate for new systems as well as system enhancements [12].

A similar approach, developed by Verner et al. [15], which is a bottom-up method in which the final counts of software are determined by summing up all individual components. The results of the method were very significant, but the sample data is restricted to only one system. This implies the model may not be generalized to other environments.

2. Research model

The objective of the study is to explore the possibility of developing a software metric using 4GL software projects. The model is simple and easy in estimating software size. It can be applicable to other software projects within the same environment as well. In the study, two sets of project specifications are examined. The first set is user specification, and the second set is program size in terms of executable statements (size).

2.1 User specification

The user specification is Data Flow Diagrams (DFDs) from which the software size components are extracted directly. This approach is totally different from those based on LOC and other software metrics, because the software size is predicted and estimated using simple counts (components) at the early stage of the development life cycle. Based on the details of DFDs, the software size components are extracted directly. Before studying the details of DFDs about the software projects, the context diagram is evaluated first. Walking through the context diagram, it shows how software projects are modeled and

interact with other modules/systems as a whole if any. However, context diagram is not detailed enough for representing the whole project's data movement, because it lays out only the sources/sinks and a single process with a generic name representing the entire software. There are no data stores and other components identified at this level. So DFDs are studied for understanding the entire software project level by level. By studying DFDs, project designers have better understanding about the data movement throughout a business process or an information system that the data undergoes.

From the first level of DFDs, it shows the main processing activities of the entire software project, such as processes are shown and data stores are added at this level. It is probably the most informative level compared to context diagram, because the context diagram gives project designers little information about what the software functions. Before proceeding with an explosion of next level of DFDs, project designers must be aware of the balance of the child diagram against the parent. To do so, they make sure both the 'data in' at the child level is identical with or adds up to the 'data in' at the parent level and that the 'data out' at the child level is identical with or adds up to the 'data out' at the parent level. The data pass between the processes on the child DFDs do not enter into this evaluation because they are internal to the process at the parent level.

After completing the level balancing, project designers explore each process on the balanced diagram into its own DFD. However, input and output requirements remain constant at that level but the data stores and sources are changed. If there are more details about each data process required, the next level explosion is continued by determining the next lower level's process until it cannot be subdivided, or it cannot be broken down to a point where the bubbles have a single input data flow and a single output data flow. This level is considered functionally primitive [6], because it cannot be further partitioned into subordinate components or the lowest levels have been reached [14] [6] [9] [8], so that the partitioning process is complete.

2.1.1 Calculation of software size components

When the entire software project is broken down into the functional primitives, we are in a better position to extract and count the size components. Before the components are counted toward the final size of a software project, it is essential to evaluate all DFDs carefully by determining their correctness. Because numerous errors, omissions, and inconsistencies can occur for several reasons, such as forgetting to include a data flow, making an arrowhead in the wrong direction, incorrect labeling

processes and/or data flow, or creating unbalanced decomposition in child diagrams etc. If the error checking procedure is complete, the process of identifying the size components can be started. The followings are the counting procedures for identifying the software size components.

(a) Input entity (in_enty)

The input entity refers to those input screens enter the boundary of an interface of a software project, or those are directly connected to different processes/modules by data flows. An input screen can be used for the creation of a new record, or can be used to change some existing data items from a database, or to delete an existing record. In the study, different functions of input screens are counted toward the size components. For those input screens that may not require any processing logic at all, such as a start menu or a query input screen. They are summed together to represent one input entity.

(b) Data flow(data_flow)

Data flows are those arrows flowing within each functional primitive. These arrows are those arrive at the processes/modules from input entities, or those enter from one process to another, or to data stores, or those leave from data stores to processes, and those depart from processes to output entities. Each occurrence of data flow within all functional primitives is counted toward the size.

(c) Process

Process is a transformation process for manipulating the incoming data and generating output according to the program statements given. The process component is important to each functional primitive, as it reflects the complexity of the module of the software. Thus, the higher the module complexity, the more interactions are required between input and output activities. In each functional primitive, the functions of the process are varied, such as updating the input data, verifying the existence of an entity (record) or preparing the outputs etc. All processes in each functional primitive are counted toward the size.

(d) Data_store

Data stores are the permanent or semi-permanent places for storing transaction data, they include the master files, transaction files, table files or any other semi-permanent files. The functions of the data stores are used either for looking up or updating purpose, depending on the

transaction processing required. If the data stores are used for looking up purpose, the counting of these data stores are summed together for representing only one data store. Since they are not required for transaction/data processing. However, if the files are used for updating purpose, such as changing the data items or deleting a record, then the data stores are counted individually. As they require different logic for transaction processing.

(e) Interaction

The number of interactions counted toward the software size including the data or control information passed between processes. The counting of interaction between two processes can be one way or two ways. In other words, in a functional primitive, a process acts as a calling process, while another one acts as a called process. In between, when a calling process only directs a called process to perform a specific job by passing either data or control information or both at the same time, one way of interaction is counted. Otherwise, when the called process finishes the execution, it is required to pass the processed information to the calling process, two ways of interactions are counted.

(f) Output entity (out_enty)

For each report/output screen that leaves from the boundary of a module/process after processing, it is counted once if different processing logic is required. On the other hand, if both output screen and printed report are the same length and having the same output data items, only one output entity is counted toward the final size. However, the following outputs are summed together as an output entity and counted toward the final size of the software project:

- i. A selection of menu screen: a displayed main menu offers several choices of selection are summed together, because they required no processing logic;
- ii. A starting output screen: like the initialization of conversational processing which leads the user to execute different jobs;
- iii. A query language output: a displayed message/output screen does not require any processing logic before it is retrieved.

After extracting the size components from all functional primitives, they all are added together and put into the equation for running multiple regression. The complete picture of the model using the size components identified above is presented in Figure 1.

2.2 Size

Size is the measure for expressing how large of the software is in terms of complexity. It is considered as a dependent variable. In this study, the size is referred to the total number of source statements run-on lines with a continuation indicator as a single statement. It excludes blank and comment lines of code, and other job control languages.

3. General data characteristics

All software projects in this study comprising the sample were built over a period of ten years by groups of senior students. Every software project was built to satisfy the real requirements of the external clients, normally most of the clients are from small medium enterprises. Before each project's work activity was carried out by a group of students, they were required to use a prototyping process for development, meeting with their clients on around three occasions over nine-week development period. This process is to ensure that the projects being developed would be satisfied and accepted by the clients. The projects addressed transaction processing, data retrieval and reporting, and file maintenance activities performed by the organizations. Under the software process employed, a software proposal outlining the functionality to be delivered was signed off by the client after one week. On system delivery, the client performed an acceptance test and system review. All projects satisfied the requirements of both the clients, as evidenced by the reviews, and the course administrators, as indicated by the marks awarded (although marks varied over the sample). A wide variety of software projects were constructed over the period. In total, more than seventy distinct working software projects were developed and reviewed.

Although the developers were students, they were in the final segment of their third or fourth year degree. Almost all of them completing their degrees went on to hold development positions with three months of the completion of the projects in the sample. More importantly, the software projects developed were functionality sound, providing an actual working solution to an actual client system. The students all had an equivalent amount of previous experience with the tools and the methodology used.

All software projects were implemented using the same tool, the Cogos 4GL Powerhouse. The software projects were all of the same generic class, such as transaction oriented data processing and retrieval applications. This commonality is advantageous in these factors that can be considered as constant in the system analysis, a condition not often encountered in software size research. When

they vary, factors such as these can clearly have an impact on software size. Given the potential contributors may be treated as constant, the degree of confidence adopted in regard to any size relationships supported by the data will consequently be greater.

Wdf is the coefficient of a data flow
 DF is the number of data flows
 Wds is the coefficient of a data store
 DS is the number of data stores
 Wo is the coefficient of an output entity
 O is the number of output entities

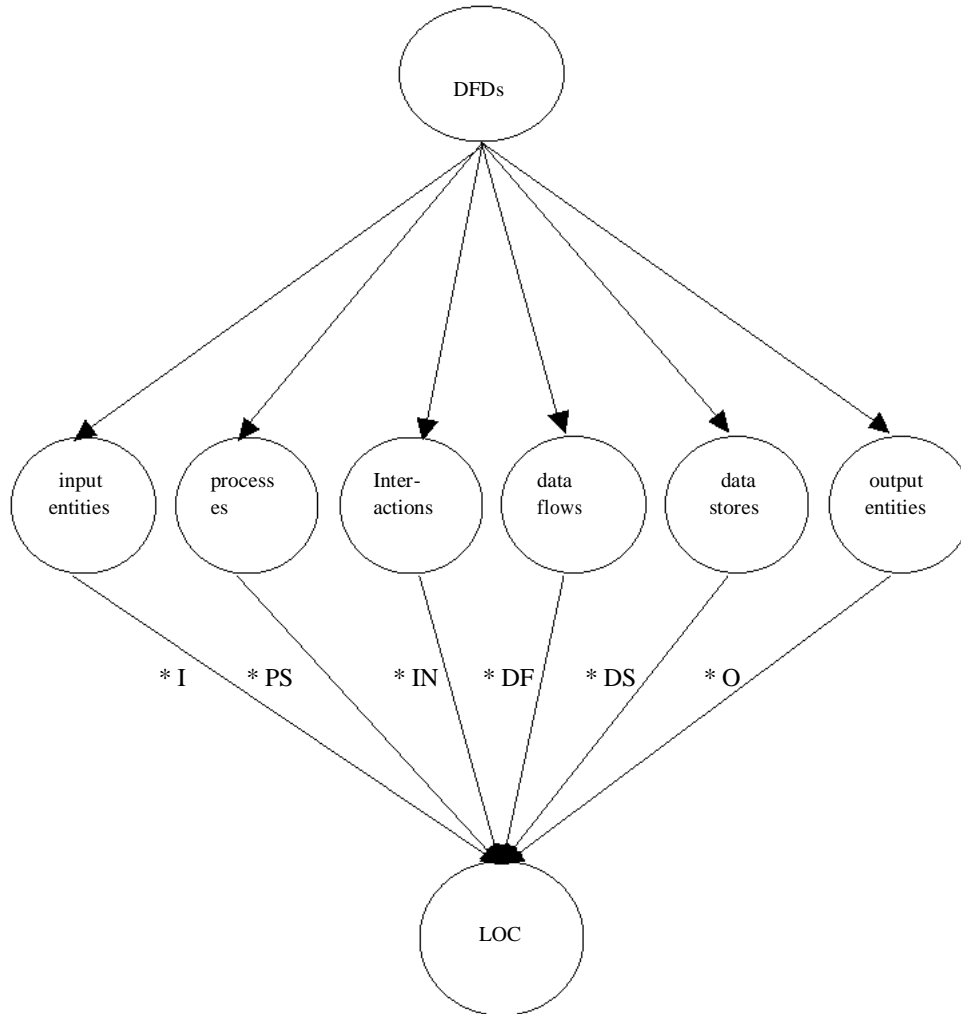


Figure 1- Size estimation using components of DFDs

$$LOC = Wi*I + Wps*PS + Win*IN + Wdf*DF + Wds*DS + Wo*O$$

Where:

- Wi is the coefficient of an input entity
- I is the number of input entities
- Wps is the coefficient of a process
- PS is the number of processes
- Win is the coefficient of an interaction
- IN is the number of interactions

4. Research methodology

The whole sample of 122 software projects is divided into two subsets of data randomly. The larger subset is called main sample consisting of two third of software projects. This subset is used for primary modeling analysis and prediction. The smaller subset called holdout sample

consisting of one third of software projects. This subset is used for validation of models developed previously using the main sample. In the study, a linear multiple regression analysis is applied for estimating and predicting the software size.

To evaluate the accuracy of regression model, the mean magnitude of relative error (MMRE) and the threshold oriented predicted measure are used. The accuracy of a project estimate is measured using the magnitude of relative error (MRE). The MRE is calculated for a project using the following formula:

$$MRE = 100 | (ACT - EST) / ACT |$$

where MRE is the magnitude of relative error, EST is the value of estimated size of a software project (in terms of LOC) and ACT is the value of actual size of a software project (in terms of LOC). Thus, the smaller the value of MRE, the better the prediction. But one important thing is that the positive and negative errors will not cancel each other out. So that the larger the value of MRE, the worse the prediction. Therefore, in an attempt to produce on average a good set of predictions, MMRE is calculated using the following formula:

$$MMRE = (1/n) \sum_i MRE_i$$

However, even the MMRE is small, there may be one or more predictions that can be very bad. So a second measure is used to examine the cumulative frequency of

MRE for a specific error level. We use the measure called PRED (p) or Prediction at Level p suggested by Conte et al. [5]. If k is the number of projects in a set of n projects whose $MRE \leq p$, the $PRED(p) = k/p$. Following the suggestion of Conte et al. [5], we report the PRED (.25) level for the estimation method. A value of $PRED(.25) \geq 0.75$ is considered desirable for size estimation.

5. Correlation analysis

Given the small degree of skewness and influential outliers are identified in some of the independent variables, the remedying steps are performed if necessary. It is essential to assess the independent variables whether they meet the basic assumptions, so as to identify any potentially useful (linear) relationships between dependent variable (size) and independent variables, as well as among independent variables themselves. After remedying the basic violations for some of independent variables, the stepwise multiple regression analysis is performed. The detailed results are presented in Table 1. Examination of the correlation matrix indicating there is a strong correlation results between dependent and independent variables. Since our focus is only to identify general patterns within the entire set of observations, the individual observations should not be omitted as they may strongly influence the regression results. Therefore, we need to identify them and access their impact if necessary.

Table 1 - Correlation coefficients

Variable	Size	In_enty	Out_enty	Interaction	Process	Data_flow	Data_store
Size	1.000	-	-	-	-	-	-
In_enty	.833	1.000	-	-	-	-	-
Out_enty	.596	.491	1.000	-	-	-	-
Interaction	.495	.415	.465	1.000	-	-	-
Process	.735	.574	.415	.310	1.000	-	-
Data_flow	.498	.373	.527	.346	.407	1.000	-
Data_store	.738	.574	.500	.429	.481	.394	1.000

All are significant at 0.01

In Table 2, it indicates the model summary of selected variables before and after removing 11 influential observations. Examination of correlation matrix shows that there is not only close relationship between dependent and independent variables, but also improving both values of

adjusted R^2 and the standard error of the estimate. Therefore, we believe the influential observations identified previously have tremendous impact on final regression results. Thus, we accept the selected variables listed in the 'after' column for inclusion in the regression model.

Table 2 - Comparison of model summary of selected variables

Variable	Before			After		
	R ²	Adjusted R ²	Std. Error of the Estimate	R ²	Adjusted R ²	Std. Error of the Estimate
In_enty	.501	.494	213.59	.693	.689	200.43
Process	.757	.750	241.25	.794	.789	195.64
Data_store	.826	.819	230.18	.856	.851	187.73
Out_enty	.845	.836	200.95	.866	.859	170.01

From Table 1 and Table 2, the dependent variable is fully correlated to all independent variables. In other words, the independent variables have varying degree of effect on the dependent variable. Among the independent variables, IN_ENTY is mostly and highly correlated with SIZE. It is firstly considered for inclusion into the regression equation. According to the results presented in Table 2, the adjusted R² of IN_ENTY is 0.689 (which is about 69 %). By this value, it explains about 69% of effect of IN_ENTY to the SIZE. This is in the expected direction. Our concern is to estimate the size of software projects as early as possible using known variables. In system analysis stage of the development life cycle, in_enty is relatively easy to identify from each module/process using DFDs. More in_enty implies more time and effort are spent in designing and constructing the software. Therefore, IN_ENTY has a major effect to the size of software projects and it is in the expected direction.

The multiple R value has increased with the addition of the PROCESS variable by 7.2%. While the adjusted R² value has increased by 0.1. Indicating with the inclusion of this variable, it adds about 10% to the validity of SIZE which the software project has explained. This is true since the size of software projects can increase accordingly when more PROCESS is involved for processing. At the system analysis phase of the development life cycle, the number of PROCESS could be easily determined using DFDs. In a complete transaction, process is one of the components interacting with input and output. More PROCESS implies higher software complexity and complicated interactions between components of software projects. Therefore, the more the number of PROCESS involved for processing, the higher the complexity of the system interface.

The multiple R value is increased with the addition of DATA_STORE variable by 3.2%. While the adjusted R² has increased by 0.062, it implies with the inclusion of this variable, adding 6.2% to the validity of SIZE which the software has explained. The same result achieved was very

significant in a study conducted by Itakura et al. [10]. Its R² achieved was 0.8. In another study reported by June et al. [14], the R² achieved was 0.98 which is the highest correlation coefficient as compared to other independent variables under the same study.

In every module, the access to data store is necessary. The access to data store could be a simple query, addition, deletion or changing process. The influence of access to data store to size of software projects depends on what kind of function it performs. The influence of access to data store using a simple query would be less compare to the function of adding new records to the same data store. The simple query function does not require higher complex steps in operations, while addition function requires more interactions if more data stores are involved.

Finally, with the inclusion of OUT_ENTY, the multiple R value is increased by 0.3%. While the adjusted R² has increased 0.008, it implies that with the consideration of this variable. It adds 0.8% to the validity of SIZE which the software has explained. The explanatory power of this variable is small, it contributes less than 10% to the SIZE. Because producing the details of OUT_ENTY is fully depending on IN_ENTY, PROCESS and DATA_STORE. The output of the report is generated directly by retrieving from DATA_STORE, and the level of complexity required for producing a report relies on the design of process. Therefore, the portion of effect to size of software projects by OUT_ENTY is already explained by both PROCESS and DATA_STORE.

Among the independent variables, DATA_FLOW is the first one to reject due to insignificant effect to the size. As pointed out previously, data flow is used to connect components of DFDs showing the connections between components in functional primitives. After examination of data flow in DFDs, a data flow shows where the next process will be taken place after finishing the previous one, or where the next destination will be for retrieving the data from. Even in a large software project, it does not imply

that more designing effort is required accordingly, but from the occurrence of data flows in the software project, we can only know how the DFDs components are connected. If there are many data flows in the software projects, it means there are more other DFDs components are connected accordingly. However, since data flows don't reflect processing in the functional primitives. Therefore, the variable DATA_FLOW has no impact to the size of software project and is rejected.

For INTERACTION variable, some detailed processing steps may not be known to system designers at the system analysis stage of the development life cycle, especially when complexity of software projects is large and complex. At the early stage, we may not be very easy to investigate how DFDs components interact with each other. DFDs only show data movement from one state to another within an entire software project. It would not show the logic or complexity required in a module, even project designers have ideas about how modules interact with one another by passing data or control information from one to another. These ideas could be implemented using other programming techniques, for instance, structure chart or Warnier-Orr Diagram etc. Therefore, the variable INTERACTION is rejected.

With the completed model regression estimation, the regression variate specified, and the diagnostic tests that confirm the appropriateness of the results administered, we can now examine the predictive equation, which includes IN_ENTY, PROCESS, DATA_STORE and OUT_ENTY. The predictive equation is written as follows:

$$Y = -2008.689 + 37.330 (\text{IN_ENTY}) + 253.428 (\text{LOG}(\text{PROCESS})) + 207.779 (\text{LOG}(\text{DATA_STORE})) + 7.743 (\text{SQRT}(\text{OUT_ENTY}))$$

where Y is the dependent variable measured in thousands of LOC, IN_ENTY is the number of input entities, PROCESS is the number of processes after taking logarithms, DATA_STORE is the number of data stores after taking logarithms, and OUT_ENTY is the number of output entities after taking square root. By using this equation, the expected thousands of LOC can be calculated.

6. Validation

After developing the model using the main sample, a validation process is followed using the holdout sample. Before the estimated size of each software project is calculated, the independent variables of the holdout sample are transformed by taking logarithms and other transformation process if necessary.

There are some estimation errors introduced when the software projects were analyzed. The relative errors of

these projects are ± 0.2 but with some minor exceptions. It looks like a good model when the mean relative errors (.03) are calculated. A good model will lead to small values of relative errors and generally to a small mean relative error [5]. However, since it is possible that large positive relative errors can be balanced by large negative relative errors, a small mean relative error may not imply that a model is a good one. So the magnitude relative error is computed for each project. Thus, the smaller the value of magnitude relative error, the better the prediction. Even more important, positive and negative relation errors do not balance each other, so that the larger the value of magnitude relative error, the worse the prediction.

In order to produce a good set of project predictions, the mean magnitude relative error (.09) is calculated. The mean magnitude relative error is evaluated using a set of 36 projects whose mean magnitude relative error is $\leq .25$. The calculated PRED (.25) = .86. That is to say, in this model, 86% of the predictions for the cases in the set fall within 25% of their actual value. Therefore, this model is being accepted for software size estimation.

7. Conclusion and limitations

The paper studied the effect of the components of DFDs in determining the size of software projects. The analysis indicates the size components are accurate and reliable in predicting the size of software projects if they are extracted at the early stage of the development life cycle. Further, it shows that project managers have better understanding about planning and controlling the software development activities before the software projects are developed.

For project designers, the results of the study provide several insights for future software projects development. (1) the size components are easily extracted from DFDs during system analysis stage. Compared to other software metrics, development effort and duration are minimized without waiting until the entire software is fully developed. (2) the weights are determined after running linear multiple regression using a large sample, as a result, the weights are very reliable for representing the effort devoted to software engineering activities. (3) the model is easier to apply to similar environment. Since the results of the study are calibrated from large sample, the model can be generalized to other similar software projects. (4) the model is very suitable for both small and medium companies, especially for those which are lack of experience project designers and need better management and tighter control at lower cost.

The results in this study appeared promising. However, we should be aware of the following limitations. First, the software projects are small and medium in terms of program complexity. The results of the model are applicable to the similar software projects, such as transaction processing,

data retrieval and reporting generation. Second, the designers in the study are students, the final results of the model may be different if the software projects are developed by the experienced programmers. Third, the model developed in the study specifically emphasized on data-strong software projects, function-strong and hybrid-strong software projects may not be appropriate.

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Web Services for forward integration in international tourism supply chains: A case study of tourism in Thailand

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Abstract

International tourism is a highly competitive and information-intensive industry. Customers need volumes of information for decision aids. Moreover, the decision-making processes are quite sensitive to the variables of personal preferences, the tourist industrial ecosystem, the legal regulations and political environments of destinations, the regional or global economic situations, the natural matters, and so on. Hence, the owners of tourism are motivated to upgrade the competitiveness of their businesses with information technologies. This paper intends to design the architecture of Web Services in international tourism, which can contribute to the forward integration in international tourism supply chains. First, the authors conduct an in-depth case study of a regional tour operator in Thailand. In the case study, we examine the strength, weakness, challenges visions, and strategic approaches of international tourism, and their relationships with the information systems in the tourist business. Then, this paper designs the architecture of Web Services in international tourism. The architecture is expected to improve the information transparency through the global tourism supply chain, construct business-to-business collaboration mechanism, provide efficient and effective information to tourists, and consequently contribute to forward integration in international tourism supply chains.

Keywords: international tourism, Web Services, Business-to-Business collaboration, forward integration, case study.

1. Introduction

International tourism is a highly competitive and information-intensive industry. Customers need volumes of information for decision aids. Moreover, the decision-making processes are quite sensitive to the variables of personal preferences, the degree of competition inside the tourist industry, the legal regulations and political environments of destinations, the regional or global economic situations, the natural matters such as SARS, and so on. Hence, the owners of tourism are motivated to upgrade the competitiveness of their

businesses with information technologies.

The business owner's expectations toward information technologies are reflected on several aspects [1]. To compete with the new entrants, IT is expected to raise entry barriers, such as switching costs, product differentiations, and access to distribution channels. For the customer side, IT is expected to lift customers' selection, switching costs, differentiation, entry barriers, and the competence in forward integration. For the supplier side, businesses expect to increase their selection and competence in backward integration. To contend with the traditional intra-industry rivals, IT is expected to improve the cost-effectiveness, market access, service quality, differentiation in product, and finally the firm itself. IT is also supposed to generate new opportunities and competitive advantages throughout the value chain [2, 3]. The expected contributions of information technologies mentioned above apply to the international tourist industry as well, especially in companion with the Internet and communication technologies. Hence the authors are motivated to conduct a research of the competitive situation and design the architecture of Web Services in international tourism, which can contribute to the forward integration in international tourism supply chains.

In the remaining part of this paper, the authors first analyze an international tour operator in Thailand in section two. The tour operator receives inbound tourists mainly from Hong Kong and Taiwan. In section three, this study summarizes the strengths, weaknesses, challenges, visions, and strategies of information technologies to improve competitiveness in the international tourism. We extract a set of propositions from the case study with managerial implications and insights. In the fourth section, this study presents the architecture of web service for business-to-business collaboration to satisfy the information needs and even the forward integration in an international tourist company. The discussions and concluding comments will be given in the final section.

2. Case study: a regional tour operator in Thailand

Company M was founded in Bangkok, Thailand in August 1996. As a tour operator in the international

tourism supply chains, it provides packages of tourism-related services for the customers, including some combination of accommodation, transportation, restaurants and attraction visits [4]. Based on Gee, Makens & Choy [5], the distribution system of travel sales can be classified into four types: one-stage, two-stage, three-stage, and four-stage systems. (See Fig. 1). As shown in Fig. 1, a tour operator like Company M runs its business in the two-stage, three-stage, and four-stage systems. So Company M's direct customers may be the travel agents, tour wholesalers, and individual or group tourists. Most of its tourists travel from Hong Kong and Taiwan. As one of the top three tour operators in the same target markets, it received approximately thirty thousands tourists from Taiwan and fifteen thousands tourists from Hong Kong in 2002. Company M provides various services for various purposes of inbound tourists to Thailand, including sightseeing, business trips, educational communications or interchanges, and supporting some large special projects, such as Asia games in 2000.

As some businesses in the highly competitive international markets, the company has undergone many challenges as well as opportunities since its foundation, yet still erects in tourism and keeps growing continually from a small company toward a medium-sized enterprise. Now there are 15 staffs working at their newly decorated home-like office during the business hours. Outside the humane office, around 40 to 60 professional tour guides travel all over the country with the tourists and provide the first line services.

The attraction of traveling Thailand can be the abundant cultural assets, good natural conditions, fascinating social customs, friendly local residents, economic tour packages, etc. However, some tour packages in Thailand have gained notoriety in the price war and poor service quality. Since 1999, Company M made a critical decision to get out of the sick price war and competition, and positioned itself as a tour company that provides high-quality, customer-oriented and personalized services, at the reasonable prices.

"Our company has invested significant efforts in innovation." Said the CEO. "Since 1999, we have developed several high-quality tour packages and gained positive criticism from the customers. In addition to the conventional sources of tourists like group travelers, we also provide personalized packages for the individual travelers. Our goal and strategy is to ensure that all tourists with different purposes can be satisfied and experience the most comfortable stay in Thailand."

"On the other hand, the company regards the employees as our most valuable properties." Continued the CEO. "All the employees, including the supporting staffs and the tour guides on the sites, are compensated with competitive salaries and benefits. Compared to our competitors, we invest and provide more opportunities in employee development. There are regularly workshops or seminars, which may help upgrade the work performance,

broaden the mindset, exchange experiences and problem-solving skills, and so on. During the storm of SARS, other tour companies just laid off the tour guides and staffs to survive. However, we sustain the coldest season with our employees by cost-saving as well as internal education and training. After the SARS disaster, the backflows of sightseers increase dramatically in the latter half of 2003. Most of our competitors became short of manpower and called the tourist guides on mission anxiously, but our company just got everything back to the normal situation with ease."

Despite the bright sides mentioned above, Company M still has its challenges and even threats. Growing from a small business toward a medium-sized enterprise, Company M has undergone the pains of authorization and structure reformation. Besides, the information delay and non-transparency reduce the responsiveness in marketing and amplify the time pressures. "Quite our information of end customers and markets are collected through the travel agents or wholesalers. They are who interact with the end customer, not us." The middle layers of information distributions usually result in information delay and inefficiency. At the supplier sides, the poorly automated transaction processes also become a burden on operations.

During 2003, the prime minister of Thailand has announced several new policies to the industry and commerce, including more rigid control over the tourist business and stricter tax policy. "We understand that the government's vision to upgrade this country and the whole environments; however, it is really tough for the business to change the conventions overnight." Complained the CEO.

Talking about the visions of Company M, some brilliant rays of light flash at the CEO's eyes. As one member of the tourism systems, Company M does not limit its role at the current position. In 2002, it achieved a phase objective to lead and became the top company in its target markets. The next-step of the strategic plan is to expand its role from a tour operator to an international travel enterprise group. "We expect the information systems to provide a communication platform between the end customers and us. All the travelers' demands or special requirements can be collected and met firsthand. The customers can also understand our products or enterprise through the Internet and submit their orders directly. There are no more essential needs of the middlemen between the customers and us." At the supplier side, Company M expects that information systems and the Internet work effectively as they would in at the customer side. Besides, it is developing a plan of backward integration for the future 5 to 10 years. "No matter how world goes on, we just keep proceeding with our goals." The CEO said full of meaning.

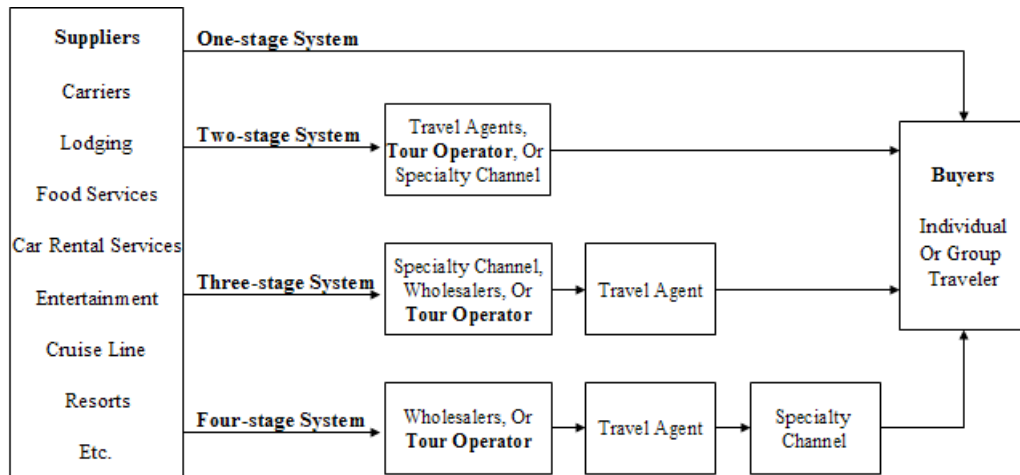


Fig. 1: Travel sales distribution system [5]

3. Implications and propositions from the case study

This study summarizes the strength, weakness, challenges, vision, and strategic approaches from the case company as Table 1.

Investigating the case deeply, this work extracts several propositions on the competition status of the international tourism and its impacts on the business investment and strategy forming. These propositions are listed as follow and illustrated as Fig. 2.

Proposition 1

The more aggressive the vision and more distinct the business objectives of the tour company, the stronger the intentions of the business owner to invest significantly in information systems and technologies—If the business owners have more strong initiative and more clear objectives in business vision, then they have stronger motivations to invest significantly in information systems and technologies.

Proposition 2

The more intensive competition inside the target market, the greater the likelihood for the tour operator to invest substantially in information systems and technologies—If the competition inside the target market are more intense, then the business will sense much more deeply the essentiality to maintain and upgrade their competitive advantages in the industry, compared to the opposite circumstances.

Proposition 3(a)

The greater the degree of substitution from the potential competitors (such as airway holidays), the greater investment of employee development the tour operator willing to make—If the potential competitors are more likely to provide packages or services with equal or similar utilities at competitive costs, then the potential

competitors will become more threatening. Hence the business owner will have more motivation to make investment in information systems and technologies to ensure their competitiveness.

Proposition 3(b)

The greater the degree of substitution from the indirect competitors/substitutes (such as the tour packages whose destinations are in other Southeast Asian areas, Northeast Asian, Australia and New Zealand, Oceania, etc), the greater investment of employee development the tour operator willing to make—Similarly, if the indirect competitors are more likely to provide products or services with equal or similar utilities at attractive prices, then the indirect competitors or substitutes will become more threatening. Hence the business owner will have more motivation to make investment in information systems and technologies to assure their competitiveness.

Proposition 4(a)

The more aggressive the tour operator's objectives toward forward vertical integration in the tour industry, the more significant investment the tour operator willing to put into the business-to-business integration technologies—Intuitively, if the tour operator has clear and strong objectives toward forward vertical integration, then the business-to-business integration technologies will be a powerful instrument for this goal.

Proposition 4(b)

The more aggressive the tour operator's objectives toward backward vertical collaboration in the tour industry, the more significant investment the tour operator willing to put into the business-to-business collaboration technologies—Similarly, if the tour operator has aimed aggressively at backward vertical collaboration, then the business-to-business collaboration technologies will be a powerful instrument for this target.

Proposition 5

The more clear and definite the tour operator's objectives toward backward vertical collaboration in the tour industry, the more likelihood that the tour operator makes efforts to persuade its suppliers (such as hotels, restaurants, etc) into the business-to-business collaboration technologies—This proposition is interrelated to Proposition 4(b). If the tour operator has definite objectives toward backward vertical collaboration, then the agreement and cooperation from the supplier side are very critical success factors. Therefore it will be motivated to win the supports from the supplier in business-to-business collaboration.

Proposition 6

The more rigid control from the government, the more likelihood that the tour operator will diversify their capital investments and business operations—The stricter legal and governmental environments cause the tour operator to diversify their business and capital investment for risk consideration.

In the following section, this paper will present the information system evolution in Company M, and how the information technologies, especially Web Services, can contribute to its vision from present through its long-term planning horizon.

Factor	Description
Vision	<ul style="list-style-type: none">● Maintaining the leading position in the market.● Forward integration from the current limited role of a tour operator, and get more control of the market through direct contact and communications with the end customers.● Backward integration with the suppliers, such as hotels, restaurants, entertainments, etc, to provide more guaranteed service quality for the tourists in the whole traveling processes.● Expand toward an integrated tourist enterprise group.
Approaches	<ul style="list-style-type: none">● Advances for more effective and efficient knowledge management systems.● Establishing a learning organization to accelerate the improvement of the manpower as well as the company.● New information platform and new information architecture for business-to-business collaboration and forward integration.

Table 1: Summaries of the case tour operator

Factor	Description
Strength	<ul style="list-style-type: none">● Good competition position in the industry.● Good relationships with the employees and competitive employee development strategies.● Innovations in product design.● Personalized services and customer oriented strategies.
Weakness	<ul style="list-style-type: none">● Immature authorization.● Lack of professional expertise in information technologies and technical supports.
Challenges	<ul style="list-style-type: none">● Pressures from business growth and transformation.● Changing governmental policies and more rigid legal environment.● Unpredictable natural disasters, such as SARS.● Uncontrollable economic depression or crises.● Vicious means from the competitors, such as the harmful price war.

4. Architecture of Web Services in international tourism.

In this section, we first describe the past and current information system architecture of Company M and then design a new architecture based on Web Services, which contributes to the vertical collaboration and integration in international tourism supply chains.

The information system architecture of the company has evolved in three phases: (1) stand-alone file system, (2) client-server architecture, and (3) Business-to-Business integration model.

At the first phase from Aug. 1996 to Dec. 1999, the CEO of Company M focused on the requirements of financial accounting and arrangement of tour packages. Thus, the information system was simply stand-alone file systems. The specifications were as follow:

- Platform: Microsoft DOS.
- Programming Language: CA Clipper.
- Database: dBase III.
- Network Connection: Not available.

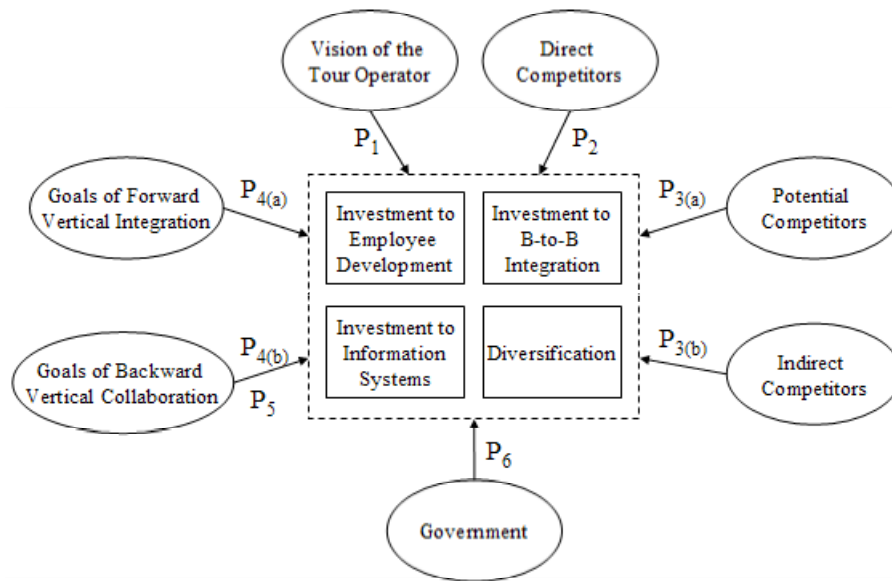


Fig. 2: A model of forming competitive strategy in the international markets

The drawbacks of the file system at this stage were:

- Data without synchronization and integrity.
- Lack of network connection.
- Difficulty to maintain and upgrade software.
- Lack of data management capabilities.

Since 2000, due to the drawbacks listed above, the CEO took the advice from one local information consulting company and decided to migrate the information system to client-server architecture (See Fig. 3).

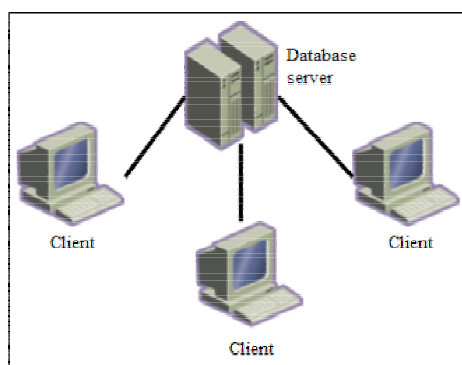


Fig. 3: Client-and-Server Architecture

Based upon this idea, the information system at the second phase included:

- Platform: Microsoft Windows.
- Programming Language: Borland Delphi.

- Database Server: Microsoft SQL Server.
- Network Connection: with LAN Connection.

Although the client-server architecture resolved the problem of data synchronization and integrity intra-company, however, the information sharing extra-companies, such as among hotels, airlines, tour agents and tourists is still completed in the traditional ways, such as fax, e-mail, telephone and mail, which are inefficient and involving high transaction costs. Hence, seeking an efficient way to exchange information among business partners become a critical issue.

Although the World Wide Web (WWW) is a simple way to share information, WWW involves lots of human efforts to parse the HTML-format document. The web pages may appear informative to readers, but their logic behind are highly unstructured and lack a predefined schema. Thus, it is difficult to understand the semantic meaning of diverse web pages and structure them in an organized way for systematic information retrieval.

The objective of Business-to-Business integration (B2Bi) is to eliminate the manual processes by allowing internal applications of different companies to directly exchange information. Additionally, there are enormous advantages of B2Bi [6]:

- Strengthen business relationships with partners and customers.
- Fast to market.
- Reduced cycle times and increase operational efficiencies.
- Enhance customer relationship.
- Reduce operational costs.

Although many B2Bi vendors provide application packages to support the B2Bi activities and particular industrial standards, such as EDI, RosettaNet, ebXML, cXML and etc., it is still expensive, proprietary, and lacks of flexibility due to the difficulty in achieving consistency and consensus for the business model of the entire organization. Therefore, the B2Bi models are often implemented in larger-scale enterprises.

Opposed to the problems of B2Bi, Web Services have the following potentials in revolution of business process collaboration [6]:

- **Interoperability:** Web Services can be written in any language, and any Web Services can interact with any other Web Services easily with the open standard protocols such as Hypertext Transport Protocol (HTTP), XML, Simple Object Access Protocol (SOAP), Web Services Description Language (WSDL) and Universal Description, Discovery and Integration (UDDI).
- **Industry Support:** Web Services address the Interoperability issue by having the widest industry support. Many major software vendors have involved in supporting the Web Services standard.
- **Ubiquity:** Since Web Services communicate with open standard protocols, any platform that supports these protocols can host and access Web Services.

Web Services has the following advantages [7]:

- **Open Standards:** Unlike proprietary enterprise solutions, Web Services are based on open standards. The fact that they are built on existing and ubiquitous protocols eliminates the need for companies to invest in supporting new network protocols.
- **Simple:** Web Services are easy to design, develop, maintain, and use as compared to the existing solutions which may involve distributed technology.
- **Flexible:** Since proprietary enterprise solutions may require point-to-point integration, changes made at one end have to be propagated to the other end, making them very rigid and time consuming in nature. Web Services-based integration is quite flexible, as it is built on loose-coupling between the applications.
- **Efficient:** Web Services allow applications to be broken down into smaller components, which make the integration of applications easier as it is done on a granular basis.
- **Dynamic:** Web Services provide a dynamic approach to integration by offering dynamic interfaces, whereas traditional EAI solutions are pretty much static in nature.

Web Services are a common program-to-program communications model, built on existing standards. The Web Services model is based upon the interactions among Service Registry, Service Provider and Service Requestor. The interactions involve the Publish, Find and Bind operations. Web Services use SOAP based messages to achieve dynamic integration between two different applications. Using WSDL describes the public and private application services. Fig. 4 shows the relationships among the relevant standards:

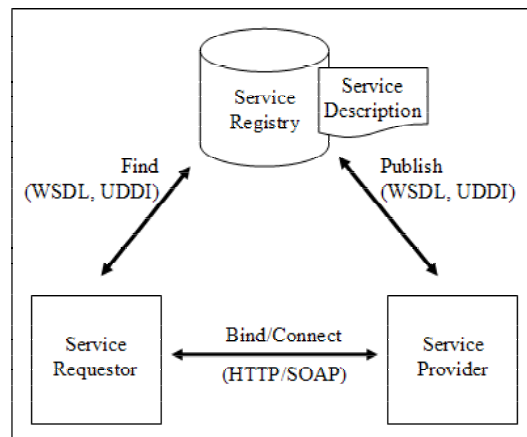


Fig. 4: Web Services Model [8]

The following summaries are the additional requirements from CEO of Company M at the third phase for Business-to-Business integration:

- Rapidly deployment.
- Reduce operational cost.
- Increase competitive advantage.
- Forward compatibility.
- Ease of installation and management.

Thus, based upon the summaries above, the Web Services Business-to-Business integration model is designed (Fig. 5):

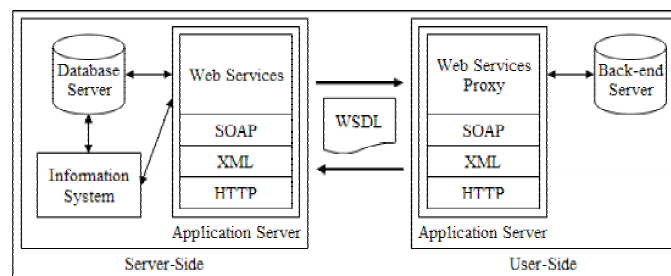


Fig. 5: Web Services B2Bi Model

The specifications of Web Services B2Bi model are:

- Platform: Microsoft Windows .NET platform.
- Application Server: Microsoft Internet Information Server.
- Database Server: Microsoft SQL Server.
- Program Language for Web Services: Visual Basic .NET.

Fig 6 shows the example of sequence diagram for the activities in this model to describe how the groups of objects interact with each other among tour operator, airlines and customers including tour wholesalers, tour agents and end travelers.

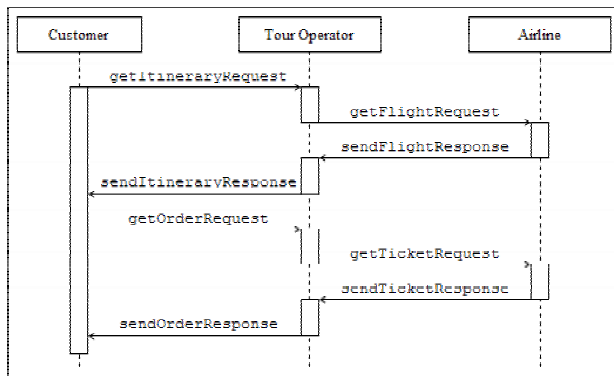


Fig. 6: Sequence diagram

Web Services represent a significant step in the evolution of Business-to-Business integration. The capabilities of Web Services allow companies to provide a front-end integration with existing application services, wrap up back-end enterprise systems as Web Services and integrate intra- and extra-services as a whole business process.

5. Discussions and conclusions

This study investigates a regional tour operator in Thailand specializing in providing tour packages for the inbound tourists from Asia, especially Taiwan and Hong Kong. Observing from various dimensions, the authors summarize the strength, weakness, challenges, vision and strategies of the case company. Then, this research extracts several managerial implications and propositions through the case analysis, and designs the architecture of business-to-business collaboration and integration for an international tourist enterprise to ensure its competitive advantages. This study develops the architecture under the belief that information systems and technologies can ensure and upgrade the competitiveness in highly competitive international tourist markets.

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A VIRTUAL BUSINESS MODEL FOR THE NEW ECONOMY

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Abstract

The new economy brought with it a new approach to designing business models. Not too many years ago the familiar organization structure was dominated by a traditional view

Key words: new economy firm, cash flow driven, return on investment, distributed assets (low capital intensity), core assets and distinctive capabilities, value chain positioning.

INTRODUCTION

Normann (2001) discusses "a new strategic logic". and suggests that: "...managers need to be good at *mobilizing, managing, and using* resources rather than at formally *acquiring* and necessarily *owning* resources"

This new strategic logic is well expressed by McHugh et al (1995) who describe the emergence of holonic, or virtual, organisation structures where :

"...a set of companies that acts integratedly and organically; it is constantly re-configured to manage each business opportunity a customer presents. Each company in the network provides a different process capability and is called a holon" McHugh et al (1995)

An example of the approach to the "new economy is provided by Millennium Pharmaceuticals. This company was founded in 1993 and is specializing in performing basic research on genes and proteins using automated R&D technologies. In an interview with the CEO, Mark Levin, (Champion: 2001)

of managers that was based upon asset ownership and vertical organization structures. The prevalent view was that ownership enhanced control and profit margins. More recently flexibility, cooperation and collaboration have become important features for success. The success of organizations such as Dell and the move by some of the largest corporations in the world towards a model within which assets are managed rather than owned has led to significant changes not only in structure but also in attitudes and managerial behaviour. As a result the "new business model" has five common attributes: the firm should be *cash flow driven*, it should focus on *return on investment*, it should function with *distributed (leveraged) assets or low capital intensity*, to do so with a single minded view on *core assets and distinctive capabilities*, and develop competitive advantage by *relevant positioning within its industry value chain*.

This article reviews these developments and uses the Australian wine industry as an example of the new business model.

described how the value in his particular industry has changed. In particular he suggested that Value has migrated:

"Value has started to migrate downstream, toward the more mechanical tasks of identifying, testing, and manufacturing molecules that will affect the proteins produced by the genes, and which become the pills and serums we sell. At Millennium, we've anticipated this shift by expanding into downstream activities across several major product categories. Our ultimate goal is to develop capabilities and a strong presence in every stage of the industry's value chain-from gene to patient".

Levin argues that the value chain for other high-tech products has, after all, tended to break down into a few separate, largely independent markets (each majoring on specific value positioning characteristics). The computer industry is used as an example with chip manufacturing, computer assembly and delivery, software and support services are now all quite independently distinguishable but interlinked markets. Where once IBM was dominant across the whole industry, Intel, Dell and Microsoft

now coexist as a value chain. Millennium sees problems with the current structure of its industry, particularly as the profitable areas of the value chain are not in the R&D process alone. Levin suggests the future instead lies in personalized medicine: "One day, everyone will have their own genomes mapped out and stored in memory chips, and doctors will look at the information in those chips and prescribe accordingly".

And:

"We want to be the leader in personalized drug therapies ...our expressed goal is to be the first company to deliver health care tailored to the patient's genetic profile. To achieve that goal we need to reach all the way to the doctors and the patients".

A strategy to achieve this goal is based on extending the alliance and partnership models that have proven to be successful. Initially these partnerships were based upon Millennium's strong R&D capability, the relationship with the partner being simply one of contract researcher. However as the company has moved further along the value chain this has changed with the partnerships becoming fifty/fifty alliances with an increasing ownership stake in the products. This strategy has been based upon identifying and "acquiring" the capabilities that will be required. Levin in fact identifies a major problem for the industry – the huge investment required in R&D, \$2b to \$5 b, sums that are encouraging mergers and acquisitions where individual companies are losing their identities. In contrast he suggests that Millennium will emerge with a strong position in the industry value chain based on this networked R&D.

A NEW PERSPECTIVE ON BUSINESS STRUCTURE

This raises interesting questions of what business structures are best suited to take advantage of these emerging trends. It is suggested that traditional hierarchical models based on the deployment of ever increasing amounts of capital to achieve market dominance through large scale virtual or horizontal market integration are unlikely to be flexible or adaptable enough. While size still matters and it is not suggested that the large corporates are yet heading the way of the dinosaur, traditional models require re-examination.

In particular it is suggested that the "new economy firm" should focus on five key attributes in developing and designing their business models, all of which are discussed in detail below. These attributes are:

The firm should be *cash flow driven*,

- It should focus on *return on investment*
- It should function with '*distributed assets*' (*low capital intensity*),
- It should develop a more single minded *focus on core assets (R&D, brands) and distinctive capabilities only*,
- A principal element of its competitive advantage should come from successfully and appropriately *positioning itself in its industry value chain*.

Clearly these components are all quite interdependent. See **figure one**

Cash Flow Driven

The first of these structural imperatives is a focus on cash flow as opposed to traditional notions of profitability. There have been a number of global accounting based crises that suggest the often cited quotation "profit is opinion, cash flow is fact" is a major consideration for corporate governance regardless of size and structure.

It should be pointed out that even the conventional (accounting based) approach to cash flow management is limited, being developed for statutory reporting purposes. An alternative model is offered as **figure two**. This model identifies the operational and strategic decision areas that impact on cash flow planning and management and breaks these down into three broad categories the sum of which gives the firms *Free Cash Flow*.

The first category is quite familiar - *Operating Cash Flow*. Cash flow analysis at this level in the context of a "new economy" business structure allows the identification of options based around delivering both customer and corporate value either by enhancing product features or by reducing costs. These options may be internal to the organization or may be external. Basic options such as outsourcing production to lower component costs or to obtain a more reliable component can be evaluated, as can the impact on both customer service (and cash flow) that may result from a shift in the companies policy towards intermediaries.

At the second level the model enables the impact on assets of alternative production and distribution strategies to be evaluated. *Cash Flow From Assets* describes the cash flow profiles that may result from alternative decisions. The options available each have significant implications for inventory, receivables and payables together with cash flow impacts from changes in the “structure and ownership” of production and logistics in the organization.

Strategic Cash Flow decisions include investment in long term fixed tangible and intangible assets. They also concern working capital to the extent these are essentially long term, considering not simply work in progress and finished goods inventories but strategic sourcing issues that are involved with the design of products to benefit from the advantages of product platforms and buying exchanges established on an industry wide basis. In addition we are also concerned with the difficult, but nonetheless important, entry and exit costs that are associated with strategic cost decisions.

The eventual success of the business is the *Free Cash Flow* that is generated. To calculate this we need to consider the additional funding required by the business if it is to achieve its objectives. These will be equity and/or debt combinations. This introduces not only the cost considerations but also the perceptions of risk that the “market” may assume and issues of corporate control. The “value of the business” then becomes the discounted value of the free cash flow at a discount rate that is judged to be appropriate reflecting this risk.

The characteristics of the target market have a strong impact on cash flow management decisions. For example highly competitive markets in which margins are ‘difficult’ due to market structure (in which concentration has resulted in a few influential companies with large market shares, seasonal and fashion driven products, or ‘luxury’ products that are prone to mark downs) may require equally competitive pricing strategies if positive cash flow are to be maintained,

A Focus on Return on Investment

While we maintain that free cash flow should be the primary measure of success there are a number of reasons for including ROI within a ‘portfolio’ of performance measures. Using an

ROI measure facilitates comparisons between not only businesses but also components within a business. This is particularly important when considering the potential returns from alternative investments within an organization. The efficiency of capital within specific functions, such as physical distribution and manufacturing within a virtual organization differ widely, and it is for these reasons that decisions to seek partner organizations occur.

Rappaport (1983) offers the *value return on investment (VROI)*. VROI uses discounted cash flows to compare strategic alternatives, Rappaport’s approach is to measure the value created per discounted dollar of investment. Thus it offers management the means to evaluate which alternative offers the largest benefit. Rappaport’s model is simply stated by:

$$\text{VROI} = \frac{\text{Post-strategy Value} - \text{Pre-strategy Value}}{\text{Present Value of Projected Investments}}$$

The existing strategy value is derived by discounting the past year’s cash flow. The post-strategy value is similarly arrived at by using a DCF technique but being careful to consider planning horizons and by using a risk adjusted discount rate such as that used by the capital asset pricing model. (The consideration of risk is the subject of another contribution in this volume of readings). One further element is required - the present value of projected investments, which comprises the present value of the stream of incremental investments in fixed and working capital.

The VROI model offers a useful means by which the likely results of alternative business models may be evaluated. Income streams (and their capital and operating costs) can be compared using a *beta adjusted* discount rate to reflect the alternative perspectives of risk that each of the structures would involve. As an example, consider the partnership between an FMCG producer and a consumer durable manufacturer moving into industrial catering systems. Clearly they both lack specific experience in the industry sector and this inexperience should be reflected objectively by considering its impact on the venture. Investors’ views of risk would be reflected in the borrowing rates offered. In contrast in a scenario in which two or more organizations can bring a ‘synergy’ into the organization structure, and in doing so *lower* the risk rather than raise it, then discount rate used for the NPV calculation is likely to be lower.

Clearly VROI must be greater than zero if it is to create value for the shareholder. It can also be assumed that a negative value would indicate that not only is it not creating shareholder value, it is also unlikely that customer value expectations are being met, or if they are it suggests something is wrong with the project costings and that future activities are unsustainable. There are other considerations. An organisation's target ROI and its financial structure are closely related. In turn both are influenced by market characteristics. It follows that operational gearing is closely linked to the expected ROI of the business. If fixed costs are a relatively large proportion of total costs then pricing and gross margin ratios must be made to reflect the financial structure if a required ROI (and cash flow) are to be met. Sensitivity analysis on cause and effect relationships within alternative markets and market segments will add insight into the impact on ROI (and cash flow) on making changes in not only the financial variables but also the structure of alliances and partnerships within the virtual organization.

'Distributed Assets'/Low Capital Intensity

The benefits accruing to this aspect of the model have been well developed by firms such as Dell and Nike. Low capital intensity (investment/sales ratio) facilitates achieving maximised targeted cash flow and rate of return objectives. Furthermore, by adopting this strategy there is an implication that less funds have to be re-invested by each partner, making more funds available for discretionary purposes (i.e., reinforcing their distinctive competences, or distribution to shareholders).

A low level of capital intensity provides flexibility for marketing strategy options. It widens the price point options available by making lower price segments attractive and feasible. High growth markets may be funded from internal funding (with cash still available for discretionary purposes). It is difficult, usually impossible, for capital-intensive businesses to fund high growth rate from internal sources without the 'benefit' of monopolistic price advantages or perhaps some other characteristic that affords sustainable competitive advantage. Furthermore the low capital intensity model also offers operational flexibility. By maintaining an optimal balance between fixed and variable costs production

volumes can be made more responsive to market volumes thereby avoiding break-even crises. At the same time market response times are not inhibited. The application of FMS and JIT philosophies and techniques compensate for the loss of control that a shift from vertical integration to virtual integration may imply.

A Hypothetical Example

Developments in the Australian wine industry are typical of a model based upon distinctive capabilities (discussed below) with little or no fixed investment and the minimisation of working capital. The objective is to achieve a low investment to sales ratio. This takes into account assumptions concerning inventory levels that service target markets, realistic receivables and payables and a targeted pricing policy that generates target gross margins. The compelling philosophical attractiveness of the model can be demonstrated by the following two simple examples that compare a virtual wine business with a typical traditional wine business (which grows, makes and stores around 70% of its sales volumes).

In a low capital intensity (virtual winery) model the investment/sales ratio is typically lower than that of traditional models by a significant amount – 30 percent compared with as much as 120 percent. Assuming similar costs and product quality the *required* EBIT/Funds Employed ratio becomes a much lower figure. For example with a Capital Intensity Ratio of say 40/50 percent compared to the traditional level of between 100 to 200 percent the required EBIT/Funds Employed figure can be as low as 10 percent, considerably less than the 30 percent required for viability by the traditional model. It follows that target revenues are also lower, often by some 30 percent – in retail terms this may be as much as 25 percent less per bottle for the same quality wine! As a result the EBIT/Funds Employed ratio can show an impressive 75 percent for the 'virtual' model versus approximately five percent for the traditional winery model.

Cash flow improvements are equally significant. It can be calculated that, based on the assumptions of same revenues, EBIT/Funds Employed and debt, the cash generated can be shown to improve by a factor of between three and four times.

Clearly, the low capital intensity model begs the question as to whether a secure long term

supply of input product and supplementary services are available from third parties. In the context of the Australian wine industry historically, a significant proportion of the wine industry's production volume has been traded between industry members as bulk "commodity product" and specialist bulk businesses have been established whose sole purpose is to supply bulk inputs (to other businesses). Huge volumes enabled these businesses to supply input product at very attractive prices on flexible payment terms. Rosemount is an example. Until the early 1990's Rosemount was a traditional wine business. It effectively adopted the low capital intensity model in the mid 1990's in order to fund its growth. This was achieved during a period of relative under supply and rising grape prices. The strategy is particularly attractive if it is perceived that over supply and falling prices have at least 3-4 years yet to run.

Under such circumstances a *virtual winery* would adjust the proportion of requirements supplied between "spot" purchases (under short-term contracts), and longer-term contracts. Supplementary services are typically available from third party sources for operational tasks such as facilities where it can "fine tune" and store "product" prior to final processing and contract storage of finished goods.

A Focus on Core Resources/Assets

It follows that the emergent "new economy" focus on virtual structure encourages partners in an alliance to develop their core resources and assets. Indeed it is the reason that each component in an alliance has attraction for the other members. Kay (2000) identifies two categories. The first category are *distinctive capabilities* such as institutional sanctioned items - patents, copyrights, statutory monopolies and so on, but which also feature "... powerful idiosyncratic characteristics ... built by companies in competitive markets." These include strong brands, patterns of supplier and/or customer relationships, specialist skills, knowledge and processes.

In contrast *reproducible capabilities* can be created, purchased or leased by any company with reasonable management skills, skills of observation, and the financial resources. Both process and product technology are reproducible capabilities; the automotive industry is but one example.

Quinn (1992) emphasised the need to cultivate a core competence (capability) and suggests that manufacturing companies are becoming more and more dependent within the value chain on links consisting of services or intellectual activities. Olve *et al.* (1997) suggest that the underlying driver of long term strategic performance is intellectual capital and used Stewart's (1997) definition to give the term meaning, that is "packaged useful knowledge". They suggest it is this approach that is the reason why a company may be valued at more than the sum of its "hard" assets. Other approaches suggest the term "intangible assets" and this has the advantage of including or detailing specifics seen as brand values, R & D and management development.

This is an interesting concept for strategic organisational structures. Given the proposal that the dynamics of the business environment will lead to a situation where knowledge and core capabilities will be viewed as having specific shelf lives, the onus is on the company to identify the core capabilities necessary for its future. Olve *et al* (1997) extend their argument by describing a capability *balance sheet*. They argue that a traditional way of evaluating a company is to analyse its balance sheet and use the notion of gearing to explore the value of the business. A feature of the balance sheet is the ratio of shareholder equity to total assets, that is the financial gearing of the company. They cite the usual arguments concerning the extent, and influence of gearing, suggesting that if the company is overly self financed (i.e. it relies too heavily on its own capabilities), it will need to earn profits in excess of 'normal' levels to ensure shareholder satisfaction. Therefore, they suggest, few companies are totally self-financing.

The analogy of planning capability requirements uses the principles of financing for growth. The 'assets' required for success are identified as capabilities and the 'liabilities' indicate how the capabilities are to be financed - that is who is to provide them. The authors continue with the notion that capabilities have limited life expectancies and therefore suggest that the liabilities reflect a degree of 'capability leverage'. The capabilities are largely 'financed' by value chain partners. The contribution made by partners is large and is complemented by externally sourced temporary capabilities, required to meet specialist needs.

Hamel and Prahalad (1994) commented that:

“Preemptive investment in a core capability is not a leap into the dark ... it is the simple desire to build world leadership in the provision of a key customer benefit, and the imagination to envision the many ways in which that benefit can be delivered to customers, that drives the capability-building process.”

They continue by suggesting that capabilities that are most valuable are those representing a gateway to a wide range of potential product markets - a core capability leader possesses the option to be a major participant in a range of end-product markets. This is a particularly important issue for strategic operations management because the options become much wider when a value chains approach is considered. Hamel and Prahalad consider this with their capability matrix. Implicit in Hamel and Prahalad's original model is the requirement that some forward thinking be undertaken to determine the direction of “potential product markets” prior to investing in core capability leadership. Indeed the virtual organization/value chain approach offers an option to spread risk reflected by an even greater proportion of externally sourced temporary capabilities.

The link here with the cash flow and ‘distributed assets’/low capital intensity’ features of the model becomes quite clear. Organisations in virtual structures are able to focus investment on distinctive capabilities thereby reinforcing their differentiation and that of the alliance. There is a minimum of investment made into what Kay describes as “reproducible capabilities”. More importantly each member is not investing in ‘duplication’ of essential distinctive capabilities as these already exist.

Leveraging Competitive Advantage: a “Positioning” Decision

Potential competitive advantage in the market place and its potential for delivering superior shareholder value (as opposed to market positioning that attempts to deliver superior customer value) is very much based on adopting the low capital intensity model, but also identifying *where within the virtual network the capabilities of individual organisations can best be deployed*. Recognition of the fact that not all of the necessary capabilities and/or capacities are internally available leads the progressive business towards identifying where in the value chain its resources are most effectively applied. Value chain positioning and competitive advantage strategy is therefore a critical activity

In a qualitative context successful “leveraged competitive advantage” is assumed to be the successful management of one or more ‘market based’ characteristics that offer the organization a competitive edge. These may be located in either the demand chain or the supply chain, but for them to be significant they should be exclusive to the organization. It could be argued that effective strategic management identifies what these are and creates an appropriate virtual structure.

Normann and Ramirez (1993) suggested:

“ ... strategy is primarily the art of positioning a company in the right place on the value chain – the right business, the right segments, the right products and market segments, the right value-adding activities”. And: “The focus of strategic analysis is not the company or even the industry, but the value creating system (the value chain) itself, within which different economic actors – suppliers, business partners, allies, customers – work together to co-produce value. Their key strategic task is the reconfiguration of roles and relationships among this constellation of actors in order to mobilise the creation of value in new forms and by new players ... their underlying strategic goal is to create an ever improving fit between competencies and customers ... ”

Of more interest to shareholders and partners is a quantitative measure of ‘value’ delivered by this set of ‘competitive advantages’ Kay (1993) offered an approach. He suggested that the added value generated by an organization could be measured simply and effectively by deducting operating expenses and a ‘cost of capital’ from revenues. If the result is positive the organization is “adding value”, if not then it is “destroying value”. There is a similarity here with the Stern Stewart EVA measure (economic added value). Both approaches use a ‘comprehensive’ cost of capital that includes not just depreciation but interest and dividend payments, management and employee development, and investment in intangible assets.

However, Kay extends his argument by using it to provide a quantitative measure of competitive advantage. Kay's measure of competitive advantage is relatively simple; it is the added value divided by the operating costs and capital charges. **Figure three** illustrates both added value and competitive advantage. Kay argues that added value and competitive advantage may be calculated from published accounting information. However, it may take some searching of the “notes to the accounts” to identify some of the cost items.

Figure four suggests how, using Kay's model, competitive advantage may be further 'leveraged' by exploring the opportunities offered by the virtual organization model. In particular:

Revenues may be enhanced by partnerships that result in more effective responses to key customer value drivers (such as time-to-market, QR (logistics responses), flexibility, and customized service packages). Revenues may also be improved by such initiatives as cooperative R & D and product-market development with complementary and competitive organisations.

Labour cost profiles are influenced by outsourcing to obtain specialist skills or preferential labour rates. 'Capitalising' production processes is also a well-used alternative. Becoming more important is the use of design (for example by designing around 'platforms') to reduce intra and inter-organisational costs and in some circumstances eliminating duplications of process, activities and, therefore, costs.

Materials and services are also influenced by inter-organisational cooperation. The automotive, pharmaceutical and chemicals industries have pioneered web based supply chain partnerships. "Elemica" is a global electronic network comprising 22 of the largest international chemical corporations. By forming a negotiations/transactions hub interactions and transactions costs are significantly reduced and asset productivity throughout the "organization" was improved by the elimination of unnecessary inventories, automated transaction systems, reduced transportation costs (not to mention a vast improvement in 'mode' utilization) and storage costs.

Capital Costs are optimized or reduced by improving the productivity of tangible assets such as manufacturing facilities and distribution systems. Partnerships in product-market development or with the application of product innovations (e.g., the biotech industry) increase overall productivity and decreases unnecessary investment. Working capital productivity may be improved by optimizing inventory allocation and location supported by applying electronic systems to intra and inter-organisational interactions.

An effective value chain strategy, therefore, takes an organisation beyond its own boundaries. It involves identifying the core capabilities necessary to compete and to produce and deliver customer value expectations and to *coordinate* the value production process. The well-known examples, such as Dell and Nike have established models that are being implemented by a number of industries through a

value chain approach. But less well-known examples of value chain positioning exist.

Returning to the Australian wine industry, it has clearly undergone some significant changes that have resulted in the repositioning of a number of organisations within the industry value chain (for example, 'brand managers', producers, distributors etc). Given the importance of economies of scale, differentiation and integration, and the fact that lifestyle is an important consideration in wine marketing, the larger companies have been taking steps to acquire and manage major brand names. Companies in other sectors of the industry have driven much of the acquisition activity. Their knowledge and experience, together with a cost efficient infrastructure, has enabled them to invest in brand marketing and to manage the economies of scale and of integration by outsourcing wine production. The result then has been a major repositioning of organisations within the industry. The industry is moving towards brand management as being a major element in its value chain positioning and competitive advantage strategy. Wine production remains important but appears not to be as important as brand marketing when cash flow generation and contribution to earnings is considered

CONCLUDING COMMENT

The new management model is clearly one in which mutual dependency, cooperation, trust and transparency are major features. Without any of these components the model is unlikely to be successful. The results that are accruing to organizations that identify (and implement) the benefits of the 'new model' are becoming apparent. The potential savings for organizations within Elemica are beginning to appear. Within North America and Europe the potential savings from "e-market" initiatives are estimated to be at \$US 15-20 billion!

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Figure one: A Business Model for the New Economy

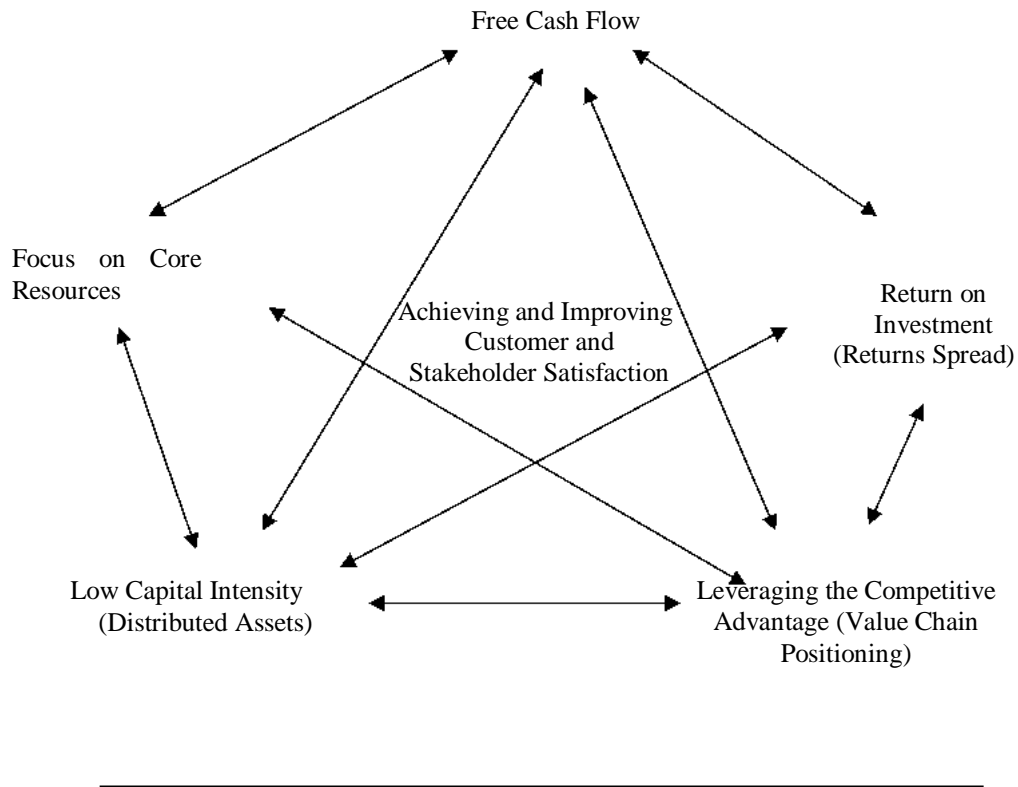


Figure two: The determinants of free cash flow: *the primary value chain objective*

*Revenues Less Discounts less Wages and Salaries less Materials, components and service
Less Capital servicing costs less Overhead expenses*

=



Operating Cash flow +/- Short-term Working Capital Requirements +/- Capital Maintenance Expenditure
= ***Cash flow from Assets***



*Cash flow from Assets +/- Fixed Assets (Tangible & Intangible) +/- Long-term Working Capital
Requirements +/- "Entry and Exit" Costs*
= ***Strategic Cash flow***



Strategic Cash flow +/- Changes in Equity & Debt funding
= ***Free cash flow***

*Nb: Tax payments have been omitted.
These may occur at operating, asset
management and strategic cash flow*

Figure three: Calculating Added Value and Competitive Advantage

$$\text{Added Value} = \text{Revenues} - (\text{Labour costs} + \text{Materials Costs} + \text{Services Costs} + \text{Capital Costs}^*)$$

* Capital costs = Interest to investors & dividends to shareholders, interest on working capital items, management & employee development, and asset structure changes during a relevant time period

Figure four: Influencing Competitive Advantage in the Virtual Organisation

Enhance revenues by cooperative:

iR D & D
iProduct development
iMarket development
i“Brand” leverage; and
iResponses to key customer value drivers

Labour, materials and services cost profiles influenced by:

iOutsourcing i“Capitalising” the manufacturing & distribution processes
iPurchasing and assembly of components and ‘modules’ rather than ‘materials conversion’
iMembership of web based interaction and transactions structures
iUtilising partner specialisation and differentiation capabilities
iOutsourcing non-core/reproducible service process and activities

$$\text{Competitive Advantage} = \frac{\text{Revenues} - (\text{Labour costs} + \text{Materials Costs} + \text{Services Costs} + \text{Capital Costs}^*)}{(\text{Labour costs} + \text{Materials Costs} + \text{Services Costs} + \text{Capital Costs}^*)}$$

Capital costs may be optimized or reduced by:

iPartnerships to leverage ‘tangible assets’ facilities
iPartnerships with owners of ‘intangible assets’

Organisational Learning in Service of Strategic Planning: Case Study on an International Organisation

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Abstract

Managing knowledge development is critical to the proper functioning of a learning organisation. Moreover, organisational learning should be incorporated into the strategic planning of such a learning organisation to ensure the long-term survival of the organisation. In this paper, these issues are critically discussed in the context of an international organisation. It is found that although the bulk of the organisation's work is knowledge-based, it faces problem in cultivating a "learning" culture within the organisation. There is little mutual learning between management and staff. The organisation also faces leadership and willingness problems. It would be critical for the organisation to come to terms with leveraging its knowledge base in planning for its sustainable development.

1. Introduction

According to Drucker (1993) [5], knowledge has become the resource leading to organisational uniqueness. Knowledge is a shared collection of principles, facts, skills and rules [8], and is a function of information, culture and skills [10]. The ability of organisation to compete will depend increasingly upon their ability to compete, develop new knowledge, and create maximum market value for the knowledge [6] [9]. In this paper, the organisation we choose to discuss is the International Telecommunication Union (ITU), a specialised agency of the United Nations at Geneva, Switzerland. In charge of regulating worldwide radiocommunications, setting up worldwide telecommunication standards and leading world telecommunication development, ITU is the world's oldest intergovernmental organisation. With a staff of more than 1,000 from all around the world, ITU has a very hierarchical structure. The Secretary-General and his deputy, together with the three directors of the bureaus, make up the top management, with department and unit heads reporting to them.

ITU may be said to be in a crisis. For more than a century, ITU's membership consisted mainly of national telecommunication administrations that contributed to most of ITU's financial and intellectual resources. These national telecommunication administrations had traditionally been (pseudo-) monopolies in their respective home countries, and could thus represent the

totality of the interest of the telecommunications industry in those countries. Since the early 1990s, however, most national telecommunication enterprises have been privatised, while the telecommunication industry has also been liberalised, allowing new entrants to the industry. These new entrants would also like to have their voices heard and their interests represented in an international forum such as the ITU. Additionally, the Internet phenomenon has also shifted the work focus of ITU from traditional telecommunications to novel information and communication technology. As such, planning to stay relevant in a world of privatised international telecommunication and advancing Internet connection, while maintaining the intergovernmental nature of the organisation becomes the top priority for ITU. ITU's strategic planning activities are carried out by the Strategies and Policy Unit (where the principal author served as administrative officer) within the Secretary-General's Office, which are then ratified by the Plenipotentiary Conference, the supreme organ of the ITU.

Based on the first-hand observations of ITU's functions and works by one of the authors who was an administrative officer in ITU's Strategies and Policy Unit, this paper attempts to capture the organisational learning process in a learning organisation, and the interaction between leadership and strategic planning (or the lack thereof) in such an organisation.

2. Managing Knowledge Development in a Learning Organisation

Knowledge and its management is central to ITU's works. The bulk of ITU's intellectual works are done by the "study groups", who are panels of experts from both inside and outside of ITU. ITU then disseminates and implements the fruits of their works. ITU will not survive without the crucial functions of knowledge development. As a knowledge-based organisation, ITU must then adapt itself to being a learning organisation.

Organisational learning has variously been defined as the process of improving actions through better knowledge and understanding [7] and interactions between adaptation at the *individual* level and adaptation at the organisational level [2]. Organisational learning may be conceptualised into single- and double-loop

learning [11]. In single-loop learning, the individual learns the “rules of the game” during his routine work in the organisation, while in double-loop learning, the changing of the rules and ultimately the organisation based on learning kicks in. While an individual learns to solve problems, the organisation develops systems and processes for attaining results. Organisational knowledge aids decision making, behaviour and actions, and is primarily developed from *individuals* in the organisation [8]. However, this is not always the case in practice. A newly elected ITU top management team typically settles in and tries to learn the “ropes” of ITU so as to effect change. Often, however, they are instead assimilated into the ITU “culture” and continues with the old ways of doing things. It may be argued that their level of learning is not profound enough so that they may discern ITU’s deficiency and cause change.

3. Organisational Learning in a Learning Organisation

Organisational learning is also about detecting errors or anomalies and correcting them by restructuring organisational theories in use [1]. In this respect, ITU’s managers have not done a good job. An average ITU manager simply slugs through his daily work without realising either the relevance or the correctness of his or his department’s course of actions. Moreover, despite a one-person internal audit department, there is no formal feedback mechanism for detecting and correcting administrative or substantial errors. The “feel good” and “save face” nature in a diplomatic environment also means that ITU staff and work participants are not exactly encouraged to voice their concerns. A small training department is more for window-dressing than offering any learning opportunities, such as scenario analysis.

Another issue which impacts ITU’s learning process is the dichotomy between explicit and implicit knowledge [4]. The former, being tangible, clearly stated and consisting of details which can be recorded and stored [8], resides primarily with ITU’s rank-and-file staff, who are mostly specialists in their various fields. The latter, which is often tacit, unstated, and based on individual experience, is often mastered by the managers, who have been wallowing in the ITU bureaucracy for years, who learned the dos and do-nots in ITU the “hard” way. Ideally, a mastery of both types of knowledge would be conducive to organisational learning, but in ITU’s case, there is scarcely any mutual learning process between the management and the staff.

4. Strategic Planning in a Learning Organisation

Strategic planning can be defined as the devising of a game plan consisting of the courses of action a company wants to take. It enables the organisation to follow a well-defined path in a turbulent environment. In

particular, in Greiner’s organisational life-cycle (cited in [12]) which postulates that organisation pass through 5 evolutionary growth stages and 5 revolutionary crisis points, the first crisis is that of *leadership*, after the solution of which the organisation learns to deal with this crisis and moves on to another evolutionary stage. In ITU’s case, there is indeed the crisis of *leadership*, as no clear goals are set and no inspirations are offered by either the top management or the middle-level managers. Both the organisation and the managers may thus be said to be yet to emerge from this leadership crisis, and therefore have not moved on to another evolutionary stage in the organisation’s growth.

Indeed, leadership is a critical issue for ITU. Senge (1990) [11] opines that a leader’s role in the learning organisation is that of a designer, teacher and steward who can build shared vision and challenge prevailing mentalities. Nevertheless, several factors exist to undermine this role for the leaders in ITU. In particular, ITU there exists the managerial sub-culture of over dependence on professional assistants to do the “learning” for the managers, rendering the latter often little more than presenters in public. The highly politicised atmosphere in an intergovernmental organisation also means that the differences in authority among the various heads are stiff, and they are very jealous in guarding their own “turf” of knowledge instead of sharing it with others.

De Geus (1995) [3] also said that a company that exists to survive needs a higher level of skill in dealing with the changing environment. As such the members of the organisation need to continually learn to adapt, manipulate and progress. This should have been the case with ITU, which is an organisation trying to find its place in a new and more variable environment. ITU should therefore incorporate a high degree of learning into its strategic planning. Although ITU does have a formal planning system in place, the system suffers from a number of deficiencies, ranging from specialist-domination of the planning process which abounds with details but lacks of vision, to an obsession in searching for the mythical “right” strategy while failing to assign ownership to any makeshift plans. And those plans are often not at all implemented. For example, during every recent ITU Plenipotentiary Conference (the highest governing organ of ITU), a Strategic Plan is typically adopted, but a new top management team which might not have drafted or been consulted about the Plan is typically not particularly interested in implementing it. It may thus be said that what ITU suffers from is not a lack of expertise or knowledge but a dearth of willingness, means and vision to incorporate them into the strategic planning process.

5. Conclusions

In summary, it is clear that an organisation that makes it its business the development and management of

knowledge should itself set an example as a learning organisation. The irony of the non-accomplishment of this task is amply observed in the case of ITU. It is critical that the managers in such an organisation should set the vision and the norm of learning in the organisation. If they fail to do so due to personal incapacity or unwillingness, the implication for the strategic survival of the organisation will indeed be profound. For the incorporation of learning into the strategic planning and implementation process of an organisation will like be the differentiating factor between those that survive and prosper on the one hand and those that become casualty of a changing environment on the other hand.

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Self-Governance for Electronic Commerce: An Evolving Framework

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Abstract

The rapid rise of electronic commerce and the latter's increasing intrusion into everyday life has not been matched by an effective governance structure. The present paper proposes an evolving multi-faceted self-governance framework for the regulation of electronic commerce by, for and of the users and service providers of electronic commerce. The idea of "electronic commerce interest group" is proposed and described, together with their interactions. The framework takes into account the policy, ethical and economical aspects of electronic commerce development, and seeks to devise balanced and sensible electronic-commerce governance solutions.

1. Introduction

The advent of the Internet over the past decade has created new possibilities for business dealings, be they transactions of products or provisions of services. As a result, tremendous convenience and savings have been enabled by electronic commerce. Nevertheless, the proliferation and invasiveness of electronic commerce into both business and individual lives have also engendered opportunities for unscrupulous parties to engage in malicious activities over the electronic medium, often with greater ease, speed as well as harms to society. A typical knee-jerk reaction to these perceived electronic endemic is the tightening of Internet regulations by authorities. This paper attempts to explore an alternative answer. Part I of the paper discusses the policy, ethical, economical and social dimensions of electronic commerce specifically and Internet in general. Based on these observations, Part II proposes a multi-faceted self-governance framework for electronic commerce activities and compares its strengths and weaknesses.

2. Some Issues in Electronic Commerce

2.1 Policy

Despite the seemingly democratic nature of the Internet, sound public policy over the Internet can make or break the healthy development of electronic commerce. A public policy which restricts both the access and the contents of the Internet, for example, will almost certainly strangle the growth of electronic commerce. Some of the important public-policy issues on electronic commerce

may be divided into three categories: intellectual property, content and privacy.

2.1.1 Intellectual Property

The property rights over intangible "property" which is the result of creativity and/or innovation are often referred to as intellectual property (IP). On the Internet, the main IP debates concerns domain names and copyrights.

2.1.1.1 Internet Domain Names

Internet "domain names" have seen intense "turf fights" during the last decade. Domain names are unique Internet "addresses" which indicate a web page. A domain name consists of at least two components – a designation of the organisation (e.g., "ums") and an abbreviation for the nature of the organisation (e.g., "edu"). The latter is known as "top-level domain" (TLD). A domain name registered in a country other than the United States usually has an additional country-designating component (e.g., "my" for Malaysia). In the United States, on the other hand, the domain names usually do not have an additional country-designating component, and these TLD's are known as "generic" TLD's (gTLD). For the electronic commerce communities worldwide, the ".com" gTLD has become a priced commodity, with its subtle phenomenological implications of commercial superiority. Nevertheless, confusion may arise out of similar gTLD. To illustrate, both University of Malaysia Sabah and University of Malaysia Sarawak may arguably have a legitimate claim to the domain name "ums.edu" provided proper registration is made.

During the latter part of 1990's, two initiatives have been made to resolve the gTLD disputes. There was initially the "gTLD Memorandum of Understanding" (gTLD-MoU) [9] developed by an international ad hoc body in 1997, with participations from both the World Intellectual Property Organization (WIPO) and the International Telecommunication Union (ITU). The gTLD-MoU proposed a seemingly autonomous gTLD governing structure with various functioning arms such as a policy advisory body, a policy oversight committee, a depositary for the MoU, a council of registrar, and an administrative challenge panel. Despite its limitations, the

gTLD-MoU may be viewed as one of the first international efforts in arriving at a self-governing structure for electronic commerce. The main advantage of gTLD-MoU is that it is a truly international attempt to resolve an international problem. The main disadvantage, on the other hand, is a lack of criteria to separate the genuine, interested participants of the gTLD debate from those who incidentally avail themselves of the benefits of the MoU.

In response, the United States proposed its own domain name system reform policy in 1998 [11]. Under the American initiative, a non-profit corporation was formed with headquarters in the United States to manage gTLDs and to resolve international gTLD disputes. Both the strength and the weakness of this structure is its backing by the American government. While US backing lent credibility to the proposal, a significant amount of suspicion has also been raised. The European Union has criticized that the American proposal was not arrived at with sufficient international consensus. Others view the US proposal as the extension of US domain name policy to the Internet community in the rest of the world. Over the past few years, however, the US proposal has more or less been grudgingly accepted and practices around the world.

2.1.1.2 Copyrights

Another contentious IP issue concerning electronic commerce is the issue of copyrights. The history of copyright law witnessed the conflicting demands between, on the one hand, the authors of protected creative works who would like to exact their due shares whenever their protected works are reproduced, and, on the other hand, the user of the protected works who would like to ensure his access to the greatest amount of materials, protected or otherwise, with as little charges as possible. This constant struggle is magnified on the Internet, as was the case with peer-to-peer electronic file swapping services, which provided a means for their members to exchange digital music files which may or may not be protected. The Internet has made reproduction of protected works relatively effortless. A further complication is that the global reach of the Internet implies that restructuring of the copyright law and policy must necessary be universal. In addition, the debates over copyrights between the developed and developing countries often assume a non-economic and political nature. Some argue that the present copyrights system protects the interests of developed countries who limit the flow of “protected” information to developing countries which cannot afford to pay the often stiff royalties for the vital information necessary for the latter’s national development. The Internet thus enables the developing countries to obtain crucial “protected” information with relatively low costs.

2.1.2 Content

The huge amount and diversity of opinion and materials expressed and exchanged on the Internet constitutes a main reason for the tremendous development of electronic commerce. Governments around the world are gently waking up to the potential of the Internet in providing essential services. They are also rudely awakened by the poorer taste or appropriateness of some of the Internet contents. The governmental impulse, then, is to regulate Internet content allegedly for the public good. This was the case, for example, in Germany [8] and China [5]. It remains to be seen whether these draconian policies would hamper the healthy electronic commerce development in those countries. Nevertheless, these measures may not be as effective in eradicating “harmful” material as they first seemed. The global nature of the Internet means that a prohibition on certain content production in one country would help the content-creation industry in another country, since the demand for the content remains the same. Therefore, a more effective system may be a self-regulatory “content” framework, such as the “content forum” with industry and expert representation such as that proposed under the Malaysian Communication and Multimedia Act 1998.

2.1.3 Privacy

The protection of personal Information is essential to integrity to both human dignity and commercial integrity. Therefore, the protection of Internet users’ and producers’ information privacy is important for the continuous development of electronic commerce. Without an adequate privacy protection framework, potential participants would be deterred from engaging in electronic commerce, lest their personal data become tradable commodity. To answer this concern, most developed countries, such as the European Union [6] [7] and Organisation of Economic Cooperation and Development [13], have been drawing up their respective data privacy laws, policy and guidelines.

2.2 Ethics

The moral outlook of the “Internet community” should be examined before a meaningful proposal of a self-governance framework for electronic commerce. This determination of the ethical attitude of those who use and who provide services over the Internet is crucial in determining the best Internet self-governing structure and in avoiding self-regulatory pitfalls.

Using ethical principles distilled from various philosophical and sociological literature, Oh et al. (1998) [12] designed a survey on the attitude of the of Internet community. The survey requested participants to rank these ethical principles in the order of their preference in utilizing the principles in resolving the moral dilemmas which the participants may encounter in the course of their Internet usage or service provision. Table 1 summarises and adapts the results of the survey in descending order of the preferences of ethical principles by the Oh et al. (1998)

[12] survey participants.

Table 1. Ethical principles and their descriptions (Oh et al., 1998)

Ethical Principle	Description
Means-Ends Ethic	If the end justifies the means, then you should act.
Might-Equals-Right Ethic	You should take whatever advantage you are strong enough and powerful enough to take without respect for ordinary social conventions and laws.
Intuition Ethic	You do what your "gut feeling" tells you to do.
Professional Ethics	You should do only that which can be explained before a committee of your professional peers.
Conventionalist Ethics	Individuals should act to further their self-interests so long as they do not violate the law.
Organization Ethics	This is an age of large-scale organizations – be loyal to the organization.
Hedonistic Rule	If it feels good, do it.
Disclosure Rule	If you are comfortable with an action or decision after asking yourself whether you would mind if all your associates, friends, and family were aware of it, then you should act or decide.
Golden Rule	Do unto others as you would have them do unto you.
Utilitarian Principle	You should follow the principle of "the greatest good for the greatest number."
Categorical Imperative	You should not adopt principles of action unless they can, without inconsistency, be adopted by everyone else.

In Table 1, it could be noted that the top two preferences in ethical principles of Internet users and producers, assuming the survey results as representative of the attitude of the Internet community, for utilization in resolving on-line moral dilemmas are Means-Ends Ethics and Might-Equals-Right Ethics which are not so positive. Oh et al. (1998) [12] pointed out that similar top preferences were also found in surveys of business school students and business managers. In other words, while the Internet community may be viewed (based on the Oh et al. (1998) [12] survey) as ruthless and aggressive, their attitude is no worse or better than the rest of the "real life" business community. Human selfishness and combativeness are just features of human characters that any regulatory framework has to work with.

Moreover, if those ethical principles in Table 1 which

may be deemed more or less "anti-social" (Means-Ends Ethics and Might-Equals-Right Ethics), "compulsive" (Intuition Ethic and Hedonistic Principle) or generally "problematic" (Conventionalist Ethics and Organizational Ethics), we are left with the moral/ethical principles in Table 2 (again in descending order of their preferences).

Table 2. "Preferred" ethical principles based on Oh et al. (1998)

Ethical Principle	Description
Professional Ethics	You should do only that which can be explained before a committee of your professional peers.
Disclosure Rule	If you are comfortable with an action or decision after asking yourself whether you would mind if all your associates, friends, and family were aware of it, then you should act or decide.
Golden Rule	Do unto others as you would have them do unto you.
Utilitarian Principle	You should follow the principle of "the greatest good for the greatest number."
Categorical Imperative	You should not adopt principles of action unless they can, without inconsistency, be adopted by everyone else.

In Table 2, it could be noted that the top two "good" ethical preferences of the Internet community, Professional Ethics and Disclosure Rule, are both dependant on the establishment of either professional or specialized bodies – "professional peers" and/or "associates." This may give us a hint that an effective Internet self-governing structure must entail, as one of its most important components, professional or specialized bodies. They may be the most effective means to counter the more "sinister" human tendencies as discussed above.

2.3 Economics

The momentous growth in the number of Internet service providers (ISP's) implies the strength of electronic commerce. It can, however, be observed that the economic growth of the Internet has been concentrated in too few hands; there is a lack of competition among the major ISP's. In the wholesale Internet market, for example, the top three US ISP's accounted for about 73% of US market share. [3] In the retail Internet market, the number of AOL subscribers outdid that of its top ten competitors. [10] The fear is that with their overwhelming market shares, giant ISP's may squeeze out smaller competitors and thereafter inflate service prices. Governmental regulation in the form of anti-trust policy is often suggested as a suggestion. But is this an effective

solution?

Not for Ronald Coase, the 1991 Nobel laureate in economics, who once said, "All solutions have costs and there is no reason to suppose that government regulation is called for simply because the problem is not well handled by the market or the firm". [4] One version of the Coase theorem states if transaction costs are zero (i.e., if the parties involved are able to make any agreement that is in the mutual benefit of the parties), an economically efficient outcome will be reached regardless of any initial definition of property rights. For example, in the case of pollution, if left alone to bargain, both the polluter and polluter will reach an economically efficient settlement, regardless of their initial entitlements.

The chief criticism of Coase Theorem is that in reality all transactions entail cost. For example, Arrow (1969) [2] demonstrated that there is a priori no market where the transaction cost is zero. However, others have argued that at the least Coase showed that for some problems there is no fixed rule or best regulation that will generate an economically efficient solution. [1]

3. Elements of A Proposed Internet Self-Regulatory Framework

The lessons learned from the extended discussions above indicate that the most important elements of a proposed self-governance framework for electronic commerce may be referred to as "electronic commerce interest groups" (ECIG), representing the interests of the various members of the electronic commerce community. The chief beneficiaries of such self-governance will be the Internet users and service providers.

One ECIG crucial for self-regulation will be a Commercial ECIG, an on-line chamber of commerce. The Commercial ECIG will enable e-merchants to act in concert to safeguard their commercial interests while the diversity of opinions and modes of business within the ECIG will prevent them from developing into a self-perpetuating monopoly. In many circumstances, the commercial ECIG may also resolve commercial disputes among its members in the form of alternative dispute resolutions, to avoid the high costs and long delays of the traditional judicial systems.

Another "interest groups" should be a Professional ECIG akin to the professional societies in the real-life community, such as Medical and Bar Associations. These professional bodies set the crucial standards for their members, as they are in the best position to know what is sound for the healthy development of their trades. Electronic commerce today is highly specialized, just as the regular working world. The hardware technicians, the software designers, the chat room moderators and the on-line auctioneers should all establish their professional associations, much like the medieval masters and their

guilds. The professional ECIG may, for example, adjudge cases of breaches in professional ethics.

Yet another, and probably the largest, ECIG is the Consumers ECIG, which is made up of electronic commerce consumers. As a consumer advocacy group, this ECIG should act as a watchdog in ensuring the quality of service delivered to the consumers.

An Experts ECIG should also be formed including prominent electronic commerce academics and researchers who have contributed and continue to contribute significantly to the development of electronic commerce. The role of this ECIG is to render learned advice in charting the future course of the Internet.

A Workers ECIG, like a union, may also be formed to look after the welfare and benefits of those who rely on electronic commerce as their means of livelihood. A healthy functioning of this ECIG is crucial to the morale and hence the productivity of electronic commerce work force.

The last ECIG, the Development ECIG, takes care of the special needs of the developing countries, representing the interests of the majority of earth's population who yearn to accede to the Internet community.

It is important that the memberships in these ECIGs are not exclusive of each other. A member of the professional ECIG, i.e., a prominent electronic commerce practitioner, may indeed also be a member of the experts' ECIG. Relatedly, ECIG memberships are not limited to natural persons, but are open to companies, organizations, or other interested entities. However, each ECIG should devise rules for the eligibility of its membership. These ECIGs are also not exhaustive, and will evolve over time. As both the mode and speed of electronic commerce evolves, new ECIGs may be formed, and some or all of the existing ECIG may be replaced. The ECIGs should be formed at local, national, regional and international levels.

The overall governance structure of electronic commerce can best be based on so-called informal consultations among the various ECIGs. The informality of decision-making by informal consultations preserves the great Internet tradition of "off-handedness" and casualness which has been vital to the continuing survival of the Internet, while providing a flexible means of resolving problems or seizing opportunity as an online community. In addition to real-life meetings, the informal consultations may be held continuously via electronic means. In this way, issues may be brought to the electronic bulletin boards in a less confrontational manner. It is hoped that sound and practical policy will subsume from the benefits of informal consultations, much as they have been so throughout the history of the Internet. A conceptual framework of interactions by informal consultation among the various ECIGs is depicted in

Figure 1.

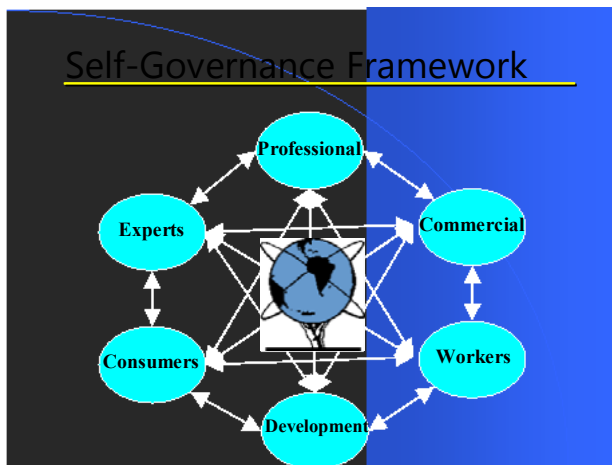


Figure 1: Conceptual depiction of a self-governance framework for electronic commerce

Criticisms may be voiced on such a self-governance system. For example, the system lacks a enforcing authorities (such as governments), and may hence be ineffective in handling serious challenges, either technical or policy, to electronic commerce. It should be kept in mind, however, that the electronic commerce community are reputedly quite proactive and would more readily rise up to challenges or accept responsibility, which is the basis for the self-governing framework is proposed for electronic commerce. Besides, just as in an off-line community, those who broke the ECIG rules, though not sanctioned by law, will often face alienation, ostracization, or outright expulsion.

4. Conclusions

The present paper discusses some of the policy, ethical and economical concerns of the Internet and then proposes a self-governance structure for electronic commerce based on policy formulation through informal consultations among the various electronic commerce interest groups. The self-governance framework proposed is not a perfect one, and will require constant refinement. It is, nevertheless, a baby step toward responsible governance of electronic commerce.

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Customer Expectations of Internet Banking in South Africa

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Abstract.

The Internet has fundamentally changed the banking industry in South Africa by giving people more immediate control over the management of their finances. This research investigated whether a gap exists between customer expectations of Internet Banking and the satisfaction of these expectations in the virtual environment by South African banking institutions. The research was operationalized by means of a survey amongst internet banking users. The research focused specifically on the way customers of Internet banking sites felt about the service and functionality they received on the Internet and whether their expectations of this banking service were being met.

What emerged from the research was that customers were happy with their basic Internet banking experience. What they were not satisfied with, were cost issues and the lack of personalised service. Issues such as speed and more advanced functionality also played a minor part. In addition, Internet banking customers felt there was a lack of integration across banking channels. Overall, the research indicates that basic user expectations are being met by Internet banks in South Africa. However, unless this satisfaction is maintained and extended, banks could possibly lose customers to the already emerging virtual, innovative and more cost-effective alternative banks of the future.

1. Introduction.

Changing consumer needs, innovative financial products, changes in the industry structure and a mix of delivery channels are reshaping the banking industry. An important factor and enabler in this process of fast-paced change and innovation is the Internet. The Internet has revolutionized the banking sector by offering customers additional functionality, 24-hour access to their money as well as time and cost savings. [1] The Internet dissolves traditional boundaries between financial institutions and empowers individuals to choose and define their own financial futures. [2] [3]

One of the effects is a growing convergence in the financial services industry, whereby traditionally specialized organizations are now offering financial services that cross all sections of the population. [4] This means that traditional banks are fast losing their key differentiating characteristics. A great challenge, therefore, is to refocus their attention on their customers and gain a much better understanding what they want from a

financial services perspective. This has forced banks to look at their internal procedures in order to cope with the fast-evolving needs and expectations of their customers: cost savings, customized products and services and more personalized attention.

This research aims to determine whether a gap exists between the customer expectations of Internet-based banking services and the delivery, by South African banking institutions, to these expectations as part of an integrated banking offering. Although some South African banks have undertaken their own studies, these are often focussed on particular aspects and often driven by various strategic and (internal) political objectives. In addition, the results of these studies are not commonly made public. Finally, these studies are often commissioned by individual institutions and fail to represent an industry-wide picture. It is important to realize that the South African situation differs fairly dramatically from that in other countries due to its very specific industry configuration and regulations, population characteristics, banking information technologies and Internet infrastructure. Thus the results from international studies are not likely to be usable in a South African context.

2. How the Internet affects Banking.

The Internet has driven a number of changes in the financial services sector.

2.1 Convergence between financial service providers.

By dissolving the boundaries between information publishers, independent advisers and traditional product providers, each group is attempting to extend their offerings in order to provide a more complete service to their customers. As specialised organisations move beyond their core competencies, this convergence poses a threat to traditional banks, especially in the light of innovative institutions offering more customer-centric services. [4] [5]

2.2 Empowered customers.

Customers are quickly coming to expect Internet access to information and products. Face-to-face contact at branches and sales offices is losing importance as more information becomes available on-line. The increased competition from innovative, virtual financial institutions

is making customers more price-sensitive. These empowered users are now demanding better Internet experiences from traditional banks and becoming less tolerant of the inferior offering given to them in the past.

“Round-the-clock access to content and commerce gives users a hyperactive sense of entitlement. Customers demand what they want and when they want it: at home, at work, across channels.” [6]

2.3 Banks focus on the future but often overlook current customers.

Banks are often racing to outdo each other in an attempt to be “first-to-market” with innovative new services. Due to the technical complexities underlying these Internet-based services, usability issues are often overlooked and this may lead to overlook the needs and satisfaction of their existing customer base. [4]

2.4 Personalization online.

A lot of effort is spent on personalisation. However, many of these efforts have not been particularly successful because they currently add little real value to the user nor do they simplify the overall user experience. Indeed, much of the current Internet-based personalisation appears to be limited to customised homepages, more targeted marketing messages, basic advice and generic recommendations. As long as they fail to deliver real and significant added value to their customer’s overall financial experience, banks will not reap the somewhat naïvely expected rewards of improved customer loyalty and account growth. [2]

3. Current state and drivers of the South African banking industry.

An interesting study by Price-Waterhouse-Coopers [7] in the state of South African banking uncovered a number of important issues. It emerged that change in the banking industry was mainly driven by technology (getting the right balance between “clicks and bricks”), consolidation (to achieve economies of scale) and globalisation. Competition was driven by IT developments and the emergence of alternative delivery channels. Internet banking was seen as one of the more successful markets. Change enablers were client sophistication (and consequent demand), new information technologies and the Internet. However, the most pressing issues were service quality, client focus and profit performance.

Eight out of nine commercial banks had a formal strategy in place to switch customers to electronic channels, against only half of the investment banks. Of the nine banks that offered Internet banking facilities, only one believed this area to be profitable. However, most banks believed that the Internet could be used to reduce costs and generate revenues. At a less than 1% penetration rate, web enabled mobile phones were experiencing limited acceptance by bank customers who believed the

technology to be slow and cumbersome.

3.1 Issues facing Internet banking customers.

Currently, there are a number of issues hampering the acceptance of Internet-based money management. These include customer satisfaction with existing service channels, security concerns, and a perceived lack of utility in the Internet channel. [7] For newcomers to the Internet, issues such as security and privacy concerns are still the greatest barriers to entry. [8] Banking organisations have a big role to play in helping to make their customers feel safe on the Internet.

Another issue facing Internet banking customers is that they perceive the Internet channel to lack functionality. Financial service providers appear to have, so far, failed to communicate a clear value proposition to customers. Most consumers reported that they do not use Internet-based financial services nor expect to use them in the near future. [1] Financial institutions thus face a challenge in demonstrating that using the Internet as a service channel will be worthwhile and functionality will be delivered.

3.2 Specific challenges facing the Internet banking service providers.

The greatest challenge for banking institutions will be to move beyond traditional ideas of banking by redefining, streamlining and integrating their core business focus to suit customers needs. [5] They need to reinvent themselves by critically examining their existing infrastructures and focusing on the key areas that directly benefit their customers. This strategy requires the banks to replace their traditional product and channel silos with a customer-centric approach, entailing enormous changes in corporate culture and operational procedures for most institutions. [3]

Perhaps the most critical challenge is to get customer service right, not just on the Internet, but across all communication channels. Customer service is currently considered the Achilles heel of most South African banks.

A second challenge is to find the right balance between “bricks and clicks” by moving cautiously in reducing the size of physical branch networks. [9] Retaining the existing physical infrastructure prevents immediate cost-savings but remains the greatest point of difference between traditional and virtual banks. This is of particular relevance in South Africa which struggles with relatively low Internet penetration rates.

Another challenge is that of channel integration. Traditional banking institutions are still struggling to integrate customer data across all the points of contact customers have with them. Even where this is achieved, they must ensure consistency in the functionality across banking channels. If the strategy is that the Internet could become the main communication channel in the banking context, this requires that a core Internet service offers comprehensive transaction, financial management and advice functionality. This functionality should become the

backbone of their channel management and can then be extended with other channels playing a supporting and complementary role. [3] Unfortunately, this strategy requires an IT architecture which is often not possible given the banks' proprietary and legacy systems. The latter often limits the Internet service functionality. This creates a vicious circle whereby the Internet value proposition is too small to move customers online, and limits the financial viability of the Internet channel. This in turn discourages the bank from investing sufficient funds to further develop the channel.

Another challenge faced by banks is the new type of Internet customers, the youth, and their very different demands and expectations. These early adopters have internalised the Internet technology, are highly active, autonomous and willing to experiment. On the other hand, they expect low fees and have no respect for the traditional distinction between banks and technology brands such as IBM and Microsoft whom they are equally willing to trust with their money. This market is important because they constitute the next generation of banking customers and, once lost, may be extremely difficult to win back. However, banks cannot focus their Internet channels entirely on this market without alienating their more techno-phobic mainstream customers who tolerate less risk and require better guidance. [5]

Finally, a major challenge is that new entrants in the Internet banking arena, such as retailers, investment companies and brokers, are seeing banking as a tool to retain and acquire customers for their core business rather than as an independent profit centre. In addition, they often have a far more streamlined technical and business process infrastructure. As a result, they are likely to market and price their banking products aggressively and can offer extremely competitive rates. [4]

4. Research methodology.

The working hypothesis for this research is that there exists a gap between customer expectations of Internet banking and the satisfaction of these expectations by banking institutions in South Africa.

4.1 Definitions.

The concept of "user expectations" as used in this research must be seen the context an interactive Internet environment and is based on the research of several authors. [7] [10] [11] [12] The following specific qualities are considered to make up the user expectations of Internet banking customers:

- Basic functionality, convenience and speed of website.
- Service levels both online and offline.
- Integration across banking channels.
- Cost of transactions.
- Quality of information on the website.
- Actual website usability.
- Personal contact independent of the Internet banking channel.
- Added value for the end user in terms of the

product/service offering.

The term "Internet banking customers", hereafter usually referred to as "users", will be understood to refer to persons who make use of Internet-based banking facilities offered by their bank, enabling them to perform real-time transactions on their bank accounts in a secure and private environment.

4.2 Research approach.

The research has been approached from a functional, practical and emotional perspective. The research methodology reflects these perspectives. The research itself was exploratory in nature. Exploratory research studies are suitable for finding out what is happening at a high level; seeking new insights and knowing what questions to ask.

The study combined qualitative and quantitative data analysis. This was necessary since the aim was to establish how people feel about Internet banking from both an emotional and practical perspective. The qualitative approach assisted in gaining an insight into the more emotive issues that cause the formulation of these opinions.

The research process began with a series of in-depth interviews with a group of ten Internet banking customers. The group was stratified according to gender, a general or private banking relationship, dial-up versus corporate access, and some spread in banking institutions. The interviews were conducted using a structured discussion guide. The aim was to uncover specific issues, feelings and thoughts people had regarding their Internet banking as well as to gauge their current and immediate banking needs and future expectations.

These results were then tested more rigorously with the help of quantitative research by means of a web-based questionnaire. This questionnaire was accessible by means of a URL sent to respondents via e-mail. The sampling was done using a combination of convenience and snowball sampling. It was felt that this was acceptable for purposes of exploratory research. This approach resulted in a larger sample that would otherwise have been possible, but introduced some significant biases.

5. Sample description and representativeness.

The in-depth interview sample consisted of 4 women and 6 men, with a length of Internet banking experience ranging from 1 to 18 months. They came from a wide variety of job functions and there was a mix of dial-up and corporate users. Half of them had a personal banker. This sample was not intended to be representative.

77 usable responses were obtained from the online questionnaire. Table 1 shows the sample demographics and compares it to the sample of a commercial survey undertaken by Webcheck. Although the detailed data results of the latter were confidential, approximate sample demographics could be calculated from the management report. It must be noted that the use of rounded values and reasonable assumptions implies that some of the figures in

the Webcheck column are approximate.

Table 1: Comparison of sample demographics.

Characteristic	Green & Van Belle July'02	Webcheck July'01
Sample size: n =	77	400
Gender: male:female	73%:27%	53%:47%
Age: 18-30:31-39:40+	45%:30%:25%	22%:32%:46%
Access type: Dial-up:corporate:both	57%:72%:29%	? : ? : 35%
Banking institution:		
□ □ Standard Bank	42%	41%
□ □ Nedbank	22%	19%
□ □ ABSA	14%	16%
□ □ FNB	12%	17%
□ □ Other	10%	(10%)

Although the sample is not random and less than one-fifth of the size of Webcheck's, some of the demographics appear to be very comparable, notably the banking institution and the type of Internet access. However, our sample has a significantly smaller proportion of 40+ year olds, off-set by the thirty-and-less group, as well as a very strong male dominance. The probability of the samples reflecting the same population is extremely improbable (p-values for χ^2 is less than 0.1%). However, despite the larger sample size of Webcheck, there are some indications that their sampling frame – especially in terms of gender and age distribution – may also not be representative of the internet banking users. Unfortunately, no information was available on their sampling methodology.

6. Opinions about banking in general.

In the in-depth interviews, most people expressed unhappiness with their physical bank, but appeared to be much more content with their Internet bank. Consequently, a number of questions were included in the questionnaire to probe the respondents' opinions about banking in general.

Important in explaining some of the dynamics in the South African banking industry is the fact that, when asked for their reasons for staying with their bank, by far the most people (42%) found that it was "too much effort to change". This was consistent across gender and age group. Other reasons given were service (17%), loyalty (10%) and competitive rates (5%). This certainly seems to rationalize a popular perception that banks appear to invest more resources into attracting new customers than they seem to invest in retaining existing customers e.g. by means of increasing service levels. However, there appears to be some conflict with the responses on a later question where 65% of respondents said that they would move their accounts if they were offered cheaper banking fees. This highlights the potential threat posed by new low-cost entrants in the financial market.

When asked whether the bank was meeting their financial expectations, 60% of overall respondents said

that their bank did not, although this ratio was more than reversed within the 31-39 age group (only 35%). This difference is statistically significant ($Z = -2.1$) and demonstrates how perceptions (and perhaps service levels) differ at this age group.

Almost everyone (86%) would like to be able to open new accounts over the Internet, without having to go to a physical branch.

Interestingly, although 58% of the sample did not want their bank more involved in their financial life, 49% said they would like more financial advice. There were two sub-groups who liked significantly ($p < 5\%$) more financial advice: 76% of women and 82% of those banking with one particular bank said that they would have liked more help in choosing additional banking products. This again emphasizes the need to segment the markets and engage in some data mining.

7. Opinions and views on Internet banking.

7.1 Levels of satisfaction.

Contrary to the relatively low levels of satisfaction with their physical banking channels, 82% of respondents said that they were happy with their Internet Bank. 100% of respondents confirmed that Internet banking made their lives easier.

Rating the advantages of Internet banking using a multiple response question, convenience (73%) was rated significantly higher than time saving (56%). 30% said it gave them more control over their money. Figure 1 gives an overview of all the advantage ratings.

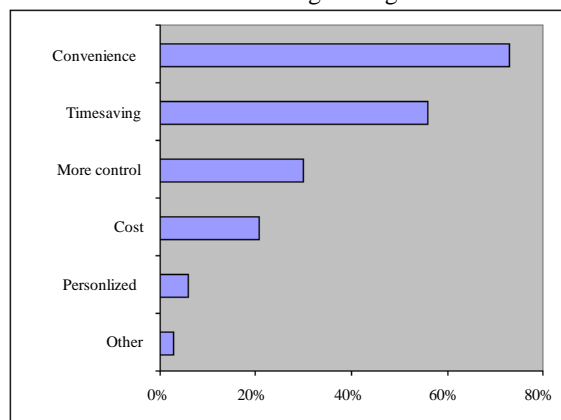


Figure 1: Perceived advantages of Internet banking.

This relates directly to the most important thing people wanted their bank to deliver on the internet: 74% said speed, 56% of the sample said convenience, 38% said functionality and 35% said cost; although there were some minor differences between banking institutions. 71% of respondents felt that their bank delivered on their requirements.

The biggest problem with Internet banking was speed – cited by half of the respondents. Figure 2 shows a ranking for the other problems.

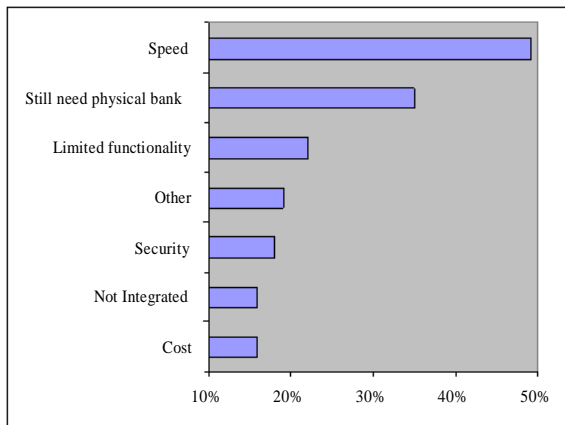


Figure 2: Perceived problems with Internet banking.

However, there was a marked difference between banking institutions (statistically significant at a 95% level of confidence). The main problem with the largest Internet Bank (Standard Bank, 56%) was perceived to be speed. For two other banks (ABSA and Nedbank) limited functionality was the main problem, though much more significantly so for the former (91% versus 53%). 67% of FNB users had a problem with cost and 44% with security and the lack of integration with existing bank channels. It must be noted that the bank websites evolve all the time and some of these issues have been addressed since the survey was undertaken.

7.2 Use, usability and safety.

Internet banking was mostly used for inter-account transfers (62%) and payments (61%), not statements (48%) or checking balances (44%). Overall, most respondents felt that their Internet banking site was easy to use, though 62% wanted to have the ability to customize their banking site. 55% of respondents felt that Internet service, in terms of feedback, solving technical errors and rectifying problems, was generally good. The great majority (77%) felt that their personal information was “safe”.

7.3 Qualitative data analysis.

The in-depth interviews as well as the many open-ended questions on the questionnaire allowed an investigation of the more emotional reasons for the way people perceived and actually experienced their Internet bank.

Although usability was not a major problem, a number of suggestions for improvement were made. Not surprisingly in terms of the speed problem, users demanded sites to be less graphically intensive to reduce download times. Simpler navigation and better information display/layout were also suggested, as were more intuitive menu options that described specific content sections better. A less complex login procedure was a requirement which may be in conflict with the security requirements.

More problematic – especially for the two institutions mentioned higher – and a lot more difficult to achieve, are

the needs relating to better functionality. Users wanted an integrated view of the different accounts, with a single point of access. They also wanted additional functionality, especially the ability to open new accounts and add new beneficiaries online. Greater access to transactional history was also mentioned. Channel integration came up as well with being able to communicate with the bank via e-mail being mentioned very frequently, as well as improved call centres with operators who are empowered to conduct transactions. Finally, some users would like to see more useful and interactive financial tools.

One of the respondents described her vision as follows:

“[I’d like to see] a management tool that helps me analyse my budgeted expenses against my income. A system that mails me warnings when funds are low and stop orders are likely to bounce. Something that lets me assess whether I can afford a new purchase. Banks make their money off interest and I am sick of them letting my overdraft and credit spiral. I want a partner that helps me control my money.”

An overriding feeling was the desire of customers to feel treated like individuals. This was validated by the questionnaire responses where 74% wanted to maintain a personal relationship with their bank, no matter how automated and electronic banking became. People were looking for added value from their banking institutions in the form of:

- Pro-active advice through personal service regarding available products and additional services available to them.
- Investment advice, recommendations and feedback on the way their accounts were performing.
- Accessibility to persons who could answer technical (Internet problems) and financial (account based) questions but were empowered to effect certain changes.

On the issues of trust and safety, most people said that they assumed that the banks would be more concerned with data privacy and safety than e-commerce shopping sites. They also saw banks to have always been on the forefront of developing secure technology, and as a result assumed that they were safer to use. It was felt that a lot of this trust had to do with banks working hard to create this perception of safety and trust.

7.4 The future of electronic banking.

When asked where people would like to see Internet banking moving, the following threads were raised.

- Transparency of service as captured nicely by one respondent into “open access” – can opt out or leave the site in seconds; “open information” – giving a choice and info about competitors; “open communication” – direct on-line contact to a human being; and “open rates” – a clear view of their charges, possibly motivated in terms of their cost structure.
- Integrated money management. Some respondents and interviewees were aware of the trend towards convergence and more integrated financial service

offerings. This trend – as already evidenced by one retailer and one life insurance company launching an Internet bank – was welcomed by respondents.

- Retaining personalized service. Many people, especially those older than 30 years, expressed the fear that there was the potential “death of personal relationships” due to banking become more and more driven by technology.
- Future costs. There was a strong concern that banks needed to pass on the (long term?) cost saving from Internet banking onto their customers.

8. Conclusions.

The original research hypothesis was that there currently exists a gap between expectations of Internet banking customers, and the satisfaction of these expectations by South African banking institutions. The results of this study indicated that Internet banking customers in general were happy with their Internet banking facility, and that their basic expectations were being met through the Internet channel.

Internet banking has delivered functionality and convenience to Internet banking customers. It has improved the service offered by traditional banking institutions and has delivered to basic Internet banking customers’ expectations. However, since people are still struggling with basic Internet issues such as cost of connection, security fears and actual operational speed, their expectations from Internet banking have been relatively simple to date and essentially needs driven.

In terms of convenience, time saving and basic functionality which Internet banking offers, users’ expectations were being met. The Internet has raised the standards of service which customers have come to expect from their banking institutions. Internet banking, by its very nature, offers basic functionality in the form of payments, transactions and general account management. It is this “added value” which banks of the future need to focus on if they are to differentiate themselves in the market, not just in an attempt to acquire new customers, but to retain their existing customers. This research study indicated that although people were relatively content with their Internet bank at the time of the study, they still had fundamental issues with their actual “brick and mortar” bank in terms of the products they offered, service levels and integration with the Internet banking channel.

Speed was one of the areas where customer expectations were not being met on the Internet. This is not entirely the fault of banking institutions in South Africa because the infrastructural problems of hardware and bandwidth within South Africa have a fundamental effect on how fast people can transact on the Internet.

43% of the sample said there was integration across banking channels. However, the open questions and interviews revealed that many people felt there was not enough integration especially between branches and the Internet.

The issue of additional costs associated with banking

on the Internet, is one of the areas in which customer expectations are not being met. From the interviews and open questions, there was an overwhelming feeling that the costs associated with Internet banking were high and unnecessary. Most people felt Internet banking should be a free, added value service integrated into their entire banking experience. Additionally, people felt that one of the main reasons they would consider leaving their bank would be due to another bank offering reduced fees.

In terms of information quality on the Internet, most people were not aware of many of the services and products offered by their banking institution. Women particularly spoke about wanting help and advice in choosing new banking products. This is interesting as the Internet is a good medium for the transmission of information to people in the most cost effective and interactive way. It is felt that banking institutions should ensure that relevant information is made available to their customers on the Internet to compliment the service. Until then, email communication and clearly organised Frequently Asked Questions (FAQ’s) can go along way to solving this problem in a cost effective way.

Most people seemed happy with the actual usability on their Internet banking site. Minor issues included comments of complex login processes, as well as not having the ability to view all accounts within one window.

The final area of customer expectation involved providing banking customers with added value services online. People felt that although basic functionality issues were being addressed, there was the potential for more in terms of what they could be offered on the Internet. People were looking for personalised communication from effective and efficient organisations to help add value to their financial lives. It is felt that banking institutions could benefit from Customer Relationship Management (CRM) programmes, to better understand their customers. Relationship building between financial institutions and their customers is vital.

In terms of the actual research methodology, it is felt that the study was appropriately designed, but lacked both sample numbers and specifically selected sample groups that would have been more representative of the banking population in South Africa at the time of the study. Additionally, the research was limited by both cost restrictions and time constraints. It is felt that in addition to the actual research methodology followed, there was the potential to conduct more extensive qualitative interviews with a more specific sample group as well as with South African banking institutions. It is felt that this additional information would have given the study a greater depth: it would have provided a deeper insight into what people were expecting from an Internet-based service as well as would have offered an insight into how banking institutions perceived their Internet offering.

9. Future research.

It is felt that the potential for future research lies particularly in the area of delivering banking services and

products to the majority of South Africans through the better utilisation of the Internet as the ubiquitous medium it has the potential to be.

In addition, future research could focus on areas such as the effect on traditional banking institutions by innovative, virtual financial institutions that are able to offer better services, competitive rates and unique products; on defining new ways of delivering value added services at reduced costs; and on understanding which financial product categories are growing or changing most rapidly online and why. Additionally, from the research itself a number of interesting issues emerged which definitely warrant future research. These include understanding the way different age groups respond to financial products and services and the differences between men and women in terms of where and how they see their banking institution fitting into their financial lives.

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Development Study of Evaluation Indexes for Internet Business Models

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Abstract

Under the prerequisite that virtual markets need a unit of analysis other than traditional markets, business model is set as the unit of analysis of this research. In this research, in order to help choose Internet business model that creates the most value, evaluation indexes for value-creation potential of Internet business models are developed. As research methods, deductive method and analytic hierarchy process (AHP) are used.

As the first stage of deduction process, the improved profits and the reduced costs, which factors are classified and quantitative and qualitative evaluation indexes of two dimensions are extracted by related studies. Then, evaluation indexes are corrected, complemented and verified through the expert interview, and analytic hierarchy is documented.

As the result, the improved profits dimension outweighed the reduced costs dimension, and each qualitative effect outweighed each quantitative effect. The overall consistency index showed to be 2%, which means that all the experts are determined to have rational consistency.

I. Introduction

As the recent development of digital technology has brought about the construction of an open-type digital network, that is Internet, an increasing number of people come to exchange a great quantity of information. Therefore, the problems involving the inverse proportion between the reachness and faithfulness of information become increasingly solved [19]. This solution in turn heightens the level of spreadability and accessibility of information, which in turn can empower customers and promote the fundamental change of the business logic of firms [35]. By using Internet, consumers are enabled to

choose the firm that is likely to offer the best quality of products and services, since they can acquire and exchange enormous information about products and services of all related firms quickly and freely.

On the other hand, the existing elements for predominance in competition - such as distribution channels and chain stores constructed through immense investment - became in name only owing to the alleviating of the inverse proportion between reachness and faithfulness of information. Furthermore, a fundamental change is appeared in the distribution channel selection for an efficient approach about suppliers and customers and in the interchange method between a firm's internal and external functions because transaction cost is decreased [17]. This fact means that the business models including a firm's operation method have been changed drastically by an emergence of the Internet.

Firms should select the most suitable business model in order to create more values in a digital economy environment. Specially, it is related with enhancing competitiveness of the existing core business and securing new business opportunities to select the most suitable business model in Internet business. The competitiveness of a firm is depending on selecting suitable Internet business models and strategies in the digital economy that is new economic environment.

However, most studies of the Internet business model have been suggested just taxonomy and some success factors or analyzed some cases. There were not the studies of a tool that can evaluate the value-creation potential of Internet business models systematically.

Therefore, this study aims to develop the evaluation indexes that can evaluate the potential of the value-creation of a business model for firms in the beginning

and help the firms select suitable business models.

II. Literature Review

1. The Definitions of Internet Business and the Business Model

The concept of Internet business is different from that of electronic commerce. Electronic commerce means that products, information or services are sold and bought on the Internet, whereas Internet business means that all processes of a value chain following by planning, development, manufacture, production, distribution and consumption of a product are connected with Internet.

The goal of Internet business is suggested on improving profits or creating values in most definitions about a business model. This study defines the business model as “structural form of the components of transactions that was designed in order to create values” by modifying the definition of Amit & Zott (2000) that structural form of the components of transactions that was designed in order to develop business opportunities.

2. The Classification of Internet Business Models

The main researches on Internet business model are as follows. Bambury (1998) divided Internet business models into the Internet unique business models and the traditional business models transplanted to the Internet. He insisted that a lot of traditional business models are applied compositely to the Internet.

Timmers (1998) found out the method to integrate information along a value chain by confirming the elements on a value chain and analyzing a interaction pattern of participants of a transaction. Through this, he classified business models into e-shop, e-procurement, e-auction, e-mall, third party marketplace, virtual community, value chain service provider, value chain integrator, collaboration platform, information brokerage, and trust services.

Rappa (2000) presented general business models such as brokerage, advertising, infomediary, merchant, manufacturer, affiliate, community, subscription, utility, and more concrete models according to business methods operated by each business model.

Yang (2000) classified business models into the type of advertisement, the type of retail shop, the type of channel, the type of cooperation, the type of franchise, and the type of joining according to main income sources.

2.1. The Value Creation of Internet Business Models

Bloniarz & Larsen (1997), Ghosh (1998), Jarvenpaa & Tiller (1999), Amit & Zott (2000), Bielski (2000), and Ethiraj et al. (2000) studied the factors that affect value creation of a business model.

Among them, the studies of Amit & Zott (2000) and Ethiraj et al. (2000) are similar to this study and provided some important factors. Amit & Zott (2000) observed the value-creation potential of business models of 59 Internet business firms in the United States and Europe.

They developed a value drive model that can evaluate the value-creation potential of Internet business model according to four dimensions of novelty, lock-in, complementarities, and efficiency. The Ethiraj et al. (2000) suggested scalability, complementary resources and ability, related specific assets, a knowledge sharing routine as success factors of Internet business model. The scalability means the ability that is able to extend a merit of a business model according to a value chain. Besides, it means using a unique complementarity of a business model in order to diversify markets, products and customers [30]. Cooperative firms develop a knowledge sharing routine in order to use a mutual ability efficiently. The knowledge sharing routine means a regular pattern of interaction between the firms transferring, recombining, and creating related specific assets [16].

III. Research Methodology

1. Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP), which enables the user to determine the relative importance of criteria sets underlying their choice behaviors [5], is selected as the appropriate analysis tool. The AHP of Saaty (1977, 1980)-is theory and reality-an often used to solve strategic decision problems [3] [4] [5] [12] [28] [29] [32] [49] [53].

According to Saaty's original proposal, a complex system is decomposed into subsystems and represented in the hierarchical form. The element at the highest level is called the goal. The elements at each level are the criteria (factors) of the elements at the level below. The elements at the bottom level are called the alternatives. In this way, AHP organizes the basic rationality of the priority setting process by breaking down a multi-element complex system into its smaller constituent parts called components (or levels). The process can be divided into three phases, which are structuring a system, comparing pair-wise and synthesizing priorities.

The principle of comparative judgment is setting up a matrix to carry out the pair-wise comparisons of the relative importance of the elements in a component with respect to the criteria, elements in a dominating component at a higher level in the hierarchy. This matrix, denoted by A in our notation, is called the pair-wise comparison matrix. Let the pair-wise comparison matrix be

$$A = \begin{pmatrix} 1 & A_{1,2} & \dots & A_{1,n} \\ A_{2,1} & 1 & \dots & A_{2,n} \\ \dots & \dots & \dots & \dots \\ A_{n,1} & \dots & \dots & 1 \end{pmatrix} \quad (1)$$

where N is the number of elements in the component. The entry $A_{ij} > 0$ measures the relative importance of the impact on the criterion from element i against that from element j . There are some obvious properties of A (1),

among which the consistency is the most important one. When matrix A satisfies the following equation, it is said to be consistent.

$$A_{ij} = A_{ik} A_{kj} \quad \text{for any } k. \quad (2)$$

It is straightforward to show that when A is consistent, the weight vector W, which gives the relative priorities of the elements, is identical to any one of the columns of A within a normalization factor. One can further show that W is the dominant eigenvector of the matrix, namely

$$A * W = N * W \quad (3)$$

Since the relative importance of the elements depends only on the relative amplitudes of the components of the vector W, we may normalize W by requiring

$$\sum_i W_i = 1 \quad (4)$$

Generally, a vector is said to be normalized if it satisfies the above equation.

In fact, the inadequate nature of the comparison process dictates that inconsistency cannot be completely eliminated. It has been argued that even when A is not consistent, the weight vector W is still determined by the dominant eigenvector of A, namely

$$A * W = \lambda_{\max} W \quad (5)$$

where λ_{\max} is the largest eigenvalue of the matrix A. It can be shown that $\lambda_{\max} \geq N$ for any positive reciprocal matrix. The equality is reached only when the matrix is consistent. To measure the consistency of the matrix A, we define the Consistency Index (C.I.) as follows:

$$C.I. = \lambda_{\max} - N / N - 1 \quad (6)$$

In practice, we consider A is very consistent if the consistency index ratio C.R. = (C.I.)/(R.I.) is less than 0.1(Random Index: R.I.), which is the average consistency index of a random reciprocal matrix of the same dimension. And also the consistency of A is acceptable if the ratio of C.I. is about 10% or less, we accept the estimate of W. Otherwise, we attempt to improve consistency [29] [38].

The general analyzing process of AHP is presented in Table 1.

----- Insert Table 1 about here -----

IV. Development of Evaluation Indexes

1. Generating the Evaluation Indexes for Value-Creation

The study found out the evaluation indexes for value-creation. Those were consisted of improved profits and reduced costs extracted by previous studies and interviews with experts and made the analytic hierarchy.

1.1. The Framework for the Development of Evaluation Indexes

To develop the evaluation indexes for value-creation potential of Internet business models, the study selected two factors such as improved profits and reduced costs that affect value-creation. Furthermore, the evaluation indexes were developed based on profit drives, expected profits, cost drives, and expected costs that were factors to measure improved profits and reduced costs. The profit drives and the cost drives were suggested as the

qualitative effect and the expected profits and expected costs as the quantitative effect.

----- Insert Figure 1 about here -----

1.2. The Analytic Hierarchy

The analytic hierarchy was presented in Figure 2. It was composed of the evaluation indexes that were extracted by previous studies and interviews with experts based on the framework for the development of evaluation indexes.

----- Insert Figure 2 about here -----

2. Defining the Evaluation Indexes

The evaluation indexes for value-creation potential of Internet business models were explained as follows.

2.1. Improved Profits

The indexes to evaluate improved profits were composed of a qualitative effect and a quantitative effect. The qualitative effect means the qualitative factor that raises total profit that a business model creates. There were complementarities, Lock-in, and novelty as indexes to evaluate the qualitative effect. The quantitative effect means expected total profit that a business model creates. There were things about potential customers and marginal incomes as indexes to measure the quantitative effect.

2.2. Reduced Costs

The indexes to evaluate reduced costs were composed of a qualitative effect and a quantitative effect. The qualitative effect means the qualitative factor that decreases total cost that a business model generates. There were transactional efficiency, marginal productivity, and reusability as indexes to evaluate the qualitative effect. The quantitative effect means expected total cost that a business model generates. There were labor cost, contents developing cost, operating cost, and marketing and selling cost as indexes to measure the quantitative effect.

3. Assigning the Importance of the Development of Evaluation Indexes and Analysis

To assign the importance of each evaluation index extracted by prior studies and interviews with experts, the related data were collected from the experts who had participated in the interview.

3.1. The Process of Survey

The questionnaire was made out based on the analytic hierarchy presented in the Figure 2. It was consisted of 52 items in five levels from goal in the highest level to final level. Two items in the same level were arranged to be able to compare. The relative importance between two items was measured on a nine-point scale.

The persons who participated in the survey were consisted of seven experts who had participated in the interview in the generating process of evaluation indexes. They were working-level officials who are in charge of developing Internet business model and consulting, and investing Internet business firms.

Two survey methods were used for the study. First, e-mails were sent to each of the experts. The e-mails included an explanation about the way to respond to the questionnaire. The completed questionnaires that the experts assigned the relative importance were sent to the researchers through e-mails.

Second, the researchers visited the experts and explained the way to respond to the questionnaires. Then they collected the questionnaires that the experts assigned the relative importance immediately. Team Expert Choice Ver. 9.5 was used for analysis. It is a software program supporting the analysis of AHP

3.2. The Results

The consistency index of the questionnaires collected from seven experts was analyzed. That of one questionnaire was exceeded the permitted limit. Then it was excluded and six questionnaires were analyzed. The results are as follows.

----- Insert Table 2 about here -----

Overall consistency index of six experts was 2%. The consistency index of each one was expert 1 (6%), expert 2 (5%), expert 3 (7%), expert 4 (9%), expert 5 (7%), and expert 6 (4%) respectively. All the experts had rational consistency because the consistency indexes of everyone were within 10% [38].

Through the result of synthesizing opinions of the experts who evaluated actual Internet business model in practical business, the study has the following conclusions.

First, the improved profits of a business model outweighed the reduced costs. It shows that how much the business model can create profits is a key point to select a business model before starting a business.

Second, the qualitative effect outweighed the quantitative effect in the improved profits and the reduced costs. It means that the qualitative effect was important than the quantitative effect to evaluate the value-creation potential of Internet business models.

Third, the order of importance was calculated that novelty is the first, complementarities, the second, and lock-in, the last among the qualitative indexes evaluating the improved profits. That is, it shows that the degree that a business model introduces a new way of transactions affects the improved profits highly, and then providing products and services in bundle and motivating customers to re-transact affect profits less.

Fourth, among the quantitative indexes evaluating the improved profits, the order of importance was calculated that marginal revenue is the first and potential customers, the second. It means that the marginal revenue affects qualitative profits highly.

Fifth, the order of importance was calculated that transactional efficiency is the first, reusability, the second, and marginal productivity, the last among the qualitative indexes evaluating the reduced costs. It shows that the degree that the transaction cost is decreased affects the improved profits highly. However, it affects profits less than the degree of the additional output as a result of adding one unit of variable factor and that of possibility of use services/information with other objectives.

Sixth, marketing/selling cost is the most important, and labor cost, the second, contents developing cost, the third, and operating cost, the least in qualitative indexes evaluating the reduced costs. That is, marketing/selling cost is produced highly, and then labor cost, contents developing cost, and operating cost are generated less.

V. Conclusions and Implications

The importance of an each index and a consistency level applying to AHP are as follows.

----- Insert Table 3 about here -----

Internet business firms must select suitable business models to create values. The competitiveness of firms is depending on selection and strategies of suitable Internet business models. However, most studies of the Internet business model have been suggested just taxonomy and some success factors or analyzed some cases. There were not studies of the evaluation index, which is able to evaluate the potential of the value-creation of Internet business models systematically.

Therefore, this study has contributions to practitioners as well as academics. As for a practical contribution, this study provides firms with evaluation indexes that can diagnose value creation potential of Internet business models and a relative importance between the evaluation indexes. As for academic contributions, this study presents a cornerstone of the study of evaluation criteria of the Internet business model.

However, the study was not able to consider on the difference of the indexes and the importance by industry. Therefore, it should be deliberated in future study.

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Appendices

Table 1. The Analyzing Process of AHP

Step 1.	Problems should be defined exactly and then requirements of problems are clarified.
Step 2.	A Hierarchical structure is consisted of from goal of problems, evaluation criteria, to comparison of alternatives considering all elements related to the problems.
Step 3.	A relative importance about all evaluation criteria is marked and a comparative matrix is made out after executing pairwise comparison between evaluation criteria.
Step 4.	The consistency level(C.R.) is calculated to check matrix consistency after finding out the relative estimate weights (W) of all evaluation criteria. If C.R. exceeds 10%, the results of pairwise comparison should be reexamined.
Step 5.	The process of step 3 and step 4 are repeated toward all evaluation criteria included the hierarchical structure made in step 2.
Step 6.	The relative estimates of alternatives calculated by each evaluation criterion are added by each alternative. It is that relative weight between the alternatives that considered all evaluation criteria generally.
Step 7.	The alternative that got most a lot of scores is selected after comparing an evaluation score of each alternative that calculated in step 6.
Step 8.	If C.R. of all evaluation results exceeds 10%, You must examine whether a mistake was with configuration of hierarchical structure of problems in the beginning or consistency lack on comparative judgment.

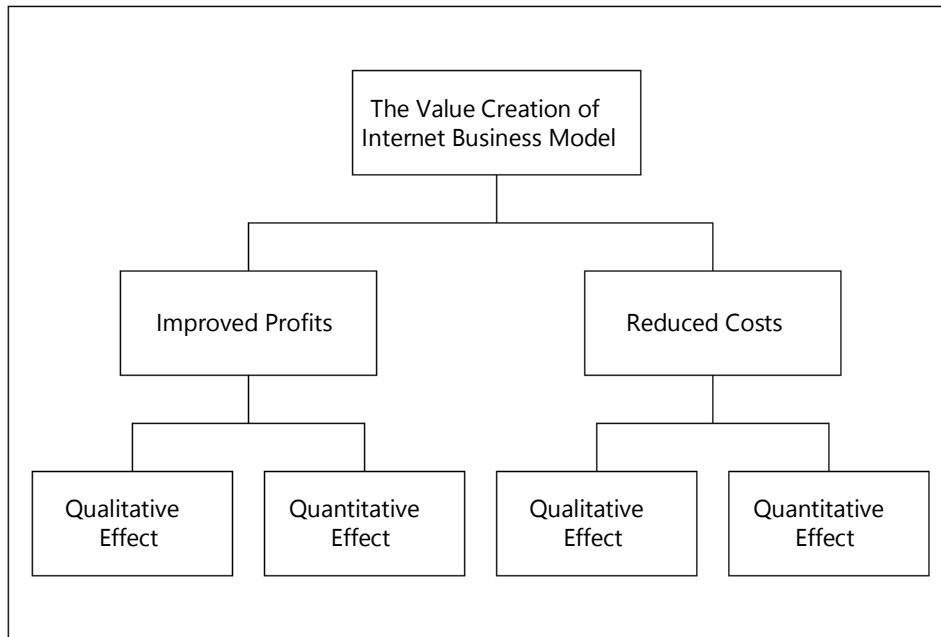


Figure 1. The Framework of Development of Evaluation Indexes

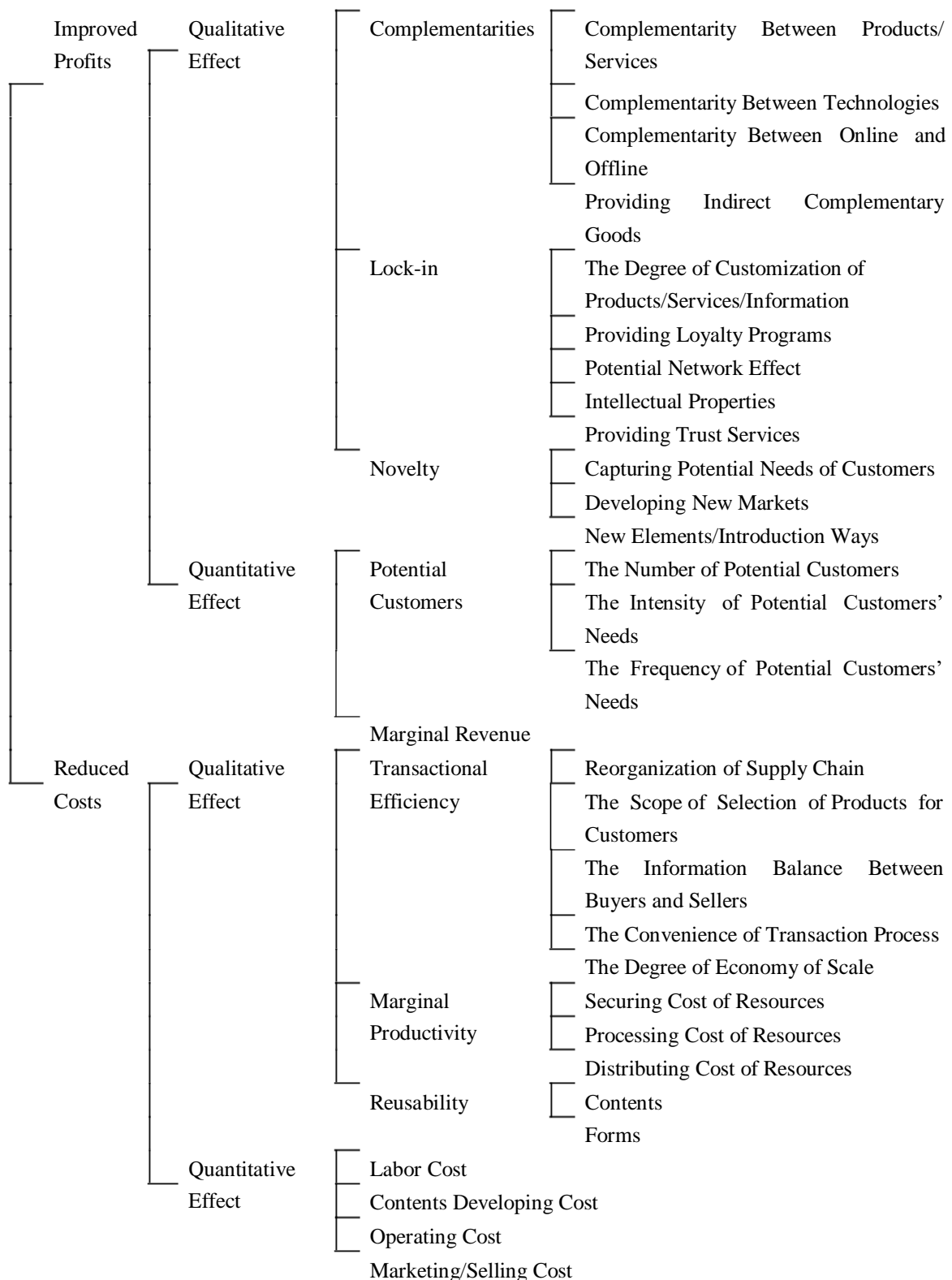


Figure 2. The Analysis Hierarchy

Table 2. The Importance of Evaluation Indexes

Level 1	Level 2	Level 3	Level 4
Improved Profits 0.808	Qualitative Effect 0.617	Complementarities 0.177	Complementarity Between Products/Services 0.030
			Complementarity Between Technologies 0.032
			Complementarity Between Online and Offline 0.105
			Providing Indirect Complementary Goods 0.010
		Lock-in 0.101	The Degree of Customization of Products/Services/Information 0.032
			Providing Loyalty Program 0.017
			Potential Network Effect 0.013
			Intellectual Properties 0.013
			Providing Trust Services 0.025
		Novelty 0.339	Capturing Potential Needs of Customers 0.115
			Developing New Markets 0.124
			New Elements/Introduction Ways 0.100
	Quantitative Effect 0.191	Potential Customers 0.085	The Number of Potential Customers 0.036
			The Intensity of Potential Customers' Needs 0.012
			The Frequency of Potential Customers' Needs 0.036
Reduced Costs 0.192	Qualitative Effect 0.139	Marginal Revenue 0.106	
		Transactional Efficiency 0.099	Reorganization of Supply Chain 0.013
			The Scope of Selection on Products of Customers 0.020
			The Information Balance Between Buyers and Sellers 0.028
			The Convenience of Transaction Process 0.030
			The Degree of Economy of Scale 0.008
		Marginal Productivity 0.019	Securing Cost of Resources 0.012
			Processing Cost of Resources 0.005
			Distributing Cost of Resources 0.002
		Reusability 0.021	Contents 0.018
			Forms 0.003
	Quantitative Effect 0.053	Labor Cost 0.009	
		Contents Development Cost 0.009	
		Operating Cost 0.007	
		Marketing/Selling Cost 0.029	

Table 3. The Consistency Index and the Importance of Evaluation Indexes

OVERALL CONSISTENCY INDEX = 2%	
Developing New Markets	0.124
Capturing Potential Needs of Customers	0.115
Marginal Revenue	0.106
Complementarity Between Online and Offline	0.105
New Elements/Introduction Ways	0.100
The Number of Potential Customers	0.036
The Frequency of Potential Customers' Needs	0.036
Complementarity Between Technologies	0.032
The Degree of Customization of Products/Services/Information	0.032
Complementarity Between Products/ Services	0.030
The Convenience of Transaction Process	0.030
Marketing/Selling Cost	0.029
The Information Balance Between Buyers and Sellers	0.028
Providing Trust Services	0.025
The Scope of Selection of Products for Customers	0.020
Contents	0.018
Providing Loyalty Programs	0.017
Potential Network Effect	0.013
Intellectual Properties	0.013
Reorganization of Supply Chain	0.013
The Intensity of Potential Customers' Needs	0.012
Securing Cost of Resources	0.012
Providing Indirect Complementary Goods	0.010
Contents Developing Cost	0.009
Labor Cost	0.009
The Degree of Economy of Scale	0.008
Operating Cost	0.007
Processing Cost of Resources	0.005
Forms	0.003
Distributing Cost of Resources	0.002

A New Approximate Algorithm for Solving Multiple Objective Linear Programming with Fuzzy Parameters

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Abstract

Many business decisions can be modeled as multiple objective linear programming (MOLP) problems. When formulating a MOLP problem, objective functions and constraints involve many parameters which possible values are assigned by the experts who are often imprecisely or ambiguously known. So, it would be certainly more appropriate to interpret the experts' understanding of the parameters as fuzzy numerical data which can be represented by fuzzy numbers. This paper focuses on fuzzy multiple objective linear programming (FMOLP) problems with fuzzy parameters in any form of membership function in both objective functions and constraints. Based on the related results of fuzzy linear programming (FLP) and linear programming problems with fuzzy equality and inequality constraints proposed by Zhang et al, this paper firstly proposes related definitions and concepts about FMOLP problems with fuzzy parameters. It then proposes a new approximate algorithm developed for solving the corresponding MOLP problems and the FMOLP problems. Finally, the use of related concepts, theorems, and the proposed approximate algorithm is illustrated by an example involving different cases which include setting various iterate steps, tolerances, weights, and satisfaction levels.

Keywords: Optimization; Decision support technology; Multiple objective linear programming; Fuzzy multiple objective linear programming, Approximate algorithm.

1. Introduction

Most of decision-making problems in the real world take place in an environment in which the goals, the constraints and consequences of possible actions are not known precisely [1]. In order to deal with such decision situations, fuzzy set theory has been applied into decision-making models.

Multiple objective linear programming (MOLP) is one of the popular methods to deal with complex and ill-structured decision-making. When formulating a MOLP problem, various factors of the real world system should be reflected in the description of the objective

functions and the constraints. Naturally, these objective functions and constraints involve many parameters which possible values are assigned by the experts who are often imprecisely or ambiguously known [2] [8]

With this observation, it would be certainly more appropriate to interpret the experts' understanding of the parameters as fuzzy numerical data which can be represented by fuzzy numbers. The fuzzy multiple objective linear programming (FMOLP) problems involving fuzzy parameters would be viewed as a more realistic version than the conventional one [2] [8].

Various kinds of FMOLP models have been proposed to deal with different decision-making situations which involve fuzzy values in objective function parameters, constraints parameters, or relationships. Transforming a FMOLP problem into a crisp programming problem is still employed by researchers [3] including methods proposed by Tanaka and Asai [9], Lai and Hwang [4], Luhadjula [5], Wierzchon [10]. Although various approaches have been made to solve a FMOLP problem with fuzzy parameter, however, most of works listed above are dealt with the fuzzy parameters with symmetric triangular, trapezoidal, or some kind of symmetric membership functions. Zhang et al [11] [12] proposed one method to solve a fuzzy linear programming (FLP) problem by transforming it into a corresponding four-objective constrained optimization problems and another method to formulate linear programming problems with fuzzy equality and inequality constraints. Based on that, this paper develops an approximate algorithm for solving the proposed FMOLP problems with fuzzy parameters in any form of membership function in both objective functions and constraints..

This paper is organized in five sections. The introduction of the related concepts about fuzzy set theory is made in Section 2. A review of related definitions and theorems for solving FMOLP problems with fuzzy parameters in objective functions and constraints are described in Section 3. The core idea of the approximate algorithm proposed for solving FMOLP problems is described in Section 4. An example is presented in Section 5 and aimed at demonstrating the concepts and methods for solving a FMOLP problem.

2. Related Definitions Used in the Paper

Definition 2.1 Let X denotes a universal set. Then a fuzzy subset \tilde{A} of X is defined by its membership function

$$\mu_{\tilde{A}} : X \rightarrow [0,1], \quad (1)$$

which assigns to each element $x \in X$ a real number $\mu_{\tilde{A}}(x)$ in the interval $[0, 1]$ where the value of $\mu_{\tilde{A}}(x)$ represents the grade of membership of x in \tilde{A} [6] [11].

Definition 2.2 A fuzzy set \tilde{A} is convex if and only if

$$\mu_{\tilde{A}}(\lambda x_1 + (1-\lambda)x_2) \geq \min(\mu_{\tilde{A}}(x_1), \mu_{\tilde{A}}(x_2)) \quad (2)$$

for every $x_1, x_2 \in X$ and $\lambda \in [0,1]$ [6] [11].

Definition 2.3 A fuzzy number is a convex normalized fuzzy set of the real line R^1 whose membership function is piecewise continuous [6] [11].

Let F and F^* be the set of all fuzzy numbers and the set of all finite fuzzy numbers on R respectively. According to the decomposition theorem of fuzzy set, we have

$$\tilde{A} = \int_{\lambda \in [0,1]} \lambda \tilde{A}_\lambda \quad (3)$$

$$\tilde{A} = \int_{\lambda \in R_0} \lambda \tilde{A}_\lambda \quad (4)$$

for all $\tilde{A} \in F$, where R_0 is all rational numbers in $(0, 1]$ [11]. $F \subset R$

Definition 2.4 Let \tilde{A} and \tilde{B} with the membership functions $\mu_{\tilde{A}}$ and $\mu_{\tilde{B}}$ respectively, and $0 \leq \alpha, \beta \leq 1$. The addition of two fuzzy number $\tilde{A} + \tilde{B}$ and the scalar product of $\alpha \tilde{A}$ are defined by the membership functions

$$\mu_{\tilde{A} + \tilde{B}}(z) = \sup_{z=x+y} \min(\mu_{\tilde{A}}(x), \mu_{\tilde{B}}(y)) \quad (5)$$

$$\mu_{\alpha \tilde{A}}(z) = \sup_{z=\lambda x} \min(\mu_{\tilde{A}}(x), \alpha) \quad (6)$$

Form the decomposition theorem of fuzzy set and the Definition 2.4, for any two fuzzy number \tilde{A} and \tilde{B} , and $0 \leq \alpha \in R$, $0 \leq \beta \in R$

$$\tilde{A} + \tilde{B} = \int_{\lambda \in [0,1]} (\alpha_\lambda^L + \beta_\lambda^L, \alpha_\lambda^R + \beta_\lambda^R) \quad (7)$$

$$\alpha \tilde{A} = \int_{\lambda \in [0,1]} (\alpha \alpha_\lambda^L, \alpha \alpha_\lambda^R) \quad (8)$$

$$\tilde{A} \tilde{B} = \int_{\lambda \in [0,1]} (\alpha_\lambda^L \beta_\lambda^L, \alpha_\lambda^R \beta_\lambda^R) \quad (9)$$

Let F^n and F^{*n} be the set of all n -dimensional fuzzy numbers and the set of all n -dimensional finite fuzzy numbers on R respectively [11].

Definition 2.5 For any two n -dimensional fuzzy numbers \tilde{A} and \tilde{B} define

- (1) $\tilde{A} \leq \tilde{B}$ iff $\alpha_i^L \geq \beta_i^L$ and $\alpha_i^R \geq \beta_i^R$, $i = 1, \dots, n$
 - (2) $\tilde{A} \leq \tilde{B}$ iff $\alpha_i^L \geq \beta_i^L$ and $\alpha_i^R \geq \beta_i^R$, $i = 1, \dots, n$
 - (3) $\tilde{A} \leq \tilde{B}$ iff $\alpha_i^L \geq \beta_i^L$ and $\alpha_i^R \geq \beta_i^R$, $i = 1, \dots, n$
- [11].

3. Fuzzy Multiple Objective Linear Programming and Related Definition and Theorems

In this paper, we now consider the situation that all coefficients of the objective functions and constraints are fuzzy numbers parameters in any form of membership function, then such FMOLP problems can be formulated as follows:

$$(FMOLP) \begin{cases} \text{Maximize} & \tilde{f}x = \tilde{C}x \\ \text{s.t.} & x \in X = \{x \in R^n \mid \tilde{A}x = \tilde{b}, x \geq 0\} \end{cases} \quad (10)$$

where \tilde{C} is an $k \times n$ matrix, each element of which \tilde{c}_{ij} is fuzzy number represented by membership function $\mu_{\tilde{c}_{ij}}$. \tilde{A} is an $m \times n$ matrix coefficients of the constraints, each element of which \tilde{a}_{ij} is fuzzy number represented by membership function $\mu_{\tilde{a}_{ij}}$. \tilde{b} is an m -vector of the rhs, each element of which \tilde{b}_i is fuzzy number represented by membership function $\mu_{\tilde{b}_i}$ and x is an n -vector of decision variables, $x \in R^n$.

In the proposed FMOLP problems, for each $x \in X$ the values of objective function $\tilde{f}x$ are fuzzy numbers. According to the definition 2.5, we have the following definitions about FMOLP problems.

Definition 3.1 x^* is said to be a complete optimal solution, if and only if there exists $x^* \in X$ such that $\tilde{f}_i x^* \leq \tilde{f}_i x$, $i = 1, \dots, k$ for all $x \in X$.

Definition 3.2 x^* is said to be a Pareto optimal solution, if and only if there does not exists another $x \in X$ such that $\tilde{f}_i x^* < \tilde{f}_i x$, for all i .

Definition 3.3 x^* is said to be a weak Pareto optimal solution, if and only if there does not exists another $x \in X$ such that $\tilde{f}_i x^* < \tilde{f}_i x$, for all i .

Associated with the FMOLP problems, let's consider the following multiple objective linear programming (MOLP _{λ}) problems:

$$(MOLP_\lambda) \begin{cases} \text{Maximize} & \langle \tilde{c}_{\lambda_i}^L, x \rangle, \langle \tilde{c}_{\lambda_i}^R, x \rangle, \lambda \in [0,1] \\ \text{s.t.} & x \in X = \left\{ x \in R^n \mid A_\lambda^L x \leq b_\lambda^L, A_\lambda^R x \leq b_\lambda^R, \right. \\ & \left. x \geq 0, \forall \lambda \in [0,1] \right\} \end{cases} \quad (11)$$

where

$$C_\lambda^L = \begin{bmatrix} c_{11\lambda}^L & c_{12\lambda}^L & \dots & c_{1n\lambda}^L \\ c_{21\lambda}^L & c_{22\lambda}^L & \dots & c_{2n\lambda}^L \\ \vdots & \vdots & \ddots & \vdots \\ c_{k1\lambda}^L & c_{k2\lambda}^L & \dots & c_{kn\lambda}^L \end{bmatrix}, C_\lambda^R = \begin{bmatrix} c_{11\lambda}^R & c_{12\lambda}^R & \dots & c_{1n\lambda}^R \\ c_{21\lambda}^R & c_{22\lambda}^R & \dots & c_{2n\lambda}^R \\ \vdots & \vdots & \ddots & \vdots \\ c_{k1\lambda}^R & c_{k2\lambda}^R & \dots & c_{kn\lambda}^R \end{bmatrix}$$

$$A_\lambda^L = \begin{bmatrix} a_{11\lambda}^L & a_{12\lambda}^L & \dots & a_{1n\lambda}^L \\ a_{21\lambda}^L & a_{22\lambda}^L & \dots & a_{2n\lambda}^L \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1\lambda}^L & a_{m2\lambda}^L & \dots & a_{mn\lambda}^L \end{bmatrix}, A_\lambda^R = \begin{bmatrix} a_{11\lambda}^R & a_{12\lambda}^R & \dots & a_{1n\lambda}^R \\ a_{21\lambda}^R & a_{22\lambda}^R & \dots & a_{2n\lambda}^R \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1\lambda}^R & a_{m2\lambda}^R & \dots & a_{mn\lambda}^R \end{bmatrix}$$

$$b_{\lambda}^L = \langle c_{1\lambda}^L, b_{1\lambda}^L, \dots, b_{m\lambda}^L \rangle^T, \quad b_{\lambda}^R = \langle c_{1\lambda}^R, b_{1\lambda}^R, \dots, b_{m\lambda}^R \rangle^T.$$

Definition 3.4 x^* is said to be a complete optimal solution, if and only if there exists $x^* \in X$ such that $f_i(x^*) \geq f_i(x)$, $i = 1, \dots, k$, for all $x \in X$ [7].

Definition 3.5 x^* is said to be a Pareto optimal solution, if and only if there does not exist another $x \in X$ such that $f_i(x) \geq f_i(x^*)$, for all i and $f_j(x) > f_j(x^*)$ for at least one j [7].

Definition 3.6 x^* is said to be a weak Pareto optimal solution, if and only if there does not exist another $x \in X$ such that $f_i(x) > f_i(x^*)$, $i = 1, \dots, k$ [7].

Theorem 3.1 Let x^* be a feasible solution to the FMOLP problem. Then

1. x^* is a complete optimal solution to the problem if and only if x^* is a complete optimal solution to the MOLP $_{\lambda}$ problem.
2. x^* is a Pareto optimal solution to the problem if and only if x^* is a Pareto optimal solution to the MOLP $_{\lambda}$ problem.
3. x^* is a weak Pareto optimal solution to the problem if and only if x^* is a weak Pareto optimal solution to the MOLP $_{\lambda}$ problem.

Proof. The proof is obvious from Definition 2.5.

In the next section, we will propose an approximation algorithm to solve the MOLP $_{\lambda}$ problem and the FMOLP problem.

4. An Approximation Algorithm for Solving FMOLP Problem

Based on the definition of FMOLP problem and MOLP $_{\lambda}$ problem and Theorem 3.1, an approximation algorithm is proposed as following for solving MOLP $_{\lambda}$ problem, the solution of which is equally the solution of FMOLP problem.

For the simplicity in presentation, we define

$$X_{\lambda} = \{x \in R_n \mid A_{\lambda} x \leq b_{\lambda}^R, A_{\lambda} x \geq b_{\lambda}^L, x \in X\}$$

The main steps of the approximation algorithm are described as follows:

Let the interval $[0,1]$ be decomposed into m mean sub-intervals with $(m+1)$ nodes λ_i , $i = 0, \dots, m$ which are arranged in the order of $0 = \lambda_0 < \lambda_1 < \dots < \lambda_m = 1$, then define $X^m = \bigcup_{i=0}^m X_{\lambda_i}$, and denote

$$(MOLP_{\lambda})_m \begin{cases} \text{Max } \langle c_{\lambda_i}^L, x \rangle, \langle c_{\lambda_i}^R, x \rangle \\ \text{s.t. } x \in X^m \end{cases} \quad \lambda_0 < \dots < \lambda_m = 1 \quad (12)$$

Step 1: Set $m = 1$, then solve $(MOLP_{\lambda})_m$ for λ_m , where $\lambda_m = \lambda_1, x_2, \dots, x_m$ and the solution is obtained subject to constraint $x \in X^m$.

Step 2: Solve $(MOLP_{\lambda})_{2m}$ for λ_{2m} .

Step 3: If $\|x_m - x_{2m}\| \leq \epsilon$ the solution x^* of MOLP $_{\lambda}$ problem is x_m . Otherwise, update m to $2m$ and go to Step 2.

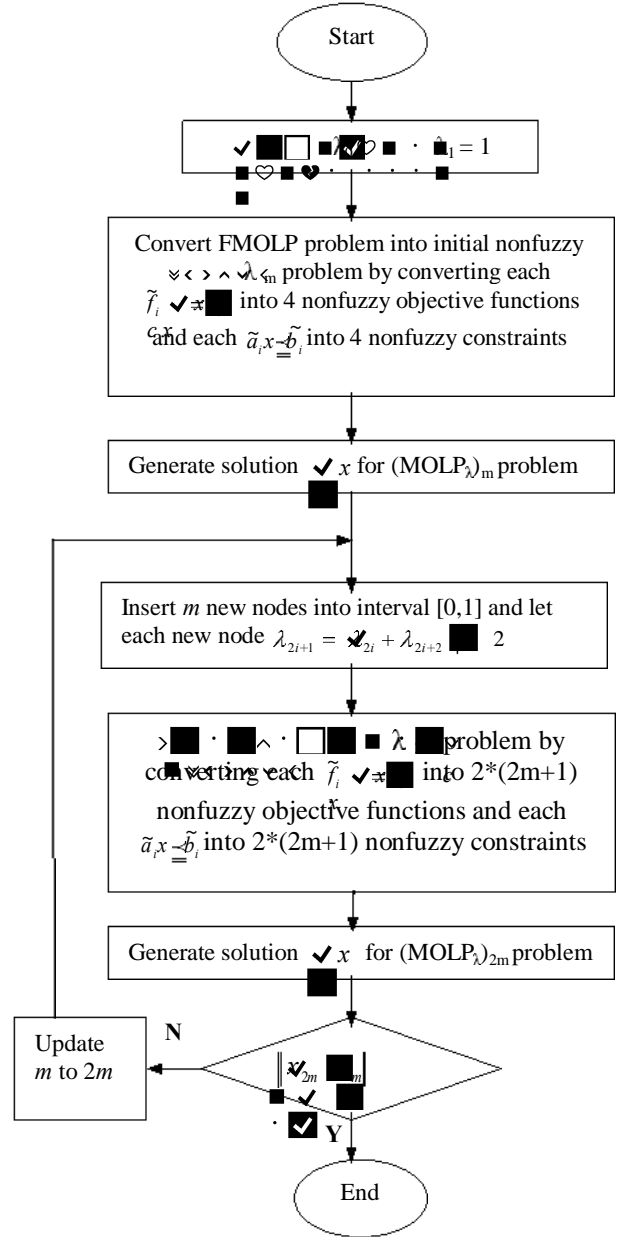


Diagram 1: The data flow diagram for the approximate algorithm

Initially, in step 1, the interval $[0,1]$ is not split, only 0 and 1 are considered, then, each fuzzy objective function f_i is converted into four corresponding nonfuzzy objective functions $\langle c_{i0}^L, x \rangle, \langle c_{i1}^L, x \rangle, \langle c_{i0}^R, x \rangle, \langle c_{i1}^R, x \rangle$, $i = 1, \dots, k$. This conversion also applies on constraints in the same way. The solution x_m is based on new nonfuzzy objective functions and constraints.

The detail data flow diagram is listed in Diagram 1.

5.1 The description of an example of FMOLP

$$\max_{\tilde{f}} \cdot \max_{\tilde{f}_1, \tilde{f}_2} \cdot \max_{\tilde{c}_1, \tilde{c}_2} \begin{matrix} \checkmark & \checkmark & \checkmark \\ \blacksquare & \blacksquare & \checkmark \\ \checkmark & \checkmark & \checkmark \end{matrix} \begin{matrix} \tilde{f}_1 \\ \tilde{f}_2 \\ \tilde{c}_1 x_1 \\ \tilde{c}_2 x_1 \end{matrix} \cdot \begin{matrix} \checkmark \\ \blacksquare \\ \checkmark \\ \checkmark \end{matrix} \begin{matrix} x_1 \\ x_2 \\ x_1 \\ x_2 \end{matrix} \cdot \begin{matrix} \checkmark \\ \blacksquare \\ \checkmark \\ \checkmark \end{matrix} \begin{matrix} x_2 \\ x_1 \\ x_2 \\ x_2 \end{matrix} \quad (13)$$

$$\text{s.t.} \quad \begin{cases} \tilde{a}_{11}x_1 + \tilde{a}_{12}x_2 \leq \tilde{b}_1 \\ \tilde{a}_{21}x_1 + \tilde{a}_{22}x_2 \leq \tilde{b}_2 \\ \tilde{a}_{31}x_1 + \tilde{a}_{32}x_2 \leq \tilde{b}_3 \\ \tilde{a}_{41}x_1 + \tilde{a}_{42}x_2 \leq \tilde{b}_4 \end{cases} \quad (14)$$

$$\mu_{\tilde{c}_{11}} = \begin{cases} 0 & x < 1 \\ \checkmark - 1 & 1 \leq x < 2 \\ 1 & 2 \leq x \leq 3 \\ \cancel{2} 6 - x^2 & 3 < x \leq 16 \\ 0 & 16 < x \end{cases}$$

$\mu_{\tilde{c}_{22}} =$	$\begin{cases} 0 & x < 1 \\ \checkmark - 1 & 1 \leq x < 2 \\ 1 & 2 \leq x \leq 3 \\ 5 - x & 3 < x \leq 25 \\ 0 & 25 < x \end{cases}$
$\mu_{\tilde{a}_{11}} =$	$\begin{cases} 0 & x < -2 \\ 2x + 4 & -2 \leq x < -1.5 \\ 1 & -1.5 \leq x \leq -0.5 \\ 4x^2 & -0.5 < x \leq 0 \\ 0 & 0 < x \end{cases}$
$\mu_{\tilde{a}_{12}} =$	$\begin{cases} 0 & x < 0 \\ x/4 & 0 \leq x < 2 \\ 1 & 2 \leq x \leq 4 \\ \checkmark - e^x & 4 < x \leq 12 \\ 0 & 12 < x \end{cases}$
$\mu_{\tilde{a}_{21}} =$	$\begin{cases} 0 & x < 0 \\ 2x & 0 \leq x < 0.5 \\ 1 & 0.5 \leq x \leq 1.5 \\ \checkmark - e^x & 1.5 < x \leq 10 \\ 0 & 10 < x \end{cases}$
$\mu_{\tilde{a}_{22}} =$	$\begin{cases} 0 & x < 0 \\ \checkmark - 1 & 0 \leq x < 2 \\ 1 & 2 \leq x \leq 4 \\ \checkmark - e^x & 4 < x \leq 18 \\ 0 & 18 < x \end{cases}$
$\mu_{\tilde{a}_{31}} =$	$\begin{cases} 0 & x < 1 \\ \checkmark - e^1 & 1 \leq x < 3 \\ 1 & 3 \leq x \leq 5 \\ 6 - x & 5 < x \leq 18 \\ 0 & 18 < x \end{cases}$
$\mu_{\tilde{a}_{32}} =$	$\begin{cases} 0 & x < 0 \\ x^2/4 & 0 \leq x < 2 \\ 1 & 2 \leq x \leq 4 \\ 10 - x & 4 < x \leq 10 \\ 0 & 10 < x \end{cases}$
$\mu_{\tilde{a}_{41}} =$	$\begin{cases} 0 & x < 0 \\ x/2 & 0 \leq x < 2 \\ 1 & 2 \leq x \leq 4 \\ \checkmark - e^x & 4 < x \leq 10 \\ 0 & 10 < x \end{cases}$
$\mu_{\tilde{a}_{42}} =$	$\begin{cases} 0 & x < 0 \\ 2x & 0 \leq x < 0.5 \\ 1 & 0.5 \leq x \leq 1.5 \\ 100 - x^3 & 1.5 < x \leq 10 \\ 0 & 10 < x \end{cases}$
$\mu_{\tilde{b}_1} =$	$\begin{cases} 0 & x < 18 \\ \checkmark - e^{18} & 18 \leq x < 20 \\ 1 & 20 \leq x \leq 22 \\ 2000 - x^3 & 22 < x \leq 30 \\ 0 & 30 < x \end{cases}$

$$\begin{aligned} \mu_{\tilde{b}_2}^{\checkmark} &= \begin{cases} 0 & x < 24 \\ \checkmark - e^{24} \blacksquare^{26} - e^{24} \blacksquare & 24 \leq x < 26 \\ 1 & 26 \leq x \leq 28 \\ \checkmark - x \blacksquare^2 & 28 < x \leq 40 \\ 0 & 40 < x \end{cases} \\ \mu_{\tilde{b}_3}^{\checkmark} &= \begin{cases} 0 & x < 42 \\ \checkmark - 42 \blacksquare & 42 \leq x < 44 \\ 1 & 44 \leq x \leq 46 \\ \checkmark - e^x \blacksquare^{60} - e^{46} \blacksquare & 46 < x \leq 60 \\ 0 & 60 < x \end{cases} \\ \mu_{\tilde{b}_1}^{\checkmark} &= \begin{cases} 0 & x < 27 \\ \checkmark - 729 \blacksquare^2 & 27 \leq x < 29 \\ 1 & 29 \leq x \leq 31 \\ \checkmark - 4000 - x^3 \blacksquare^{209} & 31 < x \leq 40 \\ 0 & 40 < x \end{cases} \end{aligned}$$

Associate with the FMOLP problem, the corresponding MOIP₃ problem is listed as follows:

Table 1: Summary of the running solution by the approximate algorithm

Table 2: Summary of the running solution by setting different weights of objective functions

According to Theorem 3.1, the solution to the MOLP $_{\lambda}$ problem is also a solution to the FMOLP problem. Here, we recommend using weighting maxmin method to solve the MOLP $_{\lambda}$ problem.

5.2 Solving MOLP $_{\lambda}$ problem by the approximate algorithm

Refer to MOLP $_{\lambda}$ problem, in step 1, the interval [0,1] is not split, only $\lambda = 0$ and $\lambda = 1$ are be considered, then totally 8 nonfuzzy objective functions and 16 nonfuzzy constraints are generated. By weighting maximum method, the solution is $(x_1^*, x_2^*) = (3.2260, 0.1932)$.

In step 2, one node is inserted in the interval [0,1], then totally 12 nonfuzzy objective functions and 24 nonfuzzy constraints are generated. By weighting maximum method, the solution is $(x_1^*, x_2^*) = (4.5985, 1.1049)$. The more detail information about further steps is listed in Table 1.

From Table 1, we can find that if the tolerance $\epsilon = 10^{-3}$, the approximate algorithm stops at step 5, if the tolerance $\epsilon = 10^{-5}$ the approximate algorithm will stop at step 8, and the number of nonfuzzy objective functions and constraints will increase dramatically.

When choose different weights w_1 and w_2 for objective functions, the different results are summarized in Table 2:

It can be found from Table 2, when $w_1 = 1$ and $w_2 = 0$, the solution (3.2260, 0.1932) is only concerned about the first objective function. When $w_1 = 0$ and $w_2 = 1$, the solution (0, 1.8506) is only concerned about the second objective function. When w_1 decreases from 1 to 0 and w_2 increases from 0 to 1 simultaneously, the solution will move from (3.2260, 0.1932) to (0, 1.8506) gradually.

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Multi-language Websites in a Multi-cultural Country: a South African Perspective.

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Abstract

This paper reports on an exploratory study done to assess the demand for multi-language websites by South Africans who do not have English as their home language but speak English proficiently. South Africa makes an interesting case study because, in spite of its eleven official languages, English is used as the default language in most business communications and for websites in particular. The unspoken – and empirically unverified – argument appears to be that most educated South Africans are fluent enough in English not to need non-English sites. This myth is soundly debunked in our exploratory study and it can be conjectured that organisations who will cater for the pent-up demand for native language websites should be able to attract a captive audience. It is suggested that the study is of particular interest to other nations who have multiple official languages but where a single language dominates the internet communications, as appears to be the case in many African and a number of Asian countries.

1. Introduction

South Africa is proud of its cultural diversity, which lends the country its unique character and constitutes one of its many strengths. The South African Constitution aims to protect cultural heritage and promote equity by proclaiming eleven official languages and guaranteeing the right to education and information in one's own language of preference.

However, it seems that there are very few South African websites available in languages other than English. In particular, apart from a small number of government sites, virtually no websites are available in the home languages of significant portions of the population, such as Zulu or Xhosa. South Africa still has, with its roughly 2.5 to 3 million internet users, a very low Internet penetration rate of well below 10%. No conclusive statistics are available on the home language of the internet users, although a large proportion of these users can be assumed to have English as a home language. However, this still leaves a huge number of users with another home language and, in the light of the economic empowerment trends, this number is expected to increase dramatically in the next few years.

A number of technical options exist to implement and maintain websites with multiple-language content, but

these generally involve not insignificant resource investments. [1] [2] (This paper does not explore the various technical approaches for multi-language websites.). It was felt that this situation therefore called for an exploratory study of empirical nature to assess whether there really is a demand by non-native English speakers. The focus is to gauge the demand for non-English websites amongst experienced internet users who have a good command of English and who work or study in a predominantly English language environment, but use a different language at home (hereafter referred to, somewhat misleadingly, as “non-English” web-users).

Interestingly, significant work has already been accomplished in the open source software arena on porting internet browser software to interfaces sporting traditional languages such as Zulu and Xhosa. This work will be extended to the OSS office suite. [3]

It must be noted that the emphasis of this research was on the language of the websites. It is acknowledged that there are many other cultural aspects which need to be given attention in interface design, such as the use and meaning of symbols and icons, colours, layouts. It was felt that many of these non-language cultural issues are still in early stages of research. In addition, it is much more straightforward to investigate language than to deal with the various methodological issues relating to empirical constructs for measuring culture.

2. Previous work relating to multi-language websites.

The internet is a medium that transcends traditional geographical boundaries. It is therefore not surprising that considerable research and development has already been devoted to multi-language sites. Not surprisingly, much of this research has been encouraged by the European Commission, although several US agencies and Asian researchers have also looked into this issue.

It is a disconcerting fact that about 85% of websites are in English, even though the non-English web users outnumber their English-speaking counterparts almost two to one (figure 1). [4]

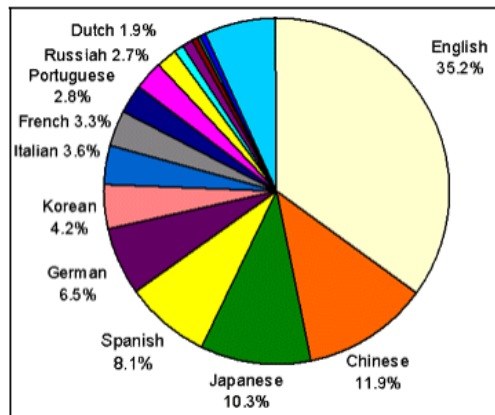


Figure 1: Online Language Populations Mar-03

Designing a site in a language other than English is easy enough. However, there is obviously also an urgent need to investigate the issues related to website design targeting users across different languages i.e. multi-language websites. Three main needs of these users were identified by Van Dijk [5]:

- Users expect the same information and functionality for each of the languages, without a bias towards the dominant language.
- Not only the information but also the instructions for navigating the website should be multi-lingual. The naïve practice of displaying a national flag icon to choose language causes confusion in countries with multiple official languages, such as South Africa.
- The website should be tested by native language speakers to avoid unnecessary language (and sometimes cultural) mistakes.

3. Multi-lingualism in South Africa

Until 1994, South Africa was officially bilingual (English and Afrikaans). Since the formal abolishment of apartheid in 1994, South African language diversity has been guaranteed in the constitution:

“recognising the historically diminished use and status of the indigenous languages of our people, the state must take practical and positive measures to elevate the status and advance the use of these languages”

The aim is clearly to empower all people and not to prejudice people from African origins. So, apart from commercial marketing considerations, there is also a strong moral obligation on South African organisations to establish multilingual websites. On the other hand, it must be recognised that not all of the eleven official languages are spoken equally widely, as shown in figure 2.

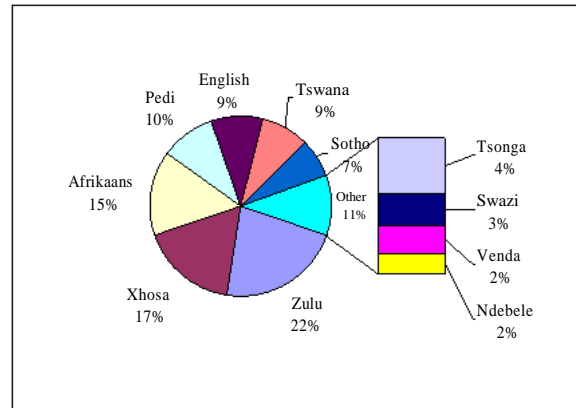


Figure 2: Home language as spoken by % of population

Although the accuracy of these figures is subject to some debate, it can be seen clearly that English is not as dominant a language as it is sometimes perceived to be. Zulu, Xhosa, Afrikaans and Pedi are more predominant as home language than English. [6] [7] It must be reiterated that these figures are not at all representative of the South African internet users. However, apart from any direct commercial advantages, the implementation of multi-language websites in South Africa would stimulate further development of these languages, exploit and promote the multi-cultural diversity of the nation, and ensure more equal access to information and education.

Despite the increased awareness about language and notwithstanding the Constitutional provisions, there is an extreme paucity of indigenous language websites. A non-systematic survey reveals a fair number of Afrikaans-only and mixed Afrikaans/English websites but only a handful websites catering for the other nine official languages. The latter are mainly central and local government sites although a few large parastatal and commercial organisations are beginning to make selected (usually pre-existing static) documents available in other languages. A more systematic census of these websites remains a useful research challenge, although it is probably a fast moving target.

4. Research approach

As seen above, there are strong ethical motivations and public relation aspects to providing multi-language websites in South Africa. However, it is believed that website providers will embark on the development of multi-language website much more readily if actual demand from existing internet users can be demonstrated.

The following research hypothesis was therefore suggested.

H₀: There is a demand for multi-language websites from current internet users whose speak English well but whose home-language is not English.

A proper full-scale survey was beyond the means of a small research effort, but it was felt that a fully representative survey should in any case only be considered after an exploratory survey has demonstrated

at least some initial support for the hypothesis and piloted some of the methodological issues.

It was decided to use a convenience sampling frame and two samples were drawn: one from a life insurance company, Momentum Life, in Cape Town, and the other first-year Information Systems students in the Commerce Faculty of the University of Cape Town (UCT). The language of conduct in both organisations is English. Since the official languages are not symmetrically distributed across provinces, this introduces a definite bias in the sample but it was felt that the exploratory nature of the research justified this pragmatic decision. In the end, 100 questionnaires were distributed in the commercial company Momentum Life and 280 to first year information systems students.

In the end, 48 completed questionnaires were returned from Momentum Life of which 38 were usable, and 97 from UCT, of which 87 were usable. This led to a total of 125 usable responses i.e. a net response rate of just under 33%.

No existing instrument was found so a new instrument was designed. First, a number of issues were identified from the literature survey. These were written down and served as the basis for the formulation of the initial questions. These were supplemented by other relevant questions in a iterative manner. Finally, a focus group session with 10 participants was asked to complete the pilot questionnaire while at the same time discussing their thoughts on various topics raised by the researchers. This resulted in an interactive discussion which was used to finalize the final questionnaire. Considerable effort was made not to give offence by clearly stipulating the ultimate objectives of the research, although native-English speakers were asked not to complete the questionnaire. People who did not use any of the other 10 official languages were, however, not prejudiced and could complete the questionnaire.

Although some of the questions were factual, most of the questions sampled opinions, beliefs and attitudes. No conceptual or theoretical constructs were employed so the questionnaire was not statistically validated. The usual confidentiality principles were observed and the normal reservations about the deficiencies of empirical sampling methods apply.

5. Sample characteristics and representativeness.

Of the 125 respondents, the male-female ratio was 52%/48%. Because 87 usable questionnaires were returned by students, almost two-thirds (63.2%) were between 18 and 25 years of age. Only 8.8% of respondents were above 35% of age. 10% of respondents were foreigners and a further 3% permanent resident non-citizens.

Only 8% of respondents declined to answer the optional race question, despite its sensitive nature. Of those who answered the question, 68% of respondents voluntarily identified themselves as black, 15% as coloured,

15% as white and 3% as Asian.

In order to qualify for the research, respondents had to access the internet at least once a month, although 49% accessed the internet daily and a further 42% at least once or twice per week. Not surprisingly, 90% rated their knowledge of the Internet average or above average.

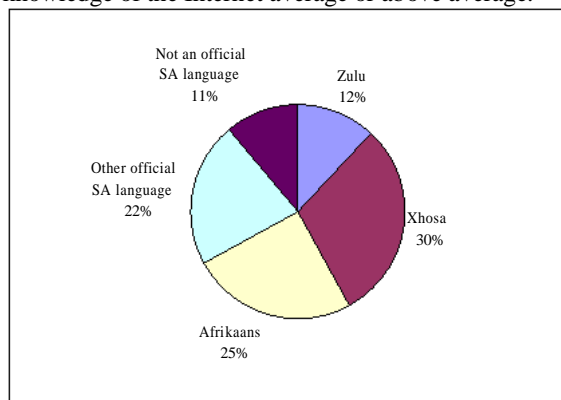


Figure 3: Home Language of Respondents

The three major home languages, comprising a full 77% of the respondents, were Xhosa, Afrikaans and Zulu. 11% of respondents have a home language which is not one of the eleven national South African languages. This is testimony to the fact that some workers and students originate from other African, European or Asian countries. The other 22% represent the 7 remaining national languages, each claiming less than 5%. Because of the predominance of Xhosa and Afrikaans speakers, most results will be presented those two sub-groups as well as for the entire group. It must be noted that especially the “Afrikaans” speakers are not likely to represent a single homogenous cultural group.

Extremely important for this research was the English fluency level of the respondents. 96% of respondents considered themselves fluent English speakers: they rated their own fluency average (34%), above average (30%) or excellent (32%). Two important conclusions can be drawn from this statistic. Firstly, there should not have been a problem with the understanding and interpretation of the questionnaire. Secondly, the understanding of English is sufficient to ensure that respondents can, in principle, navigate English websites.

It is of interest that most of the respondents are, in fact, multilingual. Of all respondents, 42% spoke Afrikaans, 39% spoke Xhosa and 36% Zulu. For instance, of all native Xhosa speakers, 52% also spoke Zulu and 21% spoke Afrikaans in addition to English.

Overall, it appears that the sample is fairly representative of the sampling frame and displays the desired characteristics for purposes of the research. However, it must be borne in mind that the sampling frame is biased in terms of geographical region, which implies a bias towards Xhosa and Afrikaans speakers, as well as exhibiting a bias in terms of the relatively young average age of the respondents.

6. Analysis of Results

6.1 Quality and lack of multi-language websites.

Respondents were asked to indicate which problems they experienced with non-English websites as compared to English websites. Although a very few people ticked specific issues (lack of content, poor usability, language errors, outdated information, poor graphics, poor translation), 78% said they had never tried to access non-English sites. Unfortunately, it is not entirely clear whether the 16% of respondents who experienced “no problems” with non-English sites did in fact access such sites. This points towards a severe dearth of non-English sites and appears to skew the value of some of the questions that follow by replacing actual user experiences with hypothesized opinions.

One particular quality concern in respect of multi-language sites is whether the translated website contains the same information. It appears that, for those multi-language sites that do exist, there appears to be quite a few problems in terms of quality or overall standard, with 25% responding “no” against a 17% responding “yes” (58% didn’t know). Although there is no statistically significant difference between the different language groups, only 9% the Afrikaans group responded “yes”. This may be explained by the fact that some Afrikaans speakers are historically very proud of their language (they have even erected a language monument) and may be quite sensitive about their language in the light of the recent “demotion” of the language from one of two to one of 11 national languages. Although this is speculation, this sensitivity seems to fit differences in the other questions as well.

6.2 Need for multi-language sites.

When asked if they would change the language of a website to their home language, if such an option is/were available, the vast majority of respondents reacted positively i.e. said they did so all the time, sometimes, or would if such an option was possible. However, this large proportion of 53% who would if it were possible, is perhaps the strongest indication of the pent-up demand for multi-language websites.

Table 1: if there’s an option to change the website language – do you do this?

Yes	No	Sometimes	Would if possible
10%	27%	10%	53%

Most interestingly, the proportion of Xhosa speakers who would do so (8%), is far less than that of the Afrikaans speakers, where a full 23% would change to Afrikaans if they could, although this difference is again not statistically significant (when using the χ^2 -test).

Survey participants were asked whether they had experienced any problems surfing the internet due to the fact that websites were predominantly in English and not available in their home language. This appeared to be the case for a full three quarters of the respondents. Overall, one quarter (26%) answered “Yes” and a further half (50%) answered “Sometimes”. Only 24% said that they did not experience such problems.

6.3 Differentiation of multi-language use.

In a society where multiple languages are spoken, the home language cannot always be used for communication. In this case, the Internet must be seen as just another communication channel. Therefore, it is interesting to check to what extent the various media and communication channels are dominated by individual’s home language. Note that it must be borne in mind that in a number of cases, the alternative language used may not necessarily be English. Participants were asked to rank their use of certain communications and media channels in their home language. Figure 4 summarizes the results for those who selected that they performed the given activities in their home language either “Often” or “Always”.

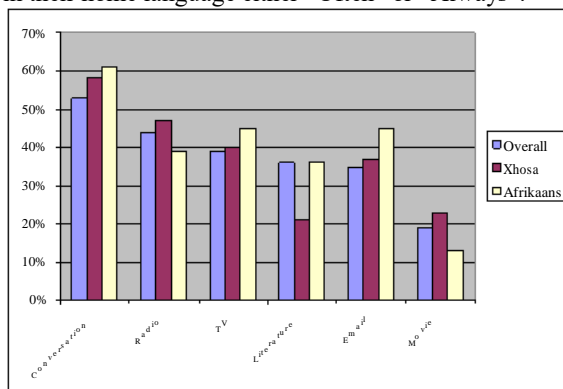


Figure 4: Use of media in home language.

Although, as might be expected, conversation is the highest with 53%, and none of the others are used by more than 50% of the sample. The fact that 47% of respondents only engages in conversation in their home language “sometimes” or even less frequently, testifies to the multi-cultural nature of interactions in South Africa, as well as the dominance of English in the work/study environment.

On the other hand, it is evident that the participants are becoming used to channels being available in their home language. For instance, 47% of the Xhosa speakers indicated that they listened to Xhosa radio stations, despite the fact that English broadcasts outweigh those in Xhosa by a huge margin. Even the least used facility, movies, has just short of 20% of the participants watching in their home language.

6.4 Desired types of home language websites.

From the open-ended feedback, and as anyone who has operated in multi-language environments knows, not all types of information lend themselves equally well for translation or digestion in home language. Financial, technology or work-related information is more likely to be acceptable in English than, say news items. This is reflected in the rankings of which internet facilities respondents would like to see available in their home language (this was a multiple response item).

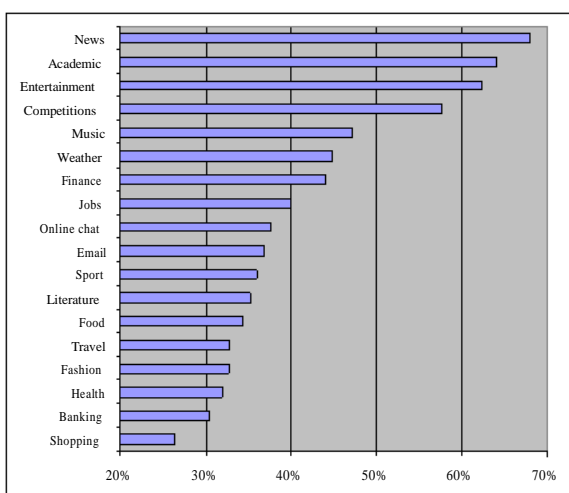


Figure 5: Ranking of internet facilities required in home language.

News was the most popular choice with 68%. Academic was next, but this response is likely to be biased by the large number of students in the sample. However, it does stress the importance of not just making commercial but also educational and informational sites available in multiple languages. Other desired categories were entertainment and competitions. Although it could be expected that finance and jobs would rank lower in importance, it is interesting to note the low weight given to sport and literature. However, the figures given for online chat, email and literature validate the percentages given in the home language use of the various communication media in the previous figure.

As an interesting aside, participants were asked whether they would be willing to pay a subscription charge to have a website made available in their home language. Despite the large percentage of people wanting such websites, 78% of the sample was not willing to pay for such a facility. Again, this figure may be overstated due to the large number of (non-income earning) students in the sample.

When asked about the desirability of banner advertising in one's home language, 43% of the respondents indicated that they would prefer banner advertising in their home language and another quarter didn't care. By contrast, 22% indicated that they wouldn't want such advertising and 8% believed it to be a waste of time. Finally, it appeared as if only 8% of the respondents had received spam (unsolicited commercial e-mail) in a language other than English. In all cases, the other language turned out to be a European language, not one of the other South African languages.

The lack of banner advertising and commercial e-mail in home languages indicate the possibility of exploring less expensive avenues where companies are hesitant of making their entire website available in other languages. Piloting with home language banner adverts – and possibly the use of opt-in mailing lists – would serve as a good feasibility test for companies prior to translating their entire websites.

7. Conclusion and further research.

South Africa is a country with many cultures and languages. The diversity of cultures is widely seen as one of South Africa's strengths, and the right to receive education and information in one of eleven official home language is enshrined in the country's new Constitution. However, unlike in Europe, there is a dearth of multi-language websites catering for the South African official languages. This is also in strong contrast to the other communication and media channels in South Africa, which provide significant home language support.

Exploratory empirical research indicates that there is a very definite demand for websites in languages other than English, even among regular internet users that speak English fluently and access many other communication media in English. 78% of respondents had never used a non-English website even though the majority has experienced language related problems on the web and would like to have a facility to change the language.

Although this demand is fairly strong, not all users see the need for non-English websites. There are also indications that some differences may exist between different cultures and language communities, but the sample was not representative or large enough to confirm these differences statistically. It is also clear that the demand also depends on the type of website: especially news, academic, entertainment and competition websites would benefit most from multi-language capability.

The implication for the researchers is that there is an urgent need to confirm these results with a larger and more representative sample. There is still much uncertainty to what extent specific requirements differ between cultures and language groups. A secondary research objective will be to investigate other cultural-specific but non-language related aspects of websites such as the manner of navigation, use of non-English browsers, symbols and overall site organisation and other underlying design assumptions.

The implications for the site providers is clear: there is a large and pent-up demand – specifically in the areas of education, news, entertainment and competitions – for multi-language websites and there is a great potential for first-mover advantages to be realised in the short term. A less costly entry strategy would be to test the water with home-language banner and e-mail advertising, although this is likely to produce some dissonance when the recipient attempts to access the English website. Finally, it is believed that there are not only a direct value and public relations proposition in providing multi-language websites. The researchers are of the conviction that there is also a strong ethical obligation towards the eradication of historical inequities and the active development of a multi-cultural sense of community as part of the nation-building process in our country by providing these websites. Most appropriately, the central and some local governments as well as some parastatals have taken the lead, albeit in a somewhat modest way. It is hereby hoped

that this research will prompt commercial and educational institutions to adopt a more engaging stance and accord the provision of a multi-language website a high priority.

8. Appendix: Some illustrative comments .

This appendix gives some qualitative responses to the questionnaire. They have been selected to indicate the wide range of emotional attitudes respondents had towards multi-language websites.

The comments of people in favour of multi-language websites range from the political, site navigation (instructions) to the actual content.

- “We need transformation; we need websites in our own languages. This in return will see us growing and going towards the African renaissance.”
- “Other language Internet should be a right, not a privilege.”
- “In the New South Africa, I would expect companies to be offering their services in Xhosa and all of the other official languages.
- “I would love to access the Internet using my own language because many times I find it hard to understand what is required of me. Thanks, God bless you!”
- “I find it extremely difficult to use some websites because their instructions are hard to follow. If they at least gave us some parts in Zulu, it would make it much easier for me.”
- “I would use the Internet for much more if I could do things in Xhosa.”
- “Although my English is improving, it would have been much easier to learn to use the Internet if they had made tutorials in Zulu.”
- “I think school and now university would be much easier if they put information into other languages. I can only ever find information in English.”
- “English is far more difficult to understand than people think. I often avoid going on the Internet because it takes me so long to find information.”
- A sensitive issue is “Afrikaans” whose official status was diluted significantly. Contrast “If Internet sites can be in Afrikaans [...] I feel we have the right to all languages.” with “Afrikaans used to be such a popular language in South Africa (pre 1994), yet there are no

Afrikaans websites available for the Afrikaans speakers.”

However, not everyone would applaud a concerted effort to move to multi-language sites.

- “English is the universal language, so don’t bother changing anything.”
- “Why learn a language that will not provide a job?”
- “I don’t fee it would make a difference if certain websites were in Zulu. [E.g. the] SuperSport website is in English and it would be much harder for me to use if it was in Zulu.”

Still others give a more balanced view:

- “To become globally competitive, English (Internet or other) is imperative since it is the international language of business. However, for entertainment purposes, other languages in SA could be used on the Internet.”
- “I would love to see my language being used, but not in all cases. I prefer English most because we [live] in a modern world.”

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Designing Business Models for Mobile Payment Services

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Abstract[♦]

Designing business models for mobile services is a complex undertaking because it requires multiple actors to balance different requirements and interests such that a 'win-win' situation is created. A business model can be seen as a blueprint of four interrelated components: service offering, technical architecture, and organizational and financial arrangements. Although little attention has been paid to how these different components are related to one another, this knowledge is needed to enhance our understanding of what constitutes a viable business model. In this paper the connections between two of these components, namely service offering and organizational arrangements, are explored by analyzing the business models of three recent mobile payment initiatives. The cases reveal that similar value elements can be realized in different ways and that, depending on the target group, dominant actors can be bypassed in the value network.

1 Introduction

The mobile telecom industry currently faces a number of opportunities that may radically change the field of mobile telecommunication. The development of new networks like GPRS (2,5 G), UMTS (3G) WLAN (WiFi), and Personal Area Networks (beyond 3G) will spark the development of mobile services. With 'mobile services' we mean all kinds of innovative services that combine technologies from the domains of telecommunication (e.g. mobile services), information technology (e.g. the Internet, PDA's) and consumer electronics (e.g. cameras). These new technologies, in combination with the

'convergence' of these domains, and concepts of content and services providers, offer opportunities for the mobile telecom industry.

To exploit the opportunities companies need to buy licenses, build networks and develop new services. Since most industry players currently lack the resources and capabilities to do so, mobile services are increasingly being developed and provided by networks of cooperating organizations. It is assumed that flexible 'value webs' will arise and replace traditional, static and linear 'value chains'. In such a 'value web' each player has different capabilities and resources, and innovation thrives on the combination of these capabilities and resources. Compaq HP, Microsoft and KPN Mobile, for instance, recently started the joint development and marketing of a mobile office application called Lucio.

Cooperation in value webs is by no means straightforward. Various studies [20,15,3] indicate that companies encounter serious difficulties in achieving the anticipated benefits from cooperation. First of all, partner organizations may use the cooperation to pursue different strategic goals, which may induce partners to act against what is agreed upon, hide the truth or try to extract confidential information from their partners. Secondly, partner organizations often come from different industries (e.g. network operators, financial institutions, and retailers) each with their own peculiar business logic. Such diversity may be necessary for the development of new innovative services, yet at the same time disrupt cooperation. Finally, cooperation gives rise to complex interdependencies between organizations because none of the partners has formal authority over the others. Hence, every adjustment has to be discussed and jointly agreed upon [17].

Given the disappointing success rates of inter-firm co-operations and the risks and cost involved in the introduction of new mobile services, it is not surprising that practitioners and academics pay a great deal of attention to the concept of business models. In our view a business model is a blueprint for how a network of

[♦] The research presented here has been conducted within the government funded BITA and B4U project. The authors would like to thank Roel Stap, Sander Hille and Paul Oude Luttighuis for their insightful comments on previous versions of this paper and acknowledge Roel Stap for his contribution to the case study research.

organizations co-operates in creating and capturing value from technological innovation [10]. Designing business models is a complex issue because technical, financial, organizational and professional user or consumer's needs and requirements need to be balanced. For instance, what makes sense from a technical point of view (better specs of positioning technology) may not make sense from a financial (higher costs) and user perspective (privacy concerns). Moreover, organizations have to balance their different interests and business logics to create a 'win-win' situation, in which each player has incentives to co-operate, and in which the combined benefits are higher and the combined efforts are smaller compared to each player working separately.

Although extensive literature on strategic alliances [7], network formation [24] is available it fails to provide insight into the subtleties involved in the design of viable business models for the provisioning of mobile services in value webs. Existing literature on business models is extensive [1,16,21,26,32]. However the predominant focus has thus far been on defining and classifying business models. Little attention has been paid to the way the various elements of a business model are and have to be related to one another. This knowledge is needed to enhance our understanding of what constitutes a viable business model.

The objective of this paper is to explore the relationship between two important business model elements: customer value and value network. The paper is structured as follows: first, a descriptive framework for studying the interrelatedness of business models elements is developed. This framework is then used to analyze the business models of three recent mobile payment initiatives, focusing on the relationship between the customer value of service offerings and the value network required to realize a service offering. The paper concludes with drawing conclusions on important issues regarding the design of viable business models and providing directions for further research.

2 A descriptive framework for studying business models

We view a business model as a blueprint of the way a network of organizations co-operates to create and capture value from the implementation of technological innovations. We look beyond the individual firm and consider the business model for a network of companies: a collaborative effort of a number of companies to offer a joint proposition to their customers. When comparing the various existing definitions of business models it is possible to distinguish some common components that are network-oriented or can easily be extended to be so [13]:

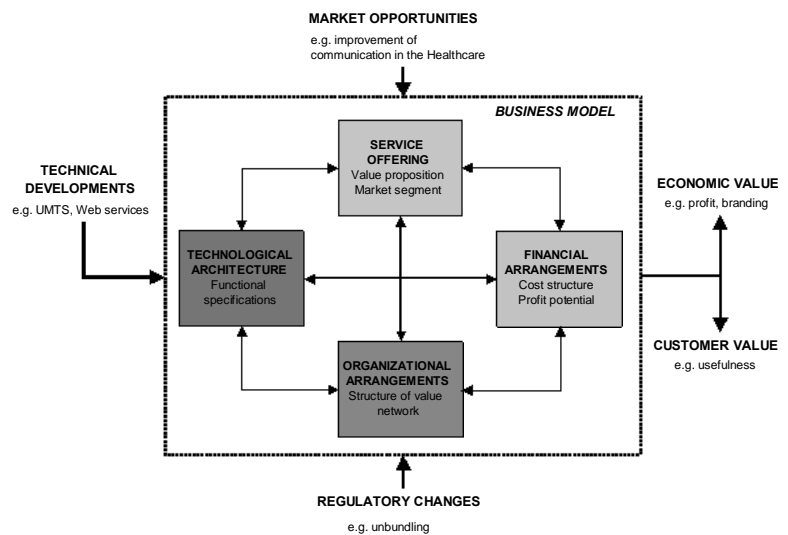
- *Service offering*: a description of the value proposition (added value of a service offering) and the market segment at which the offering is targeted

- *Technological architecture*: a description of the technical functionality required to realise the service offering
- *Organizational arrangements*: a description of the structure of the multi-actor value network required to create and distribute the service offering, and to describe the focal firm's position within this value network
- *Financial arrangements*: a description of the way a value network intends to generate revenues from a particular service offering and of the way risks, investments and revenues are divided across the different actors in a value network.

Furthermore the governance of the process of developing a business case has to be taken care for. The challenging aspect of analyzing and designing business models is that it requires managers to connect and balance different business model components (technological architecture, service offering, organizational arrangements, and financial arrangements) in the face of technical, market, and legal developments (see Figure 1), the ultimate aim being to create sufficient economic and customer value.

As the focus of this paper is on the connection between the customer value of services and the value network offering them, these components are elaborated in more detail below.

Figure 1: high level descriptive framework



An important element of a *service offering* is customer value. Value is seen as part of an equation in which customers in target markets compare the perceived benefits and total costs (or sacrifice) of (obtaining) a product or service [9, 27]. The value proposition must be

considered better at delivering the desired satisfaction more effectively and efficiently than competitors. Customer experience is the key factor here [5]. In many cases customer value as perceived by the end-user has little to do with the customer value that is envisaged in initial business models and greatly depends on the user's context as a person, professional or consumer [9]. In general, we will draw the distinction between new-to-the-world products or services and new versions of existing products or services (see also the concept of versioning: [29]). Newness is quite a troublesome concept. It concerns products that are new to the world [4], or disruptive innovations [11].

In general, *organizational arrangements* revolve around the resources and capabilities that have to be made available. In their analysis of business models Hedman and Kalling [16] conclude that in the final analysis economic value is determined by a firm's ability to trade and absorb ICT-resources, to align (and embed) them with other resources, to diffuse them in activities and manage the activities in such a way as to create a proposition at uniquely low costs or with unique qualities in relation to the industry in which the company is operating. Increasingly, organizations have to work together to deliver customer value in so-called 'value networks'. Depending upon which actor(s) contribute key assets in the creation of value and the operating risks involved, different configurations of actors are likely to result, with some taking on structural, integrative roles in the alliance and others taking supporting, facilitating roles [8,14,18,28,30,31,33].

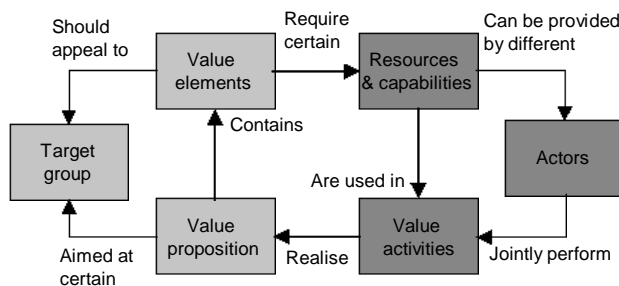


Figure 2: Connection between customer value and value network

The customer value of service offerings and the value network needed to realize customer value are closely related, as depicted in Figure 2. An important research question is how the design of a value network influences the customer value of a service offering and vice versa. This relationship will be explored by analyzing the business models of three mobile payment services. Before doing so we will first elaborate on mobile payment services.

3 Mobile payment

Mobile payment services are payment services using a mobile device, such as a PDA or a mobile phone, to initiate and confirm electronic payments. Mobile devices can be used to pay for goods and services on the Internet, ticketing machines, and at payment terminals in stores. Mobile devices are generally expected (see e.g. Krueger, 2001) to play an important role in commercial transactions. This expectation is based on the high penetration of mobile phones in many countries, the opportunities provided by 2.5 (GPRS) and 3rd generation telecommunication networks (e.g. UMTS) and applications (such as WAP and I-mode), and the positive market forecasts for m-commerce. A recent international survey conducted among 5600 mobile phone users by AT Kearny [23] indicates that 46% of the respondents would use mobile payment if it becomes widely available.

Given these high expectations it is not surprising that there have been many mobile payment initiatives in the past few years. However, the introduction of mobile payment proceeds at a slow pace, not in the last place because of the difficulty of developing feasible and viable business models. Any provider of mobile payment services has to come up with a proposition that is interesting to both consumers and merchants. This dual focus and the subsequent 'critical-mass problem' complicate the introduction [22,25]. Moreover, businesses need to account for the business logic not only of the financial services sector, but of the business logic of the retail and telecommunication sector as well. This creates a multi-party, cross-sector problem whose solution is fundamental for the successful development of mobile payment services.

An important issue in designing business models for mobile payment services is how to create enough customer value and who to involve in the value network. With respect to customer value, trust, ease of use, cost and reach are generally accepted as important elements in the value proposition of a mobile payment service. With respect to value network design an important question is the indispensability of financial institutions in offering a mobile payment service.

4 Research method

The research reported in this paper has been conducted within the BITA and B4U project¹, in which not only mobile payments cases, but also cases dealing with mobile information and entertainment services, location based services, community's, tracking and tracing, and personalised instant messaging. The findings that are discussed in this paper are based on an exploration of three mobile payment services initiatives. Before the

¹For more background information on the BITA project see: <http://www.telin.nl/NetworkedBusiness/BITA> and for the B4U project see: <http://www.freeband.nl/projecten/b4u/>

actual cases were being researched, industry reports, academic literature and company web sites have been consulted. This exploration allowed us to produce an overview of mobile payment initiatives and to narrow down the scope of the case studies. For every case representatives from mobile payment providers, retailers, and financial institutions were consulted. We conducted semi-structured interviews and talked informally with dozens of company representatives. Given the exploratory nature of the subject the interviews were semi-structured [2]. The interviews were recorded and transcribed. The data from the interviews were supplemented with information from company websites, industry reports and academic literature. We made case descriptions, which we used for cross-case analyses. To ensure internal validity, all involved researchers used the same interview and case description templates. In addition, the researchers conducted the interviews in different combinations and reviewed and discussed each other's case descriptions. The informants reviewed the case descriptions. Cases were stored in a database that was accessible for all involved researchers, for analysis.

5 Cases

In the remainder of this paper we will take a closer look at the business models of Mobipay, Moxmo and Mobile2pay in terms of service design and value network. The cases have been selected because they represent different market introduction strategies.

Table 1: cases

Case	Characterization
Mobipay	Bank-oriented: customer base of financial institutions is used to introduce mobile payment
Moxmo	Independent: customer base is built independent of financial institutions, existing payment infrastructure is bypassed
Mobile2Pay	Independent: customer base is built independently from financial institutions. Financial institution has role as trusted third party

Since both consumers and merchants play an important role in the distribution and acceptance of mobile payment products, the value proposition has been analyzed from the perspective of both actors.

5.1 Mobipay

Mobipay is a mobile payment initiative started in December, 2000, initiated by the leading Spanish financial institutions Banco Bilbao Vizcaya Argentaria (BBVA) and Santander Central Hispano (SCH), as well as all Spanish mobile telephone operators: Telefónica Móviles, Vodafone and Amena. The initiative's objective is to develop and promote an international mobile

payment solution, based on a co-operative model between mobile operators and financial institutions. Mobipay International is the holding company that owns the local initiatives in different countries.

5.1.1 Value proposition

Mobipay's value proposition provides mobile and single access to the existing payment infrastructure. Mobipay provides a transaction platform capable of supporting all kinds of payment methods. With Mobipay the consumer can pay through existing and trusted electronic payment methods using their private mobile phone as an authentication terminal. Mobipay focuses primarily on the financial institutions and telecom operators. Although Mobipay provides banks and telecom operators with reasons as to why mobile payment is of added value to end-users it does not directly offer a value proposition to these end-users. In Spain the main selling argument towards financial institutions is increased intermediated payments.

5.1.2 Value network

Mobipay provides a mobile transaction platform to financial institutions that can be used with existing payment methods. The mobile operators are more or less part of the distributed platform by integrating their mobile access services in this platform. The mobile network operator provides mobile communication services to Mobipay, which are used to access the payers' verification terminal. Mobipay offers financial institutions single and mobile access to the existing payment infrastructure. For Mobipay the support of financial institutions is important because of their relationship with customers and retailers, the users and acceptors of mobile payment solutions. Mobipay receives a fee per transaction for its services. The financial institutions handle the payment of the transactions. Mobipay is responsible for the authorization, authentication, electronic assembly and delivery of payment transactions. Financial institutions are also responsible for the distribution of mobile payment. The retailer's role is to provide payment methods to the consumer and in return is paid for the products and services in an appropriate way. The payment services are provided by the financial institutions (or third party payment providers) and will be paid for by the retailer.

Table 2 and 3 summarize the value configuration of Mobipay in terms of target group, value elements, resources & capabilities, and actors.

Table 2: Value configuration consumer side

Value element	Customer value offered	Resources and capabilities	Actors
Trust	Secure payment	Secure authentication & authorization	Mobipay
	Control over transactions	Transaction management	Financial institutions
	Trusted Third Party	Institutional rules of conduct	Financial institutions
Ease of use	Mobile phone as access device	System integration	Mobipay
Cost	Not different from normal transactions	Cost efficient payment infrastructure	Different financial institutions
Reach	Increasing number of retailers in different countries	Customer base	Financial institutions and mobile operators

Table 3: Value configuration merchant side

Value element	Customer value offered	Resources and capabilities	Actors
Trust	Secure payment	Secure authentication & authorization	Mobipay
	Trusted Third Party	Institutional rules of conduct	Financial institutions
Ease of use	No changes needed in POS	System integration	Mobipay
Cost	Cheap electronic point of sale	Secure authentication & authorization	Mobile operators and financial institutions
Reach	Increasing number of retailers in different countries	Customer base	Financial institutions and mobile operators

5.2 Moxmo

Moxmo is a recent Dutch payment initiative that provides mobile payment solutions to merchants, primarily on the Internet and non-POS situations. Moxmo was introduced by Global Payways and operates independently from banks and (mobile) telecom operators, which distinguishes it from most other mobile payment solutions.

5.2.1 Customer value

Moxmo is a mobile wallet service that allows consumers to make secure and direct payments to anyone who has a mobile or accepts Moxmo as a method of payment. Since mobile payment itself is not a product, Moxmo is collaborating closely with service providers to develop new innovative service concepts that may incorporate mobile payment. This is seen as an important prerequisite for the further growth of mobile payment, and thus of Moxmo in particular. The value proposition of Moxmo towards consumers is that it offers convenient (any time any place) and secure electronic payment.

Moxmo currently focuses on the micro-payment product-market segment. It focuses in particular on person-to-person payments, Internet payments, topping-up of prepaid accounts and ticketing. At a later stage Moxmo aims to extend these services to include parking, international transfers, debit card payments, customer cards, and ultimately payments in stores.

5.2.2 Value network

Moxmo is a start-up company owned by Global Payways. Global Payways plays three roles in Moxmo, which are divided into distinct business units. First, it is involved in developing service propositions in co-operation with third parties. These propositions should result in high-end value services and products using Moxmo. Second, it processes the transactions generated by Moxmo. Third, it wants to control the deposits stored on the electronic wallets of its customers. To do this Moxmo needs to acquire a license for Electronic Money Institution (EMI). As far as we know Moxmo is still in the process of obtaining such a license. In the meantime customer deposits are controlled by ABN-Amro. Retailers may play a role as acceptor and distributor of Moxmo. In their capacity as distributors retailers are actively promoting the Moxmo payment method to their consumers. Moxmo offers revenue sharing for each payment that is performed by consumers acquired by the retailer. Thus Moxmo hopes to win over consumers and merchants, and thus build its brand. Recently, it also took over the customer base of Paybox in Germany, which cancelled all its activities. The operational management of transaction platform and mobile wallet administrator is outsourced to an Application Service Provider. Finally, mobile operators facilitate the mobile access between the users' mobile phone and the Moxmo transaction platform.

Table 4 and 5 summarize the value configuration of Moxmo in terms of target group, value elements, resources & capabilities, and actors.

Table 4: Value configuration consumer side

Value element	Customer value offered	Resources and capabilities	Actors
Trust	Secure payment	Secure authentication & authorization	Moxmo
	Control over transactions	Transaction management	ABN-Amro
Ease of use	Mobile phone as prepaid wallet	License for EMI	Moxmo
Cost	Low cost through bypassing of existing payment infrastructure	Cost efficient independent payment infrastructure	Moxmo
Reach	Increasing number of retailers in the Netherlands and Germany	Access to customer base	Moxmo and retailers

Table 5: Value configuration merchant side

Value element	Customer value offered	Resources and capabilities	Actors
Trust	Secure payment	Secure authentication & authorization	Moxmo
	Guaranteed payment	Risk management	Moxmo
Ease of use	No clear value offering	No clear value offering	No clear value offering
Cost	Low cost through bypassing of existing payment infrastructure	Cost-efficient independent payment infrastructure	Moxmo
Reach	Revenue sharing is offered for those that become a distributor	Distribution channel	Retailers themselves

5.3 Mobile2pay

Mobile2Pay is a mobile payment initiative initiated in October 2002 by Smart Concepts. Its main objective is to create an interactive mobile sales channel that enables the payment and delivery of goods, in particular impulse purchases.

5.3.1 Customer value

Mobile2pay formulates its value proposition as ‘seeing is having’. Consumers can respond directly to advertisements published in magazines or broadcast on radio, using their mobile phone as a transaction device. The main advantages of Mobile2pay for consumers are speed of use (impulse buying and fast processing), ease of use (small smart device) and benefits (discounts).

Mobile2pay focuses on retailers, and its main objective is to set up a mobile sales channel rather than to provide a mobile payment system. With this idea Mobile2Pay defines a strategy for mobile commerce in general and uses mobile payment as an enabling functionality. Mobile2pay focuses on medium-sized and macro payments.

5.3.2 Value network

The retailers’ role is to provide payment methods to the consumer to get paid for their products and services. By offering an interactive transaction channel to its consumers retailers are able to improve their service to consumers. Fortis bank acts as trusted third party in the payment transaction between the consumer and the retailer. The bank receives an authorized and complete payment transaction from Mobile2Pay, and returns a bank guarantee. This guarantee is based on the consumer’s creditworthiness. After receiving the guarantee the retailer will ship the goods. If the retailer receives confirmation from the consumer, the bank will transfer the money to the retailers account. By deploying a dynamic spending limit, Mobile2pay filters out defaulters. Customers are rewarded for keeping their promises (faithful payment) by an increased spending limit. Mobile2Pay handles the consumer authentication and the authorization of the payment process. Finally, mobile operators facilitate the mobile access between the users’ mobile phone and the transaction platform of Mobile2Pay.

Table 6 and 7 summarize the value configuration of Moxmo in terms of target group, value elements, resources & capabilities, and actors.

Table 6: Value configuration consumer side

Value element	Customer value offered	Resources and capabilities	Actors
Trust	Secure payment	Secure authentication & authorization	Mobile2pay
	Control over transactions	Transaction management	Mobile2pay
	Guaranteed delivery	Trusted Third Party	Financial institution (Fortis)
Ease of use	Mobile device as debit card	Automatic collection	Mobile2pay
Cost	Price reductions when ordered with mobile phone	Access to customer base	Retailers
Reach	Increasing number of retailers in the Netherlands	Access to customer base	Retailers

Table 7: Value configuration merchant side

Value element	customer value offered	Resources and capabilities	Actors
Trust	Secure payment	Secure authentication & authorization	Mobile2pay
	Guaranteed payment	Trusted Third Party	Financial institution (Fortis)
	Guaranteed payment	Dynamic spending limit for users	Mobile2pay
Ease of use	No clear value offering	No clear value offering	No clear value offering
Cost	Increased sales through impulse buying	Anytime and anywhere payment	Mobile2pay
Reach	No clear value offering	No clear value offering	No clear value offering

6 Discussion and conclusion

The mobile payment providers we examined in this study follow different strategies to obtain critical mass. Whereas Mobipay invests most of its effort in bringing together financial institutions and telecom operators, Moxmo and Mobile2pay directly try to convince merchants and customers of the added value of mobile payment. However customer groups have different needs and wishes.

Trust All mobile payment providers are aware that trust is of crucial importance. However, they make use of different mechanisms. In the case of Mobipay, consumers deal with their trusted home banks. Due to this Mobipay can profit from the generally trusted laws and codes of conduct of banks and the relationship that already exists between the banks and their consumers. Moxmo, on the other hand, has to prove its trustworthiness to consumers by recurrent positive experiences. To merchants it promises guaranteed payment. However, it is not clear if it can live up to its promises. Finally, Mobile2Pay uses an escrow service to eliminate the risks for consumers and merchants. By doing so it can guarantee product delivery to consumers and guarantee payment to merchants. Moreover, by deploying a dynamic spending limit Mobile2pay filters out defaulters.

Ease of use The entry barriers for consumers vary among the studied payment initiatives. With Mobipay consumers do not need to register at all, provided that they have opened a bank account. With Moxmo users need to register and open a new bank account and with Mobile2Pay they need to register and authorise an automatic direct debit. One thing that remains to be seen is how users will value these entry barriers. For merchants the integration with existing payment products is an important issue. They are not all that eager to implement a new payment product in addition to already existing payment products such as debit and credit card payments. Mobipay is the only initiative that presents a convincing case with respect to this value element.

Cost Mobipay focuses primarily on financial institutions (banks and payment brands) and to a lesser extent on telecom operators. It leaves the promotion of mobile payment to the financial institutions and telecom operators. Moxmo sees mobile payment not as a product in itself and is collaborating closely with service providers to develop new innovative service concepts in which mobile payment can play a role. Moxmo offers revenue sharing and new service concepts to merchants. Consumers are offered convenient and secure payment. These elements of the value proposition can hardly be regarded as order winners but rather are 'dissatisfiers' (their absence provides a negative experience). Mobile2pay tries to provoke consumers into purchasing goods by offering price reductions on products that are paid for with its payment service. The impulse character of purchases is stressed ('seeing is having') and promoted as a valuable experience for consumers. Mobile2pay offers merchants an interactive transaction channel next to the Internet and attended points of sale.

Reach Mobile payment providers use different strategies to acquire merchants and consumers. Mobipay relies on financial institutions to convince merchants and consumers of the value of mobile payment. Moxmo and Mobile2pay cannot rely on the customer base of financial institutions and have to acquire customers themselves.

Merchants regard mobile payment as yet another payment product that they need to support. They seem to be willing to adopt mobile payment if it resolves some of the problems they have with existing payment products. Guaranteed payment is especially valued highly. This can be realized in different ways, as illustrated by the Moxmo and Mobile2Pay cases.

Consumers do not consider payment a service but instead they see it as "a necessary evil". Low transaction fees, ease of use, guaranteed delivery are therefore 'dissatisfiers' rather than order winners. For mobile payment providers this means that it is important not to promote payment as a product in itself but as an enabler of new value adding services. The two independent initiatives provide nice examples of this.

Although both Moxmo and Mobile2pay were typified as independent initiatives, the findings show that financial institutions *do* play important roles in both initiatives. Until it is given an EMI-license Moxmo has to rely on the ABN-Amro for the management of wallet deposits. By making use of escrow services Mobile2Pay is able to guarantee payment to merchants as well as delivery to consumers. By including financial institutions in the value network mobile payment providers are able to reduce the risks for both merchants (guaranteed payment) and consumers (guaranteed delivery). This comes, however, at the expense of increased transaction costs.

An important decision is whether or not to include financial institutions in the value network. Required guarantees and transaction costs are important influence

factors. For micro payments, which require less guarantees and low transaction costs, it does not seem to be useful to consider including financial institutions. Financial institutions do seem to be required for medium and macro payments. However it can be debated if mobile payments limited to only micro-payments will be attractive enough for consumers. The cases reveal that certain value elements can be realized in different ways and that depending on the target group it is possible to bypass dominant actors in the value network. Still the financial institutions have a strong position and bypassing financial institutions is problematic.

Based on the three cases we can draw some conclusions on customer value. First of all it is important to realise that the customer value of the services offered although technically innovative, are not experienced as very innovative to the customer. The mobile services in itself are yet another way, next to money, credit and debit cards, to take care for payments. So the positioning of a mobile payment channel next to already existing payments channels is problematic. Although new to the world from a technical point of new customers don't see the customer value very clearly. Furthermore merchants, who have control over the customer relation between the mobile payment services and the end user: the customer will only accept the mobile payment channel as it solves some of their problems. So in the service offering the issue of value have to be addressed very carefully for both customers and merchants. A possible alternative is to make mobile payments an integral part of other innovative mobile services. The mobile payment service can be presented as an additional feature of the new service.

With regard to the value network we see that bypassing financial institutions is rather problematic. Seen their powerful position within the value network it is almost impossible to by-pass banks, especially if the service will not be limited to micro-payments.

As far as our conceptualization of the design of businesses models is concerned, it is clear that we not only have to look into the value of a service from the perspective of the customer but also from the perspective of the service provider. The mobile cases show that the mobile payment provider has to position it services in a relation between financial institutions and their customers, where there are many alternatives and the dominant role of players in the existing value networks leave ample space for new entrants.

We realise that our conclusions are based on only a limited set of cases. Yet some of the identified patterns are similar to those identified in other case studies conducted in the B4U and BITA project. We hope that this article inspires other researchers to study the complex interplay between the four business model domains and their impact on customer and economic value.

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Case Study of Data Mining Application in Banking Industry

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Abstract

In this paper, we study the usages of data mining in banking industry and its related impacts. Great changes in banking services emerged from the application of data mining especially in retailing banking. We present China Merchant Bank (CMB) as an example to do case analysis, in which we explore data environment evaluation analysis model, operational efficiency model and profitability model to analysis the application performance for CMB. Finally we provide some advices of future development to CMB.

1. Introduction

Data warehouse (DW) is like a box, in which vast of data are included and processed into useful information by using various kinds of tools, such as data mining (DM), OLAP, ERP. Banking industry is the pioneer who adopts DW as tool in decision-making. DW makes it possible for business to store large amounts of disparate data in one location. DW consolidates many types of data from many data sources in order to facilitate data analysis for fact-based decision-making.

DW expanded dramatically in the late 1980s, when businesses began realizing the value of their data. Before then, the focus was more on how to integrate DW into a company's existing IT infrastructure than it was about business value. The real value of a DW is to make new business knowledge available literally at the touch of a button. Finding, collecting, and synchronizing data is all performed electronically. Thus, the e-data way of information retrieval provides the needed information in a direct, rapid, and meaningful way, in which queries and answers can be sent and retrieved directly through users and DW. Business intelligence is one of those monikers that encompass the set of products and services for accessing and analyzing data and turning it into

information. In early days DW was motivated by a number of separate factors:

1) Mainframes offload. Frequently, a company's mainframe system was busy enough already, and upgrading could be just as expensive as buying a brand-new DW. These mainframes were often transactional systems performing mission critical functions such as customer billing or banking deposits. Companies were loath to tax their mainframes any further, and the data redundancy and separate processing DW provided were enticing.

2) Dirty data. Different data from all over the enterprise, from accounts payable in compensation to customer information, was often not only hard to find but impossible to understand and often just plain wrong. The DW provided a single platform for loading this "heterogeneous" data. It also offered a pretext for data cleaning---checking it for quality and accuracy, and reformatting it so that it was comprehensive and useful before it was loaded into the warehouse.

3) Security. In order to protect their mission-critical operational systems [6], most companies limit their access to a few experts. DW offered a most generally accessible environment for frequently sought-after information.

In this paper, we study the usages of DM in banking industry and its related impacts. There are 4 parts. In part one and two we explain some background literatures, such as DM, banking services changes emerged from the uses of DM into banking services and retailing banking. In part three and four, we present China Merchant Bank (CMB)[13] as an example to do case analysis, in which we explore 3 models (data environment analysis model , operational efficiency model and profitability models) to make an analysis for CMB. We mention the customer relationship management and personalization in

marketing. At last we provide some advices of future development to CMB.

2. Background literatures

DM is the automatic extraction of hidden predictive information from databases[11]. Like statistics, DM is a technology rather than a business solution. For example, consider a catalog retailer who needs to decide who should receive information about a new product. The information operated on by the DM process is contained in a historical database of previous interactions with customers and the features associated with the customers, such as age, zip code, their responses. DM would use this historical information to build a model of customer behavior that could be used to predict which customers would be likely to respond to the new product. By using this information a marketing manager can select only the customers who are most likely to respond. The operational business software can then feed the results of the decision to the appropriate touch point systems such as call centers, web servers, email systems so that the right customers receive the right offers.

Banking industry is the pioneer to adopt DM and its related technology into application. The products banks provide to customers are financial services. Financial services are different from traditional product-making industries. Products provided by financial services are mostly intangible and customer-oriented. To gain greater profit needs maintaining customers' loyalty, which is regarded as customer satisfaction [8]. There are mainly two reasons for banks to adopted DW urgently and necessarily.

1) More and more payment options are available to customers.

New payment technologies and specifications [5] are emerging and need to gain both customers and business acceptance. The ultimate benefits include reduced processing cost, reduced lead times, increased interoperability, and increased flexibility in choosing a payment mechanism. As with any emerging technologies, some will become mainstreams and other products will wither on the vine. Therefore to gain the advantages listed above, banks should equip themselves with solid DW and related technologies to accomplished the task.

2) Rapidly changing customer requirements

The information age is characterized by rapidly changing customer requirements, market niches and focused, global competitors. The information age has greatly influenced strategies business decisions processes, SCM, CRM. The environmental changes experienced by firms in the past decade have been drastic and unpredictable. The innovation of information technology makes huge amounts of customer, market and product data available and accessible to knowledge workers [3].

3. Case Analysis of CMB

3.1 General history of CMB

CMB was established in 1987 in Shenzhen. With current assets over US\$50 billion and with US\$43.5 billion of deposits, it ranks as the 6th largest bank in China. CMB earns good reputation in domestic and abroad markets. Bankers' journal ranked CMB 187th in the top 1000 biggest banks in the world in 2002. CMB was the first bank with public shareholder ownership in China. As the pioneer in China's banking reform, CMB was the first Chinese bank to enter offshore banking and has established international banking agreements with 571 banks in 40 countries worldwide. Within China, CMB has 355 branches with its own nation-wide commercial banking network. CMB is also the first China bank to officially establish investment-banking operations in the Chinese banking industry, and more recently, has set up the first China Internet banking service. CMB was also the first bank in China to obtain ISO9001 certification.

3.2 Technology advantages of CMB

During 16 years development, CMB has been consistently adopting the technology driven strategy. In 1995 CMB put all-in-one credit card into market, which was regarded as a milestone of personal financial management in China banking industry. In the next year, CMB was the first bank to turn nationally credit and debit into reality, while in the same year, it launched IC card, which makes it possible to withdraw and deposit without distance and time limitation among companies. In addition, CMB also built the website of national ATM and domestic consumptions of POS, both of which

compose modernized and national personal financial service network supported by powerful and advanced technology, the volume of all-in-one credit card has been drastically increase and becomes the shining product of CMB. In Feb 1998, all-in-net service is developed by CMB, which is the first bank to launch on-line banking service in China. 21 months later CMB became perfect on-line corporation banks, on-line personal banks, on-line trading mall and on-line security investment and on-line payment. Till now, CMB's on-line banking is occupying an absolutely leading place in technology domain and service income area in banking sector of China. About 80% famous web sites, for instance, www.sohu.com, www.sina.com.cn , www.8848.com, choose "all-in-net" as the first or even the unique choice as payment tool. The achievement CMB has gained is not accidental. It is due to its strong and solid DW system. Moreover, In 2000 China Merchant Bank joined the ESS Technology corp., a leader in Internet, communications, PC audio and digital video, and China E-Commerce Technology Co. Ltd. (CECT) and announces a major breakthrough in Chinese Internet e-Commerce by creating the first secure e-Commerce payment gateway in China. The three companies jointly announced the new solution to facilitate payments through an Internet Set-Top-Box designed by ESS using ESS's technologies and products. The solution utilizes ESS's Internet Set-Top-Box to protect both the account holders and the bank. The Set-Top-Box automatically connects to CECT's portal and ICP website that operates the CMB gateway. CMB serves as the clearing bank, which settles all e-Commerce transactions through a debit system for each customer's account.

3.3 Why CMB use DW and DM

The DW is a site, which combines information from different, separate systems in one location. Because the information is stored together, it is easy to access. Data in the warehouse comes from a number of sources. At this point, the warehouse of CMB contains four main types of information identified by the business area: financial, general, individuals and corporations. The DW is a read-only database, which guarantees its stability over time. To do customer segmentation, CMB needs DM

urgently. For example, a pattern might indicate that married males with children are twice as likely to drive a particular sports car than married males with no children. If you are a marketing manager for an auto manufacturer, this somewhat surprising pattern might be quite valuable. DM uses well-established statistical and machine learning techniques to build models that predict customer behavior. The technology enhances the procedure by automating the mining process, integrating it with commercial DW, and presenting it in a relevant way for business users. DM helps banks improve their understanding of customer behavior so as to target marketing campaigns more accurately and to align campaigns more closely with the needs, wants and attitudes of customers and prospects. The key is to find patterns relevant to current business problems.

3.4 Principles of DM application in CMB

According to a report that released by CMB in 2002, there are several thoughts on the current state of DM software applications in CMB:

1) Automated Model Scoring

Scoring models against a database is currently a time consuming, error prone activity that hasn't been given enough consideration [2]. When someone in marketing needs to have a database scored, they usually have to call someone in IT and cross their fingers that it will be done correctly. If the marketing campaigns that rely on the scores are run on daily basis, this means a lot of phone calls and lot of manual processing. Instead, the process that makes use of the scores should drive the model scoring. Scoring should be integrated with the driving applications via published API and run-time-library scoring engines. Automation will reduce processing time, allow for the most up-to-date data to be used, and reduce error.

2) Time-Series Data

Much of the data that exists in DW has a time-based component. A year's worth of monthly balance information is qualitatively different than twelve distinct non-time-series variables. DM applications need to understand that fact and use it to create better models. Knowing that a set of variables is a time-series allows for calculations to be done that make sense only for time

series data: trends, slopes, etc.

3) Incorporate Financial Information

The results of the DM process will drive efforts in areas such as marketing, risk management, and credit scoring. Each of these areas is influenced by financial considerations that need to be incorporated in the DM modeling process. The information necessary to make these financial decisions is often available and should be provided as an input to the DM application.

4) E-banking and personalized services

CMB retain credibility by being able to offer Internet access and defend existing customer base against potential competitors. The e-banking and personalized services are seemed as something that CMB cannot ignore if it wants to fight out a way in banking industries. The Internet is particular well suited to the distribution of financial products. Fortunately there are tangible opportunities to shift manual transactions out of branches and thereby reduce costs the technology will continue to improve.

Now we are going to analysis 2 kinds of the knockout products CMB developed when combining the DW technique.

1) All-in-one credit card

Since July 1995, all-in-one credit card created a new age of personal financial management depending on its advanced technology and fashionable business concept. It has many functions, some of which are also included in credit cards other banks issue, such as arranged transactions, automatic transfers, customer demands, ATM. But the functionalities such as mobile service banking, security, automatic payment, transfers and transactions, montage, pay on net, long distance call, hotel reservation, are characterized with personal financial management services in which other banks are deficient. With the help of the DW technology, CMB is able to provide the services to the customers that tailored to their particular needs. Related card is one of the typical examples. Related card is produced by Nanjing branch and Nanjing Security bureau, which is added with some extra functions especially for the drivers. According to different individual drivers, inquiry of transportation management information and pay traffic fines are accessible in related cards.

2) Mobile banking service (MBS)

CMB cooperated with China mobile corp. and put MBS into marketing. This is a newborn personal banking service in which telecommunication techniques are utilized in order to make personal financial management more efficient than before. MBS contains many personal investment functions, from the common ones like account query, payments, functions to multifunction deposit forms transferring, moreover it also includes advanced personal investment function, as customers can do the daily security information inquiry, entrusting transactions, international currency exchange and inquiry through mobile phone.

4. Models to analysis for CMB

Bank management and government regulators need models that can accurately portray value creation in banking and offer guidelines for strategy and the regulation of strategic behavior by banks. Internet and telephone banking usage per person in the world is increasing rapidly, thereby underlining that banks are intermediaries facilitating direct and indirect financial relations among their customers, rather than creators and distributors of financial products.

4.1 Data Envelopment Analysis (DEA)

DEA is receiving increasing importance as a tool for evaluating and improving the performance of manufacturing and service operations [10][12]. It has been extensively applied in performance evaluation and benchmarking of bank branches. We make an introduction to the DEA and some importance methodological extensions that have improved its effectiveness as a productivity analysis tool for CMB branches. DEA is a multi-factor productivity analysis model for measuring the relative efficiencies of a homogenous set of the decision making units (DMUs). The efficiency score in the presence of multiple input and output factors is defined as

$$\text{Efficiency} = \frac{\text{weighted sum of outputs}}{\text{weighted sum of inputs}} \quad (1)$$

Assuming that there are n DMUs, each with m input and s outputs, the relative efficiency score of a test DMU p is obtained by solving the following model proposed by

Charnes et al.:

$$\begin{aligned} & \max \frac{\sum_{k=1}^s v_k y_{kp}}{\sum_{j=1}^m u_j x_{jp}} \\ & \text{s.t.} \sum_{k=1}^s v_k y_{ki} \leq \sum_{j=1}^m u_j x_{ji}, \quad \forall i = 1 \dots n \\ & \quad v_k, u_j \geq 0, \quad \forall k = 1 \dots s, \quad j = 1 \dots m \end{aligned} \quad (2)$$

x_{ji} = Amount of input j utilized by DMUs i ,

y_{ki} = Amount of output k produced by DMUs i

u_j = Weight given to input j ,

v_k = Weight given to output k

The fractional program shown as (2) can be converted to a linear program as shown in (3).

$$\begin{aligned} & \max \sum_{k=1}^s v_k y_{kp} \\ & \text{s.t.} \sum_{j=1}^m u_j x_{jp} = 1 \\ & \quad \sum_{k=1}^s v_k y_{ki} - \sum_{j=1}^m u_j x_{ji} \leq 0 \quad \forall i = 1 \dots n \\ & \quad v_k, u_j \geq 0 \quad \forall k = 1 \dots s, \quad j = 1 \dots m \end{aligned} \quad (3)$$

The above problem is run n times in identify the relative efficiency scores of all the DMUs. Each DMU selects input and output weights that maximize its efficiency score. In general, a DMU is considered to be efficient if it obtains a score of 1. A score of less than 1 implies that it is inefficient. The primary advantages of this technique are that it considers multiple factors and does not require parametric assumptions of traditional multivariate methods. However there are some critical factors one must consider in the application of DEA models. The discovery scores could be very sensitive to changes in the data and depend heavily on the number and type of input and output factors considered. In general, inputs can include any resources utilities by a DMU, and the output can range from actual products produced to a range of performance and activity measures. The size of the data set is also an important factor when using some of the traditional DEA models.

4.2 Operational efficiency model

Broadly speaking, operational efficiency model adopt either a production approach or an intermediation approach [4]. In the former case the branch is considered as a factory delivering services to its clients in the form of transactions. Benchmarking models examine how well different branches combine their resources to support the largest possible number of transactions. The intermediation approach considers various types of costs as the inputs, and those are combined to support the largest possible number of revenue generating accounts.

1) Model input

The model uses two broad sets of input. One set captures the resources used by the branch. The second set of inputs includes the number of accounts in different account categories. The clientele structure is tightly linked to a specific branch and it changes very slowly with time. Hence, for the purpose of a static analysis this information is part of the operating environment of the branch.

2) Model outputs

The outputs of the model is total amount of work produces by the branch in order to support the given client base. This work is produced in the form of transactions carried out of the various clients and their accounts. A standardizes measure of total work can be obtained by counting the total number of elementary tasks required in order to be executed for these transactions during a working day. Each elementary task requires summing up their standard times in order to be completed. The standard times of each task, for example, filling in a form or getting a supervisor's signature is obtained through a work measured as the total time involved in processing the tasks for all transactions carried out at a branch.

4.3 Profitability efficiency model

We now turn to the final link of the service-profit chain and address the issue of profitability efficiency. Substantial research has been done on this key issue [1][2]. We formulate the model of benchmarking the profitability.

1) Model inputs

The inputs are the resources used by the branch and revenue generating accounts. However that for some

types of accounts is indicative of the demands imposed on the branch's resources for service and maintenance, while the volume of deposits in these accounts is indicative of their contribution to profits. Hence, the accounts of each branch are measured using a different classification and different units than those used in the previous model.

2) Model outputs

The outputs are the profits generated at each branch. Revenue growth could be incorporated as a more appropriate output, but then other inputs should also be included such as service quality, demographics of the region where the branch is located, and competition. The model can be readily extended if such data is available.

4.4 Linking the operational efficiency with profitability

We use operational efficiency model and the profitability efficiency model to analysis the effects of inefficient operations and the costs of offering inappropriate products at each branch. The profitability efficiency model considers both consumable and revenue generating resources as inputs. The consumable resource is operational variables whereas the revenue generating resource is the product of each branch.

5. Retail Banking of CMB and Customers Relationship Management

The industry of universal banking is restructuring, and the customer has never met a richer supply of information and services. The old relationship between bank and customer is changing. Individual consumers are becoming ever more demanding, both on kinds and quality of services. CMB are looking to gain a competitive edge by establishing one-to-one relationships with customers and a higher degree of personalization. For example the profitability of various channels can be notoriously difficult to ascertain accurately, but the profitability of individuals using a particular ATM could be established very easily, aiding decision on whether that equipment was worth retaining or upgrading. Similarly the data might indicate that a particular product is being used by a large number of customers in a very unprofitable way. Also by using DW technology, CMB is able to do customer segmentation:

1) CMB can map the results of customer profitability analyses back to their channels to determined high-value branches, or to specific geographical areas to extrapolate high-value cities or neighborhoods to target. Changes in a customer's profitability over time can also uncover previously unknown customer behavior patterns. Many banks use profitability analysis to the creation of new services, or discarding of old ones. CMB is likely to target particular customer segment, e.g. mass affluent rather than mass market and will try to differentiate itself from existing competitors.

2) Increasing customer lifetime value

Consider, for example, customers of CMB who only use the CMB for a checking account. An analysis reveals that after depositing large annual income bonuses, some customers wait for their funds to clear before moving the money quickly into their stock-brokerage or mutual fund accounts outside the bank. This represents a loss of business for the CMB. To persuade these customers to keep their money in the bank, CMB can use DM tools to immediately identify large deposits and trigger a response. The system might automatically schedule a direct mail or telemarketing promotion as soon as a customer's balance exceeds a predetermined amount. Based on the size of the deposit, the triggered promotion can then provide an appropriate incentive that encourages customers to invest their money in the bank's other products. Finally, by tracking responses and following rules for attributing customer behavior, DM tools can help measure the profitability and ROI of all ongoing campaigns.

6. Personalizations and Customer Oriented Marketing

The Internet is leading marketer to a fundamental paradigm shift from mass marketing to personalized marketing. Databases, cookies and telecommunications technology make it very easy and cost-efficient to mass-market personalized services. Personalization on the Internet refers to the ability of customers to receive personalized information or visit a website with a home page customized for them. Through the use of databases, it is able to store information about its visitors and provide a personalized, free service for them: remaining individuals of important events, such as birthdays,

anniversaries, and graduations. Personalization represents simultaneously the extreme challenge and opportunity present in the form of Internet medium. A fundamental shift is occurring between producer and consumer. Technology-enabled consumers are actively participating in activities, tasks and decisions that were once the sole domain of the marketer. In the past, consumers' decisions were primarily limited to purchase and consumption. Today through the enabling power of technology, consumers are able to design products from their homes, and store and access information at their convenience [7].

7. What Should CMB Improve in Personal Service Area?

1) Financial Advice

One higher level of CMB goes beyond typical to offer more general financial advice, sometimes with a level of interactivity [9]. An important decision that banks will face in the future is how to develop their personalities and how to position themselves in their non-banking capacities. This means understanding customers better and becoming the sort of bank that they would want to do business with.

2) Selling Financial Products

Some banks have gone so far as to sell financial products on the Internet. At this stage it is most common to allow customers to fill in an application form for a credit card on-line and complete the transaction by more mundane methods such as the post, but we can expect that the future will see banks moving to complete sales entirely on-line, and to sell more complex products. Questions are raised such as: what will people be willing to buy on-line? What sort of people will want to make purchases? How secure and confidential can the information generated by a sale be? There are many other questions such as these, which for the time being are difficult to answer, but are likely to emerge as central areas of research not only for banks but for the business world in general.

3) Privacy

In recent years privacy concerns have taken on a more significant role not only in China but also all over the world as merchants, insurance companies, and government agencies amass warehouses containing

personal data. The concerns that people have over the collection of this data will naturally extend to any analytic capabilities applied to the data. Users of DM should start thinking about how their use of this technology will be impacted by legal issues related to privacy. For example, if the primary purpose of the collection of transactional information is to permit a credit card payment, then using the information for other purposes, such as DM, without having identified this purpose before or at the time of the collection, is in violation of the purpose and use limitation principles. The primary purpose of the collection must be clearly understood by the consumer and identified at the time of the collection. Since DM is based on the extraction of unknown patterns from a database, DM does not know, cannot know, at the outset, what personal data will be of value or what relationships will emerge. Therefore, identifying a primary purpose at the beginning of the process, and then restricting one's use of the data to that purpose are the must.

8. Summary

DW empowers banking institutions to provide Internet-based financial solutions to their retail and commercial customers via a cost-effective service. DW offers profit-generating opportunities to its clients through secure, reliable, and scalable products and services. Few business areas are changing so rapidly as the financial services area. Banks have a long history of conservatism in their business practices. However, for the past decade, changes in technology, deregulation and general economic conditions have transformed the industry. The DW technology is rapidly becoming the new medium for financial services. The ramifications of the changes are unpredictable. Many financial services firms outsource their software and hardware development to computer companies. The DW technology makes it possible for large global financial services firms to reach the most remote local markets, but also for small specialized niche banks to reach their customers world wide.

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A New Approach to Integrate Heterogeneous Databases: The Mediated Data Integration Architecture

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Abstract

Information required for decision making is generally scattered across disparate data sources. To gain competitive advantage, it is extremely important for executives to be able to obtain one unique view of information in an accurate and timely manner. The heterogeneities occur when integrating such data sources which were designed independently. MeDIInt – the Mediated Data Integration architecture is introduced to solve this problem. The mediator and wrappers are employed as the middle layer between application and data sources to homogenise heterogeneous data sources. Both the mediator and wrappers are well supported by the Mediated Data Model (MDM), an object-oriented based data model which can describe or represent heterogeneous data schematically and semantically. The MeDIInt architecture has been tested and evaluated, and the results are promising.

Keywords: Heterogeneous databases, data sources, integration, mediator, wrappers.

1. Introduction

When interoperation between multiple heterogeneous data sources is required, there would be a number of conflicts arising not only from different database designs, but also from different kinds of data models employed within heterogeneous databases. These conflicts generate the difficulties of homogenisation in terms of data model, schema and semantic [2] [3] [4] [5]. The Mediated Data Integration (MeDIInt) architecture for the heterogeneous data integration framework 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, MeDIInt does not only solve schema and semantic heterogeneities, but also conflicts from different query languages and data models, namely data model heterogeneity.

The integration approach proposed in this research incorporates the advantages of both the mediator systems and metadata repository systems. This means that new

data sources need to be registered when they are added to the integration system. However, the heterogeneities are resolved at the query time making the mediator system more dynamic. The mediated architecture basically adds a third layer between applications and data sources.

2. Architecture Requirements

The following architecture requirements have been formulated as the framework to develop the integration architecture.

- The schema evolution should not affect the integration. This is to cater for dynamic systems where schemas could be changed frequently. When schema modification is made on data sources, it should not cause large-scale modification to the integration system.
- The integration should cover the major kinds of data sources widely used such as legacy, relational model, and object-oriented model systems.
- The approach should increase automation and reduce amount of work required by end-users. Users should not have to deal with conflict resolutions once they issue queries. The different terminologies used in data sources and the different structures of data sources should not affect users when issuing queries.
- The integration architecture should require minimised modifications when a new data source is added or removed.

3. The MeDIInt Architecture

Figure 1 depicts MeDIInt (the Mediated Data Integration Architecture) which is based on mediation and wrapping techniques. The two main components are the mediator and wrappers acting as the intermediate agents between clients and multiple data sources to communicate both request queries from clients to data sources and also query results from data sources to clients.

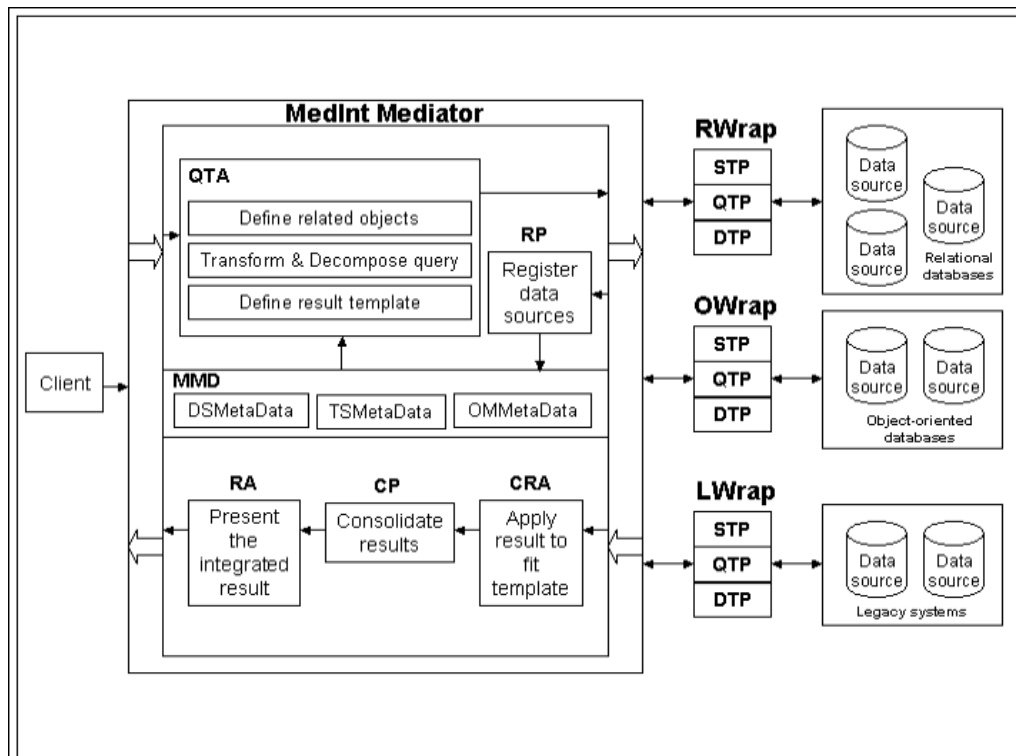


Figure 1: The MeDInt architecture

The MeDInt architecture is represented by four-tiers of components: the application systems which interface to users, the mediator, wrappers and data sources. In addition, the Mediated Data Model (MDM), a data model designed especially for the heterogeneous data integration framework [1], works along with the MeDInt Mediator and wrappers functioning as a central data model and working as the hidden backbone of the integration facilitating the communication between Mediator and wrappers.

3.1 The User Interface

In general, query languages are not capable of utilising and specifying the heterogeneities between heterogeneous systems [6]. Therefore, this approach provides a data model with a query language which captures the heterogeneities on behalf of users so that they can specify their own queries, including semantic contexts.

3.2 The MeDInt Mediator

The MeDInt Mediator provides middle-layer services, as an information integrator does, between the application and wrappers. In general, mediators are responsible for: retrieving information from data sources, transforming received data into a common representation, and integrating homogenised data [7]. In this research, the MeDInt Mediator has been designed to include the following common characteristics of the integration processes:

- registering data sources information,

- defining associate objects and requesting object schemas from wrappers,
- decomposing and transforming a query to subqueries according to data sources,
- generating a result template,
- applying the multiple sets of results to a pre-defined template,
- consolidating the conflict-resolve sets of results, and
- displaying the integrated result to the user.

3.3 Wrappers

Wrappers are in the intermediate layer between the MeDInt Mediator and data sources. A wrapper is invoked when a data source in a difference data model is added to the integration system. Wrappers mainly act as translators providing the MeDInt Mediator with information in the common data model used in the integration system by dealing with the data model heterogeneities of different data sources. The principle objective of wrappers is dealing with data model heterogeneities including the different data definition languages and data manipulation languages by mapping variety data models to the Mediated Data Model. Each MeDInt wrapper is composed of a Schema Translation Processor, a Query Translation Processor and a Data Translation Processor. One novel feature of the architecture is to push unshared characteristics to the wrappers to reduce the amount of middleware modification when a data source is added, removed or modified. In addition, the use of the Mediated Data Model eliminates problems relating to the data model heterogeneity by providing the common data model

acknowledgeable by components in the MeDInt Mediator.

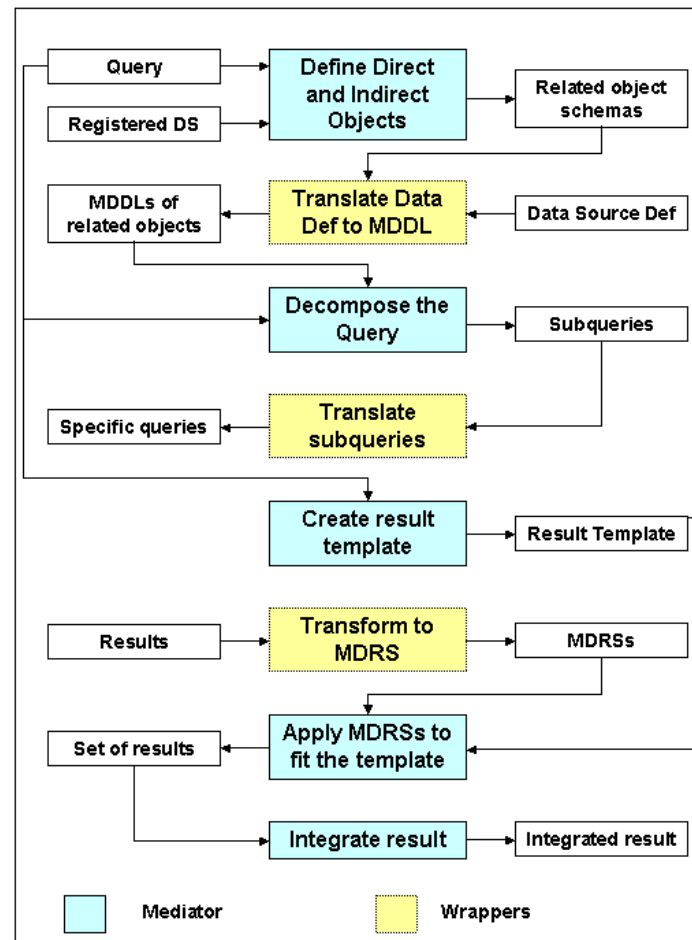


Figure 2: MeDInt Processes

4. MeDInt Processes

Figure 2 illustrates the processes of the MeDInt architecture.

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 architecture 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.

5. 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 architecture and to evaluate its correctness.

Table 1: Summary of the heterogeneities resolved in the MeDInt architecture

Heterogeneities	Conflicts	Test Problem1	Test Problem2	
			Query 1	Query 2
Model		✓	✓	✓
Schema	Naming	✓	✓	✓
	Structural	✓	✓	
	Specialisation		✓	✓
	Relationship		✓	
Semantic	Naming		✓	
	Scaling	✓		✓
	Abstraction			✓
	Representation	✓		

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 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 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.

6. Conclusion and Future Works

The research proposes the MeDInt Architecture 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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Collaborative Commerce

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Abstract

Following the evolution of electronic business, collaborative commerce uses information technology to achieve a closer integration and a better management of business relationships among parties including internal personnel, business partners and customers. Recently, market and globalisation competition, customer oriented service strategy and product complexity have pushed enterprises a step further on in collaborative commerce. In brief, collaborative commerce is (1) a collaborative technology – similar to workflow collaboration, (2) a customer-driven technology – similar to a pull-type supply chain, (3) a functionally-integrated technology – similar to concurrent engineering and (4) a business-driven technology – similar to enterprise resource planning, for cross-organisational integration. The paper will illustrate the technologies and the critical success factors of collaborative commerce adoption.

1. Introduction

Many businesses today tie collaborative relationships between partners through the use of digital technologies. The level of collaboration has moved beyond buying-and-selling to planning, designing, developing, communicating, discovering information, researching and providing services among organisations. This new form of collaboration is called collaborative commerce. Following the evolution of electronic business, collaborative commerce is defined as using information technology to achieve a closer integration and a better management of business relationships among parties including internal personnel, business partners and customers [3] [12]. In responding to ever-changing global market demand, business collaboration will bring the whole supply chain to a competitive edge by decreasing product development costs, shortening the time to market and improving product quality.

The survey of over 300 business executives by Deloitte Research in mid-2002 shows that collaborative commerce has led to better business operation and information exchange and has provided a 70 per cent rise in

profitability for those companies who adopted the technology compared with those who did not integrate with their trading partners [6]. Similar results were found in the survey conducted by NerveWire [8]. Companies with a ‘very high’, that is, level 4, external integration level appear to be more competitive in several metrics than those companies with lower integration levels. The average revenue of level 4 companies increases by about 40 per cent, which is about three times of that attained by companies at level 2 or 3. Moreover, cost reductions at level 4 are about two and half times of the average of those at level 2. This are all because the integrated environment can enhance the value chain of suppliers, business partners, customers and employees through flexible business processes, better product quality, rapid order fulfillment, improved reliability, improved capital efficiency and prompt information exchange and knowledge sharing.

The applications of collaborative commerce are various, including promising areas such as collaborative design, collaborative engineering, collaborative decision-making, collaborative forecasting, financial collaboration, sharing knowledge of human resources, collaborative inventory management and consolidating transportation. Moreover, several collaborative models are well known today. For example, collaborative planning, forecasting, and replenishment (CPFR) by the Voluntary Inter-industry Commerce Standards Association uses ERP and demand planning systems for collaborative facilities forecasting and planning. Collaborative forecasting and replenishment (CFAR), jointly initiated by Wal-Mart and P&G, provides no gap between what Wal-Mart plans to sell and what P&G plans to produce [5].

Two points need to be addressed better to understand collaborative commerce:

(1) *Collaborative commerce is the collaborative business.* Just as the terminologies between electronic commerce and electronic business can be used interchangeably, the term ‘collaborative commerce’ can be used interchangeably with ‘collaborative business’. Note that commerce describes the buying-and-selling transactions between parties. However, electronic business has a

broader meaning in which more business operations, such as design, production and transportation, are involved. However, these two terms are sometimes used interchangeably in describing business transactions via the electronic media. Similarly, 'collaborative commerce' is not limited to a collaborative development in buying and selling goods and services. It includes all levels of the activities of business operations.

(2) *Collaborative commerce is an evolutionary technology.* Collaborative commerce evolves from collaboration in the workflow to concurrent engineering and the supply chain and beyond. Three dimensions can be used to describe the movement of these technologies: collaboration, organisational integration and business operations (see Figure 1). Workflow collaboration is an improvement on individual efforts in business activities to stronger co-operation. However, most of these activities belong to the transactional type, which means that a task is assigned to an employee either after another employee has completed his or her task or concurrently with that employee. In contrast, concurrent engineering has a deeper collaborative involvement with the employees.

Concurrent engineering brings employees with different expertise together for product development. These activities involve more functional operations, such as product design, procurement and human resources management. Recent technology in supply chain collaboration, focuses more on inter-organisational integration than on the workflow and concurrent engineering. However, the supply chain linking organisations together to share information is rarely involved at this functional level. Therefore, the trend towards moving workflow collaboration, concurrent engineering and supply chain collaboration to a profound level of functional integration is apparent. This is the origin of collaborative commerce.

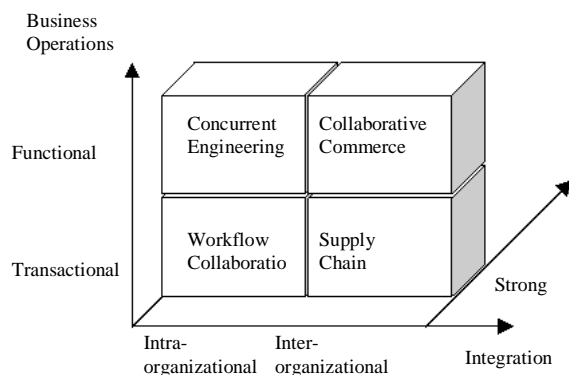


Figure 1. Collaborative Comommerce is an evolutionary technology

While the term 'collaborative commerce', abbreviated as 'c-commerce', was first coined by the Gartner Group in 1999 as the next trend of e-business models and IT investment in B2B world, it was conceptualised as a new form of business model that had been enabled and leveraged by the Internet and integration technologies [3]. Soon after Gartner's coinage of the term, major software vendors including ERP vendors and individual B2B software vendors, such as IBM, i2, SAP, AMR and so on, were competing to provide ways of conceptualising their own way of enterprise collaboration over the Internet.

Although they varied in the way they implemented c-commerce they were all clamouring for the rewards and the competitive edge brought about by the c-commerce business model. In general, collaborative commerce integrates business processes such as demand planning, planning and scheduling, order management, product development, vendor management, sales support and knowledge sharing between partners through sharing information electronically (see Figure 2). Moreover, collaborative commerce is a set of techniques to allow companies to maintain better relationships with their trading partners through automating their cross-enterprise process logic, rules, heuristic and workflow.

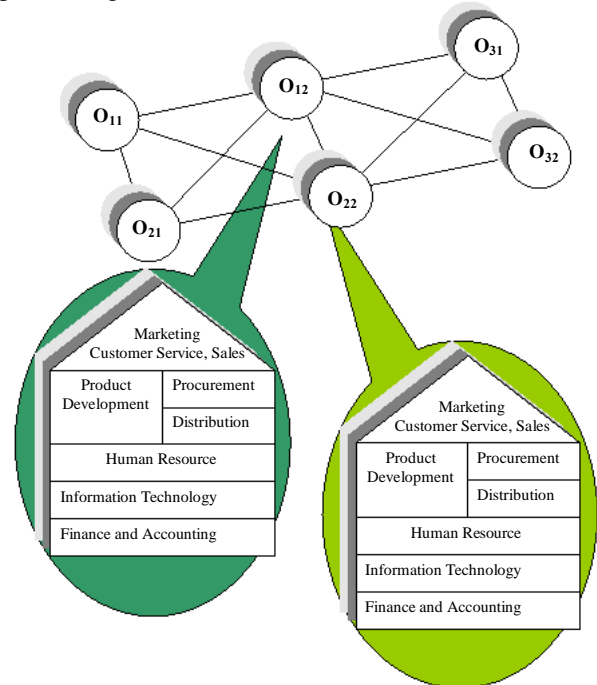


Figure 2. Collaborative commerce integrates business processes across collaborative partners O₁₁, O₁₂, O₂₁, O₂₂, O₃₁, and O₃₂.

The emergence of the collaborative commerce model articulates the succession of continuous improvements in supply chain management. To continue maintaining the competitive edge of an enterprise in the digital economy, several efforts in improving business processes and operations have been made during the past decades. First of all, enterprises adopted enterprise resource planning (ERP) to centralize originally isolated information modules within an organisation. Such efforts result in the increase of information efficiency and integrity. Later, enterprises recognised the benefit of information transparency in the supply chain. Therefore, solutions for the exchange of valuable business information within the supply chain become the focus of efforts to manage supply chain performance. Such efforts reflect the benefit of information synergy on eliminating the bullwhip effect [5].

Recently, market and globalisation competition, customer oriented service strategy and product complexity have pushed enterprises a step further on in business collaboration. To outsource minor business functions effectively and focus on core competitiveness, enterprises need to integrate their information systems with external systems owned by their collaborating partners. In this way the information shared among partners and business processes could flow seamlessly from organisation to organisation. Such system integration brings multiple enterprises to collaborate in shared business opportunities.

In summary, collaborative commerce is (1) a collaborative technology – similar to workflow collaboration, (2) a customer-driven technology – similar to a pull-type supply chain, (3) a functionally-integrated technology – similar to concurrent engineering and (4) a business-driven technology – similar to enterprise resource planning, for cross-organisational integration. The following sections will illustrate the technologies followed by the infrastructure of system integration. Finally the critical success factors of collaborative commerce adoption will be discussed, together with our conclusions.

2. Collaborative Technology

Collaboration is the focal point in collaborative commerce. Traditionally the workflow is created to deal with specific *cases* in an organisation, such as mortgage applications and engineering tests. Each case has a unique identity and a limited lifetime. That is, a case should be completed within certain time limit and will exit the workflow system when the work is completed. That also means that attributes are needed to describe the state and content of the workflow. The work in a workflow can be identified as *tasks*, which represent the indivisible units of works. The tasks are carried out by *processes*. When the

processes are carried out in a workflow they follow a specific sequence, which determines which tasks need to be performed next. There are four different types of sequences: *sequential*, *parallel*, *selective* and *iterative* routings. The sequential routing confines one task to be executed before another task while the parallel routing allows two tasks to be performed without having any result on the other. Similarly, selective routing provides the choice between or among tasks and iteration allows the same task to be performed more than once.

During implementation, the process needs to be enacted to perform a task. The enactment is triggered by *events*, such as external events (a new order having arrived), resources (an employee making a request), or time signals (at eight o'clock every morning) [1]. Note that tasks are assigned to designated *roles* of an organisation following principles such as the separation of duties, least privilege assignment and data abstraction [11]. These principles assure the successful implementation of the workflow. For example, the separation of duties assigns two sensitive tasks to two exclusive roles so that conspired perpetration can be avoided. On the other hand, the least privilege policy, also called the 'need-to-know' policy [4], provides only minimum information for completing the task. In collaborative commerce, a number of organisations, including supply chain partners or even competitors can collaborate in the workflow of an organisation. This implies that better control of access and degrees of collaboration are expected in collaborative commerce.

The workflow management system (WFMS) manages the workflow on a day-to-day basis in various application domains such as office automation, finance, healthcare, telecommunication, manufacturing and production [2]. To allow workflow collaboration across organisations, four elements need to be carefully designed: DBMS, WFMS, administration functions, and applications monitoring. The DBMS manages conventional database tasks, such as data maintenance, data integrity, concurrency control and recovery of current data and historical data. The DBMS needs to manage data sharing among organisations. WFMS deals with the workflow process definition, activities and control. Access to WFMS is across the collaborating organisations. This creates a high degree of complexity.

The applications provide services such as ERP and its corresponding data are normally managed by DBMS. The sharing of applications involves the complexity of both the data level and the functional level. The administration and monitoring element handles administrative tasks which fall outside the scope of the DBMS and WFMS, such as statistical analysis, resource management and operational management. This element also implements some access control mechanisms, especially those

mechanisms related to other organisations. For example, collaborators may be allowed to refer to the statistical data of total sales rather than sales of individual items when designing a product collaboratively.

3. Customer-Driven Technology

Collaborative commerce should be customer-driven, similar to the theme of the pull-type supply chain – pulled by the customer rather than pushed by the manufacturer. Note that the supply chain links organisations together to share information, products, and funds to fulfil their customers' requests efficiently. Supply chain processes can be identified as belonging to four cycles: the customer order cycle, the replenishment cycle, the manufacturing cycle and the procurement cycle [5]. A successful supply chain should be driven by the customer order cycle to the procurement cycle. The shorter the propagation channel, the quicker the response of the supply chain can be. The customer order cycle links customers with retailers to fulfill the customer's orders. The activities in the customer cycle include order entry, order fulfillment and order receiving. The replenishment cycle focuses on replenishing the retailer's inventory by co-ordinating between retailers and distributors.

Activities such as retail order entries, retail ordering, fulfilment of retailer's order and receiving goods are involved. The activities between distributors and manufacturers are considered the manufacturing cycle. In this cycle, the replenishment of the distributor's inventory is the focal point. The activities include the arrival of the order from the distributor, retailer, or customer; the manufacturers' production scheduling, the manufacturing and shipping of the item and receiving it by the distributor, retailer, or customer. The last cycle is the linkage between the manufacturers and suppliers, called the procurement cycle. This cycle ensures that the materials are available for manufacturing by considering orders based on the manufacturer's production schedule or the supplier's stocking needs and the supplier's production scheduling and shipping.

There are many famous implementations of the concept of the supply chain. For example, in the customer order cycle, the online catalogue is a useful implementation for putting products online for customers. This provides significant advantages in giving up-to-date information to customers. Similarly, sales force automation (SFA) automates relations between sellers and buyers by providing product and price information. In the replenishment cycle, vendor-managed inventory (VMI) allows the distributor or manufacturer to manage inventories and the wholesalers or retailers continuous replenishment programmes (CRP) allow suppliers to

replenish the inventories of retailers regularly, based on POS data.

In the manufacturing cycle, advanced planning and scheduling (APS) develops the detailed production schedules about what to make, where to make it, when to make it and how to make it by considering the availability of materials and plant capacity, among other business objectives. The objective of an organisation is to optimize the capacity of manufacturing, distribution and transportation resources based on the data collected from ERP or legacy systems. In the procurement cycle, a content catalogue that focuses on the activities between the manufacturer and its suppliers can simplify the procurement process and allow the manufacturer to keep track of the parts, specifications, prices and order processes of the supplier.

However, to maintain the supply chain relationship, the high degree of trust is needed. In general, trust is nurtured from deterrence-based trust, knowledge-based trust and identification-based trust [12]. Deterrence-based trust uses a variety of formal contracts to ensure co-operation between parties while knowledge-based trust is built on the knowledge of the other trading partner (trustee), which allows the trustor to understand and predict the behavior of the trustee. However, to build a strong relationship, identification-based trust, which allows each party to consider the other party's objective as identical to its own, is beneficial. The same idea is applied to collaborative commerce. Moreover, it should be noted that the partners in collaborative commerce also include competitors, which is not common in the supply chain. Therefore, the degree of trust and the need to do access control are especially important.

4. Functional-Integrated Technology

The degree of collaboration in collaborative commerce should go down to the level of functional integration, similar to that in concurrent engineering (CE) – a systematical approach to integrate product design and manufacturing process support to minimize product development time. Prasad [9] conceptualized the functionalities for CE as two wheels. The first CE wheel represents the integrated product and process organisation while the second concurrent wheel defines the integrated product design and development.

Both wheels have three rings to represent the three essential elements of CE. The inner ring is the hub of the wheel and includes the four Ms: models, methods, metrics and measures. Basically, the four M elements provide the fundamental methodologies for CE implementation. The middle ring focuses on the work groups which drive the wheel forward. The elements in the middle ring for both

wheels are identical: personnel teams, virtual teams, logical teams and technological teams. The centrality of these teams emphasizes the importance of team work. Logical teams are formed to deal with the work process and to ensure that the sub-process interface with one another logically (similar to the tasks in the workflow).

The personnel team is responsible for assigning tasks to roles. The virtual team is formed to assist the personnel team only when conflicts need to be resolved or missions need to be achieved. The technological team manages the quality of products. The outer ring for both wheels functions to implement the CE. In the product and process organisation wheel, the functions are manufacturing competitiveness, life cycle management, process re-engineering, CE definitions, system engineering, information modeling and the whole system product realisation taxonomy. The functions for integrated product development are concurrent function deployment, total value management, development framework and architecture, decision support systems, intelligent information systems, life-cycle mechanisms and CE implementation guidelines.

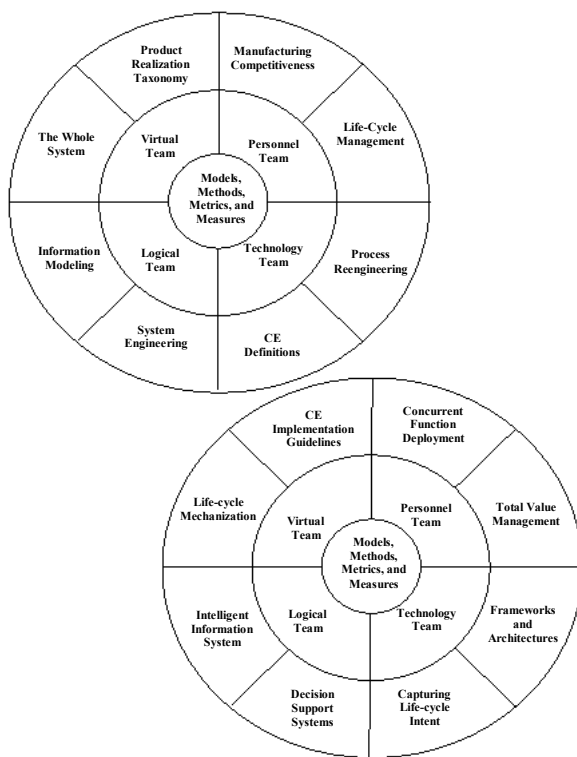


Figure 3. Concurrent engineering wheel [9].

Concurrent engineering tightly links all functions involved in the product development cycle in an organisation. A successful implementing mechanism for

cross-functional integration is therefore very important. Fleischer and Liker modified the five co-ordinating mechanisms proposed by Henry Mintzberg [7] to concurrent engineering to improve cross-functional integration. The mechanisms are (1) direct supervision through the appropriate design of organisation architecture and project management; (2) mutual adjustment through various cross-functional teams, (3) the standardisation of design and performance metrics; (4) the standardisation of work processes, such as operational procedure, planning and scheduling systems, monitoring systems and development process tools and (5) the standardisation of worker skills.

However, the organisation culture which emphasizes collaboration is the most important factor that glues together cross-functional integration. The same idea can be applied to collaborative commerce, which encourages cross-functional and cross-organisational collaboration. Both the 'hard' factors, such as the five mechanisms, and the 'soft' factor, that is, the collaborative culture, are all critical to success.

5. Business-Driven Technology

Business-driven technology creates the possibility of better information technology adoption. Successful information technology adoption can be traced back to the history of the adoption of enterprise resource planning (ERP) against computer-integrated manufacturing (CIM). In the 1960s material requirement planning (MRP) was adopted by most manufacturers to find out 'what are we going to make'. To deliver products to customers, the company needs to examine 'what it takes' to make the products and 'what we have now'. Then, if we do not have sufficient materials to make the products, we must decide 'what we have to get'.

With a little help from computers, these questions were easy to answer in that age since the business operations were simple. However, gradually, the manufacturers wanted to manage both the quality and quantity of the products so that they could deliver them to happy customers on time. This requires an integrated shop-floor control system, which controls the activities of all resources through capacity requirement planning (CRP), scheduling, shop-floor control and other mechanisms. That brings us to a full-scale shop-floor control system, called the manufacturing execution system (MES).

In the 1970s, the focal point of the manufacturers became how to integrate both MRP and MES so that they could manage orders as well as shop-floor production. The new system is called manufacturing resource planning (MRP II). The key to the success of MRP II is in the integration of individual modules and information flow. Fortunately,

a new generation of both the hardware and software was evolved by the growth of information technology. This trend nourished the integration of MRP II. At the same time, parallel to the growth of MRP II, accountants found they needed to handle tasks more than just credit and debit data: they needed methods of internal control. Internal control provides a reasonable way of protecting the business process of an organisation from the misuse of assets. At that time, the accounting information system (AIS) delivered its promise and prevailed in service industries. It is not then surprising that some functionalities of both the MRPII of manufacturing industries and the AIS of the service industries have overlapped in some degree.

In the mid-1980s the new integrated system, called computer-integrated manufacturing (CIM) was proposed by CASA to accomplish functions such as marketing and sales, engineering, R & D, quality assurance, warehousing and distribution, shipping and receiving goods, finance and accounting control, information systems, human resources, customer service and manufacturing material management. The architecture was again represented by SME as an enterprise wheel in 1993 [10]. This architecture integrates both the MRP II and AIS and beyond by introducing inventory management and sales management, financial functions and human resources to MRP II manufacturing and engineering functions to AIS. Enterprise software such as MAPIC/DB from IBM was one of the pioneers in this area.

However, as implied by its name, the core of CIM is in manufacturing; a fact that does not attract enough attention from top executives. This causes some problems, especially when integration obstacles are encountered. Few successful cases in CIM adoption were reported during that period. However, another integration approach blazed the trail in the 1990s. It is called enterprise resources planning (ERP), which compiles similar but fewer functions than CIM. The driving force of ERP is in financial functions, the most interesting function in the enterprise system to top executives. The successful implementation of ERP from companies such as ASP, BAAN, PeopleSoft, Oracle and J.D. Edward has opened a large market for enterprise system.

However, an integrated enterprise resource planning system does not provide enough competitive advantage to companies. Therefore, strategies such as linking the ERP system to electronic commerce to sell products to consumers, to suppliers to provide supply chain partnerships, to customers to provide customer relationship services, to share among employees so as to provide employee management to distribution centres to provide consolidated logistics service have been adopted. The outreach of ERP has created a new phenomenon, a

development from an integrated intra-organisation system into an inter-organisation system, called EERP, or the enhanced ERP.

As will be observed from this history, the successful adoption of collaborative commerce should be business-driven rather than manufacturing-driven. Fortunately, collaborative commerce, as part of its name implies, has built upon the current technologies such as e-commerce, mobile commerce, ERP and the supply chain. This provides the better ground for nourishing its growth.

6. Conclusions

Application platforms have improved in the last decades together with the implementation of enterprise systems. Previously a MRP system sharing information with a department a LAN setting was considered suitable. Then MRP II moved the focus from intra-department integration to inter-department integration. At that time, the single LAN moved to multi-LANs and WAN. The Internet has become the conveyer of information to almost everywhere in the world. At the same time, the system infrastructure also evolves from peer-to-peer linkage to client-server architecture and eventually becomes a three-tier architecture. This evolution supports the growth of enterprises from regional enterprises to global enterprises, which grows collaborative commerce itself.

To provide Internet access, most the commercial enterprise systems moved to the Internet-based ERP in the late 1990s. Nowadays, the new generations of telecommunication technology such as the current 3G technology and the anticipated 4G technologies integrates the wire or wireless Internet with the wireless telecommunication network. This allows the business process to be executed truly anywhere and any time. Will the new generations of telecommunication technology change the implementation of enterprise systems? Or, more precisely, will the high speed wireless transmission change the applications of enterprise system? Collaborative commerce no doubt will be one of the business models if that ever happens. But the types of collaboration may be present in many different formats. To accomplish a collaborative vision of commerce, several factors considered to enable such collaboration.

(1) *Better relationship management.* Since the collaborative commerce business model allows multiple organisations to weave a collaborative network, each collaborator should have the ability to manage the resulting dynamic business relationship. This is especially true when the collaborative community is expanded to a cyberspace marketplace.

(2) *Better business process integration.* Collaborative commerce represents the most efficient way of doing business, where enterprises unwrap their core and competitive business functions to their collaborative partners. The commitment is risky but highly rewarded. The migration to collaborative commerce is equivalent to changing business relationship from independent units to mutually dependent ones. As a result the business process of each collaborator should be understood by every partner. The business process may also need to be decomposed into smaller components so that the integration and collaboration between collaborators become possible. Moreover, the degree of concurrent operations can also be improved if the tasks can be divided into disjoint sub-tasks. The success of seamless collaboration can therefore be achieved by harmonizing all the business process in the network.

(3) *Better knowledge and information sharing.* Since the business processes are contributed to over distributed and heterogeneous networks, it is important to have a superior information infrastructure to allow the information and knowledge to be shared during the processes such as product development. Also, the better sharing of information is rewarded with better access control of the organizational data. Although sharing information is encouraged, it is not difficult to understand that all companies have their own proprietary knowledge, which is not intended to be shared with collaborators, even in the closest relationships. The company may also want to share some general information with specific partners at certain time for certain projects.

(4) *A Better collaborative culture.* Collaborative commerce brings the most talented workers together to develop products to meet consumer demands. Since the workers come from different organizations, they are influenced by different organizational cultures as well as being encouraged by different incentive schemes. Therefore, the successful building of a collaborative atmosphere across organizations determines the success of the collaborative commerce.

In conclusion, an integrated and intelligent system supporting knowledge sharing and collaboration can help companies to distinguish themselves from their competitors. There are many application areas and issues that need to be considered in the collaborative commerce. These topics include areas such as the management of a business infrastructure, capital markets and the virtual economy, improvement of data quality, support of decisions and group systems, enterprise strategies, entrepreneurship and creativity, enterprise process

management, innovation and product development, Internet law and compliance, Internet security and privacy issues and knowledge management business ethics.

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Recognizing Customer Knowledge Level towards Products for Recommendation in Electronic Commerce

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Abstract

A powerful online recommendation system in Electronic Commerce (EC) must know its targeted customers well and employ effective marketing strategies. Market research is a very important way to know the customers well. For high-tech products with great variety such as computers, cellular phones, and digital cameras, customers' knowledge level towards products may have a decisive influence on their purchase decision. While many online recommendation systems focus on utilizing data mining techniques in user profile and transaction data, this paper presents a method for recognizing customer knowledge level as a preprocess for more effective online recommendation in EC. The method consists of two Back Propagation Networks (BPN) and predicts based on customer characteristics and online navigation behaviors. A simple simulated digital camera EC store case study was conducted and the good preliminary result implies the good potential of the proposed method.

Key words: Product Knowledge, Web Usage Mining, BPN, EC

1. Introduction

While product recommendation and customization become more and more difficult due to the great and increasing variety of products available on the Internet, e-marketers endeavor to provide effective approaches for product recommendation and personalization. Approaches include: using data mining techniques to conduct market fragmentation and recommend on the basis of the consumer behaviors of each market segment; mining of customers' preference rating for offered products to automatically generate product recommendation through personalized direct marketing; web usage mining of consumer behaviors to provide product recommendation; and the use of segmentation and predictive modeling techniques for database marketing, etc. In the literature, many recommendation systems were built to provide the most appropriate products or services to meet a customer's needs by analyzing his personal preferences based on his profile and purchasing history. However, people with similar profiles may have different preferences, and past purchase patterns may no longer exist. Therefore, it may not be effective to recommend simply according to customer profile and purchase

history.

Of various factors affecting customers and marketing effectiveness, customer knowledge towards products, which consists of familiarity and expertise, has a decisive influence on what categories of products are suitable to be recommended to the customer.

Besides, product description and electronic catalog design are also very important in recommendation. The presentation of products for experts or novices must be different. It is unintelligible to use abstruse wording for the novice, and simple description and specification may not be able to satisfy the customers' professional requirements. Therefore, present and recommend products according to customers' knowledge level in EC may better suit their needs and promote the sales.

This paper proposes a method for recognizing customer knowledge level towards products (Figure 1). The method includes two neural networks; the first neural network learns to classify customers by customer profiles, while the second neural network learns to predict the customer's knowledge level towards products. Both neural networks are BPNs. Since the static user profile only provides basic properties of customers, they alone are insufficient for predicting a customer's knowledge level. A specifically designed questionnaire for customer knowledge level towards the products is combined with the user profile as the inputs for the first BPN. In addition, two sets of navigation patterns, mined from the web logs for experts and non-experts, plus the output of the first BPN (customer profile characteristic) are fed as the inputs to the second BPN. The output of the second BPN indicates the customer's knowledge level.

We begin by reviewing previous works related to our research in Section 2. In Section 3, the proposed method for recognizing a customer's knowledge level towards products is presented. The website implemented for an EC store case study is introduced in Session 4. The experiment results are described in Session 5. Finally, we summarize our contribution and give suggestions for future research in Section 6.

2. Background

2.1 Product knowledge

Customers differ in their prior knowledge about products, which consists of familiarity and expertise as defined by Alba and Hutchinson [1], where familiarity

refers to the acquaintance level towards products and accumulated purchase experiences, and expertise means the professional know-how and understanding. Furthermore, others researchers also defined different categories of product knowledge including subjective knowledge, objective knowledge, and experience-based knowledge. This paper focuses on the recognition of objective knowledge and experience-based knowledge to enhance personalized marketing effectiveness.

Customers in online environment can be roughly divided into two groups, one is expert group and the other is non-expert group. These two groups differ in the criteria for selecting products and in the product searching behaviors. Alba and Hutchinson [1] and Rao [8] both conducted researches on how product knowledge influences customers on information processing. In EC, customers' knowledge level towards products can potentially be recognized by analyzing customers' profile and navigation patterns.

2.2 Web usage mining

In online environment, the website visitors click hyperlinks that are of interest to them and the access patterns to the website may imply some of the customer behaviors. Web usage mining is one of the data mining techniques for the discovery of behavior patterns from web logs. The application of web usage mining is generally divided into two types, personalized recommendation and web site design improvement. Cho et al. [5] have proposed a personalized recommendation methodology based on web usage mining. Their proposed decision tree induction demonstrated good effectiveness and quality of recommendations. Spiliopoulou and Faulstich [13] developed a data mining system for finding the interesting patterns from the web access log. Perkowitz and Etzioni [7] improved a site by creating customized index pages and clustering pages of a site that were frequently visited

together in a single session. Simith and Ng [12] evaluated the feasibility of using a self-organizing map (SOM) to mine web log data and provided a visualization tool to assist user in navigation.

Therefore, mining customers' navigation patterns from web usage log may play a decisive role in recognizing customer knowledge level towards products.

2.3 Back Propagation Networks

Human brains learn via a neural network that consists of neurons, axons, dendrites and synapses. The brain receives inputs, analyzes them and outputs feature or pattern recognition information [9]. There are some researches have gone into creating artificial neural networks that learn in similar ways in recent years.

There are several types of artificial neural networks in use today; one of these types, BPN [11] is widely used in prediction and measurement, such as stock price prediction [2], option market trade [4], fraud detection [10], bankruptcy prediction [6], and medical diagnosis [3].

This paper proposes a method which consists of two BPNs and web usage mining to recognize a customer's product knowledge level as will be introduced next.

3. A Proposed Method for Recognition of Customer Knowledge Level towards Products

3.1 The method for recognizing customer knowledge level

In this paper, we propose a method for recognizing customer knowledge level towards products. Figure 1 shows the recognition mechanism using BPN and web usage mining.

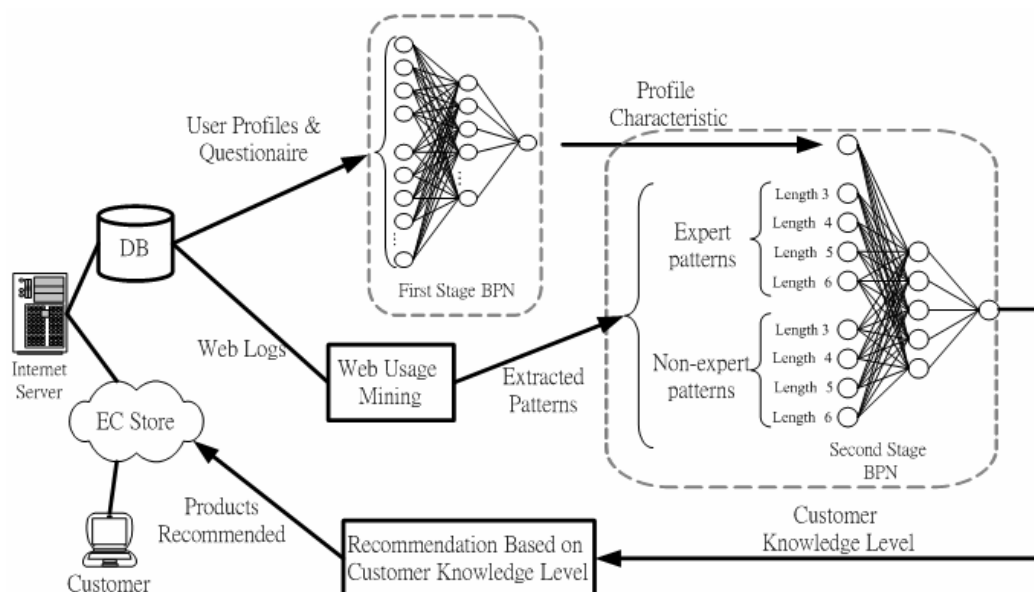


Figure 1. The proposed method of recognizing customer knowledge level using BPN and web usage mining

After consumers sign up, customer profiles and questionnaire results recorded are the inputs of the first neural network which classifies customers. The output value is between 0 and 1, where a value close to 1 means there is a high possibility that the customer has high knowledge level towards products. However, two persons with the same background do not assure that they have the same knowledge level towards a specific type of products. Hence, the output data of the first neural network is only one of the factors considered in recognizing customer knowledge level towards products.

Besides the customer profiles, every time when a customer visits the web site, the system will record all the navigation information in the log file, including the URLs the customer visited, IP addresses, time entering the web page, time leaving the web page, etc. Through sequence pattern mining on the log data, the frequent navigation paths on the web site can be extracted. The frequencies of patterns with lengths 3-6 along with the output of first BPN are the inputs of the second BPN. The output of second BPN indicates the customer's final knowledge level towards products. Once we recognize a customer's knowledge level towards products, the introduction of products, marketing, and recommendation can be personalized according to his knowledge level.

The procedure of recognizing customer knowledge level can be implemented on line in EC. The training data of the BPNs have a critical influence on the performance of recognizing customer knowledge level. The following section explains the procedure of recognizing customer knowledge level with our proposed method.

3.2 The procedure of recognizing a customer's knowledge level

1. Collect training data for the first BPN

Collect the profiles and navigation data of both typical expert and non-expert customers of the web site. The data then are divided into training data and test data sets.

2. Training of the first BPN

The customer profiles and answers to the questionnaires are the inputs of the first BPN for roughly classifying the customers. The only output value is between 0 and 1, where a value close to 1 means the customer may have a high possibility to possess high knowledge level towards products.

3. Classification of the web page contents

EC web sites usually contain dynamic web pages which connect and retrieve data from a database. Web pages retrieving different product details are regarded as different web pages. For example, "pdtl.asp" is a web page to show the details of products, "pdtl.asp?p=A" shows the details of product A, and "pdtl.asp?p=B" presents the details of product B. Although they all belong to the same web page, they should be considered as different web

contents since the URLs are different. Consequently, the more products we have, the more web pages will be created. This will lead to a difficult in finding frequent navigation sequence patterns for experts and non-experts. Product classification may be used here to solve this problem. For instance, products may be classified into fewer categories, such as professional, popular, and novice classes, and so on. This will reduce the total number of various navigation sequence patterns, and thus increase the support count of popular sequence patterns.

4. Web usage mining

Since the sequences of travel paths on web site are important, a sequence mining method is used to extract frequent navigation sequences of various lengths. With sequence pattern mining, sequences can be drawn specifically for experts and non-experts from the log file, and those sequences which are common between experts and non-experts will not be used since they can not be used to differentiate experts from non-experts.

5. Training of the second BPN

The sequence patterns with lengths 3-6 (3-6 consecutive URLs) for both experts and non-experts plus the profile characteristic are the inputs and the knowledge level, ranged between 0 and 1, is the output for the second BPN.

Following the five steps above, once a new customer registers and leaves some navigation sequences at the web site, the developed method can on line recognize the knowledge level of the new customer towards our products, and then the corresponding recommendation can proceed. However, the recommendation based on customer's knowledge level is not attempted in this paper.

4. A Case Study in Digital Camera EC Store

To testify the effectiveness of the proposed method, a case study in a simulated digital camera EC store is conducted.

4.1 The interface of the EC store

In collecting the training data, selected customers are asked to sign up, fill up the profile, answer the questionnaire which is composed of some simple True/False questions about digital camera, and leave some navigation sequences at the web site.

In the experiment, 30 typical experts and non-experts were selected to visit the developed web site and their profiles, answers to the questionnaire, and navigation logs were recorded. Figure 2 is the interface of the developed simulated EC store.

4.2 Training of the first BPN

For the first BPN, 7 different sets of training and test data were randomly generated for both experts and non-experts, where there are 27 and 3 records for training

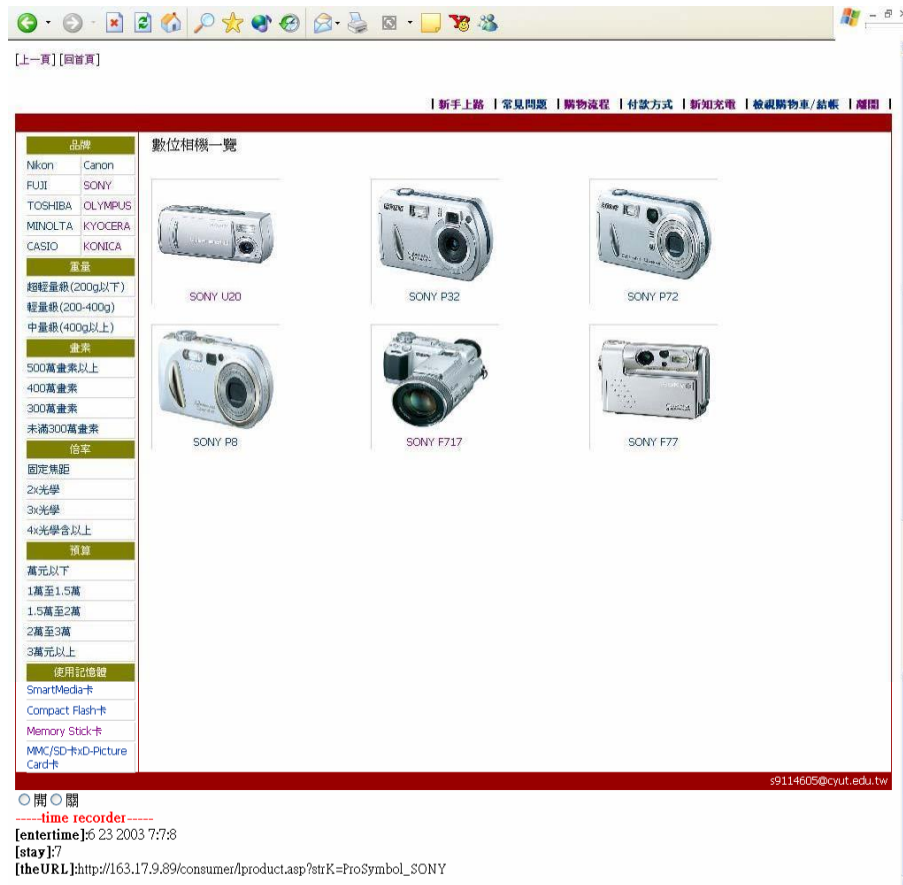


Figure 2. The interface of the simulated EC store

and test purposes for each set of data, respectively. The output of the first BPN denotes the customer profile characteristic, and the more its value is close to 1, the more possibility he has expert knowledge towards the products. The output then becomes one of the input nodes of the second BPN.

4.3 The navigation recorder

To collect customers' navigation data, we developed a navigation recorder which is a plug-in of the web site. While visitors click on the web pages, it records customers' navigation details. The 30 selected experts and non-experts were asked to navigate the EC store, their navigation sequences were recorded for further web usage mining. Table 1 shows some of the navigation details collected. Each record consists of:

1. userID: The user ID.
2. sessionId: While a client connects to the web server, the server will assign a session ID to the client. Though session ID, we can trace the navigation sequences of each session for each customer.
3. theURL: The URLs which a customer has visited.
4. userIP: The IP that each customer used to connect to the web site.
5. TimeIn: The time when the customer enters the web page.

6. TimeOut: The time when the customer leaves the web page.

7. S: Duration of the stay at the web site. Subtract the time entering the web page from the time of leaving the web page and take out the period of time during which the customer's focus is on another URL. By monitoring if a customer's focus is on another application, we can detect if the customer is inattentive while navigating the current URL.

Table 1. Some of the navigation records collected

no	userID	sessionId	theURL	userIP	TimeIn	TimeOut	S
1	aco	1050883611	http://163.17.9.89/1product.asp	211.74.236.25	03/6/3 pm08:51:30	03/6/3 pm08:51:56	25
2	aco	1050883611	http://163.17.9.89/1product.asp?strK=K_2	211.74.236.25	03/6/3 pm08:51:57	03/6/3 pm08:52:23	26
3	aco	1050883611	http://163.17.9.89/1product.asp?strK=P_K	211.74.236.25	03/6/3 pm08:52:24	03/6/3 pm08:52:33	8
4	aco	1050883611	http://163.17.9.89/logout.asp	211.74.236.25	03/6/3 pm08:52:33	03/6/3 pm08:52:38	4
5	wice	1050883677	http://163.17.9.89/1product.asp	163.17.9.75	03/6/4 pm05:33:51	03/6/4 pm05:34:11	20
6	wice	1050883677	http://163.17.9.89/1product.asp?strK=P_N	163.17.9.75	03/6/4 pm05:34:11	03/6/4 pm05:34:12	1
7	wice	1050883677	http://163.17.9.89/1product.asp?strK=P_C	163.17.9.75	03/6/4 pm05:34:13	03/6/4 pm05:34:17	4
8	wice	1050883677	http://163.17.9.89/a_new.asp	163.17.9.75	03/6/4 pm05:34:18	03/6/4 pm05:34:25	7

By sequence pattern mining from the customer navigation data which the navigation recorder has recorded, the navigation patterns for both experts and non-experts can be obtained.

4.4 Product classification and sequence pattern coding

Product classification is applied in order to decrease the total number of different navigation sequences. In this case study, we classified products into four groups by product specification. URLs showing the same classified products on the same web page file are assigned with the same web page code. Table 2 shows some of the web page codes according to the product classification and the URL.

Table 2. Web page coding based on product classification and URL

no	file_detail	theUrl	code
1	Overview: products	http://163.17.9.89/consumer/lproduct.asp	00
2	By brand - Nikon	http://163.17.9.89/consumer/lproduct.asp?strK=ProSymbo l_Nikon	01
3	By brand - Canon	http://163.17.9.89/consumer/lproduct.asp?strK=ProSymbo l_Canon	02
4	By brand - FUJI	http://163.17.9.89/consumer/lproduct.asp?strK=ProSymbo l_FUJI	03
5	By brand - SONY	http://163.17.9.89/consumer/lproduct.asp?strK=ProSymbo l_SONY	04
6	By brand - TOSHIBA	http://163.17.9.89/consumer/lproduct.asp?strK=ProSymbo l_TOSHIBA	05
7	By brand - OLYMPUS	http://163.17.9.89/consumer/lproduct.asp?strK=ProSymbo l_OLYMPUS	06
8	By brand - MINOLTA	http://163.17.9.89/consumer/lproduct.asp?strK=ProSymbo l_MINOLTA	07
9	By brand - KYOCERA	http://163.17.9.89/consumer/lproduct.asp?strK=ProSymbo l_KYOCERA	08
10	By brand - CASIO	http://163.17.9.89/consumer/lproduct.asp?strK=ProSymbo l_CASIO	09
11	By brand - KONICA	http://163.17.9.89/consumer/lproduct.asp?strK=ProSymbo l_KONICA	10
12	By weight - light	http://163.17.9.89/consumer/lproduct.asp?strK=Kheavy_1	11
13	By weight - common	http://163.17.9.89/consumer/lproduct.asp?strK=Kheavy_2	12
472	Move product from market basket	http://163.17.9.89/consumer/dbasket.asp?ProNo=13	72
473	Pay up	http://163.17.9.89/consumer/lpay.asp	73
474	Finish pay up	http://163.17.9.89/consumer/lpayOk.asp	74

4.5 Mining the navigation patterns

By mapping the sequence of URLs that a customer visited to the code table (Table 2), a navigation sequence can be converted into a coded sequence such as “2660486400604826525626,” where every two digits denote a URL. With sequence pattern mining, frequent sequence patterns can be drawn specifically from experts and non-experts. Through a sliding window, we can get all the sequence patterns of length 3-6. Table 3 shows the patterns with lengths 3-6 for the specific sequence “2660486400604826525626.”

Table 3. An example of obtaining sequence patterns by sliding window

Navigation	2660486400604826525626
Length 3	266048 604864 486400 640060 006048 604826 482652 265256 525626
Length 4	26604864 60486400 48640060 64006048 00604826 60482652 48265256 26525626
Length 5	2660486400 6048640060 4864006048 6400604826 0060482652 6048265256 4826525626
Length 6	266048640060 604864006048 486400604826 640060482652 006048265256 604826525626

After obtaining the sequence patterns from experts and non-experts, and removing those patterns which are common between experts and non-experts, expert specific and non-expert specific patterns are found.

4.6 Compute the support count for expert and non-expert specific patterns.

Calculate the support counts of all experts and non-experts specific patterns using the collected training data. Then divide the support counts by the value of the maximal support count resulting in the normalized values. Since there are only hundreds of patterns, they are all adopted in the experiment. For a large number of different patterns, only significant patterns with normalized support count values larger than a pre-defined threshold need to be included in the inputs of the second BPN.

4.7 Training of the second BPN

With sequence pattern mining, sequences can be drawn specifically from experts and non-experts, and those sequences which are common between experts and non-experts will not be used for recognition for the second BPN. With the sequence patterns with lengths 3-6 (3-6 consecutive URLs) for both experts and non-experts plus the profile characteristic as the inputs and the knowledge level (0 or 1) as the output value, we can train the second BPN and use it to predict on line if a new customer has high knowledge level soon after he registers and navigates the EC store. All the 27 experts’ or non-experts’ data were fed into the second BPN with the output values of 1 and 0, respectively to train the second BPN. The rest of the 3 experts’ or non-experts’ data were used as the test data for the BPN. The experiment results will be provided in the following section.

5. Experiment results

This case invited some experts who have often posted articles on the digital camera discussion panel and some non-experts who are very unfamiliar with digital cameras.

To avoid bias in separating the data into training and test data sets, this case study divided the data set into two subsets which consists of a training (90%) and a test (10%) data sets. Similarly, totally 7 different ways of dividing the data set were repeated (another 3 inappropriate data sets were disregarded). Table 4 shows the test result of one out

of the 7 data sets.

Table 4 The test results for one set of training and test data

	exp15	exp19	exp23	non11	non14	non25
exp	0.98063	0.041385	0.97488	0.44754	0.44716	0.45059
nonexp	0.043285	0.66249	0.054541	0.73465	0.73492	0.73251
	correct	incorrect	correct	correct	correct	correct

Accuracy: 83.33

In the 7 sets of training and test data for the proposed method, the test results show that the average prediction accuracy is 90.48%. Furthermore, we changed the ratio of training data vs. test data to 6:4, and the average accuracy is 83.33 %.

Although the accuracy is highly dependent on the training and test data sets, the good preliminary results show the high potential of the method to be applied in online customer knowledge level recognition, on which further recommendation can be based.

6. Conclusion and Future Works

This paper proposes a method for recognizing customer knowledge level towards products. The method consists of two BPNs, the first one is trained to differentiate customers based on user profile and specifically designed questionnaire and the second one is designed to predict the knowledge level, by taking into account additional navigation sequences.

In the experimentation, we divided the data set into training data and test data with the ratio of 9:1 repeatedly for 7 different sets, the accuracy is 90.48%. The results show the high potential of the method in recognition of customer knowledge level towards products.

Once a new customer registers and leaves some navigation sequences at the web site, the developed method can on line recognize the knowledge level of the new customer towards our products, and thus further online personalized product recommendation can be generated and offered.

The preliminary result of the case study has shown the high potential of the proposed method in EC. As for the future works, interesting directions to improve include the

questionnaire design, sensitive analysis of how the input data will affect the prediction accuracy, and application of a large real case study to verify the effectiveness of the proposed approach.

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ACHIEVING COMPETITIVE ADVANTAGE IN SINGAPORE MARINE INDUSTRY THROUGH E-COMMERCE

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Abstract

Singapore's Marine Industry faces strong competition and challenges in the global arena, especially from fast emerging countries such as China and Vietnam where labor costs are much cheaper. Companies of the marine industry are increasingly under pressure in a fast changing business environment to make their operations lean and profitable. Innovativeness in seeking improvements and responsiveness to market changes are essential for gaining sustainable competitive advantage. Information and Communication Technologies (ICT) can play a considerable part in a competitive strategy. E-Commerce could be of a useful tool to achieve competitive advantage, in cost reduction, product differentiation in term of quality service and responsiveness to customer requirements.

Michael Porter's model of five forces of competitive rivalry help firms identify threats to its competitive position and make plans that may include IT and e-Commerce, to protect or enhance that position. E-Commerce offers new ways to manage supply chains, enhancing manufacturing logistics and distribution systems, and linking business partners in a seamless business-operating environment. It also helps to automate business transaction (buy and sell products and services) and flow of information between organizations on the internet. The Singapore Marine Industry would need to seek continuous improvements in all areas of their operations as well as in e-Commerce techniques in order to achieve sustainable competitive advantage.

Background of Singapore Marine Industry

The Singapore Marine Industry is made up of four main sectors: ship repair, shipbuilding, rig building and the marine supporting industries.

Over the last 30 years, Singapore's Marine Industry has undergone various phases of development to emerge as one of the world's premier maritime centers. The ship repair and shipbuilding sectors have achieved world-class status and

contributed significantly to the growth of Singapore as a leading maritime hub.

The marine industry as a whole, being very labor intensive and over the years as the market environment changes, most shipyards are facing difficulties of staying competitive; and more difficulties encountered in the 1990s and beyond. Shipyards were forced to re-consolidate with mergers and acquisitions, and restructuring over the last few years to stay competitive and alive. The marine supporting industries are also facing similar problems and most of the companies in this sector internationalize their business and seek new innovative strategies to stay competitive.

Singapore shipyards face strong competition and many challenges from its counterparts in the global arena. Current over-capacity and strong competition from new ship repair facilities with lower labor costs from China, Vietnam, Indonesia, Thailand and India are expected to compete directly with established yards in Singapore over the near term leading to a downward price pressure.

The uncertain economic climate, keener competition from regional shipyards and the constraints on manpower are old issues that have to be addressed with new perspectives. The innovativeness of the Singapore shipyards in seeking improvements and their responsiveness to market changes are essential to ensure that Singapore remains at the forefront of the global ship repair center.

Competitive Strategy

Companies in the marine industry will only survive if they are competitive; like any other commercial organizations, they prosper if they achieve a competitive advantage. The two generic competitive strategies are price leadership and product differentiation. E-Commerce could be useful tools to achieve price advantage, differentiation and to combat competitive threats. The three basic strategies for competitive advantages are cost leadership, differentiation and focus (Porter, 1980). Cost leadership is simply to be able to sell the goods or provide the service at a price that is lower than that of the competition. Differentiation is where the

goods or services provided have some quality that makes them more attractive than competing products even though the competition may have a somewhat lower price. Focus is concentration on a single aspect of the market, a product niche.

Information and Communication Technologies (ICT) can have a considerable part to play in a competitive strategy. The appropriate use of Information System (IS) and Information Technology (IT) can lower administrative costs of the organization and the use of Information and communication technologies, in the logistics supply chain, can add to that advantage. The use of information and communication technologies, in addition to cost reductions, can also differentiate a product in terms of quality of service and responsiveness to customer requirements. For the niche player, information and communications technologies can be used to target information on the selected segment and to gather customer data from that segment. Eventually quick response supply and just-in-time manufacture, enabled by information and communication technologies, can provide the capability to evolve new products and services and to facilitate customization (Whiteley, 2000).

Michael Porter's model can help firms identify threats to its competitive position and to formulate plans, that may include IT and e-Commerce, to protect or enhance that position. The model shows five forces of competitive rivalry: -

- ◆ Competitive rivalry among existing firms in the trade sector;
- ◆ Threat of potential new entrants to the sector
- ◆ Threat of a substitute product or service to the existing trade
- ◆ The bargaining power of the buyers
- ◆ The bargaining power of the suppliers.

Typically one or two of these five forces dominate in the analysis of the competitive position of an organization in a trade sector. Each of these threats is further examined as below:-

1. Threat of New Entrants

Information Technology can be a barrier to entry into a market. Existing players in the sector may well have a substantial investment in Information System / Technology including the use of Electronic Data Inter-change (EDI) to co-ordinate their supply chain. This experience and investment can be difficult for a new entrant to match. The converse is that developments in IT and e-Commerce may leave existing players with heavy investment in expensive obsolescent technologies giving the new entrant the opportunity to enter the market with fresh ideas and a business plan facilitated by a new generation of IT provision. Internet e-Commerce is a technology that can facilitate new

entrants to existing markets without the need to match the IT and infrastructure investment of the existing players. Recent developments in internet e-Commerce have facilitated the entry of new players into a number of market segments, such as without having much investment in setting up the marketing distribution channel.

2. Threat of Substitution

The IT industry has itself substituted many products previously used in business; one example is the replacement of the typewriter by word processor. Of the e-Commerce technologies, Internet e-Commerce has the potential to make significant inroads into traditional retail sectors such as on-line banking or downloadable information from the web-sites that could substitute distribution channels for conventional retailing and, arguably, constituting substitute products.

3. Bargaining Power of Buyers

The use of IS/IT may help companies achieve efficiencies that enable them to meet the price requirements of the powerful buyer. Another approach is to use information communication technologies to facilitate a level of service that will keep the customer loyal. Short cycle times, quick response supply and reliable services are features that can be enabled by e-Commerce technology. Value added services such as stock control and accountancy facilities available from the suppliers are also features that can lock the customer in.

E-Commerce can also be used to reshape the supply chain. Intermediaries such as wholesalers and agents can become unnecessary when an organization can efficiently deal with small traders and members of the public using e-Commerce systems. Competitive advantage, in all three categories, can be achieved using e-Commerce for direct sales. This process of disintermediarisation can save costs of distribution, allows an organization to differentiate its products and services and/or focus its attention on selected segments of the market.

4. Bargaining power of Suppliers

The strategies of price advantage and differentiation such as branding or quality of service give a stronger competitive position for the suppliers. The ability to trade electronically is a factor in the quality of service and may be a requirement of trade from the buying organization.

5. Competition between Existing Players

E-Commerce is a factor in competition between existing players. The use of e-Commerce can: -

- Reduce the administrative costs of trading (transaction costs);
- Increase the logistic efficiency of the supply chain hence facilitate reduced stockholding and greater reliability of supply ;
- Meet the requirements of trading partners that trade is conducted electronically
- Differentiate the product or service that is offered from that of competitor organizations
- Cut out intermediaries in the supply chain, e.g. replacing sales through an agent with direct sales to the customer;
- Provide a new marketing and servicing channel.

The First Mover Advantage

The ability to gain advantage from the innovative use of IS/IT can owe a lot to timing. The first organization to implement a new type of ICT system will, if the system is successful, gain the price advantage or the differentiation while competitors are still operating with traditional methods and systems (Whiteley, 2000). The shipowners / ship-operators who are customers for the marine industry are located all over the world and the ICT system can provide the advantage for the Singapore Marine Industry.

The first mover can gain advantage but it is a risky business. New technologies and new ways of using them are expensive to develop and are often not successful. There are advantages to being a late mover: the idea has been tried, its effectiveness can be assessed and the later mover can implement an improved version of the system. In terms of technology, the advantages are that it has been tested and will be cheaper and easier to implement the second time round; it may be that standard components have been developed or that packaged solutions are available, advantages that were not available to the first mover. Newcomers to the e-Commerce scene, using EDI or Internet e-Commerce, have the advantages of being able to benefit from the work of the pioneers without the need to contribute to the development effort. The late mover does not, however, have the ability to surprise competitors or the market; it is essentially a catching up operation.

Sustainable Competitive Advantage

Having gained competitive advantage, the problem is then to exploit and sustain it. To gain competitive advantage using IS and IT usually needs an element of surprise; the system needs to be out in the market place before competitors make a start in copying the idea. Sustaining that competitive advantage requires that the technical advantage is converted into brand advantage e.g. amazon.com, or that the technical lead is sustained by continuous product and service development.

Sustainable competitive advantage from EDI systems has been rare. Most EDI systems have been implemented in trade sectors where all competitors have a mature use of IT and IS and hence the use of EDI by one player is readily emulated by the competition.

Sustainable competitive advantage appears to be more common with Internet e-Commerce; probably to be expected with a new technology where the element of surprise can be greater. The notable names in Internet e-Commerce have entered existing markets or created new markets using web technologies at a time when the entry costs to those markets were low and the element of surprise was greatest. In producing technologically sophisticated sites and developing their supply chain logistics, they have considerably raised the entry costs for newcomers.

The possible competitive use of e-Commerce has been illustrated and summarized in the Table below: -

**E-Commerce for Competitive Advantage
(Table 1)**

Force	System	Competitive Advantage
New Entrants/ Substitution	Internet e-Commerce	<ul style="list-style-type: none"> • Reduced entry costs • New sales channel • New service opportunities
Suppliers (&Trade Buyers)	e-Commerce Logistics (EDI/IeC)	<ul style="list-style-type: none"> • Cost reductions • Quick response • Lockin
Buyers (Consumers)	Internet e-Commerce	<ul style="list-style-type: none"> • New sales channel • Dis-intermediarisation • Customer Information
Competitive Rivalry	e-Commerce	<ul style="list-style-type: none"> • Cost leadership • Differentiation • Focus

Source: E-Commerce Strategy, Technologies and Applications; David Whiteley, 2000 (Pg.32)

Notes: EDI: Electronic Data Interchange
IeC: Internet e-commerce

What is e-Commerce?

E-Commerce is simply any business transaction that takes place via digital processes over a network. E-Commerce, however, is really much more than just exchanging products or services for money over the Internet. E-Commerce is an enabling technology that allows businesses to increase the accuracy and efficiency of business transaction processing. E-Commerce is also a way for organizations to exchange information with customers and vendors to the benefit of everyone involved. Eventually,

e-Commerce will likely replace the movement of paper within and between organizations, as well as between organizations and consumers (Trepper, 2000).

The Benefits of implementing e-Commerce

E-Commerce is a tool for reducing administrative costs and cycle time, streamlining business processes, and improving relationships with both business partners and customers. By using a public shared infrastructure such as the Internet and digital transmitting and reusing information, e-Commerce systems can lower cost of delivering information to customers. E-commerce systems, being of instantaneous nature, allow a reduction of the cycle time associated with producing and delivering information and services. An effective e-Commerce solution can extend the reach of business by increasing opportunities with customers, suppliers and other business partners. For suppliers, through a direct, information-rich and interactive contact with customers, electronic commerce can enhance the promotion of products (Viehland, 1999).

Organizations that compete effectively in the e-Commerce arena should therefore be able to make better decisions, which should enhance market position, and ultimately profitability.

E-Commerce techniques allow small businesses to have access to the same markets as larger businesses. Small organizations can have instant access to international markets. Customers all over the world can access the web site and buy the products whether the company has one full-time person or one thousand full-time employees. The direct reach to customers and their bi-directional nature in communicating information, e-commerce systems represent a new sales channel for existing products. Small businesses can grow very quickly and can eventually take on larger businesses in their markets. Smaller businesses may also be able to provide a personalized experience for customers who come to their Web site more easily than larger businesses that have to deal with the bureaucracy involved in designing a Web site.

E-Commerce can provide benefits beyond cost reduction. Electronic sign-offs can prevent inappropriate business transactions that can be missed in a paper-based system. Business rules can be implemented electronically so that systems would not accept transactions than have incorrect codes or insufficient electronic authorization. E-commerce will become one of the components of a brand or corporate image, especially while targeting technology-friendly customer segments. The information-based nature of the e-Commerce processes allows for new products to be created or existing products to be customized in innovative ways. Rapid progress in the areas of e-Commerce will force companies to adapt quickly and offer them opportunity to experiment with new products, services and processes (Viehland, 1999.)

Buying patterns can be tracked as well which allows organizations to make better decisions about the product and service delivery. Giving the right information to the right people of the right time can dramatically improve the company's ability to compete in its marketplace. The changing industry structures and the e-commerce systems allow for new business models to enhance competitive advantage, based on the wide availability of information and its direct distribution to end customers.

Organizations that use e-commerce techniques and technology will also attract additional consumers because of a higher level of customer service, through intelligence built into systems and the extended availability of intelligent support systems. It will also allow for more personalized relationships between suppliers and their customers, due to their ability to collect information on customers' needs and behavioral patterns. Organizations that move to the Web will be able to help their customers resolve problems faster, which will eventually lead to better customer relations and more customers. Organizations that customize the interactions of both vendors and customers will appear to be more attractive business partners, which ultimately enhances their market position. Some organizations will find that a majority of their customers prefer to conduct business via the Web rather than traditional methods, which means that the organizations that cannot keep up with the technology will find themselves in trouble.

By simply using e-Commerce techniques will not, however, necessarily lead to success. Organizations that currently suffer from inefficient processes, questionable product quality or poor customer service will find that e-Commerce enables them only to make the same mistakes faster and more frequently. On the other hand, organizations that are truly dedicated to excelling in these and all areas of their operation will benefit from electronic commerce because it will enable them to most efficiently build upon these capabilities.

(Trepper, 2000) states e-commerce, as in a useful way, the benefit of e-Commerce help to define what it is, Electronic Commerce: -

- Offers new ways to manage supply and value chains; to enhance manufacturing, logistics, and distribution systems; and to link business partners together in a seamless business operating environment.
- Provides organizations and individuals with the ability to buy and sell products, services and information on the Internet.
- Automates business transactions and the flow of information between organizations.
- Helps organizations cut customer service costs while improving the quality of service and increasing the ability of the organization to better manage the customer relationship.

Business to Business (B2B) e-Commerce

Business-to-business (B2B) e-Commerce represents an enormous opportunity for organizations both now and in the future. This will certainly also provide opportunities for the marine industry as well. According to Forrester Research, the market for B2B e-Commerce will surpass S\$1.3 trillion in 2003 (Cameron, 2000).

In Singapore alone, 97% of the 1998 S\$1.2 billion e-Commerce market represented B2B e-Commerce, according to the government's Department of Statistics. In addition, Forrester Research's overwhelming worldwide B2B market prediction of S\$1.3 trillion represents only 9.4% of all business sales in 2003 – up from 2% of all business sales in 1998. Clearly, room for growth in this arena extends beyond 2003 and this will include the marine industry.

Although B2B e-Commerce presents far greater opportunity than B2C e-Commerce, implementing it is also considerably more complex. A consumer e-Commerce site requires smooth functioning e-Commerce software, the ability to process credit card transactions, and a solid marketing plan. B2B applications are diverse and vary considerably by industry; the marine industry itself could also vary depending on which sector or areas of specialization the company is in. Furthermore, a single organization often must support a variety of arrangements with its partners – different contracts, discounts, and payment methods, for example. Off-the-shelf software can help implement such applications, but substantial customization is still required.

It is noted that the use of e-Commerce in the Singapore Marine Industry is still in the premature stage, except for the marine supporting sector where companies that are doing more international business especially of foreign owned companies with headquarters abroad and have base in Singapore. However, it has been noted that the major

shipyards in Singapore, such as Keppel and Sembawang groups have recently taken an overall e-initiatives to move from the traditional buying process to become seamlessly integrated as a marine marketplace. The OmixAsia.com is established and will serve as a B2B e-marketplace in the marine and offshore industries. The estimated volume of buying volume within this is said to be about S\$300 million. The use of this e-commerce is through membership and an entrance fee of S\$4,000 with annual subscription fees of S\$4000, and for non-members a two percent (2%) commission is payable for each transaction. This may however act as barriers for smaller companies due to the high fees charged.

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An Intelligent Web Index Engine for Financial Articles

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Abstract

The Web has become a major repository for financial articles, and the indexing of these articles in an efficient and intelligent manner has become a vital task. This paper describes an intelligent index engine developed to directly log-on to financial Web sites, download financial articles, parse the texts, and index the articles via the use of a semantic network in the domain of corporate economics. The system can be used for retrieving relevant financial information for corporate performance analysis.

1. Introduction

In corporate performance analysis, a successful financial analyst not only observes numbers shown on financial statements, cash flow schedules, or economic index summaries, but also examines related textual information contained in corporate reports, trade journals, government bulletins, and business newspapers that are mainly descriptive and qualitative in nature. Today, the Web has become a major repository of such qualitative information, and the indexing of financial articles from the Web in an efficient and intelligent manner has become a vital task.

This paper describes the design of an intelligent indexing engine for Web financial articles in the domain of corporate performance analysis. The paper first discusses characteristics of the domain, a model that can be used to effectively capture and represent the knowledge in the domain, and semantic networks developed to structure and store the domain knowledge. The paper then presents the design of the Web indexing engine, followed by an illustration of how the system is used. At the end, the paper concludes with recommendations for future research and development.

2. The domain

Similar to evaluating the health of a patient, corporate performance analysis involves a process of diagnosing the state of the health of the underlying company, and the effectiveness of such a diagnosis process relies on support of relevant and timely information. In this domain, the use

of quantitative method such as financial ratio analysis is common. However, financial analysts must open their analyses not only for quantitative constructs in financial statements, but also for many qualitative measures, such as marketing strategies, product development, and so on, contained in corporate reports, trade journals, government bulletins, business newspapers, and so on.

The domain of corporate economics includes tremendous amounts of knowledge with various types of contents and appearances, which makes it essential to find an appropriate representation scheme to structure the knowledge. Valid knowledge representation schemes should be built on common theoretical foundation that can be easily understood by the people in the industry.

Traditional financial reporting system is grounded on the value-driven accounting approach. This approach, however, leads to a very rigid definition for an organization's economics model. The counter-approach to the value-driven approach is the event-driven accounting theories which advocate that an enterprise's approach to corporate information management should focus on managing relevant business events as opposed to managing values shown on the financial reports. The event-driven approach was later applied to develop an entity relationship view of corporate economics called the REA (Resources, Events, and Agents) model [3,4,6]. The model is composed of three classes of economic objects such as resources, events, and agents, and relationships among those objects.

Intelligent information retrieval systems frequently use semantic networks to provide knowledge support for textual information processing for domains with deep knowledge [1]. The concept of the REA modeling technique can serve as the foundation for the development of a semantic network to model knowledge of corporate economics for two reasons. Firstly, the REA model has been proved to be a reliable and consistent knowledge representation scheme for corporate economics. Secondly, because its representation of entity-relationships are exclusively in one-to-one form, the concept of REA model can be used and expanded to develop a semantic network which also uses binary form to represent knowledge.

3. The semantic network

A semantic network is a directed graph in which knowledge objects are the nodes connected by their declared relationships as the links. In the semantic network of corporate economics, the three REA classes of economic objects are the knowledge objects. Defined and identified knowledge objects are related by three sets of binary semantic relationship: generalization, association, and causality. Paired knowledge objects with the semantic relationship are expressed in terms of three semantic predicates: IS_A (generalization), IS_PART_OF (association), and IS_CAUSED_BY (causality). For instance, a "salesman" IS_A "sales representative"; "equipment" IS_PART_OF "asset"; "sales" IS_CAUSED_BY "marketing".

Most semantic networks use the "spreading activation" search algorithm, which navigates the knowledge base by first activating the key objects, followed by objects that are directly related to the objects, followed by objects that are directly related to the objects previously activated, and so on [2]. Psychologists have long recognized that human memory is a system of associated concepts or "chunks" of symbolic information" [5]. The structure of semantic network is analogous to that of the human memory, and the mechanism of spreading activation mimics how human retrieve memory.

Cohen and Kjeldsen [2] also propose three rules that can be used to guide the search. First, the search can cease at a predetermined "distance" (e.g., 3 links or 4 nodes) from the original activation. Secondly, a "fan-out" algorithm can be used to stop the search at objects that have very high connectivity, or fan-out. The third type of constraint uses the idea of likelihood of the relationship between objects. In Cohen and Kjeldsen's [2] GRANT, an intelligent information retrieval system, a minimally constrained spreading activation of a given distance (4 links) is used with satisfactory rates of precision and recall.

4. The system

The intelligent index engine is written in Visual Basic 6 using MS SQL server for data management. The system contains four modules: Request, Index, Retrieve, and Administration.

4.1. The Request module

The Request module uses a COM object to log-on to a financial Web site and downloads a specified HTML page via the HTTP protocol. The module can either download one page at a time or conduct a batch download based on a list of URLs stored in the database.

4.2. The Index module

The Index module parses the downloaded HTML page, analyzes the text, indexes the articles via the use of the semantic network of corporate economics, and saves the

article. The module reads every word of the article, matches the word with the economic objects stored in the semantic network, and build indexes of the article accordingly.

4.3. The Retrieve module

The Retrieve module enables users to retrieve relevant articles based on derived keywords and specified distance for spreading effect. There are two processing elements involved in the derivation of search keys: the semantic network and a search key generator. The semantic network discussed previously is the knowledge base containing the REA objects and their relationships. The search key generator is the inference engine that draws inferences by tracing appropriate links in the semantic network. Using these two elements, the construction of a search key list is accomplished by identifying the primary search key(s) or triggers and constructing a search space (i.e., a contextual base) for the exploration of supplemental search keys by matching semantically related object(s) in the semantic network. In order not to draw the semantic relationships out too far, special rule like "constrained spreading activation" is applied. Using the key list, the search key generator forms text queries to retrieve relevant articles from the article database.

4.4. The Request module

Finally, the Administration module allows users to manage three databases: Web site URLs databases, financial articles database, and the semantic network database. This module, in particular importance, enables the researcher to refine the semantic network over times for better performance.

5. The use of the system

Credit managers and bankers often focus on the liquidity position by looking into a firm's short-term assets and liabilities, or its working capital condition. To analyze a firm's liquidity position, we use the Current Ratio which is calculated by dividing Current Assets value by Current Liabilities value. In order to gain insights into the company's liquidity position, we need to know if there were important activities, such as large bank loans or significant increase in inventory or changes in accounting reporting procedures that might affect its working capital, hence, the current ratio. With the help of the Retrieve module of the system, financial articles related to "liquidity position" in terms of current ratio concept are retrieved as a result of the search for all of the article containing words or terms that are related to the concept of "asset," "liability," and "liquidity". The relevant keywords in the semantic network include "cash," "inventory," "account receivable," "debt," and so on.

7. Recommendations and conclusions

Systems development is a key research methodology that interacts with other methodologies, such as theory building, experimentation, and observation. The advancement of intelligent text processing for Web resources often comes from new systems concepts, but systems must be developed first to test and measure the underlying concepts. The system described in this paper is a result of such a proof-of-concept approach.

Further research work will include substantial testing of the system for precision and recall measurements and the refinement of the semantic network for performance improvement.

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A Study on the Model Development for Intellectual Capital Valuation

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Abstract

As the society of knowledge becomes, the most competitive resource for corporations is knowledge. Corporations have to evaluate and improve latent values of 'Intellectual Capital' (IC), which is directly related with the futurity of corporations. Although it has been researched and proposed to evaluate IC values that have been ignored relatively to tangible asset, the indexes of evaluating IC have never been examined and adopted by many corporations. By this reasoning, there have been no systematic models to evaluate IC value and each corporation should re-develop IC valuation model. Economic wastes have been created under this situation. Therefore this study intends to develop a synthetic and systematic model for IC valuation. Consequently the model of this paper is consisted of 3 dimensions, 10 factors, 22 evaluation criteria, and 82 indexes, which was necessary for IC valuation. This model will be practically applied to IC valuation of corporations.

I. Introduction

As a society of knowledge has recently come, corporations become to focus on knowledge management (KM), strictly speaking, 'knowledge-based Management'. Key research fields of KM are approximately divided into four as follows. (1) the research on concept of knowledge management and alignment KM with competitive advantage (Nonaka, 1991; Nonaka & Takeuchi, 1995; Prahalad & Hamel, 1990; Teece, 1998), (2) the research on methodology of KM (Wiig, 1997; Davenport, 1998), (3) the research on knowledge management systems (KMS) (Vian & Johansen, 1983; Kwok & Khalifa, 1998; Zander & Kogut, 1995), finally (4) the research on IC. The fourth field on IC is originally included into financing and accounting area. However, most traditional accounting model based on financial statements focuses on financial performance. In result, differences between market value and book value have not been measured. In order to overcome this defect, some advanced countries

have actively studied with Edvinsson and Malone's Skandia Navigator as the central figure after 1980.

A few researchers studying IC have presented various indexes to value it, but a lot of indexes still are not tested and not verified (Roos & Roos, 1997; Roos, 1998). Therefore our study attempts to integrate various indexes for IC valuation that have been presented in the previous studies, to prepare framework to classify and verify them, and finally to develop organized model. This is an necessary work to reduce enormous time and expenses for developing IC valuation model of each corporation and hereafter can be available as a benchmark tool of many corporations. In sum, our purpose is to overcome some limitations of previous studies (not organized model and not verified indexes) and to develop a model for IC valuation.

II. Intellectual Capital

Until 1980, most attention of competitive advantage was paid on understanding the competitive environment (Porter, 1980; 1985). However this interest is changed to 'resource-based' perspective. In this perspective, the most important resource to sustain competitive advantage is internal resource. This internal resource have been variously named like 'absorptive capacity' (Cohen & Levinthal, 1990), 'core competency' (Prahalad & Hamel, 1992), 'strategic asset' (Amit & Schoemaker, 1993), 'Core Capability' (Zander & Kogut, 1995), 'intangible asset' (Hall, 1992), 'organizational memory' (Walsh & Ungson, 1991). Though terms are varied, all of these mean knowledge (Roos & Roos, 1997). In this sense, IC of an organization is seen as 'the sum of knowledge having latent intangible values, which will create competitive advantage' (Roos & Roos, 1997; Knight, 1999; Teece, 1998; Lev, 2000).

The problem of developing 'IC valuation model' for estimating intangible asset is the remarkable contrast

between expectation and actuality. Skandia reported that 70% of samples on investigation into KM had not related activities for IC valuation with financial performances reporting (Hiebler, 1996). This is because traditional accounting model has focused on past-oriented results rather than future-oriented capabilities. However, as importance of IC has been increased after 1980s, a few studies about IC valuation have been provided.

Edvinsson(1998), the chief architect behind Skandia's initiatives developed a dynamic and holistic IC reporting model called the Navigator. According to Skandia's model, the hidden factors of human and structural capital when added together comprise IC. Edvinsson recommends 112 measurement indexes in the Skandia Navigator and expanded the meaning of IC. Although Navigator reflects the value of innovation, the role of customers and the relationships with customers, there are some limitations as follows. First, each index is given equal weight in the equation process. Second, indexes about qualitative indexes are not included like data quality except physical estimation (Bontis, 1998, 2000). And then Brooking (1997) defines IC as the combined amalgam of these four components: market assets, human-centered assets, intellectual property assets and infrastructure assets. In total, Brooking's model is comprised of 178 indexes. While this approach has been lauded for offering a toolbox for organizations to assign values to IC, her questions are so conceptual that additional measurement process for quantitative analysis is needed. Sveiby (1999) regarded IC as external structure, internal structure, and individual competence. He also saw individual competence as key factor. Bontis (1998) split IC into human capital, customer capital, structural capital, and provided indexes to estimate them. He also presented the relationship each component with organizational performance. However these indexes are too comprehensive to measure concretely. In sum, IC can be classified human capital, structural capital, and customer capital. Though a lot of indexes have been presented in the previous studies, each index is just arrayed based on three capital components. Systematic and organized model has not been offered.

Compared with these studies, the following studies provided criteria to subdivide each capital component. Saint-Onge (1996) suggested that IC is the most concerned factor when strategy is planned in the stirring environment and that structural capital consists of strategy, system, culture, and structural components. Kaplan & Norton (1992, 1998) presented that human resources is the sum of employee satisfaction, employee productivity, employee sustainability, and employee capability. And Knight (1999) defined external capital as customer capital, supplier capital, alliance capital, community capital, regulatory capital, and competitor capital. Especially the boundary of customer is expanded to other external partners in this study. Stewart (1994, 1997) emphasized the importance of intellectual property and explained it as the starting point to develop IC model. And he pointed out main problem of managing intellectual property. Companies didn't know what intellectual property they

had and have no responsibility department. As companies couldn't take advantage of them, investment in intellectual property have not accomplished adequately. Band (1994) presented elements for explaining organizational culture as market-oriented level, strategic position, inter-organizational communication system, attitude to share information, and sharing level of management philosophy. All of above studies offered sub-components of human capital, customer capital, and structural capital. However, compared with Edvinsson and Brooking's studies, they have not presented specific indexes for valuation.

In summary, previous studies are classified two approaches as follows. (1) First, only specific valuation indexes in each capital component are presented without classifying sub-components. (2) Second, only specific sub-component criteria in each capital component are presented without indexes. These two approaches have all some limitations from the view of systematic and organized model for IC valuation. While indexes are presented in the first approach, there are no analytical criteria for classifying each capital component. And these indexes just have been presented according to researchers' literal interpretation without verification. In the second approach, specific indexes have not been offered. But availability is limited because these indexes can be used practically.

III. Model for IC Valuation

Our paper attempts to decide 'dimensions' to be criteria of model and to elicit 'factors' to subdivide dimensions through literature review because systematic model has not been and only indexes have been provided in the previous studies. Indexes for IC valuation then are classified according to elicited factors and factors are continuously classified to evaluation criteria according to similarities of indexes (<Appendix 1>).

3.1 Dimension

Dimensions of IC are classified into human capital, structural capital, and customer capital based on previous research. This paper intends to classify into individual capital concerning individual employees, organizational capital concerning organization processes and asset, and finally expanded customer capital to relational capital including customers and other participants. This classification is based on the boundary of a company.

3.2 Factor

First, **individual capital** is the most basic capital. This consists of 'knowing' (visible knowledge such as scholarship, invisible tacit knowledge), 'emotion of employees' and 'will of employees'. Based on above-mentioned standards, individual capital includes employee capability, employee satisfaction, employee sustainability, employee production mentioned by Kaplan & Norton (1992, 1998). '*Employee capability*' can be conceptualized by idea, creativities, and explicit

qualification. Sveiby (1999) referred this is a key point for organizational growth. ‘*Employee satisfaction*’ is emotional condition of employees and a lot of researchers have emphasized that if organizational system supporting employees and mental expectation of employees are not balanced properly, they may desert their job or overall organization performance may deteriorate (Lester & Kickul, 2001). The meaning of ‘*Employee Sustainability*’ is close to the concept of willingness, motivation. In Evans & Lindsay’s research in 1999, 46% of Human Resource Focus 1000 presented willingness and motivation of employees as one of the most three important issues (Eskildsen & Nussler, 2000; Eskildsen & Dahgaard, 2000). However, indexes of ‘*Employee productivities*’ like sales per employees or individual trading profit are performance after knowledge activities, not individual value as IC. It is not appropriate for valuation indexes for accumulated knowledge of employees. Therefore our paper will evaluate individual capital as employee capability/satisfaction/sustainability.

Second, **organizational capital** consists of culture, IS, organization structure (process) excluding employees in the company and is added intellectual property proposed by Saint-Onge (1996). As ‘*culture*’ is organization philosophy or the way of doing tasks, it is the basis of organizational capital. Elements such as philosophy or employee values must be formed properly for managing tacit knowledge successfully and shared for enhancing values of IC (Leonard & Sylvia, 1998; Roos & Roos, 1997). Next ‘*Information system*’ is very important factor in the information-oriented society. Numerous studies in MIS have found significant positive impacts of IS on firm performance (Barua & Kriebel, 1995). ‘*Process*’ is the same concept as organization structure by Saint-

Onge(1996). It is IC on organization processes where operates practical works. Only when knowledge is connected to actual management process, it contributes to competitive advantage. Knowledge itself has not significant meaning. Finally as ‘*intellectual property*’ is the most explicit IC because of legal protection, it can be perceived as starting point for IC valuation (Stewart, 1994, 1997; Brooking, 1997). However, valuation indexes for culture and process have hardly founded in previous studies. Even Edvinsson’s study has just estimated IS infrastructure for structure valuation (Edvinsson, 1996, 1997, 1998). Furthermore as it has focused on physical sides (for examples, number of PC per 1 employee), IS quality or usage, efficiency of IS have been missed (Bontis, 1998, 2000).

Third, **relational capital** derived from various relationships consists of customers, suppliers and community. Previous researchers have perceived customer as the most important components in relational capital. Nonaka(1991, 1995) pointed out customer is shared knowledge between a company and customers. Most previous studies have restricted external relationship to the relationship with customer. However, as roles of the other participants are more and more important and expanded, our paper attempts to expand the relationship to other participants.

3.3 Evaluation criteria

Indexes for IC valuation presented in previous studies are classified according to above-mentioned ‘dimensions’. And then these indexes are classified into ‘evaluation criteria’ again according to their similarities.

<Table 1> Components of intellectual capital

Dimension	Factor	Definition
Individual Capital	Employee capability	Creative capability or idea of employee which is put to goal accomplishment of organization
	Employee satisfaction	Human relationship or emotion about work of employee in the organization
	Employee sustainability	Will to sustain stable relationship or enthusiasm for work of employee
Organizational Capital	Culture	Founded management philosophy for goal accomplishment of the firm, shared value/creativities between employees
	Process	Efficiency in actual management process in the organization
	Information system	Knowledge level of employees about quality and quantity of information system
	Intellectual property	Capital related with mental output under legal protection
Relational Capital	Customer	Guaranteed customer satisfaction, customer loyalty
	Supplier	Acquired knowledge and suppliers’ satisfaction in the transaction
	Society	Public confidence or trust of the firm in the local community

<Table 2> Dimension & Evaluation Criteria

Dimension & Evaluation Criteria	
Employee capability capital Capability development program Individual capability of employee	Process capital Availability of purchasing Efficiency of order processing of customers Management efficiency

Employee sustainability capital Average length of services Attitude for work of employee Employee satisfaction capital Satisfaction with organizational environment Human relationship satisfaction Culture capital Value sharing level Creativities Information system capital System quality Integration level of systems Knowledge level about IS of employees	Intellectual property capital Management level of intellectual property Customer capital Customer satisfaction Stability of relationship with customers Brand management level Brand value Supplier capital Negotiation power against suppliers Supplier satisfaction Society capital Corporation image
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IV. Methodology

Data are collected from middle managements working in 50 corporations in South Korea. It took 9 weeks to finish collecting the surveys. In total, 203 valid questionnaires were returned out of 270 handouts (recording 75% of return ratio). The 95 measurement items were made out based on operational definitions. These definitions were taken and integrated from indexes of Edvinsson(1998), Brooking(1997), Sveiby(1999), Roos'(1997, 1998), Bontis(1998, 2000).

<Table 3> Survey Response Rates

Types of Companies in Sample	Number	%
IT & Network Services	55	27.09
Telecommunication, Computer, Semiconductor, Digital appliances	37	18.23
Finance/Insurance	29	14.29
Consulting	18	8.87
Aerospace industry	14	6.90
Information processing	13	6.40
Film and video industry	8	3.94
Human resource services	7	3.45
Engineering	7	3.45
Mekatronics	6	2.96
Others	9	4.43
Total	203명	100%

V. Test Results

5.1 Assessment of Reliability and Validity

The reliabilities for each scale are shown in <Table 4>. The measure scales used in the study show high levels of reliability - Cronbach's alpha is above 0.60(Nunnally, 1978). However, as reliability of employee sustainability was below 0.60, 3 items of 9 were deleted. Convergent validity is assessed by factor analysis of the scales. The factor loadings are shown in <Table 4>. Through Varimax rotation, the total 92 items (individual capital 22 items, organization capital 47 items, relational capital 23 items) are loaded onto 22 evaluation criteria. As factors above Eigen value 1.0 were loaded, two items in employee capability, three items in employee sustainability, three items in culture, three items in process, three items in process, and two items in community were finally deleted.

And we assess the discriminant validity by testing whether all items load more highly on their associated construct than on any other constructs. The square root of the average variance extracted for each construct was compared to the correlations between each construct and other constructs. All the values of the square root of the average variance (i.e., the diagonals) were greater than the correlations between constructs (i.e., the off-diagonals) in <Table 5>, indicating that all the constructs in the model exhibited the discriminant validity.

<Table 4> Reliability and convergent validity Tests

Evaluation criteria	items	Chronbach's alpha	Factor loadings
Employee capability capital Capability development program Individual capability of employee	8	.7210	0.729; 0.677; 0.782 0.668; 0.788; 0.781
Employee sustainability capital Average length of services Attitude for work of employee	6	.6600	0.771; 0.904; 0.898 0.717; 0.597; 0.827
Employee satisfaction capital Satisfaction with organizational environment Human relationship satisfaction	8	.8042	0.715; 0.815; 0.804; 0.718; 0.596 0.821; 0.743; 0.834

Culture capital Value sharing level Creativities	14	.8804	0.685; 0.689; 0.744; 0.635 0.594; 0.593; 0.629; 0.783; 0.767; 0.792; 0.733
Information system capital System quality Integration level of systems Knowledge level about IS of employees	17	.8654	0.693; 0.650; 0.751; 0.765; 0.808; 0.790; 0.794; 0.733; 0.664; 0.767 0.645; 0.778 0.663; 0.800
Process capital Availability of purchasing Efficiency of order processing of customers Management efficiency	10	.8761	0.492; 0.575 0.683; 0.751; 0.769; 0.564 0.704; 0.675; 0.558
Intellectual property capital Management level of intellectual property	6	.9063	0.811; 0.799; 0.825; 0.795; 0.689; 0.748
Customer capital Customer satisfaction Stability of relationship with customers Brand management level Brand value	16	.8748	0.447; 0.655; 0.536; 0.739; 0.779; 0.743 0.781; 0.717 0.887; 0.656; 0.878 0.477; 0.505; 0.492; 0.637; 0.847
Supplier capital Negotiation power against suppliers Supplier satisfaction	5	.8293	0.871; 0.848 0.596; 0.728; 0.667
Society capital Corporation image	2	.6998	0.716

<Table 5> Discriminant Validity

	Evaluation criteria									
	EC-C	ESu-C	ESa-C	Cul-C	IS-C	P-C	IP-C	Cus-C	Su-C	So-C
EC-C	.978									
ESu-C	-.004	.970								
ESa-C	.401	.332	.981							
Cul-C	.446	.340	.812	.988						
IS-C	.442	.047	.329	.443	.965					
P-C	.142	.176	.381	.451	.450	.984				
IP-C	.270	.098	.254	.442	.413	.393	.908			
Cus-C	.319	.107	.392	.452	.393	.480	.424	.978		
Su-C	.144	.309	.396	.428	.311	.472	.172	.462	.984	
So-C	.337	.188	.378	.545	.377	.263	.368	.440	.358	.944

*EC-C: employee capability capital, ESu-C: employee sustainability capital, ESa-C: employee satisfaction capital, Cul-C: culture capital, IS-C: information system capital, P-C: process capital, IP-C: intellectual property capital, Cus-C: customer capital, Su-C: supplier capital, So-C: society capital

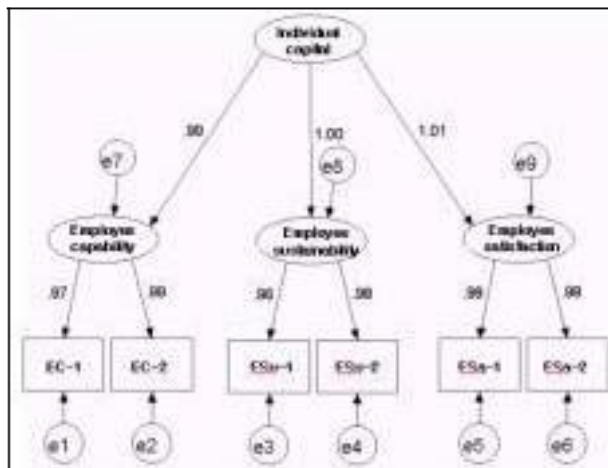
*Note) Diagonal elements are the square roots of the average variance extracted and off-diagonal elements are correlations between constructs.

5.2 Fit Measures for Proposed our Research Model

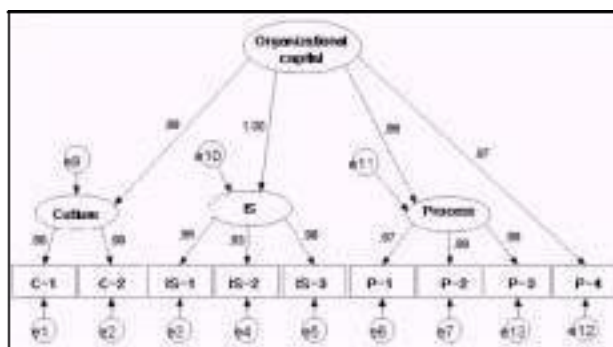
SEM (structural equation model) was conducted using AMOS 4.0. The object of this model is to show that the null hypotheses - the assumed research model with all its paths - is insignificant, meaning that the complete set of paths as specified in the model that is being analyzed is plausible, given the sample data. In other words, the object of this covariance-based SEM is to show that operationalization of the theory being examined is corroborated and not disconfirmed by the data (Genfen et al., 2000). And statistically speaking, this research model is the second-order latent variable formed by the first-order latent factors (for examples, in the 'individual capital' case, employee capability, sustainability,

satisfaction are the first-order latent factors). <Figure 1,2,3> depicts the research model of this study.

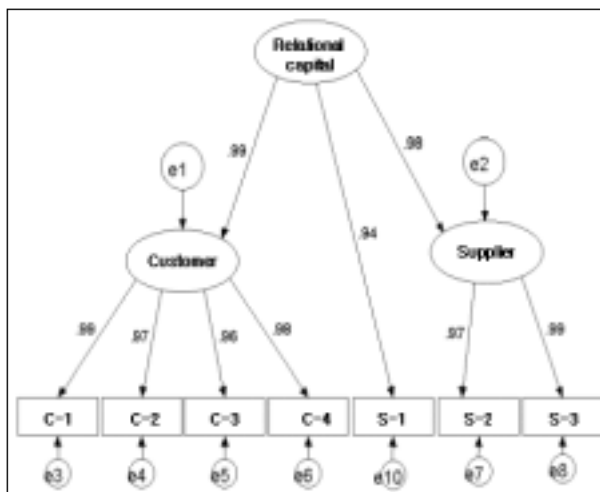
Fit measures for our research model propose in <Table 6>. A chi-square analysis indicates that the model fits the data. However, the chi-square test has been recognized as an inappropriate test for large sample sizes (Marsh, 1994). Showing the <Table 6>, the values of GFI, AGFI, RMR, and NFI are examined for the judgment of the fitness of the model. Therefore, the values of this model are higher than the acceptable level.



<Figure 1> Structural Equation Model of Individual Capital



<Figure 2> Structural Equation Model of Organizational Capital



<Figure 3> Structural Equation Model of Relational Capital

<Table 5> Goodness-of-Fit Indices of Models

	IC	OC	RC
χ^2 statistics	157.341	437.999	410.771
p-value	0.000	0.000	0.000
GFI (>0.9)	0.965	0.941	0.919
AGFI (>0.8)	0.877	0.889	0.810
NFI (>0.9)	0.992	0.986	0.981
RMSR (<0.05)	0.005	0.006	0.010

V. Discussion & Conclusion

In our analysis, we classified dimensions, factors and evaluation criteria of IC for valuation. We found that the model for IC valuation was classified into three dimensions - individual capital, organizational capital and relational capital. Compared with other previous studies, our paper tested unverified indexes of valuation and organized them to systematic model.

Furthermore due to the high demand for KM managers in today's organizations, the results of this study have several implications for practice. First, previous presented indexes arbitrarily by practitioners and researchers were integrated and tested theoretically. Therefore KM managers and CFO can use this model as a tool for IC valuation. Second, other previous studies have only arrayed indexes or presented some factors for classifying. So there has been no systematic model. Our organized model can be used as a foundation to develop and improve the value of IC in strategic respects. For examples, in the auto industry, each company compares its level of IC with others using indexes presented in our model. Analyzing the results of measuring, the company becomes to identify what is underdeveloped and to analyze causes and results in the respect of long-term strategic planning. However, it may be more effective to develop weights of indexes through interviews with domain experts for more precise comparison because of some differences between weights of indexes. In the manufacturing industry where separation of employees leads to great loss, the index of 'separation rate of employees' must be more importantly regarded and can be imposed greater weight. Thus this model should be examined and used on the strategic perspectives.

Like other social studies, we had some limitations. Financial calculating method should be accompanied for a single balance sheet. For this, concrete calculating method should be developed to announce actual \$-values. As our scales of indexes are not unified, new calculating method is needed for conversion to currency value. Though comparisons between companies may be possible through indexes of this model, future research need to develop that method to identify the changes of IC value chronologically or to compare with companies more objectively.

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<Appendix 1> Operational and Conceptual Definition of Model for IC Valuation

D: Dimension, F: Factors, EC: Evaluation Criteria

D	F	EC	Conceptual definition	Operational definition
HUMAN CAPITAL	ECC	Capability development program	Education and training program supported by the firm to improve employees' capabilities	y Training time / 1 employee, training expenses / 1 employee y Educational expenses / sales y Average aptitude test frequency y Execution rate of planned training program
		Individual capability of employee	Knowledge and capability level of individual employee	y Number of employees having certifications y Knowledge level of own work y Average educational period y Expert rate / whole employees
	ESC	Average length of services	A length of services of working employees	y Average length of services in the same position y Average length of services in the firm
		Average separation rate	Changing rate of employee to separate or enter a company	y Average separation & entering rate/ 1year, Average separation rate of experts / 1year
		Attitude for work of employee	Employees' enthusiasm level for work	y Commitment level to own work y Rate of absenteeism, lateness, leaving early
	ESAC	Satisfaction with organizational environment	Employees' satisfaction with organizational system or environment etc.	y General satisfaction with the firm y Satisfaction with Evaluation & compensation, work environment y Relative wage level compared other companies
		Human relationship satisfaction	Employees' satisfaction with human relationship (with colleagues, superiors etc.)	y Relationship type with colleagues (officially-friendly), contact frequency y Satisfaction with relationship with superiors
	CULC	organizational openness	Openness level in organizational system or structure	y Empowerment level y Woman manager rate
		Market-oriented propensity	Level to effort to understand and to satisfy customers' needs in the market	y Level to understand target market and customer needs y Customer-oriented effort level
		Value sharing level	Level to share organizational goal and vision	y Recognition level of employees about organizational goal and vision y Cooperation level between members within teams
		Creativities	Level of support for new product and service development of employees	y Expenses for R&D / sales y Number of new products which are in developing
				y Ratio of putting out new products / 1year y Ratio of R&D researchers
				y Level of support for idea development y Ratio of idea execution
IS	IS	System quantity	Volume of information system within organization	y Number of computers / 1 employee y Investment in IS / sales

I T A L	C	System quality	Satisfaction with goal achievement of IS	y	Importance/Relevance/Accuracy/Timeliness/Comparability/Uniqueness/Usefulness/Informativeness
				y	Ease of use
				y	Usefulness of system features and functions
		System integration level	Level of integration of each system around organizations	y	System sophistication integration of systems
				y	ERP, EDI
		Knowledge level about IS of employee	Level of understanding of employees about IS	y	Level of understanding of CEO about IS
				y	Level of understanding of employees about IS
	P C	Availability of purchasing	Efficiency of activities to buy and store inputs which are needed for operation activities	y	Level of operation of subdivided tasks in the order processes
				y	Average response time in order processing
		Availability of production	Efficiency in production activities to produce final products	y	Level of automation in production processes (TQM, PERT, CPM etc.)
				y	Responsibilities for products quality
		Efficiency of order processing of customers	Efficiency in distribution activities to buyers and customers	y	Timeliness of delivery
				y	Average number of channel for delivering products to customers
	I P C	Management efficiency	Efficiency in planning, executing, and evaluating management activities	y	Level of A/S
				y	Whether long-term strategy is formed for a firm's goal or not
				y	Level of strategy achievement
		IP holding rate	Present conditions of intellectual properties under legal protections	y	Whether Systematic performance/compensation system is or not
				y	Number of possessed IP
				y	Average number of year of IP
		IP values	Present values of intellectual properties	y	Market values of IP
				y	Level of usage of IP
		Investment on IP	Investment on IP for its maximum usage	y	Position of responsibility division for IP (or not)
	R E L A T I O N A L C A P I T A L	Customer satisfaction	Customer satisfaction with services and products	y	Strategy formation for IP (or not)
				y	Customer loyalty
		Stability in customer relationship	Level of stability in relationship with present customers	y	Ratio of repetitive buying
				y	Customers' trust for employees
		Level of customer management	Level of support to preserve values of products, services, brand	y	Market share
				y	Average term in relationship with customers
		Brand values	Brand position in market, which acquires customer loyalty and in result makes a profit	y	Ratio of steady customers (above 5 years in relationship)
				y	New customers / loss customers
		Negotiation power against suppliers	Power of a company in transaction and negotiation with suppliers	y	Management system to support brands (or not)
				y	Number of whole responsibility with brand management
	S U C	Supplier satisfaction	Supplier satisfaction with transaction	y	Efficiency in brand management activities
				y	Customer loyalty for brands
	S O C	Corporation image	Corporation image in community	y	Market values of brands
				y	Possession ratio of valuable brands

Asymmetrical Information and Health Care Industry: A Case Study on Indian Drug Stores

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Abstract

Health care systems are generally recognizing that information is an essential commodity, and the information is a key ingredient to being successful. Any absence of full information can lead to transactions that are ultimately disadvantageous for patients and physician and drugstores. An attempt is made in this study on information asymmetry with patients and drug stores with the principal component analysis of factor analysis and it was extracted 9 interpretable factors from 21 information variables that are possibly attributes the asymmetrical information. From the analysis, it is found that (a) expected role from Drug Store persons and (b) expected details about medicines purchased by the patients are the most important factors. This is because the price and the cost spent for the drugs and medicines are increasing day by day. Another important factor is related to patient “dependency” with drug stores persons and role of drug store persons in building the confidence in the minds of patients. A clear cut legal reforms on health care is required to be streamlined and right to avail the information from the agents of the health care sector viz., physicians and drug stores.

Introduction

Efficient functioning of market depends on the assumption that consumers and producers have full knowledge about product or services characteristics, available prices, and so forth. The absence of full information can lead to transactions that are ultimately disadvantageous [1] [2] [3]. Health care systems are gradually recognizing that information is an essential commodity; and that information is a key ingredient to being successful [4, p.5].

In India, Central and State governments primarily provide medical services. Certain charitable voluntary and private institutions, private individuals also provide medical services to the patients. The hospital firms in Indian economy characterized with perfect market structure, because of its one important feature viz., free flow of information between buyer and seller. In hospital industry, the physician on the one side and drug stores on the other side acts as an agents translating the demand for care by the patient into supply of services from the hospital. It is often observed that the absence of information is prevailing between all the agents of the medical services physician, drug stores and principal (patient). This nature of information asymmetry sometimes adversely affects the health and even resulted in death of the patient. A sudden loss or high cost of medication of a family head or a earning member of a family in a country like India force the family into a poverty pool.

The issue of the role of pharmacists in the greater system of health care provision is central to developing a longer-term outlook on the demand for pharmacists.

Confined to a role of dispensing medication, encroached upon by the availability of improving dispensing technologies and an expanded role of pharmacy technicians, the demand for pharmacists in the future could well decline. Given the growing evidence of drug related complications and the ability of pharmacists to anticipate and forestall many of these problems, however, a more likely scenario is that pharmacists are increasingly valued and demanded for their clinical skills and cost-effective role in the health care system [5].

Against this backdrop this paper made an attempt to study the following objectives: (a) the theoretical perspective on information asymmetry between the ‘triangle’ of the doctor – patient – drugstore; (b) to identify and examine the factor responsible for the information asymmetry and (c) the live cases due to asymmetrical information in the health care industry.

Earlier Views

Very limited analytical research studies are available on the health care and asymmetrical information. Large number of studies have concentrated on concepts and health problems [6] [7] [8] and empirical studies pertaining to health status of the people on the one hand and health care issues between inter and intra States and India on the other hand. Other set of earlier views are mainly concentrated on the customer satisfaction on health care services in general and doctor and nurse services in particular [9] [10] [11]. Only very few studies have discussed about the pharmacies’ role in

medical services and patient satisfaction. Therefore, it is found that most of the earlier Indian studies views are descriptive works and cases [12] [13] [14] rather than analytical one. The analytical studies [15] [16] are related to Western countries and not with that of the developing countries particularly India.

Methodology and tools used

The study based on the primary data. According to the convenience method of non-random sampling procedure, 65 respondents were selected. Each respondent was independently administrated with the questionnaire of 26 relevant informational variables viz., consultation, price, quality of service, drug information, etc [17]. The response are obtained on a 5 point scale ranging from strongly agree, agree, neither agree nor disagree, disagree and strongly disagree. Apart from percentage analysis and mean score, Factor analysis method is used to know which informational factors caused the information asymmetry between patient and drug stores. KMO measures of sampling adequacy test and Cronbach's alpha tests were also performed before proceeding the principal component analysis of factor analysis.

The first section of the article deals with the theoretical 'triangle' asymmetric information between doctor – patient – drugstores. Section II presents the live cases studies and in Section III presents the empirical analysis, its findings and conclusion is given.

Section I - Asymmetry in the 'Triangle'

The following figure indicates the asymmetric information between the various constituents of the 'triangle', that is., between doctor – patient – drugstores.

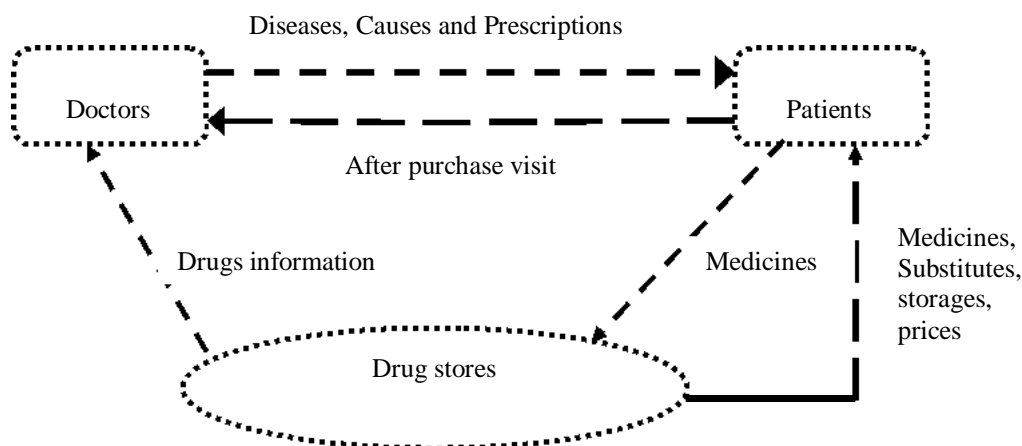


Fig. 1: Asymmetrical information between Doctor, Drugstores and Patients

The nature of information asymmetry process between the doctor – patient – drugstores would witness with regard to the services of the physician and information related to drugs from physician as well as drug stores. The absence of information has influence not only on the economics of the market situation but also the quality of physician services / products, marketing strategies of drug stores, including pricing and long-term effect on the well being of the patients, namely customer care.

Section II: Case studies

Case 1: John Hopkins using Kerala patients as guinea pigs: A major controversy over the alleged trial of a drug on unsuspecting cancer patients at a hospital by the world-famous Johns Hopkins University of the US. The drug, tetramethyl nordihydroguaiaretic acid or NDGA (M4N), was allegedly tested on 24 patients at the Regional Cancer Centre (RCC), soon after it was tested on 36 mice in the US. Reports in the local media said the drug was tried on patients suffering from head and neck tumors during 1999-2000. Several complaints have reached Chief Minister office. Also, some of the RCC doctors were planned to take matters to the court. The trial of another drug, Foscan, at the RCC has raised hackles as the Food and Drug Administration (FDA) of the US and the European committee empowered to give approval for drugs have more than once blocked clearance. A senior RCC doctor said the issue came to light "when one of the doctors in RCC found out that his patients were being used as guinea pigs for this new derivative, without his consent. "When he protested he was sidelined and he has now approached the State Human Rights Commission and the Kerala High Court for justice." "The team led by the RCC director Dr. M. Krishnan Nair instead of removing the tumors on the 24 patients as soon as they were detected, delayed the surgical intervention for varying periods to find out the efficacy of the chemical on cancer cells," he said [18].

Case 2: On Sunday, November 11, 2001, thousands of children throughout India were vaccinated against polio. The effort took a horrific turn in India where 500 children fell ill and at least nine died after a mass polio immunization campaign. Within 24 hours hundreds of children in the Indian state of Assam were taken to local hospitals and health officials report that nine children had died -- all from the same village. The BBC quoted non-governmental agencies as suggesting that the vaccines used in Assam may have been outdated. Regardless, clearly this is likely to be a setback to efforts to eradicate polio [18].

Case 3: The People's Union for Civil Liberties (PUCI) filed a complaint that the authorities in GB Pant Hospital, New Delhi, have been using contaminated, expired and damaged drugs, resulting in an increasing number of patients dying from hospital-acquired infections. The matter has been handed over to the CBI which is also probing another case related to the hospital. PUCI attributes the problem to a cover-up of purchase irregularities worth eighty-six crores of rupees [19].

Results and Discussion

The agreement level on various informational variables that explains the asymmetrical information behaviour is presented in table 1. The more than or equal to 50 per cent of the respondents agreed on the following informational attributes: (a) Pharmacy store sells toiletries, soaps etc. apart from medicines; (b) Shop person always gives me a bill for all the medicines purchased by me; (c) Check the printed prices before paying; (d) The expiry dates before using the medicines; (e) Check the information on how to store medicines; (f) Store the medicines on top of the refrigerator and out of reach to children; (g) All simple diseases like fever, pains I know which medicines to buy and use; (h) Store person always gives me the prescribed medicines and does not offer any substitute; (i) Store always has the medicines which my doctor has prescribed.

On the other hand, in the following variables the respondents expressed their disagreements level: (a) Acceptance of substitute medicines offered by the shop; (b) Does sell small quantities or in loose; (c) Buy my medicines based on the recommendations of the store person; (d) Buy the medicines from the store before going to the doctor; (e) Store person tells me alternative medicines that are available at a lower price than what is prescribed; (f) Pharmacy person always tells me how to store the medicines at home; (g) Store person always tells me the diet details to be observed while taking the medicines; (h) Pharmacy person always tells me the purpose of the medicines which have been prescribed.

The mean score and its standard deviation (Table 2) of the information variables are categorizes the variables

and respondents agreement level. It could be inferred that out of identified 26 variables, higher degree of agreement / disagreement with the mean score above 3.1 is found with 14 variables and with another 12 variables lower degree of agreement / disagreements whose mean score more than 2. The mean scores (greater than 3) of 14 variables categorically supports that the importance attached to these expected information variables by the patients from the drug stores. Though some of the variables scores are less than 3, reverse scores must be taken into account, so that it can be understood in a better way.

The extraction was based upon a varimax rotation; principal component analysis. The Bartlett's Test of Sphericity is extremely sensitive to the hypothesis that correlations within the correlation matrix are zero; even with a relatively small sample size of 65, PCA shows that we are able to reject the null hypothesis of no correlation (Chi-square (325) = 639.34, $p=0.000$). The Kaiser-Meyer-Olkin Measure of Sampling adequacy ($KMO=.512$) is less than the suggested .6 value [21] indicating that the correlation matrix may be difficult to factor. Though there is a low KMO value, 0.512 (Table 3) is within an acceptable range to proceed [22] Cronbach's alpha is an index of reliability [23] associated with the variation accounted for by the true score of the "underlying construct." The higher the score, the more reliable the generated scale is and it has indicated 0.68 to be an acceptable reliability coefficient [24].

The PCA extracted 9 factors, which attributed for the asymmetrical information between the patients and drug stores through the varimax rotation method and the extracted factors accounted 70.36 per cent (Table 4) variance and clearly indicates that above variables (26 items) are important in explaining the asymmetrical information between the drug stores and patients.

The examination of factor analysis through principal component analysis reduced the 26 items into 9 interpretable factors. Cronbach's alpha test was also performed to measure the internal consistency of each factor and it was found that out of 9 factors, 6 factors (Table 5) values are more or less equal to the suggested cutoff value of 0.70, revealing an acceptable level of reliability. The 9 interpretable factors have brought the ideas about the patient expected informational attributes with respect to drug store persons and also reflects the their own responsibility. The theory of asymmetrical information explained that agent knows full information than that of the principal and there would be adverse selection of the commodity. In this study, some of the relevant information between drug stores person and patients is shared, but certain other relevant information are communicated not upto the expected level of the patients.

A conservative criterion loading of .40 was used to determine whether individual scale items were considered for a given factor, all items did meet the criterion cut-off and considered when identifying and naming each factor.

Factor 1: Expected role from Drug Store persons dealt with information sharing on the purpose of the medicines, the diet details to be observed while taking the medicines, buying the medicines from the store before going to the doctor, storage of the medicines at home and the dosage and how to take the medicines. Higher factor scores of the scaled items, grand mean and Cornbach's alpha value signifies the variables and this scaled item explains 10.64 per cent of variance.

The expected information on expiry dates, rates or price of the medicine and interest to know the ingredients of the medicine formed as Factor 2 viz., **Expected details about medicines**. It signifies that the patients or care takers of the patients are keen in knowing the information on expiry dates of the medicines, the prices and wanted to avoid the loose purchase of the medicine. It indicates that the role of drug stores persons in providing the information about the above stated items, so that any adverse effect due to expired drugs or over priced medicines. This factor accounts 9.10 per cent of variance. The internal consistency of the scaled items (0.74) exceeded the suggested level value.

TABLE 1: LEVEL OF AGREEMENTS IN DRUG STORES INFORMATION VARIABLES

Information Variables	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
Drug store sells toiletries, soaps etc. apart from medicines	2 (3.10)	7 (10.80)	6 (9.20)	23 (35.40)	27 (41.50)
Acceptance of substitute medicines offered by the shop	16 (24.60)	21 (32.30)	17 (26.20)	11 (16.90)	-
Drug store person always gives me a bill for all the medicines purchased by me	4 (6.20)	10 (15.40)	12 (18.50)	25 (38.50)	14 (21.50)
Does not sell small quantities or in loose	15 (23.10)	23 (35.40)	16 (24.60)	8 (12.30)	3 (4.60)
Drug store person never gives me the box, just the cut stripes or open bottles	5 (7.70)	16 (24.60)	18 (27.70)	15 (23.10)	11 (16.90)
Check the printed prices before paying	6 (9.20)	11 (16.90)	14 (21.50)	21 (32.30)	13 (20.00)
The expiry dates before using the medicines	-	5 (7.70)	5 (7.70)	17 (26.20)	38 (58.50)
Expiry date information is always seen clearly	1 (1.50)	9 (13.80)	19 (29.20)	19 (29.20)	17 (26.20)
Do not have to check the expiry dates as the store owner always checks it	17 (26.20)	15 (23.10)	13 (20.00)	10 (15.40)	10 (15.40)
Expiry dates are not clear in many cases	10 (15.40)	11 (16.90)	22 (33.80)	19 (29.20)	3 (4.60)
Rates are not clear in many cases	10 (15.40)	12 (18.50)	18 (27.70)	23 (35.40)	2 (3.10)
No information on how to store the medicines	15 (23.10)	16 (24.60)	17 (26.20)	11 (16.90)	6 (9.20)
Check the information on how to store medicines	6 (9.20)	6 (9.20)	10 (15.40)	24 (36.90)	19 (29.20)
Keep all my medicines in the refrigerator	3 (4.60)	17 (26.20)	24 (36.90)	16 (24.60)	5 (7.70)
Drug store the medicines on top of the refrigerator and out of reach to children	5 (7.70)	5 (7.70)	10 (15.40)	29 (44.60)	16 (24.60)
Buy my medicines based on the recommendations of the store person	13 (20.00)	29 (44.60)	13 (20.00)	6 (9.20)	4 (6.20)
Buy the medicines from the store before going to the doctor	24 (36.90)	17 (26.20)	13 (20.00)	8 (12.30)	3 (4.60)
All simple diseases like fever, pains I know which medicines to buy and use	3 (4.60)	14 (21.50)	12 (18.50)	18 (27.70)	18 (27.70)

(Table Contd.,)

Drug store person tells me alternative medicines that are available at a lower price than what is prescribed	13 (20.00)	24 (36.90)	9 (13.80)	16 (24.60)	3 (4.60)
Drug store person always gives me the prescribed medicines and does not offer any substitute	3 (4.60)	8 (12.30)	19 (29.20)	17 (26.20)	18 (27.70)
Drug store person always tells me the dosage and how to take the medicines	9 (13.80)	10 (15.40)	17 (26.20)	23 (35.40)	6 (9.20)
Drug store person always tells me how to store the medicines at home	13 (20.00)	22 (33.80)	20 (30.80)	5 (7.70)	5 (7.70)
Drug store person always tells me the diet details to be observed while taking the medicines	10 (15.40)	20 (30.80)	20 (30.80)	11 (16.90)	4 (6.20)
Drug store person always tells me the purpose of the medicines which have been prescribed	10 (15.40)	23 (35.40)	13 (20.00)	15 (23.10)	4 (6.20)
Drug store person always makes note of the doctor who prescribed the medicines from the prescription	10 (15.40)	10 (15.40)	18 (27.70)	21 (32.30)	6 (9.20)
Drug store always has the medicines which my doctor has prescribed	2 (3.10)	13 (20.00)	15 (23.10)	22 (33.80)	13 (20.00)

Figures in brackets are percentages

Source: Field Survey

TABLE 2: MEAN SCORE OF THE INFORMATION VARIABLES

	Information Variables	Mean	Standard Deviation
1	Drug store sells toiletries, soaps etc. apart from medicines	4.02	1.11
2	Acceptance of substitute medicines offered by the shop	2.35	1.04
3	Drug store person always gives me a bill for all the medicines purchased by me	3.54	1.17
4	Does not sell small quantities or in loose	2.40	1.12
5	Drug store person never gives me the box, just the cut stripes or open bottles	3.17	1.21
6	Check the printed prices before paying	3.37	1.24
7	The expiry dates before using the medicines	4.35	0.93
8	Expiry date information is always seen clearly	3.65	1.07
9	Do not have to check the expiry dates as the store owner always checks it	2.71	1.41
10	Expiry dates are not clear in many cases	2.91	1.13
11	Rates are not clear in many cases	2.92	1.14
12	No information on how to store the medicines	2.65	1.27
13	Check the information on how to store medicines	3.68	1.25
14	Keep all my medicines in the refrigerator	3.05	1.01
15	Store medicines on top of the refrigerator and out of reach to children	3.71	1.16
16	Buy my medicines based on the recommendations of the store person	2.37	1.10
17	Buy the medicines from the store before going to the doctor	2.22	1.21
18	All simple diseases like fever, pains I know which medicines to buy and use	3.52	1.24
19	Drug store person tells me alternative medicines that are available at a lower price than what is prescribed	2.57	1.20
20	Drug store person always gives me the prescribed medicines and does not offer any substitute	3.60	1.16
21	Drug store person always tells me the dosage and how to take the medicines	3.11	1.20
22	Drug store person always tells me how to store the medicines at home	2.49	1.13
23	Drug store person always tells me the diet details to be observed while taking the medicines	2.68	1.12
24	Drug store person always tells me the purpose of the medicines which have been prescribed	2.69	1.17
25	Drug store person always makes note of the doctor who prescribed the medicines from the prescription	3.05	1.22
26	Drug store always has the medicines which my doctor has prescribed	3.48	1.12

TABLE 3: KMO AND BARTLETT'S TEST VALUE

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	0.512	
Bartlett's Test of Sphericity	Chi-Square (df=325)	639.34
	Sig	0.00
Cronbach's Alpha		.6867

TABLE 4: VARIANCE EXPLAINED BY THE FACTORS

	Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.23	16.26	16.26	2.77	10.64	10.64
2	2.71	10.42	26.69	2.37	9.10	19.74
3	2.30	8.86	35.54	2.21	8.50	28.24
4	1.90	7.31	42.85	2.09	8.06	36.30
5	1.71	6.57	49.43	2.05	7.89	44.19
6	1.64	6.32	55.74	1.93	7.41	51.60
7	1.42	5.45	61.19	1.92	7.40	59.00
8	1.29	4.97	66.16	1.55	5.97	64.97
9	1.09	4.19	70.36	1.40	5.39	70.36

TABLE 5: FACTORS DETERMINES ASYMMETRICAL INFORMATION BETWEEN DRUG STORES AND PATIENTS

Factor	Factor Score	Grand Mean	Alpha
Factor 1: Expected role from Drug Store persons			
Drug store person always tells me the purpose of the medicines which have been prescribed	0.80	2.64	0.75
Drug store person always tells me the diet details to be observed while taking the medicines	0.68		
Buy the medicines from the store before going to the doctor	0.67		
Drug store person always tells me how to store the medicines at home	0.67		
Drug store person always tells me the dosage and how to take the medicines	0.46		
Factor 2: Expected details about medicines		2.74	0.74
Expiry dates are not clear in many cases	0.92		
Rates are not clear in many cases	0.88		
Does not sell small quantities or in loose	0.50		
Factor 3: Patients' believability		2.48	0.66
Acceptance of substitute medicines offered by the shop	0.77		
Do not have to check the expiry dates as the store owner always checks it	0.71		
Buy medicines based on the recommendations of the store person	0.65		
Factor 4: Drug persons versus company and doctor		3.05	0.54
Keep all necessary medicines in the refrigerator	0.76		
Drug store person always makes note of the doctor who prescribed the medicines from the prescription	0.59		
Factor 5: Accepting one's own responsibility		3.62	0.48
Check the information on how to store medicines	0.73		
Expiry date information is always seen clearly	0.73		
All simple diseases like fever, pains I know which medicines to buy and use	0.45		
Factor 6: Information sought and verification		3.60	0.04
Pharmacy store sells toiletries, soaps etc. apart from medicines	0.66		
Check the printed prices before paying	0.64		
No information on how to store the medicines	-0.62		
The expiry dates before using the medicines	0.51		

(Table Contd.,)

Factor 7: Right Medicine		3.54	0.62
Drug store person always gives me the prescribed medicines and does not offer any substitute	0.86		
Drug store always has the medicines which my doctor has prescribed	0.71		
Factor 8: Low priced medicine and billing		3.05	-0.81
Drug store person tells me alternative medicines that are available at a lower price than what is prescribed	-0.76		
Drug store person always gives me a bill for all the medicines purchased by me	0.73		
Factor 9: Accepting loose sales and instruction on the storage		3.44	0.37
Drug store person never gives me the box, just the cut stripes or open bottles	-0.67		
Store medicines on top of the refrigerator and out of reach to children	0.49		

Factor 1: Expected role from Drug Store persons dealt with information sharing on the purpose of the medicines, the diet details to be observed while taking the medicines, buying the medicines from the store before going to the doctor, storage of the medicines at home and the dosage and how to take the medicines. Higher factor scores of the scaled items, grand mean and Cornbach's alpha value signifies the variables and this scaled item explains 10.64 per cent of variance.

The expected information on expiry dates, rates or price of the medicine and interest to know the ingredients of the medicine formed as Factor 2 viz., **Expected details about medicines**. It signifies that the patients or care takers of the patients are keen in knowing the information on expiry dates of the medicines, the prices and wanted to avoid the loose purchase of the medicine. It indicates that the role of drug stores persons in providing the information about the above stated items, so that any adverse effect due to expired drugs or over priced medicines. This factor accounts 9.10 per cent of variance. The internal consistency of the scaled items (0.74) exceeded the suggested level value.

Factor 3: Patients' believability dealt with the patients' dependency on the drug store persons. The factor included the items like acceptance of substitute medicines offered by the shop, do not have to check the expiry dates as the store owner always checks it and buy medicines based on the recommendations of the store person.

The factor 4 reflects the drug store persons and their relationship with doctor and company. The items included under this factor are: keep all necessary medicines in the refrigerator and Store person always makes note of the doctor who prescribed the medicines from the prescription and the factor is labeled as **Drug persons versus company and doctor**. This factor attributed the variance to the level of 8 per cent.

Factor 7: Right Medicine reveals the level of confidence of the patients on the drug store persons. The scaled items viz., store person always gives me the prescribed medicines and does not offer any substitute and store always has the medicines which doctor has

prescribed categorically supports that the above mentioned factor 3. This factor reflects that the drug store persons always does his duty to the patients and not act as a self-centered person or a business motive person to achieve his goal.

The drug store person sometimes suggests the alternative medicines that are available at a lower price than what was suggested by the doctor and giving the bill for the medicines purchased is included in the factor **8: Low priced medicine and billing**.

The factor **5 (Accepting one's own responsibility)**, **6 (Information sought and verification)** and factor **9 (Accepting loose sales and instruction on the storage)** are considered as less important informational items, because of the less reliability of the data (Cornbach's alpha values are less than the suggested value).

Conclusion

From the empirical investigation it is found that the 9 interpretable factors are attributed for the asymmetry information between drug stores (agent) and patients (principal), the important factors are: (a) expected role from Drug Store persons and (b) expected details about medicines purchased by the patients. This is because the price and the cost spent for the drugs and medicines are increasing day by day. It is often noticed that the price difference between 'Generic' name of medicine and 'Brand' name is very high. Physicians have a greater role and create awareness to the patients to buy the 'Generic' form of medicines.

Another important factor is related to patient "dependency" with drug stores persons and role of drug store persons in building the confidence in the minds of patients.

The listed live cases categorically supported the factors of the asymmetrical information and its impact on the patients through contaminated drugs, ignorance, etc in the health care sector. Not only these case studies, there are many live cases which emphasizes the selling of

fake drugs through the Over the Counter sales, using contaminated drugs and injections to the patients, etc. the another common cases witnessed in Indian hospital industry especially in large hospital, superspeciality and multispeciality are that the physicians or consultants and the hospital administration are forced the patients and / or care takers to buy the medicines with their own drug stores.

The most common features is that for the top 10 diseases like head ache, fever, dry cough, body pain, the patients who affected just walk into the drug stores and purchase the medicine from the drug stores without doctor prescriptions. The other occasions, the chronic diseased people normally purchase the medicine based on used medicine strips, not even with the prescription sheet of the physicians.

Under the above circumstances, the role of drug store persons is vital. It was stated in Canadian Newswire Services [25] that Pharmacists, as the most accessible of the primary health care providers, have a wealth of information and expertise to share. Pharmacists also offer solutions to some of the challenges facing the health care system Through one-on-one consultation with their patients, pharmacists can change these staggering numbers. Thus, this literature supports the study's importance in a developing countries in general and India in particular.

A clear cut legal reforms on health care is required to be streamlined and right to avail the information from the agents of the health care sector viz., physicians and drug stores.

Limitations and Future Research

The major limitation of the present study is related to the sample size. It is also evident from the analysis and the test statistics like Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Cronbach's alpha. The application Structural Equation Modelling (SEM) would give much better understand of the variables under study and that could be the second limitation of the study. However, this study provides an empirical and theoretical idea related to the principal – agent communication gap or information asymmetry and adverse effect in the health care industry.

The author suggested the following areas for further research: first investigation on price of the generic and branded medicines, use of expired and spurious drugs or medicines and its adverse effect on family. Secondly, an indepth study with respect to doctor and drug stores and their communication process with patient by taking into consideration of all relevant information attributes is need of the hour.

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A Group Decision Support Approach To Budget Allocation For The Horticulture Program Of The Department Of Agriculture Western Australia

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Abstract

Budget allocation to competing projects is an age-old problem in any organisation. Due to funding cuts and other socio-economic priorities budget allocation in public sectors is even more difficult where the norm now a days seems to be doing more for less. Traditional approaches to budget allocation are therefore inadequate to address the myriads of problems. This paper presents a new computer based group decision support system (GDSS) and process for budget allocation. The system called ALLOCATE and the group decision support process called Decision Conferencing for budget allocation are described in details. Their application in the Horticulture program of the Department of Agriculture WA is then presented. The results indicate that the process and system of budget allocation is integrated nicely and new insights are thus generated which lead to effective budget allocation.

Keywords: Group decision support, decision conferencing, budget allocation, resource allocation.

1. Introduction

In recent years, as budgets tighten in all levels of government, the Department of Agriculture Western Australia (DAWA) has had to face the challenge of achieving its goal under increasingly tight budget conditions. Moreover, as there is now increased emphasis on accountability and transparency and the application of competition principles in public sector business activities the agency is in fact under pressure to do more with less. Given its vital role as a leader in agricultural research, development and extension activities for the benefit of all Western Australians, it is important therefore for the

agency to identify those R&D and extension projects which should receive funding priorities for efficient allocation of its limited budget. To identify such projects it is essential to develop and apply a methodological framework consistent with the mission and objectives of the agency by analysing and providing a maximum possible information to the decision makers.

At present the process and criteria applied in the allocation of budget in DAWA are as follows (Agriculture Western Australia, 1997). The agency's budget working group rely on several assessment criteria. Industry program managers (PM) are informed about these criteria and judgments about desirable funds allocation. In formulating such judgments the PMs are provided with some key questions to justify their budget bid. The questions are mainly related to the issues of market failure, competitive advantage, government's commitments, agency's objectives, contribution to the State's economy, and productivity gains.

Based on responses to these questions and on several discussions with the PMs two broad principles are used by the working group in recommending budget allocation. The principles are *precedence* and *strategic merits*.

In the principle of precedence, the previous year's budget allocation is used as a guide for the current allocation. In the principle of strategic merit the PMs' budget bids are assessed to ensure that they are consistent with the strategic plan of each program and are consistent with the agency's broad strategic directions. However, wherever necessary strategic merit is supported or restricted by the consideration of: (a) legislative, contractual, and tied obligations; (b) community services obligations; (c) ministerial imperatives; and (d) equity issues.

Although rigorous in process, the current practice does not consider the competitive budget bids in an objective manner with respect to multiple criteria and multiple stakeholders in a participative environment. This paper presents a budget allocation process which addresses this gap. Our process considers multiple conflicting criteria of agency and program in an explicit way via an interactive computer based system called ALLOCATE. It also allocates the budget with respect to various wants and demands of the multiple stakeholders following a structured group decision process called Decision Conferencing (Quaddus *et al.* 1992; Quaddus and Siddique, 2001). We apply this process of budget allocation in the Horticulture Program of the Department of Agriculture Western Australia.

In the next several sections we first describe the ALLOCATE model. The group decision process called Decision Conferencing for the Horticulture program is then described which uses the ALLOCATE system as the backbone. The results of budget allocation in the Horticulture program are presented next. Finally, conclusions are presented.

2. The ALLOCATE Model

The ALLOCATE model is essentially a Multiple Attribute Decision Modelling (MADM) type benefit-cost model (Hwang and Yoon, 1981). It emphasizes a widely known process, called Decision Conferencing (Quaddus *et al.* 1992; Quaddus and Siddique, 2001) to develop the model structure. ALLOCATE uses a hierarchical structure to develop the model by interacting with the DMs. Although hierarchical structure is most popular in MADM, there is a general lack of agreement on the exact form of hierarchical representation in the MADM literature (Belton, 1985, 1990). Figure 1 shows the hierarchical structure used in the ALLOCATE model.

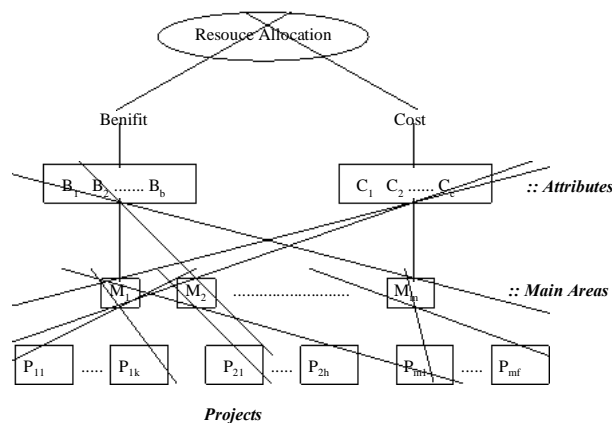


Figure 1. Hierarchical Structure of the ALLOCATE Model.

It is observed from Figure 1 that the global attributes of the ALLOCATE model are benefit and cost, which are then sub-categorised into specific benefit and cost type attributes. The projects are grouped into various main areas. Depending on the problem domain these main areas could be manufacturing, human resources etc. ALLOCATE uses a simple value elicitation approach. It also uses a simple additive model of MADM. Mathematical model of the above hierarchical structure is as follows:

$$\text{Maximise}[\text{Satisfaction}\{V_i(\bar{B}), V_i(\bar{C})\}]$$

$$i \in p$$

$$\text{Subject to } V_i(\bar{B}) = \sum_B W_{MB} W_{B^j}^P P_{iM}^B$$

$$V_i(\bar{C}) = \sum_C W_{MC} W_{C^j}^P P_{iM}^C$$

Where, p = number of projects
 $B \subset \bar{B}$ = set of benefits attributes

$C \subset \bar{C}$ = set of costs attributes (one of which is the \$cost)

$M \subset \bar{M}$ = set of main areas

$V_i(\cdot)$ = additive value function for project i

W_j = normalised swing weight of attribute j (benefit or cost)

W_{Mj} = normalised swing weight of the main area M with respect to the attribute j (benefit or cost); and

P_{iM}^j = preference score for project i w. r. t. attribute j within the main area M

It is observed from the above model that Decision Maker's (DM's) "satisfaction" with respect to the benefit and cost values is maximized over all the projects. This is done by displaying the efficient frontier and extensively interacting with the participating DMs. It is also noted that the value functions are additive in nature. Stepwise procedure of the ALLOCATE system of resource allocation is as follows:

Step 1. Problem structuring:

The ALLOCATE tree is developed.

Step 2. Project preference scoring:

P_{iM}^j scores are obtained by interacting with the stakeholders.

Step 3. Determining the weights W_{Mj} :

These are called "within" weights, i.e. within each of the benefit or cost criterion j . Found by interacting with the stakeholders.

Step 4. Determining the weights W_j :

These are called "between" weights, i.e. between the criteria j (benefit or cost). Found by interacting with the stakeholders.

Step 5. Finding the satisfactory solution:

The efficient frontier is explored in an interactive way. Both graphical and text displays are used as required.

2.1 The Decision Conference for Budget Allocation

Decision Conferencing (DC) is characterised by a problem solving environment which recognises that it is always a top level *group* in the organisation that makes decisions based on judgment – in particular uncertainty, preference, and trade-off (Phillips, 1989; Quaddus *et al.* 1992). As budget allocation must deal with uncertainty, preferences of the stakeholders and trade-off, DC is an appropriate process in this domain. In DC, the owners of the budget allocation problem participate in a single day problem-solving session that features on the spot computer modelling, aided by a facilitator and an analyst. The analyst uses a computer and appropriate software to build models and capture information. In the budget allocation process for the Horticulture program the ALLOCATE software is used. The facilitator works directly with the group to help it to structure and focus discussions, to think creatively about the problem, and to address the full range of issues involved. Information technology supports the activities of the DC by enhancing the efficiency of information flow and transfer.

Although every decision conference is different, the process consists of some common broad stages. These are: (i) structuring the problem; (ii) assessing the parameter; (iii) running the sensitivity analyses; and (iv) planning the implementation (Phillips, 1989). The decision conference for the budget allocation process was carried out as detailed below. It is noted that another software called EXPERT CHOICE was used primarily for benefit assessment (Expert Choice Inc., 1995).

Pre-conference Stage

- (i) Identify the stakeholder group from the Horticulture program.
- (ii) Identify the projects for budget allocation.
- (iii) Collect data via survey to assess project benefit; and

- (iv) Assess the project benefits by EXPERT CHOICE software, for each individual stakeholder and also for the group.

Decision Conference

- (i) Revisit the group benefit assessment by survey and fine tune the pairwise comparison data in a face-to-face environment.
- (ii) Recalculate the project benefit for the group and perform a range of sensitivity analyses.
- (iii) Find the final benefit ranking for the projects to be used in the ALLOCATE model.
- (iv) Populate the ALLOCATE system with cost and benefit data as obtained from above; and
- (v) Allocate budget as suggested by the system and as chosen by the group. Perform sensitivity analyses to achieve the final budget allocation.

3. Results of Budget Allocation

This section presents results of budget allocation exercise for projects in the Horticulture program of the Department of Agriculture WA. Both the pre-conference and the decision conference stages are described in details. It is noted that the pre-conference stage was dominated by the questionnaire-based survey to collect relevant data to assess the project benefits. The decision conference stage then fine tuned this data and dealt with the actual budget allocation in a group environment.

3.1 Assessment of Benefit

To assess the project benefits, a hierarchy of objectives has been developed from various Horticulture documents. Figure 2 shows this hierarchy. Level 1 of the hierarchy contains the program goal, which is: “A profitable, sustainable and growing industry supplying safe quality products to domestic and world markets”. To attain this goal the Horticulture Program has to achieve a number of specific objectives, which are shown in level 2.

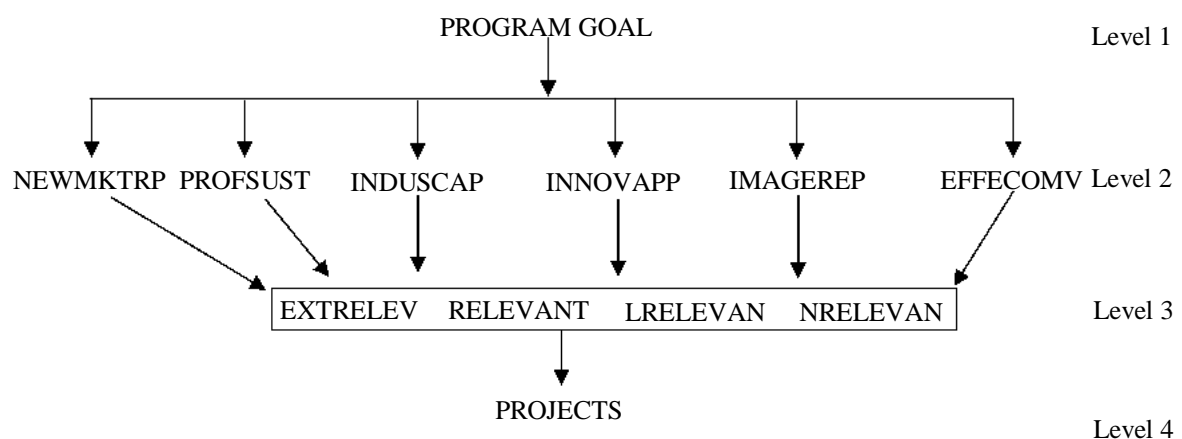


Figure 2. The horticulture program hierarchy of objectives.

Level 3 of the hierarchy provides the intensities (in terms of *extremely relevant*, *relevant*, etc.) that have been used to evaluate the degree of relevance of the various projects in achieving the program objectives. Level 4 shows the actual projects (25 of them).

Two questionnaires were developed based on the above hierarchy: (i) to **assess the importance or priority weights** of the objectives at level 2 and the intensities at level 3 of the hierarchy; and (ii) to **rank the projects** based on the degree of relevance of each project with respect to the objectives of level 2. The questionnaires were distributed to all the relevant stakeholders of the Horticulture program with detailed instructions to fill them up. Five responses were received by the deadline.

Table 1 presents comparative results of the **relative priority** of the objectives based on the survey, which have been obtained by using the software EXPERT CHOICE. All these values are in between zero and one (0 – 1). The first five columns present the individual responses. The second last column presents the average of the five responses. It is observed that the individual responses vary widely, which is expected. Last row of Table 1 shows the inconsistency ratio of assessment. This ratio indicates the degree of inconsistencies of each respondent in the pairwise assessment of the objectives. In general, if an object A is preferred to B, and B is preferred to C, then one should prefer A to C. Any violation of this indicates inconsistency. EXPERT CHOICE provides a measure of the level of inconsistency in the assessment. One should always expect some level of inconsistency in his/her assessments. But this must be less than 0.1. It is observed from Table 1 that all the inconsistency ratios are less than 0.1. However, respondent 3 has an inconsistency ratio of 0, which is unusual! The relative priority of this respondent is also doubtful! The last column, called Group, will be addressed later.

Table 2 presents the ratings of the projects as obtained from the survey. All the values in this table are in between zero and one (0–1). Note that these ratings indicate the relevance of the projects with respect to the objectives of Table 1 (see also at level 2 in Figure 2 above). As before the ratings by different individuals vary

widely. The second last column also shows the average of the five respondents.

3.2 Re-assessment in Decision Conference

The entire assessment process of the hierarchy of Figure 2 was revisited during the decision conference. A group of seven stakeholders participated in the decision conference. Since the group had already gone through the assessment via survey they were more focussed in revising/fine-tuning the assessments. Considerable time was devoted in this part of the decision conference. The group debated various issues, which primarily dominated by the meaning of various objectives of Figure 2. Sometimes the group struggled for meaning and assessment of some objectives. After much discussion the group came up with the required assessment. The last column in Table 1 shows the group consensus assessment for the objectives. Note that the group decided to give a very low priority for the EFFECINV (i.e. to maximise effectiveness of program investment) objective. The group rating of projects is shown in the last column of Table 2. Note that the group ratings are quite different from any other ratings. In fact, the group moved up the ratings of many projects during the assessment process.

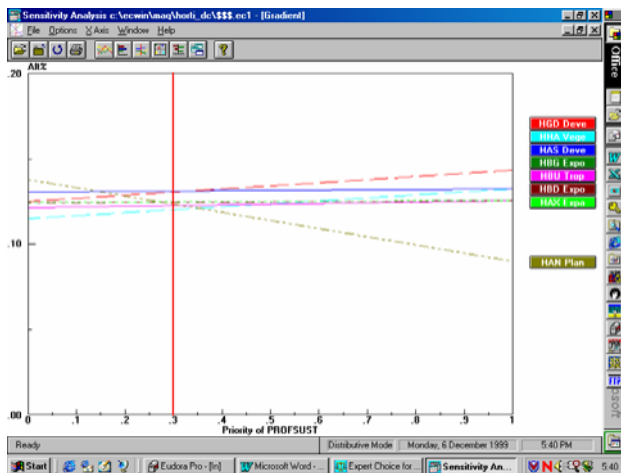
The group rating of Table 2 (last column) was used as the assessment of benefits of the projects in the next phase of the decision conference, ie budget allocation. However, before moving on to the next phase some sensitivity analysis of the projects ratings were done. In order to do that the top eight projects from Table 2 (group column) were chosen. Figure 3 shows one such sensitivity graph. It shows the sensitivity of PROFSUST objective (highest group priority) with respect to the eight projects. With its current priority of 0.301 the HAS project (Develop low input wine...) is rated first. If this priority is decreased, there is no change in the rating, unless it becomes less than 0.15 (approximately). However, if it is increased beyond 0.375 a new project (HGD Developing the Cotton Ind ...) is rated first. Therefore, for PROFSUST objective there is a range of 0.15 to 0.375 between which the ratings of the projects do not change. This is a very valuable information. Sensitivity analysis, like this, can be done for all the objectives.

Table 1. Relative priority of the objectives

Objectives	1	2	3	4	5	Ave 1-5	Group
NEWMKTRP	0.238	0.277	0.200	0.086	0.117	0.180	0.194
PROFSUST	0.179	0.266	0.200	0.430	0.233	0.272	0.301
INDUSCAP	0.123	0.176	0.200	0.238	0.235	0.204	0.135
INNOVAPP	0.101	0.101	0.200	0.033	0.143	0.105	0.129
IMAGEREP	0.090	0.116	0.100	0.174	0.144	0.132	0.220
EFFECINV	0.270	0.064	0.100	0.038	0.138	0.107	0.021
Inconsistency	0.07	0.01	0	0.09	0.09	0.01	0.02

Table 2. Ratings of the projects

Projects	Resp 1	Resp 2	Resp 3	Resp 4	Resp 5	Ave 1-5	Group
1. HBC: Developing an Internationally Competitive WA Potato Industry	0.645	0.345	0.632	0.756	0.250	0.502	0.525
2. HBD: Export Root Vegetables	0.645	0.376	0.519	0.713	0.270	0.546	0.626
3. HBG: Export Development of Brassicas	0.645	0.321	0.519	0.588	0.362	0.514	0.618
4. HHA: Vegetable Industry Development	0.645	0.321	0.607	0.553	0.345	0.515	0.607
5. HAJ: Stable Fly Management	0.193	0.145	0.330	0.257	0.097	0.214	0.442
6. HAK: Sustainable Horticulture on Swan Coastal Plain	0.594	0.276	0.440	0.409	0.728	0.527	0.604
7. HCA: Sustainable Management of Horticulture Pests	0.594	0.329	0.632	0.592	0.253	0.519	0.525
8. HAM: Pot Plant and Amenity Plant Development	0.687	0.367	0.386	0.541	0.227	0.406	0.571
9. HAN: Plant Selection and Breeding	0.687	0.419	0.372	0.802	0.352	0.513	0.623
10. HAP: Floriculture Industry Development	0.539	0.257	0.519	0.692	0.168	0.414	0.543
11. HAR: Develop Quality Control Systems for Wine	0.559	0.363	0.424	0.851	0.092	0.465	0.578
12. HAS: Develop Low Input Wine Grape Production Systems	0.369	0.376	0.745	0.981	0.283	0.554	0.661
13. HBO: Fruit Breeding	0.682	0.293	0.580	0.866	0.270	0.536	0.573
14. HBX: Regional Sustainable Resource Development	0.388	0.321	0.416	0.484	0.221	0.377	0.463
15. HHB: Horticulture Protection Initiatives	0.208	0.367	0.443	0.470	0.475	0.405	0.578
16. HBU: Tropical Fruit Development	0.510	0.333	0.406	0.492	0.092	0.342	0.618
17. HBV: Developing New Fruit Industries in WA	0.524	0.333	0.607	0.460	0.158	0.430	0.546
18. NAN: Developing the Sugar Industry	0.281	0.323	0.413	0.668	0.370	0.411	0.473
19. HGD: Developing the Cotton Industry	0.397	0.624	0.413	0.679	0.490	0.545	0.657
20. HAW: Improve Strawberry Quality	0.523	0.351	0.769	0.541	0.495	0.573	0.575
21. HAX: Expand Table Grape Industry	0.718	0.351	0.467	0.763	0.370	0.572	0.627
22. HBK: Summer Fruit Industry Development	0.349	0.387	0.494	0.702	0.144	0.438	0.590
23. HBP: Pome Fruit Industry Development	0.594	0.321	0.494	0.668	0.182	0.445	0.565
24. HBQ: Citrus Industry Development	0.594	0.321	0.494	0.553	0.192	0.425	0.587
25. HBW: Strategic Market Information	0.706	0.278	0.457	0.333	0.141	0.381	0.448



3.3 Budget Allocation

The budget allocation process began during the second half of the decision conference. The ALLOCATE software was used for budget allocation. Budget allocation model needs the dollar value of cost and benefit of each project. The group rating of the projects (last column of Table 2) was taken as the benefits of the projects and actual value of cost was taken from the Horticulture program log frame summaries. The ALLOCATE system was populated with these costs and benefits data. Various displays were then presented to the group for discussions, comments and changes, if necessary.

The group was specially alerted of the fact that for some projects the cost is extremely high compared to the benefit. The group was then presented with the “order of buy” display from the ALLOCATE software, which is shown in Figure 4.

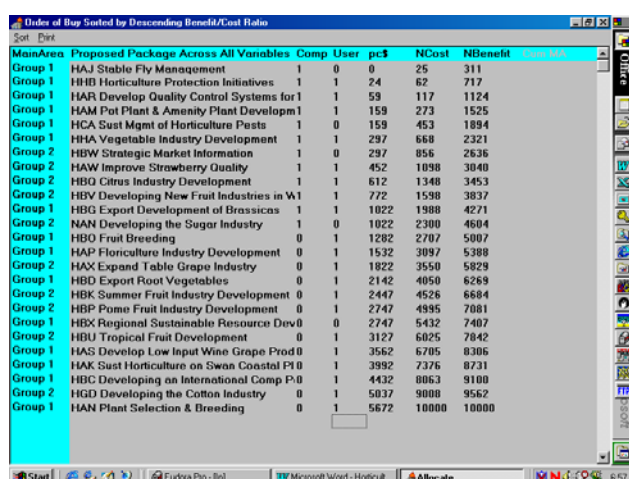


Figure 4. The order of buy.

Figure 4 is an important display. The first column shows two groups of projects, which were arbitrarily created to keep the list of projects manageable within each group. The column “Comp” presents the computer

chosen projects, where the relative benefit is more than the relative cost. The next column “User” presents an opportunity for the group to select any project they like. In this case, the group chose to select the top 20 highest benefit projects. Next column shows the total \$cost for these 20 projects, which is \$5.672 million. Note that total cost to do all the projects is \$6.403 million. The last two columns show the normalised total cost and total benefit (normalised to sum to 10000). Normalisation is done by converting both costs and benefits into a common unit of measurement. These normalised values are needed for equitable comparisons. Using this “order of buy” table the group can make the ultimate decision for project selection and budget allocation. The group can use the model prescribed projects as guide for ultimate selection of projects due to other political and non-quantifiable reasons.

After selecting the 20 top projects from Figure 4 the group was provided with the efficient graph as shown in Figure 5. This graph shows how good is the user chosen package of projects. Each dot in the figure represents a package of projects which can be displayed by clicking the corresponding dot. The dotted line running from the bottom left hand corner to the top right hand corner represents the efficient line. Any dot below this line represents an inefficient package of projects. For example, the group-selected package of projects in Figure 4 is shown by the 3rd top dot in Figure 5, which is below the dotted line. This package is inefficient as we can move up towards the dotted line and choose a package which costs the same but gives more benefit (e.g. second dot from top). Or we can move left and choose a package which will give the same benefit but will cost less (e.g. 5th dot from top).

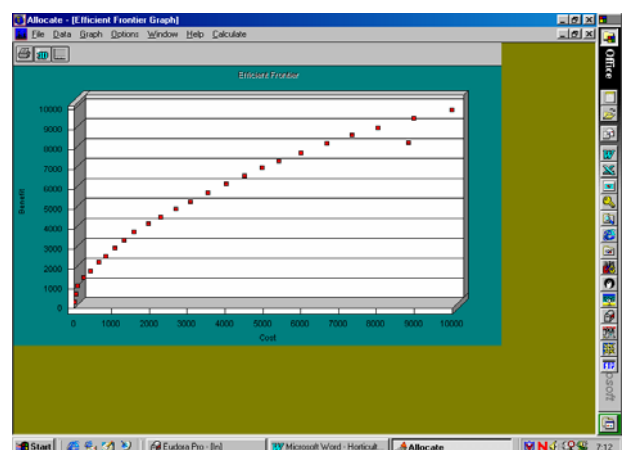


Figure 5. The efficient graph of projects.

The group can move between Figures 4 and 5 a number of times until they are completely satisfied.

In this decision conference the group investigated a number of project packages including the top five projects (fell in the efficient line), the bottom five projects (fell in the inefficient region), and the middle

five projects (fell in the inefficient region). This was an eye opener for the group. The group then wanted to populate the ALLOCATE software with the average 1-5 benefits from Table 2. This was done and results similar to above were obtained, although the project packages were different.

The decision conference was concluded with further discussions on how the EXPERT CHOICE and LLOCATE system can be used effectively for future budget allocation in the horticulture program.

4. Conclusions

This paper presents a process of budget allocation in the Horticulture program of the Department of Agriculture WA. Based on the notion of Decision Conference the process uses an ALLOCATE model for the budget allocation. The ALLOCATE model and the Decision Conference process for budget allocation is described in details.

The Decision Conferencing approach to budget allocation offers a number of benefits to the Horticulture Program. The ALLOCATE model prescribes an efficient allocation of the budget. The budget allocation will thus provide an insight into the Horticulture projects and can be used as a vehicle for any future negotiation with the Government for funding. The ALLOCATION model offers different scenarios of efficient projects and the corresponding budget, which can be used for forward planning and negotiation with the external agencies.

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An Exploratory Study of the Relationship among the High-level Management's Security Awareness, Organizational Information Security Activities, and the Execution Level of Organizational Information Security

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Abstract

As the issue of information security becomes increasingly important, high-level management security awareness on operation of organizational information security activities is a significant factor in success. Hence, the aim of this research is to explore how the organizational information security activities are being influenced by high-level management security awareness, and to use information security standard BS7799 to evaluate the execution phase of organizational information security. Combining literature research, case study and the main security codes of BS7799, this paper proposes a conceptual model of high-level management security awareness, organizational information security activities and organizational information security standard in relation to each other. In our conclusion, we discovered that the higher the high-level management security awareness cognizance about industry risks, the implementation of security measures and the threats to organizational security not only facilitate the four information security activities of deterrence, prevention, detection and recovery, they also enhance the standard of organizational information security. In practice, the conclusion of this paper hopes to remind high-level management to be aware of the threats of human factors and also to strengthen risk evaluation and deterrence activity.

Keywords : Information security, safety awareness, BS7799, case study.

(I) Introduction

The trend in the introduction of information security is reaching the mature stage overseas, but it is just at the starting stage within the country. In recent years, the rapid change in computer virus variety, the invasions by unavoidable hackers, the event of the 9/11 terrorist attack and the inferno at the Eastern Science-based Park altogether induced domestic security awareness. Nonetheless, Baskerville & Stage (1996) mentioned that information security management was an important but often ignored issue, and it was often restricted by the discussion of the information technology development

viewpoint and was rarely discussed through the management viewpoint.

BS7799 stated that one of the significant success factors in information security introduction was the support by high-level management, but there are not many high-level managers in Taiwan corporations who really understand information security, and people within the industry are biased toward sales and not on resolving projects; these are the obstacles to the information security environment. High-level managers usually do not have sufficient cognizance about information security, although they do spend a lot of money and manpower to purchase related security products like fire-prevention walls, invasion detection, computer virus protection, but they do not effectively resolve a variety of security loopholes and threats of hacker invasion. Consequently, high-level management's security awareness can influence the implementation of information security activities within the whole organization.

The full name for 「BS7799」 is 「BS7799 Code of Practice for Information Security」. It was proposed by a U.K. standard institution called BSI in 1995 and is currently the most well known security standard internationally. BS7799 is a set of fairly complex information security application and provides a complete set of policies, procedures, implementations and organizational structures as a reasonable safeguard to corporations in order to reach their corporation goals as well as to avoid, detect or correct the aftermath of unanticipated events. To combine all above mentioned points, the main aims of this research are as follows :

1. To understand what is the current security awareness of high-level management in high technology industry and how high-level management's security awareness influences the implementation of the four types of information security activities, deterrence, prevention, detection and recovery.

2. Through the use of BS7799-2 : 1999 to proceed with analysis of differences in the execution phase of information security and to understand the deficiencies in information security activities within the current high technology industry.

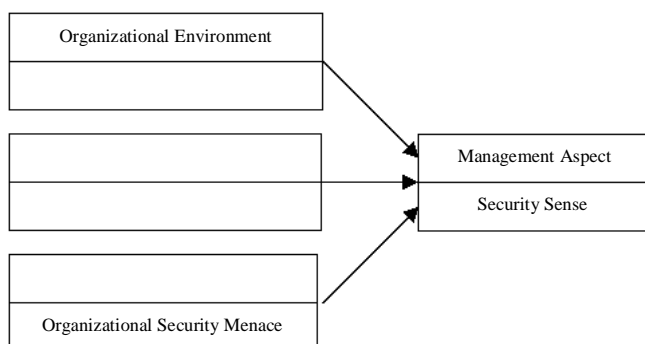
3. To propose a set of conceptual models to assist high technology industry in conducting information security activities.

(II) Literature Research

(i) High-management security awareness

Atreyi et al. [1] stated that although information security was becoming an important management issue, the industry did not attach importance to this in practice. Management's concern in information security was always lower than other issues (Brancheau, Janz & Wetherbe, 1996; Olnes, 1994). Verton (2002) did survey 459 CIO's and IT managers of medium and large corporations comprehensively about information security and discovered that less than 50% of their employees had IT security education and training within the company, indicating that high-level management in medium and large corporations attached low importance to information security. In addition, Zviran & Haga (1999) pointed out that high-level management did not give sufficient concern to information security, which could lead to serious invasion of information systems. The lack of concern by high-level management to information security might even influence the establishment of a corporation.

Goodhue & Straub [2] were the first researchers to apply the satisfaction level theory to cognizance of information security and proposed that the organizational environment, information system environment and individual characteristics could influence users to pay attention to the importance of security. Straub & Welke [3] improved Goodhue & Straub's Security Concern Model to become industry risk, risk reduction in security control measures and individual factors, which could influence high-level management's cognizance regarding information security.



Drawing 1 : High-level management Security Concern Model

(ii) Organizational Information Security Activity

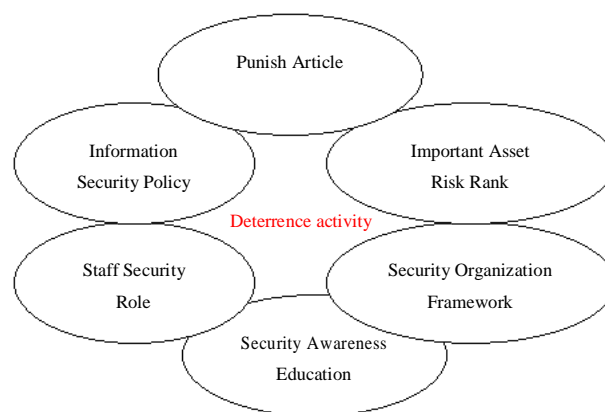
Based on the General Deterrence Theory, scholars (Forcht 1994; Martin 1973; Parker 1981) proposed four different types of sequential security activities, which

could reduce information systemic risk. These four activities are : deterrence, prevention, detection and recovery.

Blumstein et al. (1978) wrote that the deterrence theory provided disincentives or restricted the occurrence of abnormal behaviors and also provided restrictions by deterring potential perpetrators. Furthermore, Straub and his research partners successfully applied deterrence theory to informational system environment. Straub (1998) mentioned that information security activities could deter potential computer hackers who stealthily or overtly violate organizational policies.

Respective explanations of these four activities are as follows :

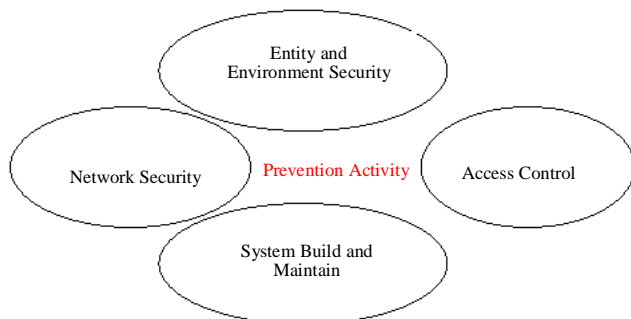
1. Deterrence activity : Blumstein et al. (1978) wrote that deterrence activity might cause potential hackers to understand the risk of penalty. Parker (1981, 1983) pointed out that deterrence activity should include : security policy and clauses to reduce the invasion by white-collar people. Dunn (1982) also mentioned that deterrence activity should clearly explain how to use information system legally and to reduce potential hackers' perpetration motives. Straub (1990) stated that deterrence activity in practice should include : input of security man-power and time, reasonable system usage guidelines and clauses for system usage. Straub (1988) also wrote that security awareness education was a type of deterrence activity. The following drawing partially summarizes the above-mentioned details:



Drawing 2 : Deterrence Activity (sorted by this research)

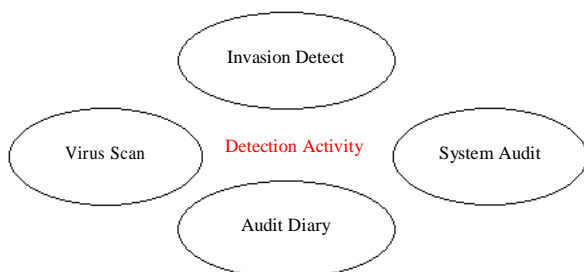
2. Prevention Activity : Gopal & Sander (1992, 1997) wrote that prevention activity was mainly a proactive security control measure, including implementation of information security policy and prevention of invasion or intentional abusive usage by unauthorized people. Hsaio et al. (1979) stated that prevention activity should include : physical security and security software (e.g. password protection). Straub (1998) also mentioned that implementing door control system and password saving

and extraction control system for the computer room was also considered as prevention activity. Atreyi et al. [1] believed that operating system and database management including security functions and even the use of special security software could all prevent the risk information system from being invaded. The prevention activity can be categorized into the following parts :



Drawing 3 : Prevention Activity (sorted by this research)

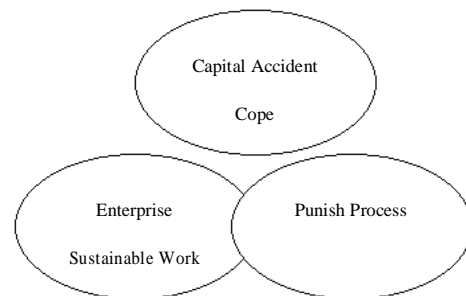
3. Detection Activity : Detection activity is mainly for collection of invasion records and also to identify potential perpetrators. Straub & Nance (1987) wrote that only few invasion events were discovered by a pre-emptive type of detection activity because detection activity was more like fishing expeditions and could not successfully lock in on a target. However, Nance & Straub [10] also stated that relying only on two activities of deterrence and prevention could not totally avoid the occurrence of invasion events, organization also required detection activity to detect invasion before its occurrence. Straub (1998) indicated that detection activity could include two types : a pre-emptive type of security response and a reactive type of security response. The pre-emptive type of security response is to detect potential problems (risks) preemptively prior to their occurrences, examples of pre-emptive detection are invasion detection reports, system auditing, virus scan reports. Reactive type of security response is to proceed with detection through security invasion records after the event. The following is a brief summary of detection activity :



Drawing 4 : Detection Activity (sorted by this research)

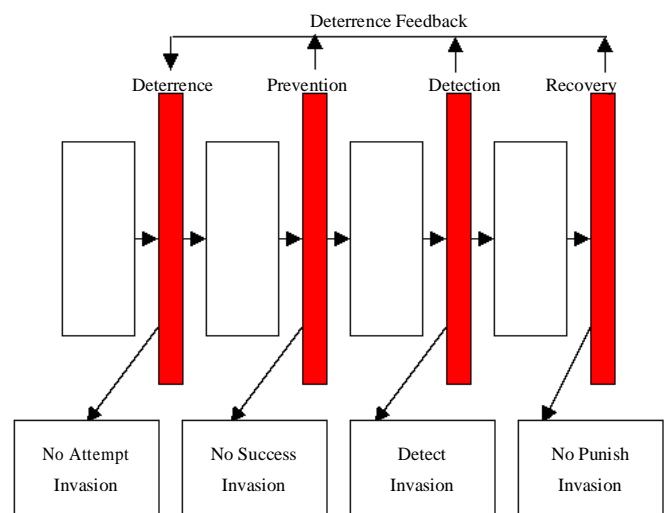
4. Recovery Activity : Straub (1998) stated that the majority of top-managers were rarely concerned about how to recover after security was invaded and the system

was damaged leading to unsalvageable corporation loss. In fact, other than deterrence, prevention and detection, effective security procedures needs to include recovery activity to reduce damages caused by invasion activity so that corporations can recover their operations at the shortest time period and also to punish perpetrators. Recovery activity is summarized below :



Drawing 5 : Recovery activity (sorted by this research)

According to deterrence theory, Straub (1998) stated that the combination of these four security activities could have continuous future deterrence effects. The integration of these four activities is as follows :



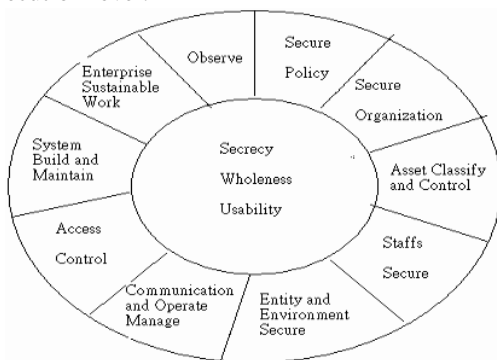
Drawing 6 : The process of four security activities (sorted by this research)

(iii) Evaluation of Information Security Execution

NIST in the U.S. announced the self-evaluation guide on the information security management system in 2001 and requested using the Risk Based Decision Mode as a basis for secrecy, wholeness, undeniability, regularity and usability of the information industry for self-evaluation. In our country, "the Electronic Information Management

Center within the Directorate General of Budget Accounting and Statistic Executive Yuan, R.O.C.” also announced “self-evaluation form for external auditing on information security” to assist corporations in understanding the facts in executing information security management system and can be used as a reference for improvement.

BS7799 includes two parts, Part 1 : Practical criteria for information security management and Part 2 : Standard for information security management system. Because BS7799 Part 2 explained in detail the requirement for establishment, implementation and maintenance of information security system, pointed out that organizations need to follow one type of risk evaluation for the most appropriate control items, and also used the appropriate control items for their own needs, we will use BS 7799-2 to analyze the differences in the execution phase of information security in order to understand an individual company's current information security execution level.



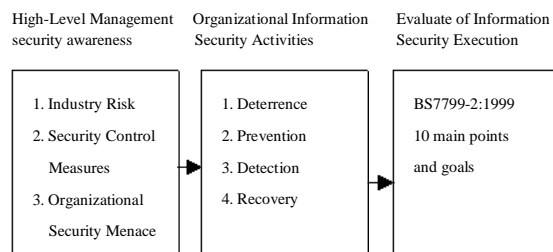
Drawing 7 : 10 main points and goals of BS7799
(sorted by this research)

(III) Conceptual Model and Research Method

(i) Conceptual model

Similar to the literature research discussed previously, Straub (1998) stated that if organizations implemented those four security activities, they could effectively deter potential hackers and reduce invasion risks for organizations. In addition, Straub (1998) also mentioned that if high-level management executed these four security activities, this would effectively reduce systemic risk. Hence, the level of high-level management cognizance and security awareness about industry risk, security control measures and threats to an organizational can influence the execution of information security activities and can even influence organizational information security standard. R.Von Solms et al. [6] also wrote that through BS7799, high-level management could evaluate the information security execution phase to adjust the deficiencies in organizational information security activities in order to meet legal standards,

industry standards, customer requirements, supplier requirements and the requirements of anyone who is related to corporation profits. Through literature research, we proposed a conceptual model to evaluate high-level management security awareness, organizational information security activities and organizational information security execution.



Drawing 8 : This research paper's conceptual model

As indicated in drawing 8, Straub (1998) mentioned that high-level management's security awareness and cognizance about industry risk, implementation of security measures and threats to organizational security could lead to differences in organizational activities of deterrence, prevention, detection and recovery. Consequently, we believe that high-level management security awareness affects organizational information security activities. Solms & Haar (1994) wrote that organizational information security control measures could use international security evaluation standards to understand the execution level of organizational information security. Because BS7799 is an internationally well known security standard, we believe that BS7799-2 : 1999 can be used on organizations' deterrence, prevention, detection and recovery activities to proceed with the differential analysis on information security execution phase and to understand the differences between an organizations' four information security activities and the basic standard.

(ii) Creation of Assumptions

Through the modification of variables in the conceptual model, various assumptions were made in this research. Assumptions are categorized into two main parts : The first part is assumption between the relation of high-level management's security awareness and organizational information security activities. The second part is assumption between the relation of organizational information security activities and evaluation of information security execution phase.

Assumption 1 : When high-level management's understanding is higher with respect to the cognizance on industry risk, implementation of security measures and threats to organizational security, organizations can do better on the four information security activities of deterrence, prevention, detection and recovery.

Assumption 2 : When high-level management is being influenced by other external factors, they cannot do as well for those four information security activities.

Assumption 3 : Organizations pay more attention to prevention activities than other activities of deterrence, detection and recovery.

Assumption 4 : As organizations' information security activities of deterrence, prevention, detection and recovery are being actually executed, they can better conform to the information security standard of BS7799-2 : 1999.

(iii) Research Method

This research paper uses various case studies to solve research problems, mainly directed to : factors that influence high-level management security awareness(Why), how high-level management security awareness affect the c of organizational information security activities(How) and investigation about what is used to evaluate organizational information security execution phase(What). Further analysis through interviews and other literature are conducted to investigate the execution phase of information security in the current high technology industry.

Case study is a form of empirical inquiry for investigation, Yin (1994) wrote that when research objects and actual situations were not very distinctive, using case study to solve "How" and "Why" types of research problems and through multi-varied evidence sources could emphasize the object events for research purposes. Because case study conforms to our research aim, we will use case study to solve research problems.

(IV) Analysis Individual Cases

I Individual case findings

Our method to choose cases is as follows : 1.Choose higher information density within high technology industries; 2. Industry members who agree to accommodate us by having interview visits. Data collected conforms to points raised by Yin(1994) : (1) Using multi-varied evidence sources with two or more sources to obtain evidence; (2) Establish a database for individual cases to formally assemble together all the collected data from interview visits; (3) Connect all relevant evidences and connect research problems, data from interview visits and verified conclusions together.

Table 1 : Basic data for individual cases

Individual Case Name	Industry	capitalis_ation	Overseas Subsidiary Location	Staffs population	Execution IS Initial Time	co-opera tive enterprise
X Company	Informat_ion	700 million	USA .	1300 .	1979/8	Trend Symantec Sysware
Y Company	Photoele_ctic Tec_ hnology	680 million	China .	1100 .	1999	Trend An Yi Accounting Services Company

This research paper analyzed the interview results of system development engineers from Company X and the MIS departmental head of c Y as well as these two companies' information, together with other information security management literature were analyzed. The conclusions of analysis are discussed below.

(i)The Security Awareness of High-level Management

Comparison was conducted based on "cognizance of industry risk", "security measured implemented" and "threats to organizational security" (shown in Table 2), it was discovered that high-level management's security awareness performance from Company X is not only affected by security events within the same industry, this company also pays attention to the importance of human factor threats; although the organization does not conduct risk evaluation, this company has an IT background, so it believes that it is more likely to be influenced by mainframe computer loopholes and copyright issues, hence the security measures are biased toward the technological side. The security awareness of high-level management within Company Y is not influenced by events within the same industry, it would strengthen security phase only through client requests. Because high-level managers do not have IT backgrounds, they need to be informed by employees from lower levels to know basically that the organization is affected by copyright issues, hacker invasions and other human and non-human factors. When faced with security problems, they should authorize lower level employees to solve problems, hence this company is also biased toward the technological side. In comparison, the security awareness of high-level management from Company X is higher than those from Company Y; furthermore, security awareness is higher if high-level management have IT backgrounds.

Table 2 : Comparison of security awareness between high-level management in individual cases

High-Level Management awareness		X Company	Y Company
	Industry Risk	affected within the same industry, enhance deterrence activity	affected without the same industry, within the customer
	Security Control Measures	biased toward the technological side	biased toward the technological side
	Organizational Security Menace	mainframe computer loopholes and copyright issues, and no risk estimate	copyright issues and hacker invasion, and no risk estimate

In addition, other factors of organizational information security goals, security behavior, serious information security events, security event reports and high-level management's managing methods can be used to understand high-level management's level of security awareness (shown in table 3). For example, high-level management in Company X believes that security is mainly for maintenance of normal organizational operation system, when security events occur managers not only are management involved in managing the event, they also proactively teach employees about the importance of security so they adjust information security

activities based on their experience of previous serious security events. In contrast, although high-level managers in Company Y also believe that the goal of the company's information security is to maintain normal operation of the system and procedures, they normally authorize lower level employees to manage serious security events when they occur, so their support for information security is more passive and their security activities will also be influenced by previous serious security events that occurred. Hence, the other factors listed in the table below can further strengthen the support that high-level management's security awareness in Company X to be higher than that of Company Y.

Table 3 : Comparison of other security awareness factors in individual cases.

	X Company	Y Company
security goals	maintenance of normal operation system	maintain operation of the system and procedures
security behavior	positive attitude	passive attitude
serious IS events	hacker invasion	virus invasion
after events action	prevention and detection	enhance prevention
security event reports and managing methods	management involve	management authorize

(ii) Organizational Information Security Activities

X and Y Companies' information security activities are shown in table 4. Although Company X's deterrence activity does not have a uniform information security policy, its policy does include some provisions about information security and employees understand their own responsibilities in security. Even though there are no information security experts to assist the drive of information security activities, high-level management actively participate in the policy formulation on information security and also regularly educate and train employees on information security. This induces the organization to conduct deterrence activity, indicating that this company pays attention to the importance of information security and can deter intentional or unintentional hackers. In contrast, although there is a uniform information security policy in Company Y, high-level managers only orally support this issue and do not personally drive the matter; the information security education is conducted irregularly depending on the volume of sales. In addition, there is no clear strict penalties in penalty clauses, so their overall performance in deterrence activity is passable.

With respect to prevention activity, although Company X does not have suitable documentation, because high-level managers have IT experience and there are more information technology personnel in the organization, this company tends to apply self-management of information security protection, maintenance or correct versioned security software purchase in the areas of physical security, internet security, saving and extraction control, virus protection

and system development, so its prevention level is very good. In contrast, Company Y has suitable documentation, but because high-level managers do not have IT experience and there are few information technology personnel in the organization, the physical security, Internet security, saving and extraction control and system development tend to be outsourced. The IT personnel only need to conduct simple information security maintenance and management. Hence, the overall performance of Company Y is passable.

Table 4 : Comparison of information security activities between individual cases.

	X Company	Y Company
Deterrence Activity	achieve expect security experts, risk analysis ,policy formulation ,management actively participate	achieve expect security experts, risk analysis, irregularly depending management passively participate
Prevention Activity	have quite level except suitable documentation	although have suitable documentation, but not have quite level
Detection Activity	no detection unit each team member to detect, have inner and outer auditors full use daily	no detection unit have inner and outer auditors few use daily
Recovery Activity	security limit is lower : strict penalties continuous procedures	no security limit no strict penalties procedures irregularly

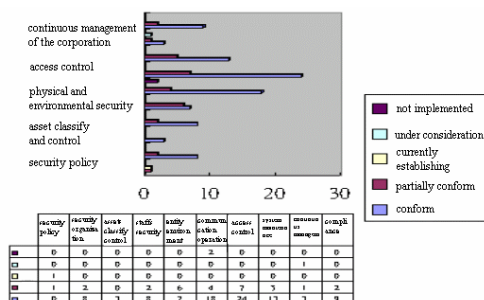
Regarding the detection activity, although Company X does not have a security detection unit, each team member within the organization does his/her best to detect the existence of any undiscovered security invasion and even uses abnormalities reported in auditing diary to find relevant security events. Company auditors will regularly audit to find out whether the company complies with security environment and security measures; and clients will come unannounced to audit the use of working capital by the company. Hence, the overall performance of detection activity in Company X is clearly better. There is no security detection unit in Company Y as well, but invasions are often discovered only after the event. Although there is a security diary to report abnormal security events, it is rarely inspected and reviewed to determine whether any abnormal events are occurring. Because the internal and external auditors in this company are not very familiar with IT, complete and effective audits cannot be achieved. Consequently, the overall performance of detection activity is very poor for Company Y.

Regarding the last activity of recovery, the specified information security limit is lower for Company X; damage recovery is to proceed when that reached is lower than the specified limit . There are rules for strict penalties, but no record of cases about actual penalties being applied. There are regular meetings to review the continuous operation procedures in the organization as well as regular important data about assistance from other sources in case of a serious events occurring, so the overall performance of recovery activity for Company X is fairly good. In Company Y, there is no clear

information security limit, no active execution of strict penalties and only modifications of continuous operation procedures irregularly, so the recovery activity for Company Y is passable.

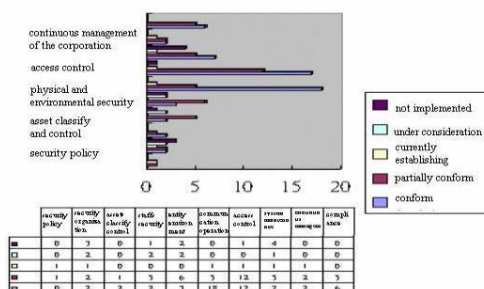
(iii) Evaluation of Execution phase on Information Security

This research paper used the ten main control points in BS7799-2 : 1999 to evaluate whether company X and Y's execution phase of information security conforms to the standard. We used conform, partially conform, currently establishing, under consideration and not implemented to evaluate information security execution phase for both company X and Y, and categorized them into three results : good performance, passable performance and poor performance. These three results are relative concepts and are not absolute.



Drawing 9 : Evaluation of information security execution phase for company X.

It can be seen from drawing 9 that based on the ten controls in BS7799-2 : 1999, company X nearly conforms to all controls, except the security policy and few parts are either currently establishing, under consideration or not implemented. This result supports the performance of those four information security activities mentioned previously. Hence, the information security execution phase for company X is judged to be of good performance.



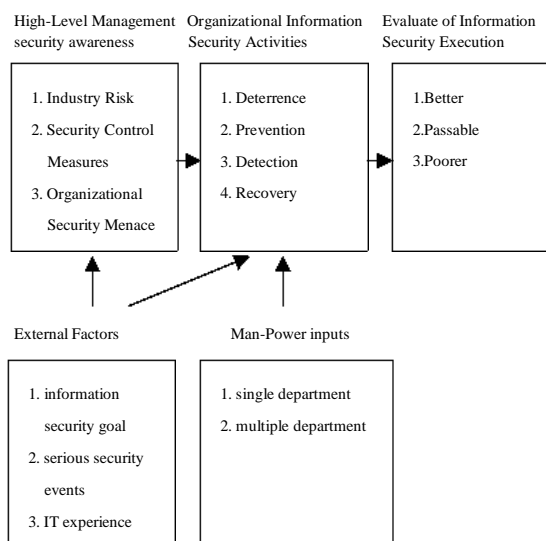
Drawing 10 : Evaluation of information security execution phase for company Y.

It can be seen from drawing 10 that based on the ten controls in BS7799-2 : 1999, company Y conforms to the standard for the following controls : communication and operation management, saving and extraction control, system development and maintenance and compliance.

The rest, for example : security organization, personnel security, physical security, physical and environmental security, saving and extraction control, system development and maintenance and continuous operation management of the corporation, are mainly categorized into the partially conform type.

It appears that the majority of security organizations, physical and environmental security and system maintenance and development are in the not implemented category. Therefore, the overall result of company Y supports the performance of those four information security activities mentioned previously. Hence, the information security execution phase for company Y is judged to be of passable performance.

Based on the above analysis, the former conceptual model is modified (as shown in drawing 11) to understand that the security awareness of high-level management not only influences organizational information security activities, external factors also influence organization information security activities of deterrence, prevention, detection and recovery. Furthermore, adding the man-power input through high-level management information security activities also influence the execution phase of organizational information security.



Drawing 11 : Modified conceptual model .

The following table lists the variables in individual cases :

Table 5 : A list of variables in individual cases

	X Company	Y Company
Industry Risk	Yes	No
Security Control Measures	Widely Understand	Narrowly Understand
Security Menace	Understand	Not Understand
information security goal	fit organization goals	fit organization goals
serious security events	Yes	Yes
IT experience	Yes	No
Security Activities	Deterrence passable others better	Detection passable other poorer
Man-Power inputs	Multiple department	Single department
Evaluate Security Execution	better	passable

II Verification of Assumptions

Our verification result for this research is contained in table 6.

Table 6 : This research's verification result for both company X and Y.

hypothesis	X Company	Y Company
Assumption 1	fit	partial fit
Assumption 2	fit	high-level managers do not have IT backgrounds
Assumption 3	fit	fit
Assumption 4	partial fit	partial fit

(V) Conclusions and Recommendations

This research is mainly to investigate how high-level management security awareness affect the drive for organizational security activities, and ten control points from BS7799-2 : 1999 are used to evaluate the performance in the execution of other information security. Our conclusions are as follows :

1. Through analysis of individual cases for the understanding of organizational information security goal, serious information security events previous occurred and IT experience can influence the bias of organizations for particular information security activities.

2. High-level management with higher security awareness can do better on the four information security activities of deterrence, prevention, detection and recovery with better performance in the execution of information security.

3. Through individual cases to understand slight deficiencies in the performance of deterrence activity in organizations, which appears in corporations with weak information security management.

4. Through individual cases to understand that corporations have a tendency to ignore threats from

human factors. This can be a hidden worry worthy of consideration.

5. Through individual cases to understand that corporations need to strengthen risk evaluation to effectively distinguish sources of threat and severity level in order to assist in the choice of effective security control measures.

Our research follow-up recommendations are listed below :

1. Outsourcing of information security can be investigated to determine how it influences information security management between corporations.

2. We recommend that follow-up research can be directed to discover how organizational information security activities can be improved through humans, technology, policies and procedures and to propose effective improvement methods.

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An Adaptive Two-Phase Spatial Association Rules for RSI Data Mining

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Abstract

Spatial association rule mining is a kind of spatial data mining to carry some interesting and implicit knowledge about spatial associations from spatial databases. Moreover, many excellent studies on Remote Sensed Image (RSI) have been conducted for potential relationships of crop yield. Lee and Chen [13] proposed a two-phase algorithm by creating Histogram Generators for fast generating coarse-grained spatial association rules, and further mining the fine-grained spatial association rules w.r.t the coarse-grained frequently patterns obtained in the first phase. However during the image processing, partitioning the image into parts can improve its efficiency; to this point, the concept of image blocking is incorporated onto the coarse-grained two-phase data mining of spatial association rules. Therefore, an adaptive two-phase spatial association rules mining method is proposed in this paper to improve two-phase method in terms of efficiency. The proposed adaptive method conducts the idea of partition on an image for efficiently quantizing out non-frequent patterns and thus facilitate two-phase process. Such adaptive two-phase approach saves much computations and will be shown by lots of experimental results in the

paper.

Keywords: Spatial Database, Data Mining, Spatial Association Rules, Remote Sensed Image

1. Introduction

Those spatial data, from satellite photos or automated data gathering tool, such as remotely sensed images, local population, and what not have many widely-used sides of application, in many of today's research fields. When storing large amount of either spatial or non-spatial data in the spatial database, the past data gathering tool always emphasizes on how to improve on searching spatial data as well as storage system. However, there is very likely some knowledge or expertise potentially resided in this large amount of acquired data that is not discovered. In this case, it's very important at this moment to find an effective method to acquire this undiscovered knowledge or expertise from such large amount of spatial data and to further analyze for it to be applied on decisions of spatial applications. With the help of spatial data mining, more interesting and useful information are discovered [2][3][4][5][6][7][8] [9][11][12] [13][14][15]. This has, in turn, brought up a new,

very popular field for research today.

The methods in [3][4][5][13][15] for data mining on Remotely Sensed Images (RSI). In [3], the method is to take advantage of the association between reflectance intensities on RSI and crop yield through association rule. But if applying data mining simply on discovering this knowledge from large amount of remotely sensed images, it does not sound very economical considering the time spent and efforts put in. So, designing an effective data mining method is very worthwhile for in-depth research.

More details on methods will be discussed in Section 2. Section 3 presents a method for adaptive two-phase spatial association rules mining. Section 4 verifies the validity of our proposed method through experimentation and discussion. Last section is our conclusion.

2. Literature Reviews

2.1 Association Rules

An association rule [1] is “ $X \rightarrow Y, (s, c)$ ” where X and Y are itemsets with X being the antecedent and Y being the consequent of association rules. In example of the association between population and crop yield, s denotes the degree of support in which it represents the probability that X and Y occurs simultaneously, and c denotes the degree of confidence in which it represents the probability of Y occurrence when X occurs. Therefore, $c = \frac{\text{support}(X \cup Y)}{\text{support}(X)}$. In some

reference, support count = $s \times |D|$, where $|D|$

is the count in data table. Throughout our paper, the support count (*count*) will be taken as the

count of frequent itemsets. Decision makers can pre-define a minimum support count and minimum confidence in order for the elimination of infrequent itemsets and the creation of association rules through frequent itemsets.

2.2 Spatial Data Mining on RSI

Images on RSI can be parted into a couple of different types such as TM, SPOT, AVHRR, and TIFF. Take TM image on RSI as example, TM consists of seven bands which are B for Blue, G for Green, R for Red, RIR for Reflective-Infrared, MIR for Mid -Infrared, TIR for Thermal-Infrared, and MIR2 for Mid-Infrared2 [3][4][5][13][15]. Each band contains a relative reflectance intensity value in the range 0 to 255 for each pixel. One remotely sensed image is associated with yield, in the way which that one yield image is a map that defines agricultural yield standards. It is often shown in color or gray-scaled image. Shown in Figure 1 (a) is a remotely sensed image and Figure 1 (b) is a yield image. Incorporating the association between remotely sensed image and yield, data mining is to excavate the useful expertise that may help the experts or agribusiness people to improve crop cultivation.

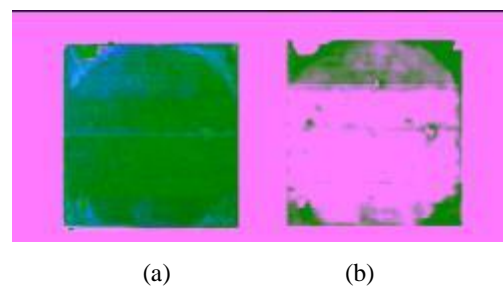


Figure 1: Remotely sensed image and Yield map

2.3 Two-Phase Spatial Association Rules Mining Method

Two-phase association rule architecture for RSI data mining is proposed by Lee and Chen [13]. First, an image from RSI database is acquired. Do a color count and analysis of variance on this image. According to the analysis of image from RSI database, the Histogram Generator (HG) from the user-predefined intervals is generated. HG looks for the most representative characteristic value in an image to quickly find the coarse-grained association rules. From these coarse-grained association rules, fine-grained association rules are found. This method is primarily divided into four steps. First step is color count and analysis of variance on remotely sensed images. Second step is to generate Histogram Generator according to user-predefined intervals. Third step is to mine out the coarse-grained association rules according the user generated HG through algorithm of association rules. Fourth step is to mine out the fine-grained association rules according to the coarse-grained association rules.

3. Adaptive Two-Phase Spatial Association Rules Mining Method

The two-phase data mining of spatial association rules in Section 2.2 can improve the Apriori method in terms of its efficiency. However during the image processing, partitioning the image into parts can improve its efficiency; to this point, the concept of image blocking is incorporated onto the coarse-grained

two-phase data mining of spatial association rules. Image blocking performs the mining on each of the disjoining blocks partitioned from an image. The motive of taking on the image blocking is due to the inter-pixel redundancy in image data [16]. That means, the occurrences of neighboring image points redundancy is quite high; in other words, there is a higher possibility of more frequent itemsets. Therefore, the adaptive two-phase data mining of spatial association rules is to eliminate the blocks which do not produce frequent itemsets to improve its efficiency through image blocking.

3.1. Flowchart of the Adaptive Two-phase Data Mining of Spatial Association Rules

Figure 2 is the flowchart of adaptive two-phase spatial association rules for RSI data mining. Exploration of the frequent itemsets in coarse-grained association rules is made in four main steps. First step is to partition an image. Second step is to produce local frequent itemsets and record local non-frequent itemsets at the same time. Third step is to group each local frequent itemsets into global candidate itemsets. Fourth step is to add together the support count in global candidate itemsets as well as in non-frequent itemsets to be the final support count in global candidate itemsets. When bigger than the minimum support count, a global frequent itemsets is produced. Next sub-section will put more emphasis on each of the four steps.

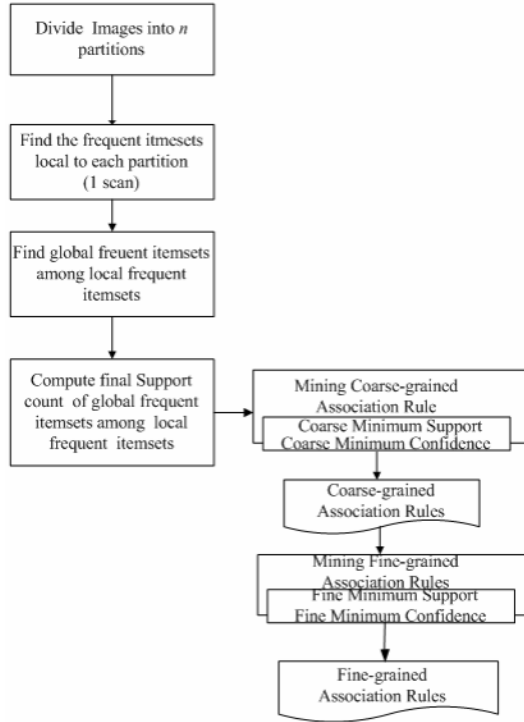


Figure 2. Adaptive two-phase association rule flowchart for RSI data mining

3.2 Procedures of the adaptive two-phase data mining of spatial association rules

Step 1: Partition the image

According to the mined coarse-grained association rules by Histogram Generator proposed by Lee and Chen [5], T^{HG} is the data table through HGs quantization of T^{origin} , which incorporates the RSI and yield images into one data table based on their positions of coordinates. Perform data mining on T^{HG} to explore the coarse-grained association rules. First is to partition into n number of disjoining blocks $\{P^1, P^2, \dots, P^n\}$. Divide the minimum support count by the count in data table T^{HG} . Multiply what's left in the previous calculation by the count in P^i to obtain the minimum support

count in each block ($s_p^c = \frac{s^c}{|T^{HG}|} \times |P^i|$), where

s_p^c is the minimum support count in the block,

$|T^{HG}|$ is the count of data table T^{HG} , s^c is the

minimum support count and $|P^i|$ is the count in the block.

Example 3.1: Table 1 is an image of 8×2 pixels, after which the data table T^{HG} is made from quantization by four HGs on bands R, G, B and Yield, respectively. The image is partitioned into four small blocks ($n=4$) in which block P^1 consists of $\{1, 2, 3, 4\}$, block P^2 of $\{5, 6, 7, 8\}$, block P^3 of $\{9, 10, 11, 12\}$, and block P^4 of $\{13, 14, 15, 16\}$. Whereas minimum support count (s^c) is 10, the minimum support count in

$$\text{each block is } s_p^c = \frac{s^c}{|T^{HG}|} \times |P^1| =$$

$$\frac{s^c}{|T^{HG}|} \times |P^2| = \frac{s^c}{|T^{HG}|} \times |P^3| = \frac{s^c}{|T^{HG}|} \times |P^4| =$$

$$\frac{10}{16} \times 4 = 2.5.$$

Table 1. Four partitioned blocks 8×2 image

data table						
Partition	Id	coordinate	R	G	B	Yield
P^1	1	0,0	3	3	3	3
	2	0,1	0	0	0	3
	3	1,0	3	3	3	3
	4	1,1	3	3	3	3
P^2	5	2,0	3	3	3	3
	6	2,1	0	0	0	3
	7	3,0	0	0	0	3
	8	3,1	1	1	1	3
P^3	9	4,0	3	3	3	3

	10	4,1	3	3	3	3
	11	5,0	3	3	3	3
	12	5,1	3	3	3	3
P^4	13	6,0	3	3	3	3
	14	6,1	3	3	3	3
	15	7,0	3	3	3	3
	16	7,1	3	3	3	3

Step 2: Exploration of local frequent itemsets in each block

Step2.1: Calculate local frequent 1-itemsets

(F_1^i) for each P^i . And each item in local frequent 1-itemsets is represented as $I(band_j^{S_a}, Yield^{S_a'}, count)$ because the itemsets in F_1^i can be represented as an association rule that consists of a antecedent and a consequent. For the association rule by the itemsets I , its antecedent is represented as $I. band_j^{S_a}$ and consequent as $I. Yield^{S_a'}$. $I.count$ is the support count of the itemset. For example, $I(R^0, Yield^1, 5)$ represents the color value of R as 0, the color value of Yield as 1 and the support count equals to 5.

On the other hand, record all the local non-frequent 1-itemsets that are smaller than the minimum support count in the block onto NF_1^i . Similarly, the format of local non-frequent 1-itemsets is $I(band_j^{S_a}, Yield^{S_a'}, count)$, where $I. band_j^{S_a}$ is represented as the antecedent, $I. Yield^{S_a'}$ as the consequent and $I.count$ as the support count of the itemsets.

Step2.2: Assume $\theta_1 \hat{I} F_{i-1}^i$ and $\theta_2 \hat{I} F_{i-1}^i$ where

q_1, q_2 . To produce local frequent 1-itemsets (F_1^i), first step has to consider whether or not $\theta_1.Yield^{S_a'}$ equals to $\theta_2.Yield^{S_a'}$. And if they equal to each other, they are joined together to produce local candidate 1-itemsets (C_1^i). In local candidate 1-itemsets, each format of the itemsets is $I(band_1^{S_{a1}}, band_2^{S_{a2}}, \dots, band_{i-2}^{S_{a_{i-2}}}, band_{i-1}^{S_b}, band_i^{S_g}, Yield^{S_a'}, count)$, of which $I(band_1^{S_{a1}}, band_2^{S_{a2}}, \dots, band_{i-2}^{S_{a_{i-2}}}, band_{i-1}^{S_b}, band_i^{S_g}, Yield^{S_a'}, count)$ is the antecedent, $I. Yield^{S_a'}$ is the consequent and $count$ is the support count. The support count is defined as $\min(q_1.count, q_2.count)$ of these established association rules in the local candidate itemsets. When the support count is larger than the minimum support count in the block, local frequent 1-itemsets (F_1^i) will be produced. local frequent 1-itemsets are formatted as $I(band_1^{S_a}, band_2^{S_a}, \dots, band_i^{S_a}, Yield^{S_a'}, count)$. Similarly, $I. band_1^{S_a}, I. band_2^{S_a}, \dots, I. band_i^{S_a}$ is represented as the antecedent, $I. Yield^{S_a'}$ as the consequent and $I.count$ as the support count of the itemsets. For example, $q_1=(R^0, G^0, Yield^1, 4) \in F_2^i$, $q_2=(R^0, B^0, Yield^1, 3) \in F_2^i$. When $q_1.Yield^1 = q_2.Yield^1$, $I(R^0, G^0, B^0, Yield^1, 3)$ will be produced and support count = $\min(4, 3)$; again when the support count is larger than the

minimum support count in the block, the global frequent itemsets of $I(R^0, G^0, B^0, Yield^1, 3)$ will be produced. The color value of R is 0, of G is 0, of B is 0, of Yield is 1, and the support count is equal to 3.

On the other hand, record all the local non-frequent l-itemsets that are smaller than the minimum support count in the block onto NF_l^i . Similarly, the format of local non-frequent l-itemsets is $I(band_1^{S_a}, band_2^{S_a}, \dots, band_l^{S_a}, Yield^{S_a}, count)$, where $I(band_1^{S_a}, band_2^{S_a}, \dots, band_l^{S_a})$ is represented as the antecedent, $I.Yield^{S_a}$ as the consequent and $I.count$ as the support count of the itemsets.

Example3.2: Take Table 1 for example, the block P^3 in which local frequent 1-itemsets are produced, $(R^3, Yield^3, 4)$, $(G^3, Yield^3, 4)$ and $(B^3, Yield^3, 4)$ are also produced. Furthermore, the local frequent 2-itemsets are $(R^3, G^3, Yield^3, 4)$ where $count=4$ obtained from $\min(4, 4)$.

On the other hand, no local frequent itemsets are produced in the block P^2 because the support count of the itemsets is smaller than the minimum support count in the block. Our method records the itemsets onto the local non-frequent itemsets so as to produce the local non-frequent itemsets such as $(R^3, Yield^3, 1)$, $(G^3, Yield^3, 1)$, and $(R^3, G^3, Yield^3, 1)$.

Step 3: Composition of a global candidate itemsets from each local frequent itemsets

First step is to incorporate the local frequent l-itemsets F_l^1, F_l^2, K, F_l^n in each block into

a global candidate l-itemsets (C_l). Second is to calculate the support count in C_l ; that is,

$$C_l.count = F_l^1.count + F_l^2.count + \dots + F_l^n.count.$$

Example 3.3: In Table 1, the local frequent 3-itemsets in P^1 are $(R^3, G^3, B^3, Yield^3, 3)$, and the local frequent 3-itemsets in P^3 and P^4 are $(R^3, G^3, B^3, Yield^3, 4)$. Incorporation of both comes the global candidate 3-itemsets which are $(R^3, G^3, B^3, Yield^3, 11)$, where $count=(3+4+4)=11$.

Step 4: Calculation of the final support counts in global candidate itemsets for establishing the global frequent itemsets

Adding together the established global candidate itemsets C_1, C_2, K, C_l in Step 3 and the support count in each local non-frequent itemsets (NF_l^i) yields

$$C_l.count = C_l.count + NF_l^i.count, \text{ and the final}$$

support count in the global candidate itemsets can be produced. If the support count is larger than the minimum support count (s^c), then they are the global frequent itemsets.

Example 3.4: Again take Table 1 as an example, the global candidate itemsets $(R^3, G^3, B^3, Yield^3, 11)$ are produced in Step 3. There are local non-frequent itemsets such as $(R^3, G^3, B^3, Yield^3, 1)$ in the P^2 . Thus the final global candidate itemsets that are produced are $(R^3, G^3, B^3, Yield^3,$

12), where $\text{count}=(11+1)=12$ that is larger than the minimum support count 10. So the global frequent itemsets (R^3 , G^3 , B^3 , Yield^3 , 12) are produced.

4. Experimental results of adaptive two-phase data mining of spatial association rules

The experiments conduct on the time-related ratio between the adaptive two-phase data mining, the two-phase data mining of spatial association rules and the Apriori.

Figure 3 shows the time-related ratio between the adaptive two-phase data mining which incorporates the Histogram Generator count that is 128 as well as blocking and the Apriori on five 50,000 pixels images under different color counts. Figure 3 also shows the time ratio between the two-phase data mining which incorporates the Histogram Generator count that is 128 but excludes the blocking and the Apriori. When the time ratio is less than 1, it

implies that both the two-phase data mining and the adaptive two-phase data mining are effective. From the Figure 3, the adaptive two-phase data mining yields the time ratio that is significantly less than the two-phase data mining; in other words, the adaptive two-phase data mining can improve the two-phase data mining of spatial association rules on its effectiveness.

Figure 4 is the time-related ratio between the adaptive two-phase data mining which incorporates the Histogram Generator count that is 128 as well as blocking and the Apriori. It also shows the time ratio between the two-phase data mining which incorporates the Histogram Generator count that is 128 but excludes the blocking and the Apriori. When the time ratio is less than 1, it implies that the adaptive two-phase data mining is very effective. From the Figure 4, the adaptive two-phase data mining requires significantly less amount of time; in other words, image blocking in the first and coarse-grained association rules in the later are able to enhance the two-phase data mining in its effectiveness

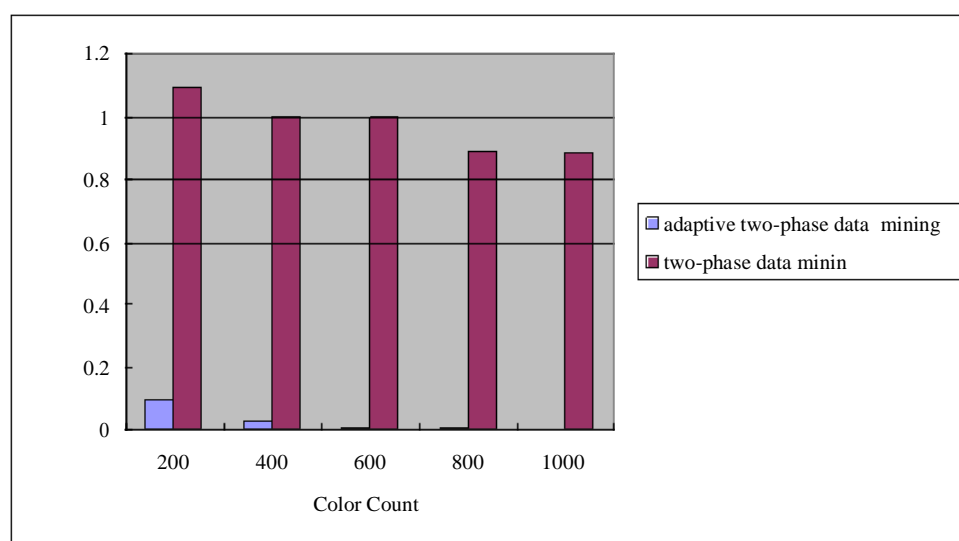


Figure 3. Execution time comparison between 128 HGs w.r.t. Partition (adaptive two-phase data mining) and 128 HGs (two-phase data mining) for some color count

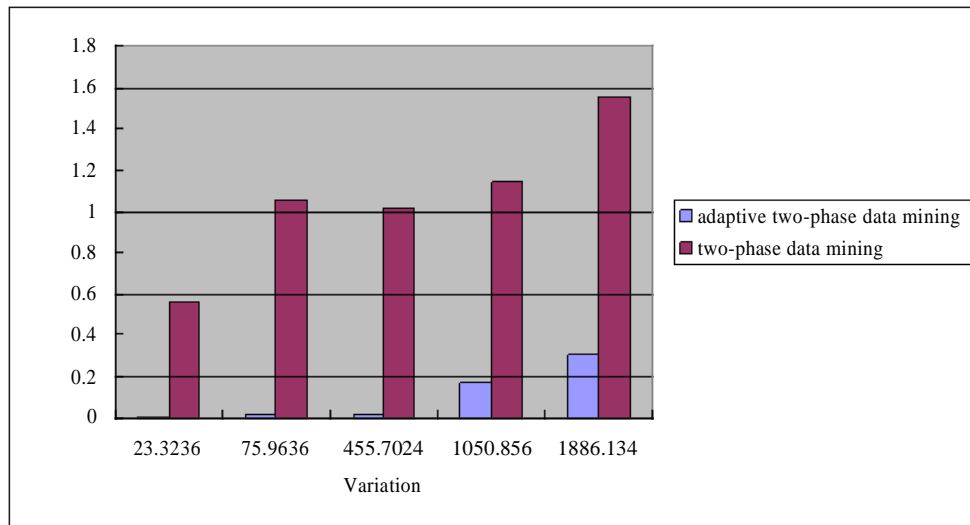


Figure 4. Execution time comparison between 128 HGs w.r.t. Partition (adaptive two-phase data mining) and 128 HGs (two-phase data mining) for some variation

5. Conclusions

Our proposed two-phase data mining method in this paper is essentially effective for the applications of data mining on remotely sensed images. Adaptive two-phase spatial association rules mining method conducts the idea of partition on an image for efficiently quantizing out non-frequent patterns and thus facilitate two-phase process.

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E-Learning in India: Experiences, Issues & Challenges

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Abstract

There is massive potential in the higher education space spread across the Asian continent especially in countries like India and China. Global players operating in this space are eyeing these markets. This throws opportunities as well as challenges. There are many players, local as well as global, who have experimented or are experimenting online (pure play) or blended models in education. There have been failures and mistakes, which have thrown lot of learning. As a result players have improvised their offers. Online education is now working. Though the progression is slow, it is expected to grow exponential in the coming years.

E-learning is network enabled learning. There is a race to get into e-learning space in India given the scope and size of this market in India. But many organizations and academic institutions trying to foray into E-learning are getting imbalanced due to the lack of proper understanding of the market place and internal/external requirements. IT assimilation throws unimaginable challenges. What should be the operating strategy, deliverable value, approach, processes and technology assimilation strategies so that the entire organization moves towards successful implementation of the E-learning project without compromising on its existing competencies is a serious matter for researchers to ponder. This paper tries to answer some of the above issues with the help of the experiences gained from one of the largest online education project launched and running quite successfully in India. The suggested framework evolves around discovery of a collaboration model with software and connectivity service providers and criteria of collaboration to be drawn from the learner needs and requirement. The collaboration should balance to achieve necessary value proposition for the intended learner segment by careful crafting of the Learner Centric Value Chain.

1.0 Introduction:

Campus-based education has an important place in building knowledge strength of economies though it has its limitations, especially with respect to reach and capacity. With growing population and ever increasing need of quality education for all, there is an enormous potential to tap the education market, especially in the

developing countries. The role of distance and open learning has become very important in recent times to address the educational needs of the society. Advances in information and communication technologies have provided a much needed medium in the form of internet for distance education to flourish. The new technologies are not just improving existing forms and structures of higher education through better in-campus information infrastructure but are also transforming learning from focus on the institutions and instructors to focus on the learners. There are mainly two types of delivery method adopted by educational institutions in India - in campus and distance learning model. Both these models could operate in their zones in non-information and communication technology (ICT) based environment. With the use of ICT in content creation and delivery mechanism, the approach and the target segments are getting overlapped - the in-campus model extending reach and the distance model enhancing interaction quality and quantity. In such situation, it has become a daunting task for institutions to figure out synergies between their legacy and the evolved approach.

E-learning is network enabled learning. Many organizations and academic institutions trying to foray into E-learning are getting imbalanced due to the lack of proper understanding of the market place and internal/external requirements. IT assimilation throws unimaginable challenges [1]. There is a race to get into e-learning space in India given the scope and size of education market. Given the population base of around one billion and a huge working class in India, the opportunity for a cost effective open learning model to tap the potential is definitely quite tempting. With a huge demand and limited supply in the distance learning space, e-learning models have made only little ground and there is continuous search for a more viable model.

What should be the operating strategy, deliverable value, approach, processes and technology assimilation strategies so that the entire organization moves towards successful implementation of the E-learning project without compromising on its existing competencies is a serious matter for researchers to ponder. This paper examines the e-learning potential in the perspective of sector structure and size. The e-learning throws opportunities as well as challenges and there are many local as well as global players experimenting online (pure

play) or blended models in education. There have been failures and mistakes, which have thrown lots of learning. As a result players have improvised their offers. Though the progression is slow, it is expected to grow exponential in the coming years. This paper focuses on higher education and highlights issues in the e-learning based on a case study. Thus an attempt has been made to provide a framework for e-learning.

2.0 Evolution of E-Learning:

E-learning has evolved in the last couple of decades from a simplistic computer based supportive system to a highly advanced model used as a core strategic application by players in this space. Like any other service, concerned organizations need to respond to challenges like advancements in technology, changes in stakeholder demands and the challenges and opportunities arising due to globalization. Institutions and corporates across the globe have been experimenting with different models of learning throughout, alongside the advances in technology to add value in the learning process to address the challenges.

The e-learning germinated as a concept when in mid 70's research scientists who were also involved in academics interacted with students through computer networks. It was used by academia for information exchange and then as a support to university level courses. The universities started tapping the digital networking capabilities from the early 80s aggressively and started testing newer applications for feasibility. In 80's various experiments were done at the secondary level education which were national as well as global initiatives, linking school children and teachers across schools of some western countries. The results indicated knowledge enhancement and exposure to a global perspective for learners [2]. However, the first fully online Executive Education program in 1982 by the Western Behavioral Sciences Institute (WBSI) did not produce very encouraging results. This provided some important lessons for the domain experts like un-workability of long textual presentations by the instructors in online systems. Also the experience suggested that group learning applications yield better results than standalone applications. The Open University of UK rolled out first application of computer conferencing in 1989 on large-scale in a distance education course which was quite successful [3].

The Internet-based education became focus of study in distance as well as campus base educational institutions in the 90s and still continues to hold attention for some potent reasons. The advent of email system as a means of communication has been a big boost to online education projects as it provided a medium for easy online two way interactivity [4]. Internet is becoming the primary delivery mechanism because of its reach, cost efficiency and relatively easy availability. It provides flexibility not only

to the learner to learn at his/her pace from anywhere/anytime but also to the instructor to operate at his convenience. A web-based course enables opportunity of creating newer learning models.

The developments in the online learning have led to initiatives among interested groups in different parts of the world to assess the differentials vis-à-vis offline distance learning. Efforts to assess the effectiveness of online education system and there by developing a comprehensive model have remained inconclusive. One such case study concluded that the quality of distance education was inconclusive and, thus, much is still unknown regarding how and in what ways, technology can enhance the teaching learning process [5].

The on-line education models have been developed across a continuum from physical to digital version taking all necessary elements to make them student centric learning models. Some examples of such efforts include European Campus 2000 initiative [5] and BESTnet and AFRINet initiative which linked universities and related entities in the learning space in US, Canada, Latin America and Africa [6].

In the late 90s, the thrust shifted to benchmarking and developing standards of e-learning. The example of such endeavor includes the initiative by the Institute for Higher Education Policy, US which established benchmarks and ranked institutions in e-learning space. The benchmarks were based on institutional support, course development, teaching/learning, course structure, student support, faculty support and assessment methodology [7].

3.0 The E-learning Sector in India:

3.1 Structure:

A quick recap of the market place is essential to have the perspective in place. The structure can be understood with the help of figure 1 given at the end. At the core of the process are service providers and the customers, whereas the government, infrastructure developers, content providers, technology vendors, and strategy consultants etc make up the external but essential entities in the game. The service providers could be academic institutions, both hybrid as well as pure online institutions, NGOs, individuals or corporates imparting education to the employees. Similarly the customers could be individual learners, academic institutions or employees. The corporate-employee interaction is gaining quite a bit of significance of late along with the academic institution-student interaction. For example 37 per cent of the 130 corporates surveyed in India by Federation of Indian Chamber of Commerce said that they use e-learning for skill upgradation and training of employees [8]. The government support is essential in educational services and may come in the form of fixed grants and development of the basic telecommunication

infrastructure. The other external players also have a very important role in the entire structure in terms of developing the required technologies, support materials, infrastructure as well as providing trained man power to handle various specialized tasks related to online delivery. These different players have played varied roles in different countries. In some countries the initiatives are divided across private and government institutions whereas in others like India the initiatives have mainly come from the Government or the government owned institutions, primarily because of no prior experience and the capital and risks associated with such large projects.

3.2 Size:

The size of the market can be mainly categorized across students segment and corporate segment. Whereas there are no authentic figures to indicate the domestic education market of India in value terms that can be tapped through e-learning but one can take clues from the information about market subsets or the rough projections of players in the field.

The market size for e-learning has close linkages with distance education market because the players in this space are targeting the same segments. Therefore, understanding of distance learner segment is essential to get some understanding of e-learning market. One can get an idea about the distance education market in India by looking at table 1. The table gives the increase in enrollments at Distance Education (DE) institutions for the period 1975-2001. The share of distance mode has gone up to 20 % in 2001 from 2.6 % in 1975-76 as percentage of total student registered for higher education (HE). Thus every fifth student at tertiary level is enrolled with the DE system. The growth in this segment is expected to be 30-40%. According to government reports, presently there are 10 Open Universities in India, with some having more than 0.1 million students. There are about 90 dual mode universities and a few privately owned professional institutions offering courses through distance mode. Thus the potential of distance education is enormous in India. The ten open universities in the country have around 0.6 million students across 3,200 study centers with around 36,000 councilors. The study centers are normally controlled by the regional centers. The learner/councilor ratio is around 16 whereas the study centre/ regional centre ratio is around 30 which depicts gaps in required mentoring and management of study centers and service levels. [9][10][11][12].

It has been estimated that in early 1990s, over 1.5 million Indian students in the higher education level were studying abroad. The US is the leading exporter of higher education in Asia followed by France, Germany and the U.K. India is fourth major importing country of educational services after China, Japan and Korea [13][14]. According to an estimate by Global Alliance for Transnational Education, about US\$ 27 billion worth of

higher education is exported to Asia and Pacific by three countries namely USA, UK and Australia. Roughly 50,000 students are enrolled for studies abroad from India and the number is leaping every year.

The VSAT service providers who are presently very active in education space peg the market for VSATs at around 4800-7200 units in next 3 years and 8000-12000 units in next 5 years. At present there are hardly 25-30 units functioning, disseminating education services to around 500 institution centers across the country [15].

The corporate market is very huge and companies have started using e-learning model [16]. For example LG Electronics in India decided in 2001 to impart 70% of training to its employees online [17]. There is push in corporate across private and public to using cost effective methods of training.

4.0 E-Learning Models in India:

There are mainly three types of models adopted by educational institutions in India with the advent of World Wide Web platform:

1. In-campus
2. Distance learning
3. Blended

4.1 In-campus:

Various academic institutions are enabling their existing processes with the information technology support for better administration, course management and value interaction. They normally use basic Learning Management Systems (LMS) from off the shelf or a customized package developed by the software solution providers locally. Various premium management and technology institutes of India fall into this category where instructors are using applications like Web-CT, Blackboard etc. to support instructor-learner interaction and course management.

4.2 Distance learning:

Many institutes of repute like Indian Institute of Management, Calcutta, Management Development Institute, Gurgaon, Indian Institute of Technology, Delhi and National Institute of Design, Ahmedabad, are collaborating with academic publishing houses to offer short term executive development programmes mainly targeted at corporates. These programmes are totally web-based without any face-to-face component of any sort. The numbers are growing gradually and there are different experiences of learners across these various programmes.

4.3 Blended:

In this category, academic institutions with strong brand equity are trying to offer educational services with the aim of providing face to face experiences. There is face-to face faculty interaction in the beginning of the program followed by one way video and two way audio conferencing. The institutions in this category, typically have the content and brand to capture the market place but do not have the facilities and technical know how of offering online courses. This obstacle is being taken care of by collaboration with V-SAT service providers.

This model has the limitation with regard to number of learners that can be serviced at a particular receiving center as well as instructor capacity to handle queries in real time interaction mode across number of receiving centers.

4.4 Issues:

With the growing use of ICT in content creation and delivery mechanism, the approach and the target segments are getting overlapped – the in-campus model extending reach and the distance model enhancing interaction quality and quantity. In such situation, it has become a daunting task for institutions to figure out synergies between their legacy and the evolved approach. One can figure out critical areas of competency that apply in different models that can service learner requirements across learner styles, infrastructure and needs. The areas are mainly content, interaction and platform. The institutions are positioned at different slots across three dimensions of Platform, Interactivity and Readable content between physical and digital modes of these dimensions (Fig.2).

The institutions in India have tried alternatives across delivery and content dimensions but have yet not touched the third dimension. The Institutions, who had their courseware organized, were comfortable to digitize the content and got on to the e-learning mode by using web base delivery methods. The learners, however, have not been able to find enough value due issues mainly related to compatibility of the new interface with the legacy procedures, systems and mindset. The learner's preference is still for a hardcopy of the material or physical book as compared to digital content. The hyper linked quality has not been able to offset the comfort of using a physical book. Most of the learners in distance mode are working people who normally find time while traveling in a common passenger vehicle or their homes after office/ working hours. They normally do not have internet access in such places and if at all it is there, the costs are well beyond the perceived utility by the learners.

It is now only that in last couple of years, the third dimension is being looked at seriously by some institutions. This has been a result of continuous effort

across academia, content players in software sector and corporate learning chiefs. This is, however, just the beginning and there are still lots of apprehensions by the teaching community and learners which need to be analyzed and taken care of.

5.0 Case Study: Indira Gandhi National Open University

The Indira Gandhi National Open University (IGNOU) enrolls more than 1.3 million students in 235 academic programs leading to certificates, diplomas and degrees at under graduate and post-graduate levels [18]. It started first time in the country in 1998-99 using computer networks to support distance learning in two disciplines – the degree programs in Computer Application and Management. The project called 'Management Education through Interactive Delivery Systems' (MEIDS) was initiated in late nineties to offer degree and short capsule programs to distance learners through a blend of technology and offline support. Students were provided with online application facilities, continuous assessment, online query handling and online access to digital library with the help of an external software developer. The software developer also provided the hosting facility. The content delivery plan included a hard copy of the reading material along with the web support for most of the content. The content was primarily developed in-house or by leading experts of the field on contractual basis. The mentoring included sessions by local faculty at 20 partner institutions and weekend teleconferencing sessions from IGNOU head office. The partner centres were required to have the facility of receiving teleconferencing, internet connectivity, online continuous assessment supervision and administrative liaison between students and IGNOU. The first Masters Degree program in management was launched in 1999 along with 20 other short capsule programs. The prospective learners for degree program were required to go through a comprehensive written test. Around 275 students were enrolled from all parts of the country for all the programs on offer. The revelation of experiences by the learners provided lot of substance to figure out challenges and opportunity of e-learning in this country. The authors conducted a survey of the first batch of learners through this system. Out of 275, a sample of 150 was chosen by clustering from different programs. 35 of the learners responded. The methodology of the study was based on critical incidence technique which has already proved effective in assessing perceptions about use of computer base self-service facilities. The respondents were asked to list the most satisfying and dissatisfying experiences during the last six months of the program. The responses were clustered and factored to find the priority list of critical processes for action.

From the learners perceptions, following experiences were recognized as the top of mind satisfiers:

1. Quicker online registration and assignment assessment completion without a breakdown of the network possibly in allotted minutes (67%).
2. An immediate response through e-mail or telephone within 1-2 hours by the responsible service provider to provide process tracking facility for learners (62%).
3. Modular, comprehensive and updated course material to be received by the learners in the scheduled time and should be properly backed by web support without frequent failure of web support (62%).
4. There should be multiple channels of communication (56%).

The top dissatisfiers were as follows:

1. The connectivity fails during registration process or assessment test submission (77%).
2. The partner institution doesn't care to attend their grievances (69%).
3. The IGNOU coordinator is not available at critical times on phone or is not responding e-mails same day (66%).
4. The resource person on teleconferencing is not fully prepared on the topic (62%).

From the above results, following conclusions can be drawn about the processes considered to be the most critical for the value delivery by the learner segment catered by open universities like IGNOU:

1. Quicker Response.
2. Friendly software application and performance.
3. Modular design of courses within the program and comprehensive instructional material delivered in time.
4. Multi-channel delivery approach and flexible pedagogical structure.

6.0 Suggested Framework:

In the light of the issues discussed, it seems likely that the partnership trend among the different players which includes education service providers, software solution provider and connectivity service providers is going to increase in the future. Each provider will focus on its competence area. The collaboration criteria and the enrichment of Learner centric Value Chain (LCVC) need to be centered on the requirements of the learners. The frame work has been presented in figure 3. Although the learner is interacting only with the service provider, the feedback need to go to all the players involved and all the

players need to model their activities keeping the end customer, i.e. the learner at the center. Experiences learned so far suggest that the learner requirement vary and therefore, the value proposition has to be mapped accordingly. The efforts should focus at finding a collaborative model, centered on the right segment of learners, which will be decided based on the offering and competencies. The academic institutions should focus more on content and expert interaction, the software solution providers should focus on learner centric web ready content and other requisite interfaces and the connectivity providers should provide satisfactory links across the users.

7.0 Conclusion:

Given the massive potential and stiff competition in the e-learning space in India, the players need to work on a proper model in order to maximally exploit the opportunities and create win-win solutions for all the players involved. Whatever be the e-learning model, the service provider needs to pay utmost attention to learner needs of flexibility and tolerance by way of providing modular based programs through multiple channels of communication and with high performance, friendly application support. The core idea should be to create a learner centric value chain which can eliminate any scope of dissatisfaction and enhance satisfaction of the remote learner.

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Note: The full paper is available from the CD of conference proceedings.

Table 1: Growth of Distance Education in India

Year	Universities	Students (millions)	% of DE in total HE system (Total enrolment in HE) in millions
1975-76	18	0.06	2.3 (2.49)
1981-82	22	0.19	5.7 (3.34)
1990-91	40	0.56	10.1 (5.55)
1999-2000	74	1.58	17.0 (9.31)
2000-2001	74	2.00	20.0 (10 approx)

Source : Swamy Kulandai (2002)

Figure 1: The Structure of E-learning Sector in India

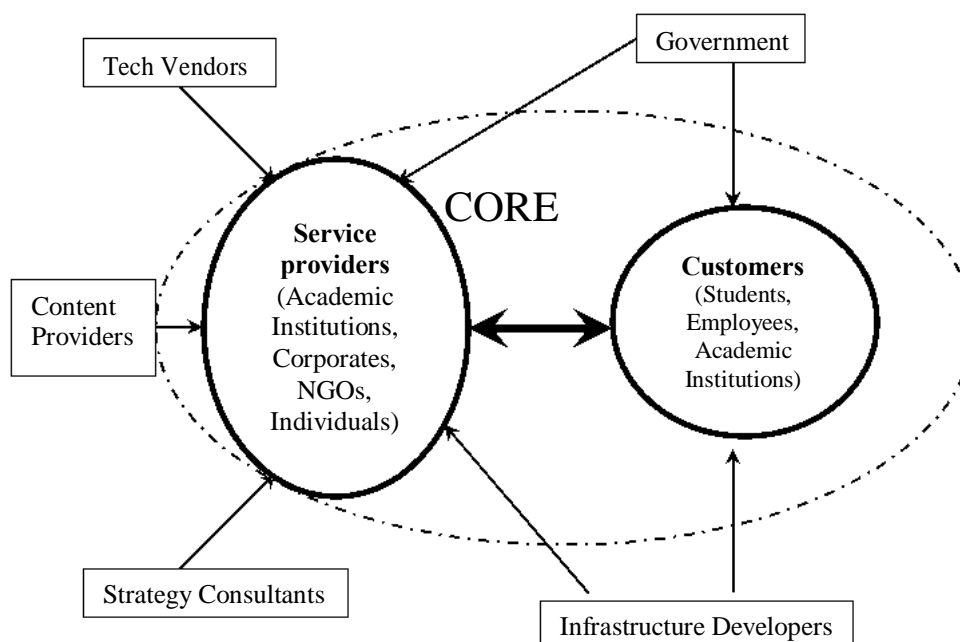


Figure 2: Dimensions of E-Learning Models

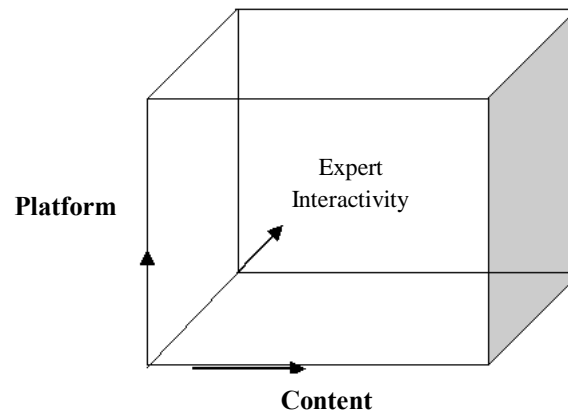
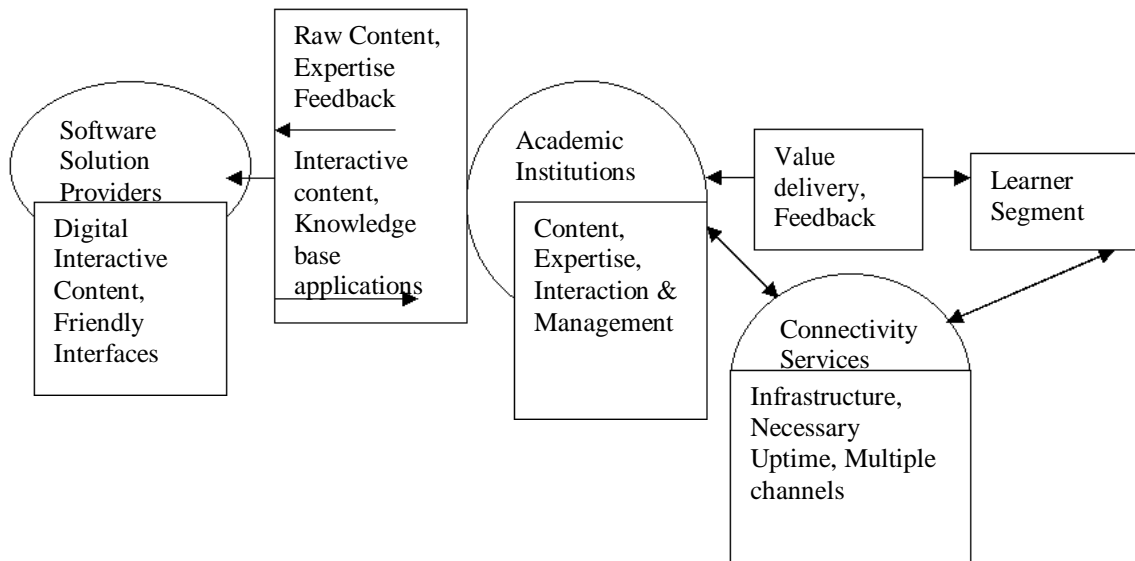


Figure 3: Learner Centric Value Chain (LCVC)



Changing Demands of Leadership in New Economy – Critical Competencies for e-Leadership

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Abstract

Progresses in the field of information and communication technologies in last one decade or so have transformed our lives in many ways. One of the strongest impacts of these breakthrough discoveries can be seen in the way businesses are run. Organizations today are faced with a fundamental challenge of finding competitive advantage in a world in which many of the old sources of competitive advantage are no longer enough. In such dynamic environment leaders have the challenge of developing new skills and competencies to cope up with the competition and uncertainties of the environment. This study is an attempt to find these changing dimensions of leadership. The study has special significance for practitioners. It gives the dimensions of leadership, which the leaders of future need to develop. Leaders willing to win and organizations willing to succeed in the new business environment need to compare their actual strengths with the ones they would need to be successful and develop the required competencies accordingly.

1. Introduction

We live in an era of rapid changes in every sphere of life, be it individual life styles, organizations or societies [1] [2]. These changes are primarily driven by the technological revolution of last one decade or so, especially in the field of information and communication technologies. The business environment though trying to reach a stable state, is still in a state of great flux. Gary Hamel, in his famous work “Leading the Revolution” says [3, p 4]:

“...We now stand on the threshold of a new age – the age of revolution”.

It is this ‘age of revolution’ which has been given various names like ‘new economy’, ‘digital economy’, ‘information age’, ‘knowledge age’, post-industrial economy’ etc by the scholars [3] [4] [5] [6]. Organizations today are faced with a fundamental challenge of finding competitive advantage in a world in which many of the old sources of competitive advantage are no longer enough. This has implications for leadership too. There is increasing acknowledgement by scholars that the requirement of leadership competencies for success in new economy will be different from that for the old economy [7] [8] [9]. Identification of these dimensions is

important for leaders as well as organizations in order to be successful as well as to implement organization wise strategies for leadership development to face the challenges of the new economy.

2.0 Research Question and Literature Review

The study attempts to answer the question whether there is any change in the requirements of leadership for successfully operating in the new economy and if indeed there is change in leadership requirements, what are the leadership dimensions which are more important than others for the new economy.

The study looks at leadership from competency perspective. The review of literature suggests that in recent times more and more importance is being given to leadership competencies under various leadership approaches. The existing competency literature on leadership includes many studies of current leadership competencies and surveys of leaders inquiring about their views on future leadership competencies [10] [11] [12] [13]. However literature is lacking to assess how leadership competencies will be different in the new economy as compared to the traditional old economy. The studies done in India on business leadership primarily focus on past and current successful leadership examples and the issues related to leadership development [14] [15] [16] [17]. Although these studies are certainly informative and lessons learned continue to be applicable, these cannot be sufficient guides for the changing business environment. What is more important today is not to analyze how one achieved success in the past but to identify how to be successful in the future. There is huge gap in available literature when it comes to leadership issues for the future in Indian context. This study is an attempt to bridge this literature gap.

On review of extant literature, following competencies were identified for the study:

Vision, problem solving, integrity, team Building and team work, human resource management, innovative and creative thinking, initiative, customer orientation, teaching (coaching, mentoring), interpersonal skills, communication, self-awareness, financial management/quantitative ability, technical competence,

technology adoption and management, negotiation, influencing others, flexibility, speed in decision-making, ability to take risk, ability and willingness to learn, conflict management, external awareness, and stamina (physical and mental).

3.0 Methodology

A survey of Indian corporate leaders, both from old economy as well as digital economy organizations was conducted with the help of a self administered questionnaire. The subjects belonged to top and senior level executives of Indian corporations as well as Indian subsidiaries of multi national corporations. Though most of the competencies used in the study have been used by researchers in earlier studies, a pre-test was employed to refine the questionnaire. A sample of 40 leaders was selected by convenience sampling for pre testing and reliability analysis was carried out via item to total correlation and Cronbach coefficient alpha using SPSS-11.0. All the competencies were found to be above the cut off point of 0.3 and the values of Cronbach coefficient alpha for old economy as well as digital economy was found to exceed 0.7.

An informal face validity test was conducted and the questionnaire was shown to academicians and industry experts. After satisfactory responses from the experts, the questionnaire was subjected to factor analysis using SPSS 11.0. All the competencies were factor analyzed together to test the convergent validity for old economy and digital economy separately. A minimum value of 0.40 was used to indicate the loading of any factor. It was found that the competencies for both, old economy as well as new economy were convergent.

The main study was carried out during April 2002 to August 2002. The sample was chosen by stratified random sampling from ET 500 (March, 2002) and Global 500 (July 22, 2002) [18] [19]. The companies were stratified into new economy and old economy organizations to have equal representations of the view points of both sets of leaders.

The questionnaires collected for the pre-test were also included for final analysis. A total of 249 correctly completed questionnaires were received, of which 109 belonged to leaders from new economy organizations and 140 belonged to old economy organizations. The reliability of the scale for old economy and digital economy was assessed again via item to total correlation and Cronbach coefficient alpha using SPSS-11.0. All the competencies used in this study exceeded the cut off point of 0.3 on item to total correlation. The Cronbach coefficient alpha was 0.938 for old economy competencies and 0.931 for new economy competencies.

4.0 Analysis and Findings

Dependent samples t-tests were used to see if leaders perceived certain competencies to be more important for new economy as compared to old economy. Based on the average rankings of individual competencies for new economy, a set of competencies was identified to be critical for successful e-Leadership.

The results of dependent sample t-test reveal that the importance of most of the competencies has changed significantly from old economy to new economy in the perception of Indian leaders. The p-value of 0.05 was used for testing the null hypothesis that there is no significant difference in the importance ratings for a particular competency for digital economy as compared to traditional old economy. The competencies for which the test does not support a significant difference (p-value greater than 0.05) are listed in the table 1.

Table 1: Leadership Competencies, which are not significantly different in new economy from old economy

Perception of old economy leaders	Perception of digital economy leaders	Perception of old economy & digital economy leaders taken together
Integrity Interpersonal Skills Communication Skills Self Awareness Conflict-Management Stamina	Problem Solving (p=0.053) Communication Skills Negotiation (p=0.060)	Communication Skills Negotiation Influencing Others (p=0.064)

Communication skill is common for all three and we can conclude that requirement of communication skills, as leadership competency has not changed in digital economy from traditional old economy. Other skills, requirement of which have not changed in the perception of old economy leaders are integrity, interpersonal skills, self-awareness, conflict management and stamina. In the perception of digital economy leaders, communication is the only skill whose requirement has not changed significantly since p-value for problem solving and negotiation is very close to 0.050. If we take the perceptions of both, digital economy and traditional old economy leaders together, we can see that requirements of 'negotiation' and 'influencing others' besides 'communication' have not changed, though the test results are very weak for 'influencing others' competency.

Table 2 lists the competencies which have changed most in importance for new economy from old economy in the descending order.

Looking at the rankings, only for the new economy, the top five competencies which can be said to be critical for success in the new economy are Vision, Customer

Orientation, Technology Adoption & Management, Speed in Decision-making and Innovative & Creative Thinking.

Table 2: Leadership Competencies that have changed most for new economy

	Competency
1	Technology Adoption & Management
2	External Awareness
3	Speed in decision making
4	Teaching (Coaching, Mentoring)
5	Ability and willingness to learn
6	Innovative & Creative Thinking
7	Customer Orientation
8	Human Resource Management
9	Flexibility
10	Ability to take risk
11	Team Building & Team work
12	Technical Competence
13	Vision
14	Financial/Quantitative Ability
15	Initiative
16	Conflict Management
17	Stamina (physical and mental)
18	Self Awareness
19	Interpersonal Skills
20	Problem Solving
21	Integrity
22	Influencing others
23	Communication Skills
24	Negotiation

5.0 Conclusion

The study supports the view that the requirements of leadership are changing. It specifically brings forth the competencies whose importance has changed most and also how a different set of competencies has emerged to be critical for success in digital economy.

This study will be significant to both academicians and practitioners. It fills a big gap in leadership literature when it comes to assessing the changing requirements of leadership competencies for digital economy. From a practitioner's perspective, this study gives the dimensions of leadership, which the leaders of future need to develop. Leaders willing to win and organizations willing to succeed in the new business environment need to compare their actual strengths with the ones they would need to be successful. The leadership competencies identified in this

study to be important, will help the managers in developing right kind of competencies to become successful leaders. The findings of the study could be useful for the human resource managers in making right selections for leadership roles. The study should also be useful for the old economy organizations, trying to adapt to the new business environment.

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Fuzzy-based Balanced Scorecard for E-business

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Abstract

The balance scorecard [6] is a performance measurement system that supplements traditional financial measures with the criteria that measures performance from three additional perspectives: customer perspective, internal business perspective, and innovation and learning perspective. In recent years, the balanced scorecard has been applied to information technology in order to ensure that IT is fairly evaluated. The same methodology has also been applied to E-business. Since some of the parameters in the measurement are somewhat inexact, the idea of fuzzy logic can be applied to allow manipulation of both exact and inexact (fuzzy) inputs from the e-business to the balanced scorecard. This fuzzy model works with a grade of membership and portrays inexact information represented by fuzzy statements, and explains both fuzzy conditional statements and the inference mechanism. This paper tries to develop a frame-work for Fuzzy-based Balanced Scorecard for E-business.

Introduction

Internet technology is creating a universal technology platform for buying and selling goods and for driving important business processes inside the firm. It has inspired new ways of organizing and managing that are transforming businesses and the use of information systems in everyday life. Along with bringing many new benefits and opportunities, electronic business (E-business) has created a new set of management challenges. An organization must understand the management, organization, and technology issues that must be addressed to benefit from E-business. The successful organization requires the high level information integration, and companies increasingly are depending on such infrastructure to remain efficient and competitive. The Internet has shrunk the information asymmetry. Now the businesses are not required to make trade-offs between the richness and reach of their information.

E-Business

E-business can be described as the process of buying and selling or exchanging of products, services, and information; generating demand for them through marketing and advertising; servicing customers; collaborating with business partners; and conducting electronic transactions within an organization via computer networks, including the internet. E-business will improve business performance through low cost and open connectivity by introduction of new technologies in the value chain and connecting value chains across businesses in order to improve service, reduce costs, open new channels and transform the competitive advantage. [15]

Companies are becoming increasingly aware of the many potential benefits provided by E-business. [15],[2]. Some of the E-business potential benefits are: support of Business Reengineering efforts, expansion of the market reach that goes beyond any border, strengthening of relationships with customers and suppliers, cost reductions through the deployment of electronic internal and external business processes, and lower telecommunications costs as a result of the inexpensive Internet infrastructure. E-business projects often are deployed on the basis of a step-by-step approach. A well-known Gartner-model describes four levels of E-business: (1) the publishing level focusing on showing information of the company on a web site, (2) the prospecting level with customer oriented information, (3) the business integration level which is transaction centric and can be defined as E-commerce, and (4) the business transformation level which is the mature level of E-business that includes supplier and customer integration. *Completion of steps of the E-business project plan* will represent this evaluation item. An E-business project represents a capital investment that entails expenses as well as revenues. The start of an E-business project is also the initiation of a permanent commitment to resource demands because of ongoing expenses that often difficult to predict.

Because of the intangible nature of some of these benefits, it is difficult to measure the contribution of E-business initiatives to business performance and to manage these projects to ensure that real profits are realized. In practice, E-

business projects are often managed too technically and little attention is paid to the business case.

Uncertain Future

The new world of business imposes the need for variety and complexity of interpretations of information outputs generated by computer and information systems. Such variety is necessary for deciphering the multiple worldviews of the uncertain and unpredictable future. With increasing computerization in organizations, organizational routines originally embedded in standard operating procedures and policies become embedded in the firm's dominant logic embedded in programs and databases in the form of 'best practices'. Such formalized information systems tend to be inflexible and are often based upon designers' belief that they have already identified the organizational and environmental properties. However, with increasingly rapid, dynamic and non-linear changes in the business environment, static assumptions embedded in such systems become vulnerable. Growing realization of such vulnerabilities is behind increasing interest in designing information systems that can take dynamic and diverse interpretations of changing information into account.

Performance Measurement

For years, firms valued financial performance or market share as the most important success measures. The large firms fostered competition among their brand groups or retail outlets and measured success by the bottom line (profits). Many still do. During the mid- to late-1990's, the dot-com firms ignored financial measures and focused on growth, much to their dismay. These approaches are narrowly focused and place more weight on short-term results rather than addressing the firm's long-term sustainability [1].

These weaknesses paved the way for enterprise performance management systems that measure many aspects of a firm's achievements. The **Balanced Scorecard**, developed by two Harvard Business School professors in 1990 [6], is one such system. Fifty percent of organizations worldwide have adopted the Balanced Scorecard with excellent results ("The E-Commerce Balancing Act" 2000). The scorecard approach links strategy to measurement by asking firms to consider their vision, critical success factors for accomplishing it, and subsequent performance metrics in four areas: customer, internal, innovation and learning, and financial. In the following sections typical goals and metrics in each perspective are described.. However, it is important to remember that each firm defines the specific measures for each box—the system is very flexible.

Customer Perspective		Internal Business Perspective		Innovation and Learning Perspective		Financial Perspective	
Goals	Measures	Goals	Measures	Goals	Measures	Goals	Measures

Four Perspectives

The *customer perspective* uses measures of the value delivered to customers. These metrics tend to fall into four areas: time, quality, performance and service, and cost. They can include measures such as time from order to delivery, customer satisfaction levels with product performance, amount of sales from new products, and industry-specific metrics such as equipment up-time percentage or number of service calls.

The *internal perspective* evaluates company success at meeting customer expectations through its internal processes. The items with greatest impact in this area include cycle time (how long to make the product), manufacturing quality, and employee skills and productivity. Information systems are a critical component of the internal perspective for e-business firms.

The *innovation and learning perspective*, sometimes called the *growth perspective*, is one of the Balanced Scorecard's unique contributions. Here, companies place value on continuous improvement to existing products and services as well as on innovation in new products. These activities take employees away from their daily work of selling products, asking them to pay attention to factors critical to the firm's long-term sustainability—especially important for e-business firms. Measures in this area include number of new products and the percentage of sales attributable to each; penetration of new markets; and the improvement of processes such as CRM or SCM initiatives.

If the projected outcomes result from the previous perspectives and performance metrics, the financial perspective will be on target too. Financial measures include income and expense metrics as well as return on investment, sales, and market share growth. Companies must be careful to relate measurements from the first three perspectives to the financial area whenever possible.

Each firm will select metrics for the four perspectives based on its objectives, business model, strategies, industry, and so forth. The point is to understand what the company wants to accomplish and devise performance metrics to monitor the progress and see that the goals are reached.

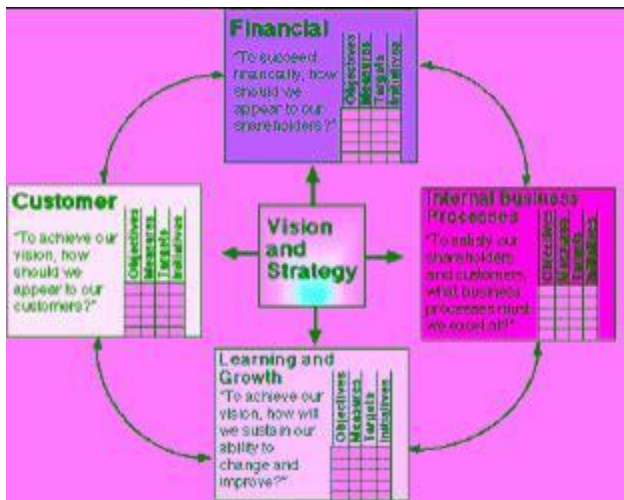


Figure 1

Scorecard Benefits

The Balanced Scorecard system helps a firm obtain timely information to update its strategy. Its four perspectives balance long-term and short-term measures and evaluate every part of the firm and how each contributes toward accomplishing selected goals. It also helps firms leverage their relationships with partners and supply chain members. The scorecard can be used by all types of organizations, both profit and not-for-profit, and in all industries, if they select appropriate metrics.

The Balanced Scorecard has many other specific benefits. First, it provides a way to go beyond financial metrics in measuring many different aspects that lead to effective and efficient performance. Second, it creates a long-term perspective for company sustainability. Third, it forces companies to decide what is important and translate those decisions into measurable outcomes that all employees can understand. Next, it is a great communication tool because employees can use the scorecard as a guide to coordinate their efforts. In addition, it supports employee evaluation in that individual performance can be tied to successful outcomes on the metrics. Also, it provides a way to measure intangible as well as tangible assets. This is especially important for firms using e-business models because knowledge, information, and innovation are critical to their success. Finally, the Balanced Scorecard

is valuable because of its flexibility in allowing firms to select appropriate metrics for their goals, strategies, industry, and specific vision.

The general BSC-framework can be translated to the more specific needs of the monitoring and evaluation of the IT function and recently the IT BSC has emerged in practice [5],[18],[16],[17]. Many firms have successfully implemented the Balanced Scorecard. Hilton Hotels attributes its number-one ranking in customer satisfaction during 2000 and highest industry profits to this approach (Jackson and Baskey 2000). In another example, Wells Fargo Bank created Online Financial Services in the early Internet days to capitalize on new technologies. Its goal was to migrate current customers and draw new customers to the online channel. Using the scorecard as a roadmap to provide value to customers and to be sure internal processes and the technology could handle the anticipated volume, Wells Fargo beat its goal of 1 million customers within a short time ("The E-Commerce Balancing Act" 2000).

Balance Scorecard in E-Business Application

The Scorecard can use a Business-Centred model and structured sets of questions to enable you to assess where and how effectively you currently use e-business, and to explore and identify areas where e-business can be extended and improved [10], [3]. It is not a rigid 'e-specification' for every business but an independent and balanced source of innovation and challenge across key business processes [11], [12]. It can be designed to cover the impact of e-business on commercial strategy and operations and also reviews technical strategy in areas such as infrastructure and security.

The Scorecard can provide a comprehensive real-world framework coupled with a business process focused diagnostic tool to help the organization, irrespective of its size or nature of business, to identify 'where its main e-business opportunities are' and 'what it needs to do to enhance its e-business'. Larger, more complex, organizations can leverage key recommendations from the Scorecard assessment process across the business. Smaller organizations can benefit from the 'knowledge investment' made by medium and larger sized companies in e-business and are able to implement solutions more quickly. Appendix shows the generic measurement parameters [18], [12], [4].

Measurement

You can't improve what you can't measure. So metrics must be developed based on the priorities of the strategic plan, which provides the key business drivers and criteria for metrics managers most desire to watch. Processes are then designed to collect information relevant to these metrics and reduce it to numerical form for storage, display, and analysis.

Decision makers examine the outcomes of various measured processes and strategies and track the results to guide the company and provide feedback. Leading organizations agree on the need for a structured methodology for using performance measurement information to help set agreed-upon performance goals, allocate and prioritize resources, inform managers to either confirm or change current policy or program direction to meet those goals, and report on the success in meeting those goals. Also it is essential to know the data flow correctly so that it can be measured accurately.

Data Flow in BSC

There are two sets of more-or-less continuous data flows required in the BSC system:

1. Downward information flow

Line managers at the Directorate, Department, and Branch levels define goals, desired outcomes, initiatives, metrics, targets, and schedules. The goals, metrics, targets and schedules are aligned with those specified in the top-level strategic plan and balanced scorecard performance plan. Some of these parameters may have to be translated from general to more mission-specific to apply to the work being performed at each organizational level. Specific desired outcomes and initiatives to attain them are developed by these managers, and the metrics, targets and schedules are then developed. This results in a hierarchical set of balanced scorecards that are pertinent at each organizational level. It also has the effect of giving the organizational stakeholders a meaningful role in performance evaluation and strategic management.

2. Upward information flow

Define collection methods for each of the BSC metrics. This is the most expensive, labor-intensive, aspect of the BSC system, and has the most impact on the rank-and-file employees. I therefore recommend that for survey-based measurements, surveys should be carefully and professionally designed to minimize complexity and impact on the employees' time. Aggregate metrics data by organizational code. Create reports at each line management layer. These will provide feedback to the managers on metrics that are pertinent to their own strategic interests. Aggregate at each level (without filtering or loss of data). At the senior management layer, combine the metrics data into the 'vital few' needed to give an overall picture of the agency's balanced scorecard, on a continuous basis. These two information flows are illustrated in the Figure 2, using a notional organization chart:

PERFORMANCE EVALUATION DATA FLOWS

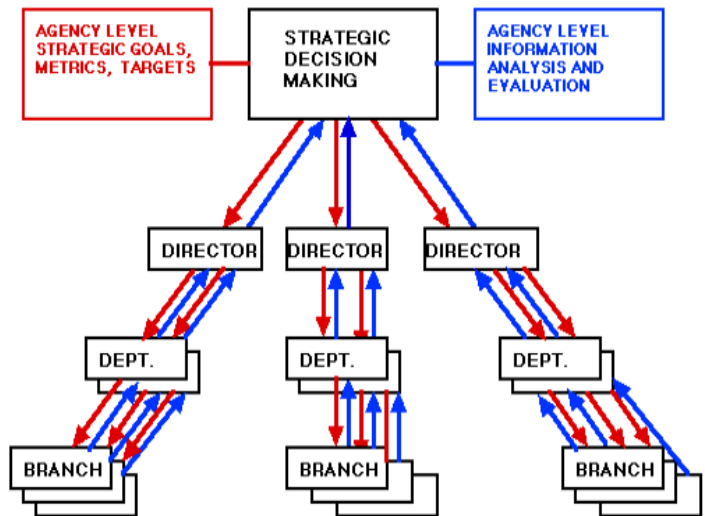


Figure 2 : Performance Evaluation Data Flows

In this figure, the top-level strategic goals, metrics and targets are in red, and they flow downward from the headquarters strategic planning office. The balanced scorecard measurements, in blue, are collected starting at the bottom (branch level) and flow upward. (This is analogous to the circulation of blood from arteries to veins.)

At each level of the organizational hierarchy, the data are aggregated across the lower levels. Aggregation serves to reduce information overload. Periodically, measurements can be collected, aggregated and analyzed at each management level. These data provide the managers with knowledge of strategic performance within their own part of the organization. In other words, the performance evaluations are not only for the top-level managers. Each manager, at each level, benefits by seeing the same metrics as they apply to his or her own area of responsibility. This is an incentive to support the balanced scorecard: *we are measuring ourselves - and we get to use the data we collect for our own purposes.*

As it is clearly evident from the discussion above, there are a number of parameters in the performance measurement as far as the E-business balance scorecard is concerned. Out of all these parameters, some are exact (like financial data) and some are inexact (like customer satisfaction, etc.). As far as the inexact parameters are concerned, most of the items depend on some information flow and communication. The communication may be in the form of analog (human-based) or digital (computer-based). The analog communication may be ambiguous, vague or unclear. Since the measurement in these cases are, somewhat, inexact, the idea of fuzzy logic can be applied to allow manipulation of both exact and inexact (fuzzy) inputs from the e-business to the balanced scorecard.

This fuzzy model works with a grades of membership and portrays inexact information represented by fuzzy statements, and explains both fuzzy conditional statements and the inference mechanism.

The Notion of Fuzzy Sets

The characteristic function of a crisp set assigns a value of either 1 or 0 to each individual in the universal set, thereby discriminating between members and nonmembers of the crisp set under consideration. This function can be generated such that the values assigned to the elements of the universal set fall within a specified range and indicate the membership grade of these elements in the set in question. Larger values denote higher degrees of set membership. Such a function is called *membership function* and the set defined by it a *fuzzy set* [20].

Let X denote a universal set. Then, the membership function μ_A by which a fuzzy set A is usually defined has the form

$$\mu_A: X \rightarrow [0,1] \quad (1)$$

where $[0,1]$ denotes the interval of real numbers from 0 to 1, inclusive.

The fuzzy set provides us with an intuitively pleasing method of representing one form of uncertainty. Obviously, the usefulness of a fuzzy set for modeling a conceptual class or a linguistic label depends on the appropriateness of its membership function. Therefore, the practical determination of an accurate and justifiable function for any particular situation is of major concern. The methods proposed for accomplishing this have been largely empirical and usually involve the design of experiments on a test population to measure subjective perceptions of membership degrees for some particular conceptual class. There are various means for implementing such measurements. Subjects may assign actual membership grades, the statistical response pattern for the true or false question of set membership may be sampled, or the tie of response to this question may be measured, where shorter response times are taken to indicate higher subjective degrees of membership. Once these data are collected, there are several ways in which a membership function reflecting the results can be derived.

Fuzzy-based Measurement

The process of human-based communication consists of a vast array of different types of simultaneously communicated signals, many of which conflict with each

other. It is, therefore, difficult to determine the precise intention and meaning of the communication, because of both distortion from environmental noise and ambivalence on the part of the sender. Nevertheless, the receiver must respond appropriately in the face of this fuzzy or vague information [21].

Suppose that X constitutes the universal set of all possible signals x that may be communicated by the sender. Because of the distorting factors mentioned above, a clear, unique signal may not be available. Instead, the message received is a fuzzy subset of M of X , in which $M(x)$ denotes the degree of certainty of the receipt of the specific signal x . In order to determine whether an appropriate response can be chosen based on the message received or whether some error was involved in the communication, an assessment of the quality of the transmission must be made. Let the maximum value of membership that any $x \in X$ attains in the set M correspond to the *strength* of the transmission. If the set M is large, no unique maximum, then the message is called *ambiguous*. If the support of M is large, then M is considered to be *general*. The clarity of the message can be measured by the distance between the maximum membership grade attained in M and the next largest grade of any signal x in M . When the message received is strong, unambiguous, and clear, then the signal attaining the maximum membership grade in M can easily be selected as the most obvious intended communication. Difficulty occurs, however, when the message is weak, ambiguous, or unclear. In this case, the receiver must determine whether the problem in the communication lies in some environmental distortion (in which case a repetition of the signal may be requested) or in the sender of the message (in which case a response must be made that is, as far as possible, appropriate).

Usually, the receiver of the communication possesses some background information in the form of probabilities or possibilities of the signals that can be expected. If $p(x_1), p(x_2), \dots, p(x_n)$ represent the probabilities associated with each of the signals $x_1, x_2, \dots, x_n \in X$, then the probability of the fuzzy event of the receipt of message M is given by

$$p(M) = \sum_{x \in X} M(x) p(x) \quad (2)$$

The receiver can use this information to assess the consistency of the received message with his/her expectations. If the probability of the received message is high, then it can be assumed that little distortion was introduced by the environment. On the other hand, if the message is very clear and unambiguous, then as appropriate response can be made even if the probability of the signal was low.

Instead of the expectation or background information being given in probabilistic form, this information may be given in

the form of a possibility distribution r on X . In this case, $r(x) \in [0,1]$ indicates the receiver's belief in the possibility of signal x being sent. The total possibility of the fuzzy message M is calculated as

$$r(M) = \max_{x \in X} [\min(M(x), r(x))] \quad (3)$$

As in the case of probabilistic expectation, if the received message conflicts with the expected possibility of communication, then the receiver may attempt clarification by requesting a repetition of the transmission. Before this new transmission is sent, the receiver will probably have already modified his/her expectations based on the previous message. If r_0 indicates the initial expectations of the receiver, and r_1 is the modified expectations subsequent to the receipt of message M , then

$$r_1(x) = \min [r_0^a(x), M(x)] \quad (4)$$

for each $x \in X$, where a indicates the degree to which past messages are considered relevant in the modification of expectations. The procedure for signal detection now consists of the following: a test of the consistency of M against the expectations and a test of the message M for strength and clarity. If both of these values are high, the signal attaining the maximum value in M be comfortably assumed to be the intended signal. If both tests yield low values, the expectations are modified and a repetition is requested. If only one of these tests yields a satisfactory value, then either a new signal is requested or a response is made despite the presence of doubt.

An additional complication is introduced when we consider that the receiver may also introduce distortion in the message because of inconsistency with the expectations. Let

$$s(M, r) = \max_{x \in X} [\min(M(x), r(x))] \quad (5)$$

correspond to the consistency of the received message with the possibilities expectations. Then, let M^s denote the message that the receiver actually gets, where

$$M^s(x) = M^s(x) \quad (6)$$

for each $x \in X$ where $s = s(M, r)$. The less consistent M is with the expectations, the less M^s resembles M . Since the receiver will be modifying his or her expectations based on the message thought to have been received, the new possibility expectation structure is given by

$$r_1(x) = \min[r_0^{1-s}(x), M^s(x)] \quad (7)$$

for each $x \in X$.

Finally, once a determination has been made of the signal $x \in X$ that was sent, an appropriate response must be chosen. Let Y be the universal set of all responses, and let R , the subset of $Y \times X$ be a fuzzy binary relation in which $R(y, x)$ indicates the degree of appropriateness of response y given signal x . A fuzzy response set $A \in Y$ can be generated by composing the appropriateness relation R with the fuzzy message M ,

$$A = R \circ M \quad (8)$$

or

$$A(y) = \max_{x \in X} [\min(R(y, x), M(x))] \quad (9)$$

for each $y \in Y$. The membership grade of each possible message y in fuzzy set A thus corresponds to the degree to which it is an appropriate response to the message M . A more interesting case occurs when the elements $y \in Y$ are not actual messages, but instead indicate characteristics or attributes that the appropriate message should possess. This allows for creativity in formulating the actual response.

Conclusion

In this paper, the balanced scorecard concepts are applied to E-business projects. The fuzzy logic framework has been applied to a generic E-business balanced scorecard and presented as a measuring and management instrument. The proposed fuzzy logic framework can be applied to the inexact parameters of three perspectives (out of four): the customer perspective, internal perspective, and Innovation and Learning perspective. These fuzzy-based monitoring instruments are a must when building, implementing and maintaining an E-business balance scorecard.

Appendix

Measurement Parameters

Customer Perspective	
Goals	Possible Measures
Build awareness of a new Web site service	Survey target awareness of service Number of visitors to the site
Position firm as high tech	Survey target attitudes
Increase number of software downloads from the Web site	Number from Web site log
High customer satisfaction with Web site	Survey of target at Web site Number of visits and activity at site
High customer satisfaction with value of online purchasing	Number of complaints (e-mail, phone) Number of abandoned shopping carts Sales of online versus offline for same products
Increase the amount or frequency of online sales from current customers	Mine the database for change in frequency of purchases over time
Build customer relationships	Number of purchases per customer over time (using cookie data) Customer retention percentage
Appropriate target markets	Data mining to find purchase patterns by targeting criteria
Buy-to-delivery time faster than competition	Number of days from order to delivery Competition delivery times
Increased coupon use from Web coupons	Number who redeem
Build communities on the site	Number of registrations to community Number of posts to community bulletin board
Value for Business Partners	
Increase number of affiliates in program	Number of affiliates over time
Cross-sell to partner sites	Number of visitors to partner site from our site

Innovation and Learning Perspective	
Goals	Possible Measures
Online service innovation	Number of new service products to market in a year Number of new service features not offered by competitive offerings Percent of sales from new services
Continuous improvement in CRM system	Number of employee suggestions Number/type of improvements over time
High Internet lead to sales conversion	Revenue per sales employee from Internet leads Number of conversions from online leads
Increased value in knowledge management system	Number of accesses by employees Number of knowledge contributions by employees
Successful penetration of new markets	Percentage of the firm's sales in each new market

Internal Perspective	
Goals	Possible Measures
Improve the quality of online service	Target market survey Number of customers who use the service Time to run the service software from Web site
Quality online technical help	Amount of time to answer customer e-mail Number of contacts to solve a problem Number of problems covered by Web site FAQ Customer follow-up survey
Quick product cycle time	Number of days to make the product
High product quality for online service	Product test statistics on specific performance measures

Web server size adequate and operational 24/7	Number of actual simultaneous Web page requests ? maximum possible Percentage of up-time for server Number of mirrored or backup sites
Optimized number of customer service reps responding to online help	Number of inquiries to customer service rep ratio
Superior Web site content management	Number of updates per week Web site log traffic pattern statistics
Optimized inventory levels	Average number of items in warehouse Inventory turnover Supplier speed to deliver product
Supply Chain Value to firm	
High supplier satisfaction	Supplier profits from our firm's orders
Partner value	Number of visitors from partner site to ours and number that purchase Partner contribution to product design

Financial Perspective	
Goals	Possible Measures
Increase market share for online products	Market share percentage (firm's sales as percentage of industry sales)
Double digit sales growth	Dollar volume of sales from one time period to the next
Target 10% ROI within one year for each new product	ROI
Lower customer acquisition costs (CAC) in online channel	CAC (costs for advertising, etc. divided by number of customers)
Increase conversion rates at Web site	Number of orders divided by number of visitors to site
Increase individual customer profit	Average order value Profit contribution over time less CAC
Achieve at least a 10% Net profit in first year of new product	Net profit as percentage of sales

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An Empirical Study on Consumer Acceptance of Digital Products and Physical Products in Electronic Markets

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Abstract

Although E-Commerce has marketability as well as usefulness, there are few empirical studies on consumer acceptance using the transaction cost theory. This paper suggests that consumer product acceptance is determined by the difference of transaction cost. And the uncertainty and asset specificity which determine the transaction cost can affect the consumer acceptance of products. In addition, we focus on the different characteristics of digital and physical products in electronic markets.

We found that transaction cost, uncertainty, and asset specificity have a significant effect on consumer product acceptance of digital products, while only transaction costs and uncertainty have a significant effect on consumer product acceptance of physical products. In consequence we provide companies to some guidelines of strategic planning for the development of products in electronic markets.

1. Introduction

Recently electronic markets have reduced time and costs, and provided opportunities by creating new values, such as a cyber marketing channel. Physical products were the only goods available for marketing in the early stage of electronic markets. However, the importance of marketing for digital products has been increasing in that demands on digital products have been increasing dramatically in information-oriented society.

The main reason to take notice of digital products is that the purchasing process of digital products differs from that of physical products. And digital products have different economical characteristics from physical products; Reproduction cost and distribution cost are almost zero, and then the price of digital products can continue to fall. Furthermore, the price of digital products may be set high according to the value that customers feel as the products could be customized and personalized to meet the desire of customers [24][32]. That suggests that customer acceptance of products could be different according to the characteristics of products.

Previous studies said that consumers preferred a purchase in the market where transaction costs were low. And the asset specificity and uncertainty of products and a process affected transaction costs [23] [25] [30] [38]. However, since the advent of the Internet, those studies were not enough to explain consumer's purchase with economic terms in electronic markets. Some researchers have studied the purchase of physical products with a viewpoint of transaction cost in electronic markets [4] [5] [10] [23] [25] [29] [30]. But studies on adoption of digital products in electronic markets have hardly been performed. Therefore, this study aims to find that the influence of asset specificity and uncertainty of physical products is different from that of digital products in electronic markets based on the transaction cost theory. Furthermore, it is going to verify whether consumers' product acceptance is distinguishable regarding the different characteristics of physical and digital products.

This study contributes for firms to realize economic incentives and different characteristics of physical and digital products in electronic markets. It causes firms to be able to cut down costs, not just seeking low price strategies but overall cost reduction strategies. Thus, the study also contributes to suggest some guidelines of differentiation strategies for firms to develop new products for meeting consumers' needs.

This paper is structured as follows. The next section shows the transaction cost theory. In the third section, we develop hypotheses through reviewing previous studies on consumer purchase process regarding each products group; physical products group and digital products group. Section four describes the measurement and methodology, followed by empirical results in Section five. Section six discusses main findings, and Section seven concludes this study.

2. Transaction Cost Theory

The transaction cost theory has been developed as a useful framework to explain business administration such as management strategy, marketing, and organizational theory [1] [7] [12] [19] [20] [28] [37]. The transaction

cost means the cost of negotiating, monitoring, and enforcing accompanied by an exchange between two parts. Williamson[38] said that the transaction cost has been formed, because opportunism occurs by the limited rationality that human beings have. Moreover, the transaction cost is produced according to properties of assets such as products and services as the object of exchange, and it is caused by conditions such as uncertainty, information impactedness, and atmosphere of transactions.

Particularly, the asset specificity is an important concept among some factors to affect transaction cost. If assets are specific, the possibility to be exposed to opportunism is high. The transaction of the assets is hard, and then a high transaction cost is produced. Whether non-specific or specific assets are decided by the impossibility of relocating the assets without sacrificing their value. The asset specificity refers to the degree to which durable investments, that are undertaken in support of particular transactions, the transaction-specific skills and assets that are utilized in the production processes and provision of services for particular customers, such as human (e.g., people who have specific technology or knowledge), physical (e.g., specific facilities), site (e.g., geographical proximity), and temporal asset specificity (e.g., specific time) [23] [25] [38].

Uncertainty, presented with the second property by affecting transaction costs, means that the impossibility of forecasting problems and accidents occurred in the middle of transactions. It causes transaction costs, since decision-making is difficult because people cannot forecast future problems. It can be divided into two, the uncertainty of a transactions itself occurred in the transactions process and the uncertainty of a product itself. Researchers insisted that the more complicated the transactions and the product explanations are, the more the uncertainty and transaction costs have increased [23] [25] [38].

3. Hypotheses

3.1 Physical Products, Transaction Cost, and Consumer Acceptance

Studies on the transaction cost theory have been performed in both electronic markets and traditional markets. Most studies showed that the transaction cost of physical products in electronic markets became lower compared to traditional markets [4] [5] [10] [25] [39].

Williamson [39] insisted that electronic markets have a low transaction cost, but high risks in the process of transactions. That is, a price and search costs of products become lower in electronic markets, whereas the process of decision-making has been complicated because of the risk of the fall of product's value in the middle of transactions, and the cost related to a physical transfer from a seller to a buyer and the cost for participating markets.

Malone et al. [25] suggested that electronic markets have been more efficient since as information technology

is improved, it simplifies a complicated product explanation and decreases asset specificity in electronic markets.

Clemons et al. [10] showed firms make decisions on minimizing the risks and costs of producing products. That is, improved information technology causes the firms to reduce costs of exchanging and processing information by the reduction of coordination costs. And it makes the possibility of information usage and processing capability increase.

Bakos [4] [5] proposed the hypothesis on reduced price in electronic markets. He suggested that the Internet have attracted thousands of buyers and customers to electronic markets and then electronic marketplaces have been generated. And the search cost of the electronic marketplaces has been getting lower and lower.

Liang & Huang [23] studied that consumer acceptance based on the transaction cost theory applied for electronic markets. They suggested that consumers move to the electronic markets which have a low transaction cost. Because consumers' product acceptance is influenced by transaction cost consisted of the uncertainty and the asset specificity. This study also showed that some products, such as books and flowers are more suitable for marketing on the web than any other physical products.

As discussed above, in electronic markets, the problems or risks occurred in the process of the transactions have decreased and the properties of products have been explained as enough as buyers can select the product because of improved the availability of information technologies. And then the uncertainty of the transaction and the product becomes lower. Besides, asset specificity has become lower since it is not necessary for customers to stick to the specific time or the specific site. As a result, the transaction cost decreases [26] [40]. Therefore, consumer acceptance of physical products in electronic markets will increase. Accordingly, this discussion leads to the following hypotheses.

Hypothesis 1: The consumer acceptance of physical products increases in electronic markets. Because the transaction cost of the products becomes low as uncertainty and asset specificity have decreased.

Hypothesis 1-1: The transaction cost of physical products becomes low as uncertainty and asset specificity of them have decreased in electronic markets.

Hypothesis 1-2: The consumer acceptance of physical products increases as the transaction cost of the products becomes low in electronic markets.

Hypothesis 1-3: The consumer acceptance of physical products increases as uncertainty and asset specificity of the products becomes low in electronic markets.

3.2 Digital Products, Transaction Cost, and Consumer Acceptance

As discussed the chapter 3.1, transaction costs has decreased gradually in electronic markets. However, these results maybe just applying for physical products. Could the same result be expected for digital products? Because

they have different characteristics from physical products [31].

Products mean the things firms are going to sell, that is, physical things in narrow meaning. In a broad sense, however, products mean the tangible and intangible things satisfying human desire and providing functional, social, and psychological benefits and utilities. Therefore, products are all things including products, services, and ideas that can be acquired through exchange [24]. Physical products are music CDs, shavers, groceries, the clothing which exist in the traditional store and are able to touch directly, whereas digital products have not physical forms such as software, traveling information, an electronic books, information of stocks, and MP3 files [6] [21] [31].

Digital products can satisfy consumer demands by providing customized products and services quickly, and can become the source of inventing values by making knowledge as products through information technology [3] [11] [13] [14] [15]. Bakos & Brynjolfsson [6] insisted that digital products can create new opportunities through contents re-package strategies such as licensing, rental, a differentiated prices and using cost per unit. Thus, the asset specificity of digital products will be increased by providing specific products to a customer because of the characteristics of digital products that can be customized and personalized in electronic markets. For example, customized and personalized digital products are software by version, traveling information, education information, and stocks information for an each customer.

For digital products, software offers enough product information and gives an opportunity of using a trial version [6]. Therefore, the uncertainty of digital products is considered to be low in terms of the characteristics of these digital products. That is, the uncertainty of digital products becomes lower by providing enough product information and also transactions are simple in electronic markets, and the transaction costs are decreasing.

Digital products have the following advantages. Firstly, the products are not extinguished (indestructibility). Secondly, the products are very likely to be changeable easily (transmutability). And thirdly, the products are reproduced easily (reproductibility) [31]. It costs very much to produce the first digital product. But it does not cost much to reproduce it because marginal cost is almost zero. The transactions of digital products are expanded to various fields such as online newspaper, digital image, music, software, all kinds of information services and games through the Internet. Some studies suggested that transactions of digital products in Internet business is getting more and more active, even though the market size of digital products is far small comparing to that of a physical product at the moment [6] [21] [31].

It was presented that a price of digital products was low in study of Strader & Shaw [29] which studied a cost difference between traditional markets and electronic markets. Some physical products have advantages in a product price, search cost and a sales tax section on the buyer side and in advertising cost and indirect cost on the seller side, whereas digital products have advantages in

almost all fields such as marketing cost, overhead cost, inventory cost, product cost and distribution cost in electronic markets. Strader & Shaw [29] suggested consistent results that the price of digital products and search cost in electronic markets is lower than that in traditional markets.

As discussed above, the asset specificity of digital products will increase by offering customized products and services quickly and expanding benefits and values that an each customer feels. And then consumer acceptance of digital products increases. The uncertainty of digital products will be low in that customers can easily get all the information of products and even experience them in advance through the Internet. However, the transaction cost of digital products will hardly increase because added costs to expand benefits and values are lower than that of physical products and firms are able to apply various price strategies to the transaction of digital products [3] [6] [11] [13] [14] [15]. Accordingly, consumer acceptance of digital products will still increase. The following hypothesis summarizes the above discussion.

Hypothesis 2: The consumer acceptance of digital products increases in electronic markets. Because the transaction cost of them becomes low even though uncertainty has decreased but asset specificity has increased.

Hypothesis 2-1: The transaction cost of digital products becomes low even though uncertainty has decreased but asset specificity has increased in electronic markets

Hypothesis 2-2: The consumer acceptance of digital products increases as transaction cost of them becomes low in electronic markets.

Hypothesis 2-3: The consumer acceptance of digital products increases as uncertainty has decreased but asset specificity has increased in electronic markets.

4. Research Methodology

4.1 Sample and Data Collection

The subjects were individuals (male and female) who have purchasing power in an electronic market and have experience that they have ever used the Internet. The sample was consisted of 238 undergraduate students who were taking Internet business course, 72 graduate students (business persons are 44 among them), and 77 businessmen including I firm and S firm. The data collection was performed during two months from May to June in 2000. Eventually, 340 responses were obtained.

Out of the 340 responses, 57 had to be excluded because 47 of them had incomplete data and 10 of them reported that they had never experience in purchasing in electronic markets. As a consequence, 287 questionnaires remained as the samples for this study.

4.2 Physical Products and Digital Products

According to Kim [21], for physical products, books

and cards were ranked at the highest, and then PC and computer parts and software were ranked high in electronic markets. For digital products, Kim [21] also suggested several widely used products such as traveling information services, reservation of hotels or performances, information services on stocks, education services, electronic books that could be read through the Internet, games and MP3 files in electronic markets. Therefore, this study selected ten physical and digital products considering the study of Kim [21] and the characteristics of the products. The physical products selected in this study were books, music CDs, household electric appliances, life goods, shoes and clothes, and gift goods and the digital products were software, traveling and reservation information services, educational information services, and information services on stocks.

4.3. Measurement of Variables

Consumer acceptance was measured by one item on a five-point scale. This item was developed by relying on the measure of Liang & Huang [23]. Transaction cost was measured by seven items on a five-point scale. These measures were adopted from the work of Williamson [37] [38] and Malone et al [25]. Uncertainty was measured by two items on a five-point scale. These items were developed by relying on the measures of Williamson [38], Malone et al [25], and Liang & Huang [23]. Asset specificity was measured by five items on a five-point scale. These measures were adopted from the work of Williamson [37] [38], Malone et al [25] and Liang & Huang [23].

<Table 1> Measurement of variables

Construct	Items	Operationalization
Consumer Acceptance	Decision on purchasing products	(Liang & Huang, 1998)
Transaction Cost	Search Cost	(Williamson, 1975), (Williamson, 1981), (Malone <i>et al.</i> , 1987)
	Comparison Cost	
	Examination Cost	
	Negotiation Cost	
	Order/Pay Cost	
	Transportation Cost	
	Post-Service Cost	
Uncertainty	Product Uncertainty	(Williamson, 1981), (Malone <i>et al.</i> , 1987), (Liang & Huang, 1998)
	Process Uncertainty	
Asset Specificity	Site Asset Specificity	(Williamson, 1981), (Malone <i>et al.</i> , 1987), (Liang & Huang, 1998)
	Physical Asset Specificity	
	Human Asset Specificity	
	Brand Asset Specificity	
	Time Asset Specificity	

The reliability of these items was confirmed, since the Cronbach's alpha of transaction cost, uncertainty, and asset specificity were estimated as 0.82, 0.78, and 0.84 respectively. Further, the validity of these items was confirmed by factor analysis.

4.4 Method of Analysis

Data analysis was conducted using a structural equation modeling to evaluate research model and understand the relationship of four variables such as consumer product acceptance, transaction cost, uncertainty, and asset specificity. Structural equation modeling has many advantages over path analysis or regression analysis especially when the observed

variables contain measurement errors and the interesting relationship is among the latent (unobservable) variables [7].

To analyze the difference of the relationships of four variables according to the characteristics of products, this study divided products into two product groups, such as a physical product group and a digital product group and evaluated the research model with each products group.

5. Results

5.1 Hypothesis 1 Test

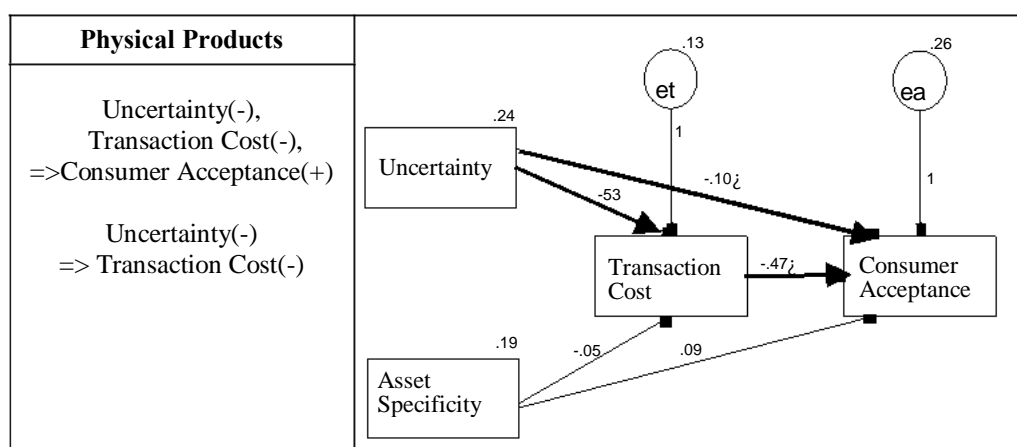
Consumer acceptance of physical products in electronic markets was evaluated. Table 2 showed coefficients of variables and Figure 1 suggested the result

of consumer acceptance of physical products.

<Table 2> Coefficient matrix of consumer acceptance of physical products

	Transaction Cost	Uncertainty	Asset Specificity	Squared Multiple Correlations
Consumer Acceptance	-.470*	-.102*	.092	18%
Transaction Cost		-.529*	-.051	29%

*p<0.05; **p<0.01.



*p<0.05; **p<0.01.

<Figure 1> Consumer Acceptance Model of Physical Products

Structural equation modeling was conducted using AMOS to test the fit between research models (Figure 1) and data set. There is no single recommended measure of model fitness. Therefore, a variety of measures are suggested [8] [16] [18]. Since chi-square statistics is very sensitive to both sample size and distribution of observed variables, several fit measures must be considered simultaneously.

In general, the goodness-of-fit is satisfactory when chi-square is not significant, the Goodness of Fit Index (GFI) is greater than 0.9, the Adjusted Goodness of Fit Index (AGFI) is greater than 0.8, and the Root Mean Square Residual (RMSR) is lower than 0.1 [18]. Overall, the various goodness-of-fit statistics indicate that the model shows a good fit with the data. In our dataset, the value of GFI is 0.996, the AGFI is 0.96 and the RMSR is 0.007 respectively.

As for the physical products, uncertainty (-0.529) significantly influences transaction cost indirectly but

asset specificity insignificantly leads to transaction cost. Transaction cost (-0.470) and uncertainty (-0.102) significantly influence consumer acceptance of physical products directly, whereas the direct influence of asset specificity on consumer product acceptance is not significant. That is, transaction cost and uncertainty are significant variables for consumer to accept physical products. Therefore, Hypothesis 1-2 is supported and Hypothesis 1-1 and Hypothesis 1-3 are partially supported.

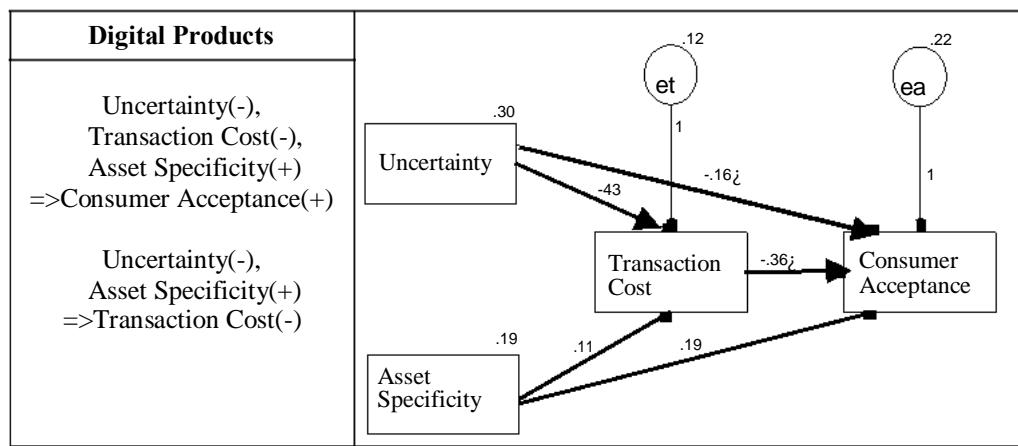
5.2 Hypothesis 2 Test

Consumer acceptance of digital products in an electronic market was evaluated. Table 3 showed coefficients of variables and Figure 2 suggested the result of consumer acceptance of digital products.

<Table 3> Coefficient matrix of consumer acceptance model for digital products

	Transaction Cost	Uncertainty	Asset Specificity	Squared Multiple Correlations
Consumer Acceptance	-.364*	-.163*	.194*	19%
Transaction Cost		-.433*	.107*	32%

*p<0.05; **p<0.01.



*p<0.05; **p<0.01.

<Figure 2> Consumer Acceptance Model of Digital Products

Overall, the various goodness-of-fit statistics indicate that the model shows a good fit with the data. In our dataset, the value of GFI is 0.997, the AGFI is 0.974 and the RMSR is 0.006 respectively.

As for the digital products, uncertainty (-0.433) significantly influences transaction cost but asset specificity (0.107) significantly leads to transaction cost indirectly though the strength is marginal. Transaction cost (-0.364), uncertainty (-0.163) and asset specificity (0.194) significantly influence consumer acceptance of digital products directly. Therefore, all Hypothesis 2-1 to 2-3 are supported.

6. Discussion

The verification of the hypotheses about digital products showed that uncertainty, asset specificity, and transaction cost are critical variables to cause consumers to accept them. The uncertainty and asset specificity have indirect influence on transaction cost, and this accords with transaction cost theory of Williamson [39]. For digital products, the indirect effect of asset specificity on transaction cost decreases the strength that transaction cost has effect on consumer products acceptance, whereas

the consumer acceptance of digital products was higher than that of physical products because of the direct influence of asset specificity on consumer products acceptance.

However, the verification of the hypotheses about physical products showed that the influence of asset specificity on consumer products acceptance is not significant. It could be interpreted that asset specificity is relatively small, and the physical products were not able to affect consumer acceptance because of standardization and simplification of products in an electronic market.

7. Conclusions

Based on the transaction cost theory, this study suggested a consumer acceptance model of physical and digital products in electronic markets and verified the relationship of transaction cost, uncertainty, asset specificity, and consumer acceptance. The study showed that transaction cost is a critical factor for consumers to accept products even in electronic markets.

The consumer acceptance was different according to two products groups. For digital products, there were negative(-) effect of transaction cost, negative(-) effect of

uncertainty and positive(+) effect of asset specificity on consumer acceptance. However, for physical products, transaction cost and uncertainty had negative(-) effect on consumer acceptance. That is, the study showed that the transaction cost of digital products is different in a degree of asset specificity and uncertainty. The uncertainty of digital products could decrease as providing product information more; for example order and delivery information or payment information in electronic markets. Transaction costs have become low since uncertainty is decreased. Eventually, the consumer acceptance of digital products goes up. Furthermore, the asset specificity of digital products could increase by personalization and customization in electronic markets. That means that consumers are willing to accept customized own products because digital products can give high value toward specific users.

Therefore, companies should develop new product lines considering the characteristics of digital products. In order to sell digital products efficiently in electronic markets, it will be necessary to establish strategies that manage uncertainty and asset specificity related to products.

This paper suggests that firms could recognize digital products newly considering the characteristics of the products. That is, the paper suggests that the asset specificity of digital products is a critical factor and a way that increases consumer acceptance of digital products in electronic markets. Secondly, the consumer acceptance model contributes to provide some guidelines of product development and strategic planning for digital products.

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The Impact of Customer Profile and Customer Participation on Customer Relationship Management Performance

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Abstract

There are two main sources of knowledge about customers: customer profile and customer participation. The companies use information technologies to analyze the customer profiles and extract tacit knowledge about customer via customer participation. The result of this experiment demonstrates that the use of customer profile improves customers' perception on goods quality and increase the effectiveness of Customer Relationship Management (CRM). In addition, customer participation can improve customers' perception on goods quality and enhance performance of CRM through perceived participation. The result indicates that the customer profiles and customer participation are two crucial factors for companies to maintain customer relationship.

1. Introduction

Companies are now focusing on high customer retention and maintaining long term customer relationship [2][28]. Customer relationship management (CRM) is a high customer retention strategy. It is very important to know more about customers' needs and offer customize products and services in order to improve customer satisfaction and loyalty [6]. To collect customers' profiles and to get customer participate are two main strategies to know more about customers' needs. CRM research highlighted the knowledge about customer are critical but the tacit knowledge of customer are not much

emphasized which the company need to make CRM efforts effectively [19]. Therefore, corporations should seek new interaction mechanisms to achieve complete communications and building partnership with customers and get more non-structured information of customers that is leveraged to drive CRM activities. In the context of urgent demand of tacit information about customers, customer participation in the service research should be considered as one important source of knowledge about customers besides customer profiles acquired by database technologies. Also, user participation is able to directly increase users' perception about the services provided by the companies.

The main objectives of this paper are to (1) discuss and integrate the CRM, customer knowledge management, customer participation relative researches to infer the conceptual model include customer profile and customer participation and measures of CRM performance; (2) to investigate the relationship between the degree of using customer profile and customer's perception on goods quality; and (3) to investigate the relationship between the degree of customer participation and customer's perception on goods quality and CRM performance.

To draw the impact of customer profile and customer participation on the CRM performances, this study examines the theories of CRM, customer participation and customer knowledge management.

2. Customer relationship management

The new marketing paradigm is based on knowledge and experience [21]. The knowledge-based marketing paradigm indicates corporations need to know more about customer and the experience-based marketing paradigm suggests that bring more interactions into customer related activities. From the 90s, there are lots of similar terms: customer management, customer information systems, customer value management, customer care and sometimes customer centricity or customer-centric management, but now clearly, the term Customer Relationship Management has overtaken the market [4].

CRM is an interactive process that turns customer information into customer relationships through active use of and learning from the information. It is a cycle for encompassing major group of actions: knowledge discovery, market planning, customer interaction, and analysis refinement [28].

Ryals and Knox [25] address the philosophical bases of CRM are: a relationship orientation, customer retention and superior customer value created through process management and successful implementation of CRM requires cross-functional reorganization, especially marketing and IT, to work closely together to maximize the return on customer information. The impact of use of IT on marketing reflecting the database marketing grew in significance in the late 1980s [21]. In summary, CRM integrated practices of database marketing to support short-term market tactics and conceptual frame to relationship marketing to develop long-term customer relationship strategy.

3. Customer knowledge management

There are some characteristics about the companies perform well on customer relationship management: excellent product, excellent management, and the use of knowledge about customer [7]. Customer knowledge management is going to be a research stream in Taiwan

recently [14]. There is similar concept: knowledge-enabled customer relationship management (KCRM) addressed by Tiwana in 2001. KCRM is a business model/strategy to manage customer knowledge to generate value-creating lock-ins and channel knowledge to strengthen relationships and collaborative effectiveness. It's more than a technology-focused solution [30].

Customer knowledge management is integrating with IT and business processes turns the customer information to knowledge which used to support marketing, sale and service decisions and build up good and strong relationships with customer base on knowing customer's need and create value to customer [14]. Knowing customer more, the corporation can precisely invest on valuable customers and reduce the cost on valueless customers [31]. In summary, CKM is the management technique turns the information from customer to the strategic-support knowledge to reinforce the value of goods which company offer for customer.

4. Customer participation

Insufficient knowledge base of customer limits the value which company can offer to the customers [7][39]. The basic component of customer knowledge comes from customer profile that obtained by use of database technologies in organizations. The customer profile is a more structured part of customer knowledge and a more non-structured part could come from customer participation.

In the service research area, customers contribute information or efforts in the service encounter process with the service provider fulfill the process together while the service produced and consumed at the same time [5][13][23][29]. For example, the patients describe their own symptom to doctors. It makes the process of diagnosis more smoothly. These services performance is heavily influence by the information and efforts of customers [13][17].

There are different dimensions of participation including personal interaction, information sharing, and responsible behavior. It suggests that participation has a positive impact on customer's perceived product/service quality and customer satisfaction and a mixed impact on retention. Different aspects of participation do not contribute equally in these models; specifically personal interaction was found to have more significant effects while the information sharing were thought to be of particular significance from a conceptual perspective [13]. There is a similar result in the new product development research area. It indicates that through close contact with customers, designers can accurately identify market requirements, quickly refine product specification and reduce time to market to remain competition [10].

Not much CRM research did specific effort on getting and using the non-structure information about customers [19]. And customer participation could fulfill the shortage of applications gaining tacit customer knowledge. Customer participation in the delivery of service process highly related the perceive quality of service, customer satisfaction and new product's performance [13][17]. Customer would contribute his own information in the process of participation and also get information about the corporation. This is a two-way communication between buyer and seller which would create impacts on the CRM's performance.

There are some similar discussions on participation in numbers of different research areas. In the service research, customer participation refers to the contribution of customer information and effort spent in the process of service encounter [5][13][23][29]. Customer participation influence the quality of service [13][17]. In the information system development research, user participation would influence user perceived system success and user satisfaction [34]. In the advertisement research, scholars concern about the impacts of customer involvement of advertisement and products on the

purchase decisions [37].

5. The research framework and hypothesis

Figure 1 presented this study's conceptual model derived from preceding discussion.

There are two main kinds of knowledge sources in the CKM construct, Customer profile and Customer Participation, the former represent use of IT to acquire and create information about customer in the organization and the another shows there are two-way communication and interaction between corporation and customers. In the CRM performance construct includes three measurements: Customer Satisfaction, Customer Loyalty, Customer Retention, this conclusion drew from the literature [8][16][33].

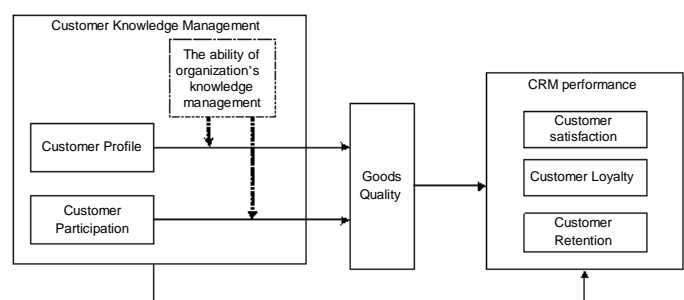


Figure 1. Conceptual model

5.1 The effect of customer profile on perceived goods quality

Goods mean the service or product which company offers to customers. Although there are many measurements to examine the quality of products, customers usually determine the quality of product base on their own subjective points of view [35]. From this viewpoint, the main factor of product's quality would base on the degree of conformation to customer demand. And it's harder to measure the quality of service when the goods is intangible [23]. The output of service is the process itself. The judgment of service quality would base on customer experiences and perceptions on the process [35]. The above discussion shows that it is crucial to measure customers' perception on goods quality.

Customer profile is a base form of customer knowledge. By obtaining and analyzing customer profiles, corporation can develop products and services to fit the customer's needs. Showing customers that the company is using their profiles to provide customized goods will also lead users to raise their perception on good. To examine this proposition, we propose the first null hypothesis of this research:

H1: Company obtained and used of customer profile could not influence its good's quality offer to customer.

5.2 The effect of customer participation on perceived goods quality and CRM performance

Besides getting customer profile to find out customer's needs, corporations also need to seek solution to gain more tacit information from customer to know customer better [19]. This situation indicates corporation should build some channels and launch activities to enable the transform of tacit information with customer. Based on preceding discussion on customer participation, it is possible for corporation to interact and get insights of customer needs through customer participation. Getting customers to participate in value delivery processes helps customers to know corporation ability better and raises the customers' perception on goods. The customer participation has also positive effects on customer satisfaction, customer loyalty and customer retention [10][13][17]. To examine this proposition, here propose the second and third null hypothesis of this research:

H2: Customer participation could not influence the goods' quality that companies offer to customer.

H3: Customer participation could not influence the performance of CRM.

H3a: Customer participation could not influence the customer satisfaction.

H3b: Customer participation could not influence the customer loyalty.

H3c: Customer participation could not influence the customer retention.

5.3 The effect of ability of organization's knowledge management

The building design research pointed out that there are several reasons that buildings do not meet the needs of their users, such as clients' need are not studied and documented and hard to trace and management these requirement and it also proposed a project focuses on the development of methods and tools to capture customers needs and interpret them into requirement and to manage the conformity of technical solutions [15]. It shows that organization don't know where their best knowledge is and how to use it well. The front end of company capture customer input continually while the limited ability of company's knowledge management might cause difficulties transferring the customer's requirements into new product characteristics and also to build meaningful and strong customer relationship with customer [7]. In order to discover main effects of customer profile and customer participation on the goods quality and performance of CRM, this research control the ability of organization's knowledge management as a constant construct which represents the organization use 100% of customer knowledge well and not examine this construct's effect in this framework.

5.4 The effect of goods quality on CRM performance

Service quality the company provide to customer positive affect the customer relationship quality, customer satisfaction and loyalty [20][32]. The quality of goods would influence the customer's buying decision-making. When quality of goods is higher than customer's expectation, customers are motivated to buy the goods. The goods quality depends on customers' subjective perceptions on how these high quality goods will bring them benefits [35]. High perception of goods quality leads to high customer satisfaction, loyalty and retention. To examine this proposition, here propose the third null hypothesis of this research:

H4: The quality of goods could not influence performance of CRM.

H4a: The quality of goods could not influence customer satisfaction.

H4b: The quality of goods could not influence customer loyalty.

H4c: The quality of goods could not influence customer retention.

6. Research Design

To test the relationships of customer profile and customer participation on perceived goods quality and performance of CRM, this research employ an experiment with scenarios of services encountered and the recall-base questionnaire. The primary advantage of using scenarios is that they eliminate difficulties of observation on the use of customer profile and the practice of customer participation in organization's everyday working. And also the use of scenarios reduces biases from memory lapses, rationalization tendencies, and consistency factors, which are common in results based on retrospective self-reports [26].

Recently, the on-line bank has prompted their on-line services and this would be a focal development in the future of the banking industry. This is the reason that this research used on-line bank service as scenarios and focus on five on-line services: credit card's bonus and gift exchange service, high amount transaction confirmation, payment reminder service, comments, and new service development conference, to narrow down the complexity and more precise reappearance of variable manipulation.

The subjects for this experiment were composed of students from four departments of EMBA in the Fu-Jen University. There were 119 EMBA students involved in the experiment and data collected using individually completed questionnaires after the last step of experiment. Of the 119 subjects, 96 subjects' questionnaires were valid. Among these 96 subjects, 68 were male, 28 were female.

7. Experimental Design

The experiment employed a 2X2 between-subjects design, in which customer profile and customer participation were manipulated. Each treatment is a scenario that was combination of one of two customer profile scenarios (high or low) with one of two customer participation scenarios (high or low).

This study deemed these three conditions would affect the perception of subject on the process. After separating subjects based on these conditions, assign subjects based on questionnaire filling time would reach random sampling. Subjects were asked to fill out the questionnaire and set their own account and password which be used to login the experiment system as realized scenarios of on-line bank. Subjects then read the explanation of specific terms and notice. The program drew data from the personal-data questionnaire to assign subject into one treatment of experiment. Subjects used their own account and password to login the on-line bank of the experiment. The first page subjects read was subject's account data which was default value represented the scenarios of on-line bank. Subjects were asked to transfer money for credit card payment used the on-bank interface which was a practice for subjects to familiar the operation of experiment on-line bank system and also a cue that the subject was one of on-bank customer. Subjects will then proceed to credit card bonus and gift exchange service. This step was the beginning of experiment's manipulation. The different semantics and operation on the page of on-line bank represented each manipulation of the experiment. Subjects then updated the setting of payment inform service, high amount transaction confirmation service. The different semantics and operation on the page of on-line bank represented each manipulation of the experiment. Only subjects in high participation treatment then asked to provide their comments. The last step is to ask subjects to participate in a new service development conference.

After the manipulations, subjects fill out the questionnaires based on the experience of previously operations of the on-line bank system.

8. Manipulation of factors and Measurement of Variables

Customer profile and customer participation are two independent variables of this study respectively. Each of them were manipulated as high and low degree based on the previous researches discussed above and represented as on-line banking system. The detail of manipulation and definition of independent variables are discussed below.

8.1 Customer Profile

Customer profile variable indicated that organization has had acquired the customer's information by different kinds of channels or systems to transform this information into practical instruments to provide customized goods. This study manipulated low and high degree of customer profile by the different semantic descriptions on the webpage such as "these gift are prepared for you based on your past transactions via our on-line banking service" as the cue and let subjects believed this on-line banking system provided customized service base on their own profiles and this would be the highly customer profile degree.

8.2 Customer participation

Customer participation means customer has to contribute some effort or information in the process of products or service fulfillment for customer. And this variable indicated that organization had built mechanisms and also invites customers to participate actively. This study manipulated this variable by supply different flexibilities of services for customers in the low and high customer participation treatments. In the high customer participation treatment, the subjects have more than one options base on their own demand and there was only one choice for subjects in the low participation treatment. For example, subjects in high participation can decide mean

and time to get informed on the due date of payment and the subjects can not decide in the low participation treatment.

8.3 Questionnaire

After going through all of the experiment steps, subjects were asked to fill out the questionnaires. The questionnaire is divided to two sections: first section contains four questions to check whether the subject perceived the proper scenarios in the right manipulation treatment. And the second section contains 20 questions of the intermediary and dependent variables included perceived goods quality, customer satisfaction, customer loyalty, and customer retention. All the questions are 7 points likert scales used number 7-1 presented very strong agree to very strong disagree and positive semantic statement.

9. Result

9.1 Data Validation

To measure the internal consistency of the collected date, this study assessed the instrument's reliability by the Cronbach Alpha coefficient. The result presented in the table 1. All Cronbach alpha values reach the level of generally considered acceptable reliability.

Table 1. Cronbach Alpha coefficient value

Constructs	Number of items	α
Perceived customer profile using	2	0.78
Perceived participation	2	0.66
Goods quality	5	0.86
Customer Satisfaction	4	0.89
Customer Loyalty	6	0.80
Customer Retention	1	1.00

The questions were adapted from relative researches and examined by two experts. Questions were modified to reflect problems encountered by the pretest subjects. The content validity and face validity would be acceptable.

To ensure the subjects had perceived the scenarios

in the right aspect, this doubt was tested using the two-tailed t-test. The results presented in table 2, 3, 4, and 5.

Table 2. Mean and St. Dev. of high and low customer profile

	Treatment	n	Mean	s.d.
Customer profile	H	49	5.73	1.24
	L	47	4.75	1.63

Table 3. t-test result of high and low customer profile

	t-value	d.f.	p-value
Customer profile	3.328	94	0.001*

*p<0.05

Table 4. Mean and St. Dev. of high and low customer participation

	Treatment	n	Mean	s.d.
Participation	H	45	5.46	1.17
	L	51	4.89	1.52

Table 5. t-test result of high and low customer participation

	t-value	d.f.	p-value
Participation	2.016	94	0.047*

*p<0.05

The results show that most of subjects perceived the right scenario and the high and low degree of manipulation also made significant difference.

9.2 The effect of customer profile

Table 6 shows the result of main effect of two independence variables on all dependence variables.

Table 6. Results of MANOVA

		F-value	p-value
Customer Profile	Goods quality	5.033	0.027*
	Customer satisfaction	1.303	0.257
	Customer loyalty	2.002	0.160
	Customer retention	0.140	0.709
Customer	Goods quality	1.064	0.305

Participation	Customer satisfaction	1.440	0.233
	Customer loyalty	0.333	0.565
	Customer retention	0.303	0.583

*p<0.05

The result shows that the use of customer profile would reflect on customers' perception of goods quality (p=0.027). Thus null hypothesis H1 is rejected. That is, the degree of using customer profile by company is positively related to customers' perception of goods quality. This means subjects have perceived the service was designed based on their historic transaction and are more satisfied for their needs thus raised their perception on the goods quality.

9.3 The effect of customer participation

The result indicated customer participation is not significantly related to the subjects' perception on goods quality, customer satisfaction, loyalty and retention (see table 6). Thus there is no significant evidence to reject the null hypothesis 2 and 4. Wu [34] suggests that perceived participation should be an intermediary between participation and user satisfaction in the information system development research area. It would be discussed later of this paper to see if the perceived participation makes different.

9.4 The effect of goods quality

The effect of perceived goods quality on the CRM performance is presented in the table 7. It shows that goods quality makes significant effect on the customer satisfaction, loyalty, and retention thus the hypothesis 3 is rejected.

Table 7. The effect of goods quality

		F-value	p-value
Goods Quality	Customer satisfaction	9.313	0.000*
	Customer loyalty	4.698	0.000*
	Customer retention	3.013	0.000*

*p<0.05

10. Discussion

According to Wu [34], perceived participation is an intermediary between user participation and user perceived success and satisfaction on the information system development. Thus here to see if the same result comes out in this study. Table 8 and 9 shows the effect of perceived participation.

Table 8. The effect of Customer participation to Perceived participation

		F-value	p-value
Customer participation	Perceived participation	4.063	0.047*

*p<0.05

Table 9. The effect of Perceived participation

		F-value	p-value
Perceived participation	Goods quality	7.78	0.000*
	Customer Satisfaction	9.55	0.000*
	Customer Loyalty	4.861	0.000*
	Customer Retention	3.845	0.000*

*p<0.05

The results shows that perceived participation indeed intermediate between customer participation and customer perception of goods quality, customer satisfaction, loyalty, and retention.

11. Conclusion

Based on the finding of this study, it's necessary to modify the research framework to suit the results of test. Figure 2 shows the final model.

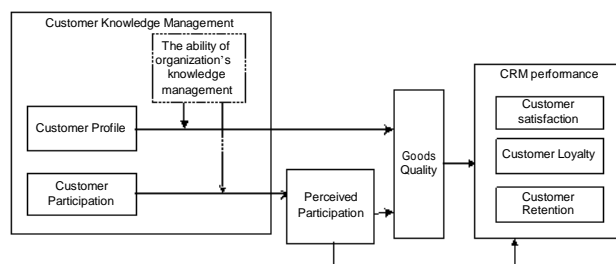


Figure 2. Modified model

This study investigated the effect of customer profile and customer participation on the goods quality. The finding suggests that the organization apply customer profiles into practical characteristics of products or service will raise the customer perceived goods quality and further affects the CRM performance. In this study, since the condition is simulated, it can be argued that the effect would be greater when the customers see their real profiles were used. Base on this study's findings, the impact of customer participation on goods quality and CRM performance is mediated by the perceived participation. In this study, users did not actually interact with representatives from the company. It can be argued that the effect would be greater when the customers interact with real person. This process changes customer's attitude toward this organization and reflect on customer satisfaction, loyalty and retention.

Although every effort was made to accomplish the scenarios of experiment toward be a near-real environment, limitations do exist because the subjects knew it is experiment and have different levels of perception as customers of an on-line bank. These would cause the inaccuracy of results between scenarios environment and the real-world cases.

Overall, this study explores the different dimensions of CRM theoretical development drawn from service research area in the context of service industry as main trend business world. These findings can be considered as the elements of building strong customer relationship that ultimately is needed in order to survive in today's competitive environment.

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A Prototype of Retail Internet Banking for Thai Customers

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Abstract

Internet Banking is one of the channels for providing banking services. It is a delivery means that banks employ to expand their services in addition to traditional services provided through a branch's counters and ATMs. This paper aims at investigation, design, and development of an Internet-based retail banking prototype for Thai customers. The data were gathered from three major sources which were; (i) a survey on existing Internet banking services both overseas and in Thailand, (ii) questionnaires distributed to Internet users, and (iii) interviews with the executives of the major Thai banks. It was found that more than half of the sample Internet users in Thailand are very interested in using Internet banking services. The main features needed are balance inquiry, bill payment, fund transfer, business information, and payment for goods purchased. The prototype was then developed and validated.

1. Introduction

For a long time, banking has been one of the most important business sectors. It deals with almost all other businesses ranging from small activities to very large ones. Banks serve as financial intermediaries for individuals, companies, corporations and institutions both in public and private sectors.

In the banking business, providing good services to customers is an essential element of which every bank is conscious. In Thailand, most Thai banks have expanded their operations by setting up more branches to gain access to more customers. Having more branches enables banks to provide services covering larger areas although it requires large amounts of money for construction and equipment, as well as the high cost of hiring more staff.

Due to technological breakthroughs, banks have brought automatic teller machines (ATMs) to provide services to the customers. With these machines, the customers can make deposits, withdraw money, and check an account balance almost any time they want, in addition to the bank-working hours. Nevertheless, numbers of ATMs are limited, i.e., they cannot be available everywhere and there are several transactions that require customers to go to the bank by themselves.

Such transactions include opening a new account, borrowing money, etc. At the same time, banks have limited working hours, thereby bringing inconvenience to the customers. Owing to exorbitant costs, banks are obviously unable to open more branches, install ATMs everywhere, or extend working hours to facilitate and respond to the demand of every customer.

Contributed by substantial growth in information technology, especially with the advent of the Internet, both public and private sectors have modernized their operations in favor of providing services to their customers. In terms of banking business, many banking activities can be done through the Internet that will make banking services available any time and anywhere, covering the customers' offices, or even customers' homes. This will eliminate the necessity of setting up more branches and install ATMs everywhere. The customers can perform several banking transactions through their personal computers with modems, and their Internet account numbers. Such a process is called "Internet Banking".

Like traditional banking, Internet banking can be divided into two main categories, i.e., personal banking or retail banking and business banking or corporate banking. For retail customers, although they have small amount of money compared to corporate ones, they all comprise a large customer base and their banking activities do occur more often and regularly. Therefore, Internet banking can be another efficient channel of delivering services to such customers.

Although Internet banking, originated in western countries, is a good alternative that helps to get rid of exorbitant costs incurred from establishing new branches and ATMs, it may lead to some important problems in Thailand. In the case of Thai banks, there may exist some questions of what is the suitable strategy in delivering the service, what are the most appropriate features to be included or what are the actual customers' requirements, as well as which way Thai Internet banking will move to in the future. Therefore, this study aims to; (i) investigate retail banking services on the Internet, (ii) conduct a series of interview and a questionnaire survey in order to study the needs for Internet banking services for Thai customers, and (iii) develop a prototype of a retail banking service on the Internet for Thai customers. The proposed prototype is focused on the front office

system. It also simulates the host of the bank system by building a three-tier architecture including a front office system, database system and some processes in the back office system that support the front office.

2. Review of Literature

2.1 Internet Banking

In general, there are three ways banking services can be offered electronically to the home market [1]. The first is when banks supply their customers with bank-branded software to load onto their computers at home. Then, by using a modem and dialing the bank's main computers, customers can query their balances, review their account activity, transfer funds between accounts, and pay bills. This client-based service, for which bank software is loaded directly onto the client, is offered by banks such as Citicorp and Bank of America. The limitation of this kind of service is that the customer must dial the bank directly from his or her computer. This type of connection might prove a hardship when traveling overseas.

The second kind of delivery mechanism available to banks is to use an on-line service provider. By giving their customers access to their accounts by one of these avenues, the banks are taking advantage of an existing global network infrastructure to deliver their services. In doing so, they are, in effect, outsourcing many of the security issues and responsibilities as well. Institutions such as First Chicago Bank and Bank of America are using this method, and, through various online service providers, they are providing customers with home banking.

The third method of delivering home banking services is by owning and maintaining a dedicated Web server. This mechanism provides the capability of offering customers a fuller range of services, but increases the risk for the Web owner. Financial institutions such as, Security First Network Bank and Wells Fargo have gone down this route. These banks have developed their own Web servers, and offer services directly on the Internet. Examples of Banks that offer Internet Banking are reviewed as follows;

2.1.1 Foreign Banks

- Security First Network Bank

In mid-1995, the U.S. government's Office of Thrift Supervision gave approval to Security First Network Bank (SFNB) to provide Internet-based banking services. SFNB, formed by three banking companies (Huntington Bancshares, Inc., Wachovia Corp., and Area Bancshares Corp.), is an FDIC-insured bank that basically exists only on the Internet. In October 1995, SFNB opened its government-insured checking accounts to its customers via the Internet, and as of that date it was the only bank to have received approval to

conduct online operations between accounts, update balances in real time, open accounts, and reconcile bank statements. Services also include an on-line check register that functions similarly to personal finance software, and customers can view digital images of their cleared checks. (At present, SFNB is under RBC Group).

- Citibank

Citibankonline.com, the online banking component of Citigroup, continues to enhance its already broad online banking offering. With a single login, Citibank online banking customers can view all of their accounts held at Citibank. Credit card customers can link their account to view it alongside other deposit and loan products. Furthermore, customers have the ability to link or unlink their accounts together, at their discretion. Online banking customers can also make internal transfers from their deposit accounts to their loan accounts, including their Citibank credit cards [2].

Other Internet banks are shown in Table 1.

TABLE 1
Examples of Internet Banking Services

Bank	Online Services
NetBank [4]	Account summary, tax information, fund transfer among accounts, bill payment, check copy request, check & deposit slip reorder request, bank mail, and financial calculator.
Nbank [5]	Account summary, transfer among accounts, bill payment, pending transaction, custom reports, notification system, password and personal information.
Wells Fargo [6]	Account information, foreign currency, travelers cheques, cashier's / official bank check, check copy reorder, statement request, user preferences, transfer funds, online bill payment, financial planning.
ANZ [7]	Balances and transaction history, credit card statements, fund transfer and bill payment, business accounts, share trading and investment management.
USABancShares [8]	Interactive customer service, account balance, ask questions through web site, account summary, fund transfer, loan advance, loan payment, bill payment, and message center.
Bank of America [9]	Account balances, accounts summary, fund transfer, self-service feature (reorder check, order a copy of a check or statement), download transaction information to financial management software, send and receive secure customer online mail, bill payment and bill presentment.
BankOne [10]	Account summary, download account activity, funds transfer, bill payment, bill presentment, customer service (read messages, send a message, update profile, reorder check), and financial management software.
Fleet [11]	Online Banking with HomeLink (check balance, check recent transactions, confirm cleared deposit, confirm check cashed, bill payment, personal financial software, customized PIN, online investment).

2.1.2 Thai Banks

- Siam Commercial Bank

Sceasy.com was a new service, initiated in September 1999, by the Siam Commercial Bank (SCB). SCB is the first bank in Thailand to introduce this kind of service under the name "www.scbpark.com" later changed to "www.sceasy.com". The present version of the service allows customers to use the following online services: sign-up, balance inquiry, fund transfer, fund transfer to the third party, current and past statement inquiry, check withholding, bill payment, loan application, and online shopping [3].

- Bank of Asia

Bank of Asia was the second bank in Thailand to provide an Internet banking service called "AsiaCyberbanking". Its system was tested in January 2000, and became available around September 2000. Bank of Asia does not provide application services on the Internet banking for the following reasons:

1. Before giving approval to each Internet banking applicant, the bank requires signed documents for identification purposes, despite the application screen being available in its web site. The bank considers the Thai postal service as unreliable: documents sent to customers and returned to the bank may be delayed or undelivered. Therefore, customers have to apply in person at the bank.

2. There are more likely to be junk files submitted by those who do not really want to apply for the service. Nevertheless, the bank does create mandatory information management to eliminate these junk files [12].

So far, customers in AsiaCyberbanking service include both individual and corporate customers. Online account summary, account inquiry, inter-account fund transfer, bill payment, etc. are available to individual customers, while online import-export and remittance services are provided to corporate ones [13].

- Thai Farmers Bank

Thai Farmers Bank's Internet service formally commenced operation on December 2000 under the website name "www.gototfb.com". The range of services includes application for services (such as opening a new account, applying for TFB Internet banking), balance inquiry, viewing all transactions occurred, inter-account fund transfer, fund transfer to a third party, inter-bank fund transfer, salary payment (juristic person users only), bill payment transactions, and personal information changes [14, 15]. (Thai Farmers Bank is now Kasikorn Bank. -- www.kasikornbank.com).

Other Thai banks that offer Internet banking include Bank of Ayudhya (www.krungsrionline.com), Krung Thai Bank (www.ktb.co.th), and Bangkok Bank (www.bbl.co.th).

2.2 Features Comparison between Foreign and Thai Internet Banking

A survey on Internet banking services offered by foreign banks, particularly those in the U.S., and Thai banks reveals a noticeable difference. The former are largely non-branch banks, i.e., each bank simply establishes its own head office and delivers services through electronic channels such as ATMs, the Internet, phone, etc., whereas the latter mainly provide services through their own branches and subsequently introduce Internet banking as another means of delivering services.

With regard to pattern of services, both foreign and Thai banks generally provide the same basic services including account summary, statement inquiry, bill payment, and fund transfer. Differences exist only in the detail of each service, and other supplement services in each bank. Some features of these services are summarized below.

2.2.1 Fund Transfer

Currently, features in fund transfer service provided by foreign and Thai banks are similar. That is, they offer inter-account fund transfer and fund transfer to a third party whose pre-authorization is registered. Nevertheless, they differ in that foreign banks permit their customers to transfer funds across banks for inter-account fund transfer and/or fund transfer to a third party, depending on the policy of a particular bank. First Internet Bank of Indiana (www.firsttib.com), for instant, offers inter-account fund transfer both within the bank and across banks, while fund transfer to a third party is not allowed at all. Through "Live Chat" inquiry, the expert from the bank clarifies authenticity for security reasons, and if customers wish to transfer funds to a third party, they can use a cheque instead [16]. Several foreign banks also perform the same service.

2.2.2 Bill Payment

In general, functions in bill payment services offered by both foreign and Thai banks are similar for single payments for the current day or the future. After transactions have been done, customers can check both history and pending transactions, which can be cancelled prior to due date. Some Thai banks, however, do not provide all of these functions but only offer immediate bill payment. Almost all foreign banks prefer to have multiple payment (customers can pay bills to many payees in one process) and recurring payment (customers can set up scheduled future payments covering long period) options.

One obvious difference in this service as provided by foreign and Thai banks lies in the fact that foreign banks generally offer an "add payee" function, customers simply fill out payee's name, address,

account number, and then select payee types available in a combo box such as electric, gas, credit card, etc. Generally Thai banks, on the other hand, do not provide this "add payee" feature. Their customers are permitted to make payments only to payees specified by the banks. Other Thai banks though provide an "add payee" feature, but payees must be in the banks' list, i.e., they are required to make contact with the banks before being in the payee list.

Finally, although the Internet banking services provided by banks around the world have some different features, they have one thing in common, that is, almost every bank requires their customers to be local residents only. For this reason, it might be inferred that Internet banking is a service designed under the concept of "Think Global, but Do Local," even though the Internet contains technology that can link people worldwide.

2.3 Important Factors for Internet Banking Services

From the preliminary survey, it can be concluded that the first thing that should be emphasized when developing Internet banking is customers' need. Focus should be given to new systems seeking to supply new services. Banks should introduce advanced services that attract a large number of customers.

Secondly, banks should study consumer behaviors. Even if excellently developed, Internet banking will be futile unless customers like it. Consumers, for example, may be concerned or unsure about the system, and prefer traditional services. Banks should, therefore, try to inform and convince them.

The third factor is security. In order to make customers feel safe, special attention should be paid to the security system. The fourth factor is the user interface. Banks should simplify system usage procedure and provide response time at an acceptable level.

Finally, functions should be able to off-load work from branches, so that users are aware that services provided through Internet banking are the same as those at branches, but the former is far more convenient. All of these are major points to which an Internet banking developer should pay careful attention. Nevertheless, the structures of Internet banking and timing to implement it depend critically on which particular policy the banks' executives concentrate. Nowadays, technology stands ready to serve the decision.

3. Vision of Thai Bank's Executives

The following section derives from the interview with four Thai bank's executives, one from the Bank of Asia, Thai Farmers Bank, Krung Thai Bank, and Siam Commercial Bank. The results of the interview are summarized as follows; [17, 18, 19, 20]

3.1 Policy of Internet Banking and the Whole Picture

Normally, the core banking system is made up of two parts: a deposit system and a credit system. The services are provided as either "services at the branch", where customers take their passbook to the counter for any transaction or "self-services", where transactions are performed via automatic machines such as ATMs. Self-service also include non-cash services such as telephone banking, and Internet banking that does not involve cash but is concerned with such transactions as statement inquiry, inter-account fund transfer, payment for purchased goods and services, etc. A non-cash service is one of the channels that enable banks to offer more services to their customers; however, this is rather new for the Thai banking system.

The core banking system in Thailand remains unchanged. Deposit and credit systems are still the dominant part of retail banking. In view of Internet banking, a major concern that plagues one of the executives is the question whether Thai banks are "following a craze." In Thailand, so far, there are approximately 600,000 to 800,000 Internet users, mostly (around 500,000 to 600,000) consisting of students, and the remaining of 200,000 are workers in private companies. When compared to the whole Thai population of 66 million, this figure is substantially small. Although the ratio in some countries is higher, Thai banks are less likely to compete with banks in those countries. Nowadays there are a large number of virtual banks offering in several countries, and most of them do not establish an office or branch, i.e., they are virtual banks in a real sense. The only investment required is to open web sites that impose a very low cost. Comparatively, Thai banks incur substantial costs, due to their established offices and branches.

If, in fact, the Thai banks are "following a craze", the immediate question is "do we need Internet banking now?" The answer is "yes", because unless banks do it now, they are more likely to lose their customers sooner or later. New customers, mostly of a young generation, will replace the old ones. These new customers, by nature, are eager to learn new things, and hence more likely to enjoy new technology. It is, consequently, reasonable for banks to provide Internet banking to serve this group of customers.

3.2 Security Concern on Internet Banking

The security system is another crucial issue for Internet banking to which banks pay careful attention. Bank of Asia, for example, has set up preventive measures; standardized by ABN-AMRO Bank (Bank of Asia is a member of ABN-AMRO Bank). Security systems initiated by the measures include a firewall and data encryption. In addition, the bank inserts its own

add-on module into the security system. At present, the bank follows a 128 Bit SSL standard. Similarly, Thai Farmers Bank also employs the same security system, i.e., firewall, and it is in the process of obtaining a SSL-128 Bit standard.

With respect to digital signature, the opinions are different. Since digital signature is quite new for Thailand and a law has not created to support it, some banks are currently studying on how to apply it to their Internet banking services. Thai Farmers Bank insisted that digital signature is unlikely to be used in Thailand because of the lack of CA, which is very difficult to obtain, inconvenient, and costly. The Siam Commercial Bank's Executive viewed this issue on a different point, he clearly suggested that SSL is sufficient, and digital signature is not necessary, as evidenced by the boom in e-commerce in the U.S., where identification verified through credit card number is sufficient. The application of digital signature imposes more expense and complex procedures to the users, and may have a negative affect on the use of Internet banking.

3.3 Customer Database

To the question whether the "Internet-banking customer database should be integrated with, or segregated from, the existing customer database", a senior director of Bank of Asia supported the concept that the customer database should be integrated because transactions generated from the Internet service have to be incorporated with normal transactions. On the other hand, the Thai Farmers Bank Executive suggested that there should be no integration (i.e., Internet-banking database and normal database). The two cannot be fully integrated, when considering terms of design. The reason is that once customers register on the Internet, the bank must have a database that keeps such data. In short, some data must be segregated, whereas others must be shared.

The Executive Vice President of Krung Thai Bank indicated that the customer database should depend on implementation methods as well as the computer system of a particular bank, and the segregated system might be more beneficial. The Vice President of Siam Commercial Bank expressed his view that the two databases should be segregated, because information on Internet-based customers is different from those of normal customers. The database may be shared, but detail may be different because the marketing concepts for Internet-banking customers are very much different from those of normal customers. At present, the customer database of Siam Commercial Bank is still integrated, but this may not be so in the future, depending on the policy. In conclusion, Thai banks should integrate databases, that is, allowing customers to have accounts that can be used either through Internet banking or branches' counters. Later, these accounts may be separated.

3.4 Feasibility of Internet Banking in Thailand

From the point of view of banks' executives, they all believe that Internet banking is likely to grow significantly in the near future. The major reason contributing to such growth is the steadily increasing number of Internet users and most of them are well educated and middle-class people in society. They, therefore, tend to rapidly accept new technology. Seemingly, the likely growth is independent of e-commerce law, and most banks are now in the process of Internet banking development. Although the law will serve to assure users legally, it may introduce more difficulties to the application of the system. However, banks' major concern lies in the competition; if some banks develop Internet banking whereas another bank does not do, this bank is more likely to lose customers, particularly prospective customers. Generally, targeted customers of these banks are the new generation people with a relatively high education.

Growth of Internet banking in Thailand depends crucially on an appropriate timing and number of Internet users. Obviously, the greater the number of Internet users, the higher the chance of success will be.

The Critical Success Factor (CSF) for Internet banking implementation in Thailand can be summarized into 5 areas;

- Customers' confidence in the security system: the extent to which the system is reliable for the customers.
- Convenience and simplicity that the system provides.
- Banks' policy on timing and priority of implementation.
- Banks' marketing strategies to enhance customers' demand.
- High system flexibility in response to market demand.

3.5 Strengths and Weaknesses of System Development

Bank of Asia's executive stated that the strength of the Internet banking system of the bank is that its database is characterized by a CIS (Customer Information System) which enables the bank to see the whole picture of their customers. Once Internet-customer logs in to the system, all information on that customer will be shown on only one screen, thereby bringing about convenience to the customer. He or she does not have to know whether the account is current or saving or time deposit, and does not have to key-in an account number, because it will be shown by the system. This system, as a consequence, allows the bank to add on several functions easily. The bank pays great attention to its security system, which several parties can be concerned about. Presently, the security system is quite reliable.

Thai Farmers Bank's executive indicated that convenience is the strength of their system, whereas the small number of users or a very low demand is the weakness of the bank's Internet services. It is estimated that there are approximately 800,000 Internet users, which is smaller than the number of mobile-phone users, over half of these Internet users are students.

Krung Thai Bank's executive said that easy access to the system and availability to the customers is an important strength and security might be the major weaknesses of their system at the moment. Siam Commercial Bank's executive said that since the bank is the first to launch Internet banking, its brand name should, therefore, be its strength. Another strength is that the bank uses its own staff to write software, thus leading the bank to achieve a higher degree of flexibility than those that cannot write their own software.

All the executives agree that the budget for system development is a major concern. Internet banking requires a large amount of investment. The approximate figures for implementing internet banking for the four banks are: 20 million baht (500,000 USD) for Bank of Asia, 20 – 30 million baht (500,000 – 750,000 USD) for Thai Farmers Banks, 10 million baht (250,000 USD) for Krung Thai Bank, and 30-40 million baht (750,000 – 1 million USD) for Siam Commercial Bank.

3.6 Obstacles to System Development

It can be summarized from the interviews that the problems and obstacles of developing internet banking in Thailand are as follows;

- 1) Highly changing requirements cause the bank to consistently monitor the market and adjust the system accordingly.
- 2) Most customers perceive Internet banking as a 24-hour service, but in fact, most of the other systems of the bank do not run 24 hours a day, since they are run with a batch system at night.
- 3) Since Internet banking has to utilize resources from several departments, the supports from managerial level as well as the cooperation from operational level are very crucial.
- 4) Owing to rapid change in technology, human resource development keeping up with the change poses a certain problem.

4. Prototype Development

The methodology used for prototype development was substantially based on a Software Development Life Cycle (SDLC) comprising eight different steps, i.e. preliminary planning, study of relevant theories and researches, data collection, analysis, design, development of system prototype, verification test and

improvement, and conclusion and documentation.

4.1 User Requirement Analysis

User requirement was obtained from the analysis of banks' customer requirements for Internet banking services. The analysis is entirely based on questionnaires surveyed, covering 318 participants. Of this, 245 are Internet users, whereas 73 have never used the Internet. Most of the latter are relatively ill educated, rather aged, and Internet-illiterate. On the grounds of data analysis, it is found that those who are Internet-illiterate provide no relevant information for this research, and thus are ruled out from the analysis.

The questionnaire analysis reveals the five most popular services as, in order, balance inquiry, bill payment, fund transfer, business information, and payment for the purchased goods or services. It should be noted that although the business information service provides customers with banking and other economic information is one of the first services offered via banks' web sites, it is still of interest for all customers. In regard to payment service for goods or services purchased via the Internet, customers want to make payments from their own accounts, in addition to credit cards, which are widely used in e-commerce.

Also demonstrated by questionnaire analysis, highly secure service is what Thai Internet users require first. The other crucial elements are reliability, confidentiality, facilities, fast process, good user interface, and variability. Furthermore, the most important influences in attracting Internet users to Internet banking services are time saving and fast processing. The other reasons center around facilities, elimination of the need to travel to banks, a new alternative, 24-hour service, modernity, and cost saving. On the other hand, factors that dissuade Internet users from using Internet banking services are uncertainty in security system, no need to use, lack of support by law, unwillingness to pay more fee, and non-ISP member.

The figures from questionnaire analysis show that those who are willing to use the service at the level of "very interested" and "interested" account for up to 64.5%, while the level of "moderate" comprises 20.8%, and "not interested" and "indifferent" are made up of only 14.7%. Of this number, those who are most likely to use the service account for 12.7%. Based on an estimated number of Internet users in 2005, prospective users of Internet banking service will approximately vary between 353,943 and 408,238 throughout Thailand.

4.2 Proposed Prototype (CNet Bank)

The prototype developed in this paper is called "CNetBank", shown in Figure 1., and is divided into six main parts: banking information, system sign-in,

banking transactions, customer information management, system administrator, and customer help services. The first part includes banking information, help for general customers, and application for CNetBank online member. The second part covers not only the verification of a customer's authority, but also the identification of whether the customer signing in is either a CNetBank customer or CNetBank system administrator. CNetBank customers can access both the third and fourth part of the system. In the third part, a customer can do several banking transactions involving account summary, statement, bill payment and funds transfer, while in the fourth part, a customer can manage his or her information such as changing personal information, editing a personal account, and changing user name and password. In the CNetBank system, an administrator can access the fifth part to simulate the back-office system. The final part, customer help service, is divided into two sections – help for general customers, and help for Internet banking members. Both types of help perform similar function, except that the latter provides member information for the relevant members only.



Figure 1. CNet Internet banking startup page

From the system point of view, the prototype consists of two main parts: front-office functions and user interface. In this prototype, it is focused solely on the presentation of a front-office system, whereas the back-office system is partly presented in the administrator center page in order to simulate the back-end operation of pending transaction and recurring fund transfer processes.

The front-office system of this prototype, called CNetBank Personal Online, contains the major service features developed on the basis of user requirements derived from the customer survey using questionnaires. Furthermore, it was developed under the guidelines obtained from the visions and conceptions on Internet Banking derived from four Thai bank executives' interviews. Service functions mentioned above can be represented in the structural chart, a top-down chart showing each level of a design, its relationship to other

levels, and its place in the overall design structure shown in Figure 2.

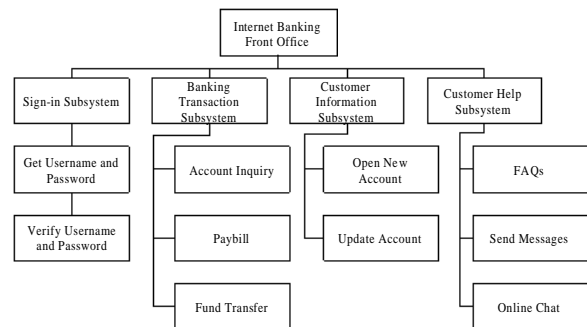


Figure2. Structural Chart for Front Office System

4.3 Features

The advantages of the CNetBank are summarized as follows;

1) Customers who open at least one savings account or current account with the bank can apply for the Internet Banking service online by filling out only one account number. Right after being given approval, a customer is allowed to increase or decrease number of his or her account and third party account all of which are used in Internet Banking service without asking for permission to the bank. This is because the system is designed to link with all account information and personal information of customers. As such, the system can instantly check the number of customers' accounts during online time. Furthermore, if the customer opens another account after applying for an Internet Banking service, information on this new account will appear in the "account management" screen of that customer, and a customer can select this new account to be used in Internet Banking. On the other hand, a customer can withdraw any account from Internet Banking, and then all information on that account will no longer exist. This "account management" feature, therefore, provides customers with high flexibility in managing his or her accounts used in Internet Banking.

2) Customers can conduct bill payment and fund transfer by specifying "today transaction" and/or "future transaction". This service allows customers to be well prepared for their bill payment and fund transfer. For example, if customers know that they will be busy at any given date in the future, they are, by this service, assured that their bill payment and fund transfer will be conducted.

3) Transaction checking is another key feature that enables customers to check both history and pending transactions that occurred in either payee account, payer account or both for up to 12 months. For pending transactions, customers can cancel them prior to the due date.

4) In fund transfer, customers can set a period of

recurring fund transfer for up to 12 periods, thereby saving their time and expenses in traveling to the bank.

5) Every fund transfer transaction provides a memo for customers to take note. When a transaction is viewed, the memo will appear behind it. For bill payment, customers do not have to write a memo, because it will be automatically managed by the system.

6) In this prototype, customers are permitted to deal with their own security information at any time. That is, they can change user name and password themselves. They can also change their address and personal information themselves.

7) The customer help center offers four service channels including frequently asked questions (FAQs), message sending, online chat, and a call center. The key feature lies in the online chat that provides real time conversation between customers and bank staff through the Internet. When online chat is in use, the bank will instantly know whom the bank is talking to and his or her personal information. This enables the bank specialist to respond to customers' questions more effectively, and to offer products and services more suited with the customers' interest.

4.4 Experts' Validation

From interviewing Internet banking experts, the following comment and suggestions on the CNetBank prototype were provided.

1) In reference to the security system, modern systems typically require customers to use their e-mail address as a user ID instead of an arbitrary name when they apply for the service.

2) In online application forms, they should require customers to fill out only necessary information such as personal information and bank account number both for verification, and current address for contact with the bank. Here, an e-mail address is very important. Any other unnecessary information should not be required because it may cause customers to be tired and must be kept in the database that, in practice, should not be bulky.

3) For web design in Internet Banking services that mainly involve money, they should be simple, easy to use and understandable.

4) An "Account summary" describing information on all accounts customers have with the bank is a good idea. However, it should be available for customers to choose which accounts do appear or do not appear in the "account summary". This is because some customers do not want account information to be shown in Internet Banking.

5) With respect to the system configuration of actual Internet Banking used nowadays, when customers are applying for Internet Banking services, they will access a web application server with several web servers working together. Networks are linked as an Ethernet

with load balance working as an operator. Before ODBC linking to the host transaction server where the customers' information is kept in the database server and transaction information are kept in the transaction server, there will be a firewall dealing with enhanced security. Transaction server processes occur through a watch table, a file used for time checking in updating transactions. Upon the information being updated, the system will link it to be processed in the bank's host, which is usually a mainframe system.

4.5 Comparison between the proposed prototype and the actual system

1) The survey on Thai banks reveals that, in light of bill payment, any payee whose name and account number is available in the payee list typically contacts banks before hand. If a payee is not in the bank's contact list, an Internet Banking member of that bank will not be able to use the bill payment service to make payments to that payee, and will not be able to add the payee to the bill payment service. In order to use bill payment service, the payee and payer are also required to be customers of counterpart banks. These are two limitations imposed by both Thai banks and this prototype. Some eminent foreign banks, on the other hand, allow their customers to add a payee at will, by simply filling out the payee's information.

2) In light of fund transfer, the system in this prototype permits customers to conduct inter-account fund transfer and fund transfer to a third party with the condition that both sending and receiving accounts must be opened with CNetBank. Fund transfer to foreign banks is not allowed, however. In any case, the survey on fund transfer transactions in Internet Banking services of Thai banks shows that Siam Commercial Bank and Thai Farmers Bank provide fund transfer to a third party. The former requires that both accounts be in the same bank (intra-bank only), while the latter allows inter-bank fund transfer through the Internet. For the foreign banks, some of them such as Netbank, allow customers to make inter-bank fund transfer to a third party via the Internet, whereas some banks impose conditions that a counterpart bank be a nominated company only.

3) Customer information linked to Internet Banking may cause some customers (who are not confident in doing Internet Banking transactions) to be uncertain whether their information will be available if hackers attack the system. In a real banking system, an extremely reliable security system is established. It is required that there be a firewall and other necessary check points in the back end system. Moreover, transaction information in the Internet must be encrypted through secure socket layer (SSL) for at least 40 bits (from a standard of 128 bits) so that it is difficult for a hacker to access the system. In this system, on the

other hand, is not necessary to implement SSL, because the developed system is only a prototype.

4) In light of service fees for all types of fund transfers and bill payments offered in the CNetBank, there is no function designed for charging the fees from customers, because the business rule of the CNetBank allows them to use its services free of charge. This is applied to any transactions at any time (not just during the promotion period). However, this is not the case in the real world where banks can gain substantial income from charging service fees for every transaction occurring in their Internet banking services.

5) Regarding security in fund transfer to the third party, banks pose a limit on the amount of the transfer. Some banks, for instant, set a limit amount of 500,000 Baht (USD 125,000) per day for each username. CNetBank, allows customers to transfer up to 50,000 Baht (USD 1,250) per transaction. This means that, in a single day, customers can transfer funds to a third party several times. However, it might be unsecured for the bank to do so.

6) In order to facilitate customers, CNetBank permits its customers to immediately add the account number of other persons into the system for the purpose of fund transfer. Customers are not required to submit requests to the bank for permission, in view of security; this might be unsecured as well. In practice, banks have to pre-approve customers' requests prior to giving approval. For example, Siam Commercial Bank sends a letter of agreement to their customers to sign and return to the bank. Thai Farmers Bank requires their customers to submit a copy of an identification card and census record after adding an account number of other persons. Upon verifying these documents, the bank allows the other account number to be used in its system.

7) The online chat service provided in this system is viewed in terms of technology development that supports the bank's customers. It can be said that real banks can afford to provide this service or even voice chat, ICQ, and Internet phone to support their customers in addition to a traditional call center. There may be an issue whether these services are worthwhile in the long run, because banks have to allocate people for delivering the services. This point should be left to economist to further investigate, and if it turns out that the services are not worth investing in, online chat provided in this prototype may become a weak point.

8) CNetBank is merely a prototype and efficiency of hardware resources obtainable limit development tools used in the development. For example, Microsoft Access, which cannot be used in the real banking business, is employed as a database management system, but it can be used in CNetBank prototype because the information on customers used in this system is imaginary and small.

5. Concluding Remarks

As long as businesses are in a highly dynamic and competitive environment, the search for modern technology is unavoidable. Internet banking is another channel to provide value added services to either existing or new bank customers. The survey from the executives of four Thai banks reveals that there is a potential growth for retail Internet banking in Thailand. Therefore, this paper proposes the prototype of a retail Internet banking system that meets the requirements of Thai customers. The data from the interview and the questionnaire are used to develop such a prototype, called CNetBank.

CNetBank prototype is divided into six parts – banking information, system sign-in, banking transactions, customer information management, system administrator, and customer help services. The first part includes banking information, help for general customers, and application for CNetBank online member. The second part covers not only the verification of a customer's authority, but also identification as to whether the customer signing in is either a CNetBank customer or CNetBank system administrator. CNetBank customer can access both the third and fourth part of the system. In the third part, a customer can do banking transactions including account summary, statement, bill payment and funds transfer, while in the fourth part, a customer can manage his or her information such as changing personal information, editing a personal account, and changing user name and password. In the CNetBank system, an administrator can access the fifth part to simulate the back-office system. The final part, customer help service, is divided into two sections –help for general customer, and help for Internet banking members. Both types of help perform similar function, except that the latter provides member information for the relevant members only.

After prototype development was initially carried out, it was evaluated, reviewed, and commented on by experts. The prototype was then improved and adjusted in accordance with these comments. Ultimately, the prototype was completed with several prominent advantages contained in the service features derived from the survey on user requirements that identify customer needs. In addition, the prototype provides flexibility in account management, time scheduling in transactions, checking for both history and current transactions, and scheduling of recurring fund transfers for up to 12 periods, etc.

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The Impacts of Establishing Enterprise Information Portals on e-Business Performance

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Abstract

The Enterprise Information Portal (EIP) provides access - a single point of personalized, on-line access - to business information and knowledge sources, and real-time access to core application and processes. EIP is defined as an ultimate window that presents e-business fruitful results. Our research focuses on investigating the relationship between organizational characteristics and whether EIP is adopted in the business operations and the relationship among the function application degree, implementation type, integration ability, and users of EIP and e-Business performances. The result of our study shows that: (1) Between those organizations have and those have not adopted EIP, there are significant differences in the maturity and familiarity of information technologies, and organizational size; (2) In the way of implementation EIP, the relationship among function application degree, implementation type, integration ability, and e-Business performance are also significantly influence; (3) The impact between function application degree of EIP and e-Business performance will be enhanced by high e-business degree; (4) The impact between implementation type of EIP and e-Business performance will be intervened by e-business degree; (5) The implementation time of EIP has no significant impact on the relationship between implementation EIP and e-Business performance.

1. Introduction

The rapid developments of Internet and information technology not only provide great growth opportunities, but also change the way that enterprise operates and shaped the era of digital economy. The U.S. Census Bureau's e-Business Steering Committee divides the "electronic economy" into three layers: e-Business infrastructure, e-Business ("any process that a business organization conducts over computer-mediated network channels"), and e-commerce ("any transaction completed over a computer-mediated network that involves the transfer of ownership or rights to use goods or services") (Mesenbourg, 2000). As Gerstner (2000) indicated, "Today, e-Business is just Business – real business." Thus it can be seen e-Business will play an important role in digital economy to enhance competitive advantages.

Due to technology advances and the wide dissemination of information, many institutions suffer from information overload and need to apply information

management to deal with this information chaos in this digital world. Furthermore, organizations increase the requirements of experience and knowledge sharing, system integration ability, and personalized. The Enterprise Information Portal (EIP) provides access - a single point of personalized, on-line access - to business information and knowledge sources, and real-time access to core application and processes. According to Shilakes & Tylman (1998), Enterprise Information Portal is considered an emerging market opportunity, an amalgamation of software applications that consolidate, manage, analyze and distribute information across and outside of an enterprise (including business intelligence, content management, data warehouse/mart, and data management applications.)

Recently, industry trend-watchers have forecasted the rise of portal development in corporations. For instance, Gartner Group predicts with 80% probability that more than half of all major companies by the end of the year 2001 will implement corporate portals as the primary method for organizing and discovering corporate resources (Detler, 2000). Likewise, the Enterprise information Portal adoption rate based on a Delphi Group survey of Fortune 500 companies in 1999. About 35% of these companies have implemented a corporate portal and another 30% are in the pilot/experimental stage of development (Aneja et al., 2000). Further, Shilakes & Tylman (1999) estimate that the market for portal tools and services will be worth upwards of \$14.8 billion by the year 2002. Consequently, the Enterprise Information Portal is the most important business information management project of the next decade (Collins, 1999).

Our research focuses on investigating the relationship between organizational characteristics and whether EIP is adopted in the business operations and the relationship among the function application degree, implementation type, integration ability, and users of EIP and e-Business performances. Then, we address the e-Business degree and implementation time in intervening the influence of the impact of establishing EIP and e-Business performance.

2. Related Research

2.1 Enterprise Information Portal

Reynolds & Koulopoulos (1999) identify four phases of web portal development: boolean search, categorized

navigation, personalization and, finally, integration of additional features providing direct access to other specialized information and commercial worlds. This web portal evolution impressed the corporate community, which viewed the possibility to use the same technology to manage structure and facilitate the task of accessing the companies' internal information.

There has been a great interest during the past two years in the emergence of Enterprise Information Portal. In sum, an enterprise portal can be defined as a single point of access (SPOA) for the pooling, organizing, interacting, and distributing of organizational knowledge (Aneja et al., 2000; Schroeder, 2000).

Since newly developed, the terminology related to the Enterprise Information Portal has not been settled yet. The terms "corporate portal", "corporate information portal", "business portal", and "enterprise information portal" are used, some times, interchangeably as synonyms (Dias, 2000). Cutter Consortium also indicated Enterprise Information Portal is a "fuzzy word" (Chen, 2002).

Shilakes & Tylman (1998) identified Enterprise Information Portal as an amalgamation of software applications consolidate, manage, analyze and distribute information across and outside of an enterprise and enable companies to unlock internally and externally stored to make informed business decisions. Eckerson (1999) uses another term "business portal" and defines it as an application that provides business users one-stop shopping for any information object they need inside or outside the corporation. Dias (2001) uses a term "corporate portal", closely related to EIP, and use technical point of view to identify corporate portal uses metadata and eXtensible Markup Language (XML) to integrate unstructured data to structured data from operational databases, supplying access to corporate information through a personalized interface, available over the internal hypertext network-The Intranet. On the other hand, Murray (1999) stated that portals that focus only on content are inadequate for the corporate market and that "corporate portals must connect us not only with everything we need, but with everyone we need, and provide all the tools we need to work together" (Murray, 1999).

Portals have fairly complex structures and features. According to survey results for Intelligent Enterprise readers, once deployed, EIP resources will be divided among these functions: B2B e-commerce(38%), B2E e-commerce(37%), B2C e-commerce(25%) (Willen, 2000). However, their functions and elements are relatively easy to define (Roal et al., 2002). First, from an operational perspective, the strength of corporate portals lies in its ability to provide Web-based access to enterprise information, applications and processes. Second, from a functional perspective, they leverage existing information systems, data stores, networks, workstations, servers, and applications as well as other knowledge bases to give each employee in every corporate site immediate access to an invaluable set of corporate data anytime, anywhere (Kendler, 2000; White, 2000).

Functions and features are fairly difficult to define separately because they may have inter-related macro and micro level components. In most corporate portals, features and functions co-exist at the same level because they are still in the maturing process. Typically, the more common functions are the components that provide access to the range of disparate enterprise databases and information resources and the ease with which users can set up personalized access to enterprise and external information resources (White, 2000). In most enterprise portals, these functions may include, but are not limited to security, network, administrative tools, search, content management, collaboration personalization, extensibility, easy to use, and scalability (Eckerson, 2000).

2.2 E-Business

E-business is more than just an Internet presence or e-commerce transactions. It is a new business design "that emphasizes a finely tuned integration of customer needs, technology and processes" (Kalakota & Robinson, 1999).

Kalakota & Robinson (1999) define e-business as the complex fusion of business processes, enterprise applications, and organizational structure necessary to create a high-performance business model. e-Business includes e-commerce, as well as both front- and back-office applications that form the engine of modern business (Kalakota & Robinson, 1999).

e-Business is an enterprise with the capability to exchange value (goods, services, money, and knowledge) digitally. It has properly designed business processes for this new way of conducting business. Further, it understands the human performance challenges not only within its organizational boundaries but also for other people in its enterprise network: customers, partners, and suppliers. e-Business is a new way of doing business that involves connectivity, transparency, sharing, and integration. It connects the expanded enterprise through a universal digital medium to partners, suppliers, and customers. It requires the integration and alignment of business processes, technology, and people with a continuously evolving e-business strategy (Hackbarth & Kettinger 2000).

2.3 Organizational Characteristics

The organizational characteristics have significant impacts on quality and effectiveness of the planning process of information systems. The planning method of information systems must match the organizational characteristics (Premkumar & King, 1994). The relationship between organizational characteristics and whether Information Technology is adopted has been emphasized in both empirical and prescriptive studies (Yap, 1990; Grover et al., 1993; Yap & Thong, 1995; Premkumar & King, 1994).

Thong & Yap (1995) found that business size is the most significant discriminator in determining the use of information technology. Because here are some limitations for the small companies to adopt IT, such as

poor resources, financial constraints, lack of specialists, and high sensibility to outside pressures. They also demonstrated that competitiveness in the environment and information intensity does not significantly influence the adoption of information technology by small businesses. Grover et al. (1995) found that organizational structure and centralization influence organizations to adopt telecommunication technology.

According to prior research, this paper conduct seven organization characteristics from related research, including business size, information intensity, formalization, centralization, the maturity and familiarity of information technologies, industry type, and competitiveness of environment.

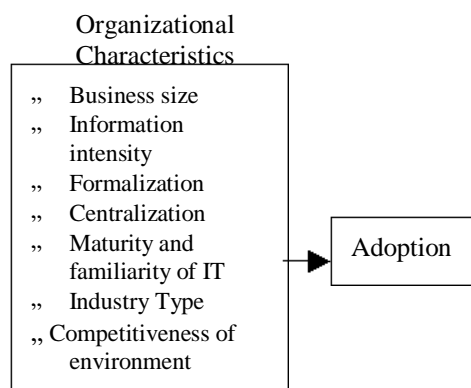


Fig. 1 Research Modal 2

In research model 1, we want to investigate the correlation between organization characteristics and the strategic decision to implement the Enterprise Information Portal. In independent variables, we induced seven organization characteristics from related research, including business size, information intensity, formalization, centralization, the maturity and familiarity of information technologies, industry type, and competitiveness of environment. The dependent variable, adoption, can be divided into two groups, adoption and non-adoption.

In research model 2, we would like to investigate the relationship among the implement of EIP and e-Business performances. Then, we address the e-Business degree and implementation time in intervening the influence of the impact of establishing EIP and e-Business performance. There are 4 directions to probe into the implement of EIP including application function degree, implementation type, integration ability, and users of EIP. In aspect of e-Business performance, we induced three different indicators from related literatures to measure, included operation performance, marketing performance, and adaptability performance. In intervening variable, the implementation time of EIP is different from each corporation, the time period my influence the e-Business performance. In addition, EIP is an important part of e-Business. Therefore, e-Business degree may influence the e-Business performance.

3. Research Method

3.1 Research Model

The objectives of this study were to understand the relationship between organizational characteristics and whether Enterprise Information Portal is adopted in the business operations and the impact of e-Business performances when implementing Enterprise Information Portal. According to the research objectives and related researches and literatures, there are two phases of research model were shown in Fig. 1 and Fig. 2.

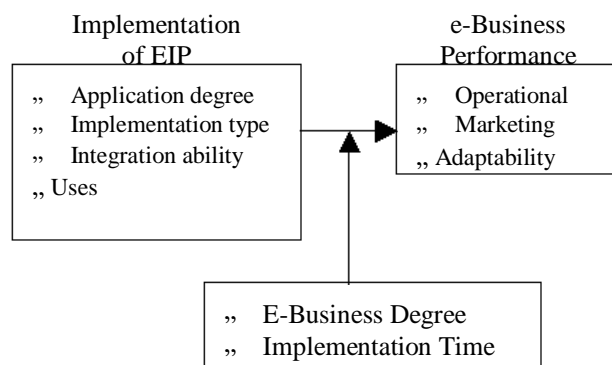


Fig. 2 Research model 1

3.2 Hypotheses

The relationship between organizational characteristics and whether information technology is adopted has been emphasized in both empirical and prescriptive studies (Yap, 1990; Grover et al., 1993; Yap & Thong, 1995; Premkumar & King, 1994). According to the results of prior researches, organizational characteristics do significantly influence the adoption of information technology. The organizational characteristics have significant impacts on quality and effectiveness of the planning process of information systems. The planning method of information systems must match the organizational characteristics (Premkumar & King, 1994). This leads to Hypothesis 1 (all hypotheses will be stated as null hypotheses):

H1: Organizational characteristics do not significantly influence the adoption of enterprise information portal.

We induced seven organization characteristics from related research, including business size, information intensity, formalization, centralization, the maturity and familiarity of information technologies, industry type, and competitiveness of environment. This leads to the following additional hypotheses:

- H1a: Business size does not significantly influence the adoption of EIP.
- H1b: Information intensity does not significantly influence the adoption of EIP.
- H1c: Formalize does not significantly influence the adoption of EIP.
- H1d: Centralize does not significantly influence the adoption of EIP.
- H1e: The maturity and familiarity of information technologies does not significantly influence the adoption of EIP.
- H1f: Industry type does not significantly influence the adoption of EIP.
- H1g: Competitiveness of environment does not significantly influence the adoption of EIP.

According to survey results by Chen (2002), applications functions of EIP do significantly influence on business performance. Consequently the stronger application function ability the corporations have, the corporation can more easily to achieve the requirements of increase ROI, enhance competitive advantages that the corporate needs. So, the stronger application function ability of EIP, the more brilliant e-Business performance. This leads to Hypothesis 2:

H2: The application ability of EIP does not significantly influence the e-Business performance.

- H2a: The application ability of EIP does not significantly influence the operation performance.
- H2b: The application ability of EIP does not significantly influence the marketing performance.
- H2c: The application ability of EIP does not significantly influence the adaptability performance.

The EIP product market is relatively young because it only started in early 1998 (Raol et al, 2002). The market is very immature and it is crowded with vendors offering different capabilities. Each product available on the EIP product market, when compared to its competitors has its own characteristics, distinct structure or additional components, presented as competitive (Dias, 2002).

White (1999) point out the two functions of EIP, decision-making support and collaborative processing, classifying EIP into four main categories: "Intranet Portal", "Collaborative Portal", "Decision Processing Portal", "e-Business Portal". It's the phases of EIP evolution. An EIP begins to add real business value to an organization when it supports access to information managed by decision-processing systems. In Other word, in the phase of decision process portal, EIP start to add real business value to corporate and in the phase of e-Business portal, EIP can contribute the hugest business value to corporate. For the reason, different implement

type of EIP may influence the business performance. This leads the Hypothesis 3:

H3: The implementation type of EIP does not significantly influence the e-Business performance.

- H3a: The implementation type of EIP does not significantly influence the operation performance
- H3b: The implementation type of EIP does not significantly influence the marketing performance
- H3c: The implementation type of EIP does not significantly influence the adaptability performance

Application integration services enable EIP to provide users with a centralized, unified, and consistent environment for interactions with all applications (Hummingbird, 2000). As described by Shilakes & Tylman (1998), central to the concept of Enterprise Information Portals is the assumption that disparate applications (content management, business intelligence, data warehouses/marts and data management) will :1) access other internal and external sources of information and data , 2) exchange information (bi-directional) and 3) use that information within the application for processing and analysis. In other words, these applications must be integrated with each other and to other external systems. The biggest selling point of EIP is their ability to present information from diverse sources through a common interface. Consequently, the most visible integration requirement for EIP is to provide an integrated web interface-based view of all (whether data store, content, or application server-based) of the information resources of the enterprise and external information resources that are the target of the EIP application (Joseph, 2001). This leads Hypothesis 4:

H4: The integration ability of EIP does not significantly influence the e-Business performance.

- H4a: The integration ability of EIP does not significantly influence the operation performance.
- H4b: The integration ability of EIP does not significantly influence the marketing performance
- H4c: The integration ability of EIP does not significantly influence the adaptability performance

Besides employee, the user of EIP includes suppliers or partners and customers. EIP can Diver business advantages through real time collaboration among employee, customers, suppliers and partners. EIP users can be external users, such as suppliers, partners, and customers. It will promote business volume and operational performance. Therefore, the different users of

EIP may influence the e-Business performance. This leads Hypothesis 5:

H5: The users of EIP do not significantly influence the e-Business performance.

H5a: The users of EIP do not significantly influence the operation performance.

H5b: The users of EIP do not significantly influence the marketing performance.

H5c: The users of EIP do not significantly influence the adaptability performance.

e-Business degree of organization is also the one of the factors may affect the e-Business performance. The successful implementation of the EIP is not only based on the business strategies that are tailored for the company, the corporation itself has also implemented e-Business in a satisfactory level. If the corporation still relies on traditional paper work culture, the competitiveness of the corporation will be decreased because of lack of informatics and digital technology. Furthermore, it will also create a barrier for the industry to launch and be one of the users of the prosperous internet, and it will not be able to gain all the benefits that the EIP can bring as a result. We therefore propose the following hypotheses:

H6: The impact between the implementation of EIP and e-Business performance will not be intervened by e-business degree.

H6a: The impact between application degree of EIP and e-Business performance will not be intervened by e-business degree.

H6b: The impact between the implementation type of EIP and e-Business performance will not be intervened by e-business degree.

H6c: The impact between the integration ability of EIP and e-Business performance will not be intervened by e-business degree.

H6d: The impact between the user of EIP and e-Business performance will not be intervened by e-business degree.

Furthermore, the implementation time of EIP is different from each organization, and the length of time will affect the performance. Base on the result of prior research, Chen (2000) mentioned the implementation time of IS has a significant impact on business performance. In other words, the longer time of the implement of system, the better business performance have. We therefore propose the following hypotheses:

H7: The impact between the implementation of EIP and e-Business performance will not be intervened by implementation time or EIP.

H7a: The impact between application degree of EIP and e-Business performance will not be

intervened by implementation time or EIP.

H7b: The impact between the implementation type of EIP and e-Business performance will not be intervened by implementation time or EIP.

H7c: The impact between the integration ability of EIP and e-Business performance will not be intervened by implementation time or EIP.

H7d: The impact between the user of EIP and e-Business performance will not be intervened by implementation time or EIP.

3.3 Sample and Data Collection

The sample frame for this survey was constructed using stratified disproportionate random sampling from the list of Taiwan Top 1000 companies was furnished by Common Wealth Magazine. The survey includes data from finance, service and manufacture industry sampling 100, 300, 600 firms respectively as the sample for this study. The key informants were the IT senior managers.

4. Analysis and Results

4.1 Data Collection

1000 surveys were mailed to IT senior managers on Dec, 2002. A month after the first round mailing, reminders and follow-up questionnaires were mailed out to 883 non-responding firms. 192 surveys were returned and 181 had complete data usable for analysis, yielding an effective response rate of 18.1%.

Among 181 respondents, 52 respondents indicated that they had completed an EIP deployment and 35 respondents were developing. They all start to implement EIP, so we classify 87 (48%) respondents into adoption group. Another 50 respondents were still in the conceptual stage of EIP project, and 44 respondents have yet to plan and establish. We classify 94 (52%) respondents into non-adoption group.

4.2 Stability Test

The non-response bias was tested in two ways. First, early and late respondents were compared upon four descriptive variables (e.g., industry type, turnover, total assets and employee numbers). The results of Chi-square test indicated that no significant differences in these four variables between early and late respondents (p-value are 0.102, 0.205, 0.586, 0.468). Thus, there was no evidence of obvious response bias in the sample.

Second, population and sample was compared upon three descriptive variables (e.g., industry type, total assets and employee numbers). The Chi-square test results also provides evidence that there was no non-response bias problem in the sample (p-values are 0.1845, 0.429, 0.072).

4.3 Validity & Reliability Test

Content validity is the determination whether the scale items used in the survey cover sufficient contents of the

underlying constructs. Firstly, it was established through a careful assessment of the literature. Secondly, the pre-test is done by 3 EMBA students, and some refinements are done according to their suggestions. Finally, at each stage, the questionnaire is iteratively revised by experts in the MIS field.

Those items to represent a construct as a one-phase measurement model or a dimension as a two-phase measurement model must have the unidimensionality to make sure the total score is valid to measure a single concept. The items without the convergent validity should be eliminated, according to factor loadings.

In this study, we used Exploratory Factor Analysis (EFA) to test the construct validity of the measures and evaluate the factor loading. Principal component analysis with a Varimax rotation technique was conducted on all items and no restrictions were placed on the number of components to be extracted. The principal components

were extracted on the basis of the “eigenvalues greater than 1” heuristic

In determining the appropriate minimum loadings required, loadings greater than .30 are considered significant; loadings of .40 are considered more significant; and loadings of .50 or greater are considered to be very significant. Thus, items were eliminated if the factor loading was below .50.

Both the Bartlett Test of Sphericity, a statistical test for the presence of correlation, and Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy are to determine the appropriateness of the factor analyses. Table 1 shows that KMO measures of sampling adequacy are higher than 0.725, with accepted level above 0.5, and the Bartlett test of Sphericity indicated significant differences in each construct, with p-value less than 0.05, the model is statistically significant and further analysis could be conducted.

Table 1 KMO & Bartlett test of sphericity

Construct	KMO Measure of Sampling adequacy	Bartlett Test of Sphericity	
		Approx. Chi-Square	p-value
Organizational characteristic	0.725	1488.760	0.000*
Application ability	0.875	401.999	0.000*
Implementation feature	0.900	1691.983	0.000*
Integration degree	0.861	592.938	0.000*
e-Business degree	0.891	2088.584	0.000*
Operation performance	0.884	661.550	0.000*
Marketing performance	0.725	336.933	0.000*
Adaptability performance	0.844	591.508	0.000*

Cronbach’s coefficient alpha is a widely used measure of scale reliability. Typically, a scale is reliable if α value is 0.7 or higher. Reliability tests were performed through the calculation of Cronbach’s α for each construct. Besides one construct named information sharing which alpha value is 0.6933 slightly less than 0.7. Others’ alpha value ranged from 0.7067 to 0.9468. Consequently, the result indicates internal consistency of the scales.

study, due to industry type is belongs to nominal data, used Chi-square test to proof the hypothesis. Others are used one way ANOVA.

ANOVA requires the test for homogeneity of variance first. To compute the Levene test for homogeneity of variance, as show in Table 2, the results are not significant in all variables of organizational characteristic. This is evidence that the assumption of homogeneity of variance has not been violated.

4.4 Hypothesis Testing

4.4.1 The Relationship between Adoption EIP and Organizational Characteristic

In the variables of organizational characteristic of the

Table 2 The relationship between organizational characteristic & the adoption of EIP

Organizational Characteristic	Levene (p-value)	Method	Adoption EIP		Result
			F (χ^2)	p-value	
Business size	2.470(0.118)	ANOVA	7.295	0.008*	rejected
Information intensity	1.409(0.237)	ANOVA	0.000	0.983	not rejected
Formalization	0.481(0.489)	ANOVA	0.411	0.522	not rejected
Centralization	0.485(0.457)	ANOVA	0.019	0.892	not rejected
Maturity and familiarity of IT	2.655(0.105)	ANOVA	21.061	0.000*	rejected
Competitiveness of environment	0.045(0.832)	ANOVA	0.496	0.482	not rejected
Industry type	-	Chi-square	(2.781)	0.245	not rejected

The result of the one-way ANOVA and Chi-square test indicates that between those organizations have and those have not adopted EIP, there are significant differences in the “business size” and “maturity and familiarity of information technologies” ($p < 0.05$). Thus, H1a and H1e are rejected. In addition, as show in Table 2, the correlation between other organizational characteristics included “information intensity”, “formalization”, “centralization”, “industry type”, and “competitiveness of environment” and adoption of EIP was not significant.

Therefore, H1b, H1c, H1d, H1f, H1g aren’t rejected.

Moreover, in order to find the organizational characteristic which can totally explain the reason why corporate adopted the EIP technology, we used stepwise discriminate analysis to test. Table 3 shows, in sequence, the variable of organization characteristic in explaining why corporate adopted EIP is related to “maturity and familiarity of information technologies” and “business size”.

Table 3 Stepwise discrimination analysis of organizational characteristic

Order	Organizational Characteristic	F	Wilk’s Lambda	Standardized canonical discriminat function coefficient
1	Maturity and familiarity of IT	21.061*	0.895	0.853
2	Business size	12.389*	0.878	0.399

4.4.2 The Relationship between Implementation of EIP & e-Business performance

This study grouped application degree into high, medium, and low three categories based on the average score of the items, then analysis with e-Business, operational, marketing, and adaptability performance by ANOVA. It can be seen from the Table 4 that the hypothesis H2 is rejected for all performance indices.

Because we force to divide application degree into three group, its may reduce or enlarge the variability of application degree. This study tests the hypothesis again to ensure the result by stepwise regression analysis. As show in Table 5, the result is the same as ANOVA. Application degree of EIP does significantly influence the e-Business performance as well as three sub-construct of e-Business performance included operational, marketing, and adaptability performance.

Table 4 The result of application degree and e-Business performance

Variables	Sum of Squares	df	Mean Square	F	p-value
E-Business performance	12.971	2	6.486	14.800	0.000*
Operation performance	13.690	2	6.845	14.832	0.000*
Marketing performance	9.959	2	4.979	6.540	0.002*
Adaptability performance	15.715	2	7.858	15.956	0.000*

Table 5 Regression analysis of application degree and e-Business performance

Variables	Samples	R ²	β	t	p-value
E-Business performance	181	0.156	0.395	5.752	0.000*
Operation performance	181	0.154	0.393	5.713	0.000*
Marketing performance	181	0.082	0.286	3.995	0.000*
Adaptability performance	181	0.155	0.394	5.737	0.000*

In order to classify EIP into several types, this study employed the factory analysis according to its feature. Responses to the 17-items scales analyze by using a principal component analysis with a Varimax rotation through Exploratory Factor Analysis. The result extracted three factors solution of implementation features and named as follow: information application, information presentation and information sharing In all, the factor loading is greater than 0.5 level and accumulated percentage of variance is equal to 62.198%.

To test H3, we grouped the respondents by conducting the cluster analysis on the score data of the feature factors, and then used the ANOVA to check if the average scores of the implementation features of different group of respondents are significantly different. We used the Ward’s method, one of the hierarchical cluster methods,

for the cluster analysis. The respondents were divided into three groups were 33 (18.7%) low gradation EIP, 126 (70%) developing EIP, and 21 (11.5%) omnibearing EIP; they were so called because of the difference in their perceptions of the implementation feature factors.

Table 6 shows the results of the ANOVA of the scores of performance indices of the three groups of respondents. It can be seen from the table that H3 is rejected for the e-Business, operational, marketing, and adaptability performance. Therefore, the relationship between implementation type of EIP and e-Business performance has significantly influence. Omnibearing EIP type has high e-Business performance than other two types of EIP in evidence.

Table 6 The result of implementation type and e-Business performance

Variables	Sum of Squares	df	Mean Square	F	p-value	Scheffe
E-Business performance	14.628	2	7.814	14.628	0.000*	A3>A2,A1
Operation performance	14.625	2	7.312	14.625	0.000*	A3>A2,A1
Marketing performance	18.480	2	9.240	18.480	0.000*	A3>A2,A1
Adaptability performance	14.569	2	7.284	14.589	0.000*	A3>A2,A1

Ps. A1: low gradation EIP; A2: developing EIP; A3: omnibearing EIP.

As well as application degree, this study grouped integration ability into high, medium, and low three categories based on the average score of the items, then analysis with e-Business, operational, marketing, and adaptability performance by ANOVA. It can be seen from the Table 7 that the hypothesis H4 is rejected for all performance indices.

Because we forced to divide grouped integration ability into three groups, it may reduce or enlarge the variability of grouped integration ability. This study tested the hypothesis again to ensure the result by stepwise regression analysis. Through Table 8, the result of the correlation of integration ability and e-Business performance is significant as well.

Table 7 The result of integration ability and e-Business performance

Variables	Sum of Squares	df	Mean Square	F	p-value
E-Business performance	16.702	2	8.351	20.014	0.000*
Operation performance	16.460	2	8.230	18.456	0.000*
Marketing performance	14.783	2	7.391	10.066	0.000*
Adaptability performance	19.011	2	9.505	20.056	0.000*

Table 8 Regression analysis of application degree and e-Business performance

Variables	Samples	R ²	β	t	p-value
E-Business performance	181	0.251	0.501	7.739	0.000*
Operation performance	181	0.243	0.493	7.589	0.000*
Marketing performance	181	0.131	0.361	5.185	0.000*
Adaptability performance	181	0.247	0.497	7.665	0.000*

On the based of 52 respondents had completed an EIP deployment. The users of EIP were divided into employee, partners/suppliers, and customers. As show in Table 9, H5

is not rejected. Hence, whatever the user type, the Impacts of Establishing Enterprise Information Portal on e-Business Performance do not significantly influence.

Table 9 The result of user of EIP and e-Business performance

Variables	Sum of Squares	df	Mean Square	F	p-value
E-Business performance	1.480	2	0.627	1.229	0.235
Operation performance	1.928	2	0.803	1.232	0.226
Marketing performance	1.918	2	0.757	0.876	0.325
Adaptability performance	1.501	2	0.794	1.530	0.238

4.4.3 The Intervening Variable of e-Business Degree

To test the impact between the implementation of EIP and e-Business performance if be intervened by e-business degree, this study grouped e-Business degree into high, medium, and low three categories based on the average score of the items. We verify the hypothesis by two-way ANOVA. If the result is significant, we go a step further to confirm the intervention is to enhance or weaken the impact by the graph of curve.

Table 10 demonstrates the impact between the implementation of EIP and e-Business performance is intervened by e-business degree. H6a is rejected. Fig.3

illustrates the interaction of application degree and e-Business degree. Whether the level of application degree is, high e-business degree has higher e-business performance than others. For this reason, we can infer the intervention is enhancing the impact between the implementation of EIP and e-Business performance. Furthermore, the curve line of low e-Business degree is not in common with others, especially in medium application degree. This is because in the group of medium application degree and low e-Business degree, among total 8 respondents, only one corporation was developing EIP. 3 corporations were still in the conceptual stage of EIP project, and other 4 respondents have yet to plan and establish. They all completely accomplish the

implementation of EIP to lead to the bias of the result.

Table 10 The interaction between application degree and e-Business degree

Source of Variance	Variables	Sum of Squares	df	Mean Square	F
Application degree * e-Business degree	E-Business performance	7.169	1.792	5.113	0.001*
	Operation performance	8.909	2.227	5.722	0.000*
	Marketing performance	7.218	1.805	2.737	0.030*
	Adaptability performance	6.508	1.642	4.061	0.004*

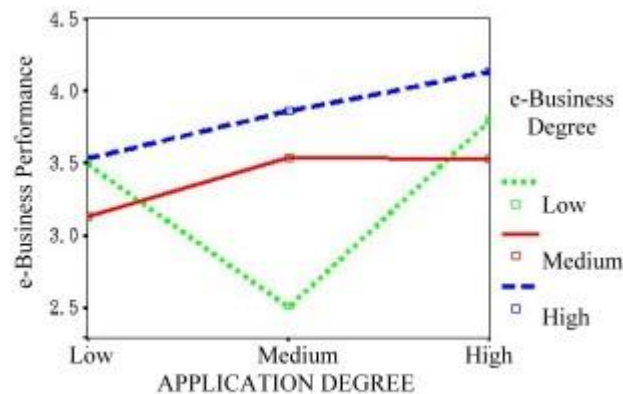


Fig. 3 Application degree and e-Business degree interact on e-Business performance

For the sake of accuracy of the result, we test the hypothesis again based on 52 samples had completed an EIP deployment. It can be seen from the Table 11 that the hypothesis H6a is rejected as well. As show in Fig. 4, high e-business degree has higher e-business performance than others consistently. The curve of line of low e-Business

degree is also different. The bias is formed on account of the low application degree only has three samples and high application degree just has one sample, in low e-business degree group.

Table 11 The interaction between application degree and e-Business degree (n=52)

Source of Variance	Variables	Sum of Squares	df	Mean Square	F
Application degree * e-Business degree	E-Business performance	2.424	0.808	2.942	0.043*
	Operation performance	5.295	1.765	5.299	0.003*
	Marketing performance	4.307	1.436	2.636	0.061
	Adaptability performance	0.332	0.111	0.279	0.840

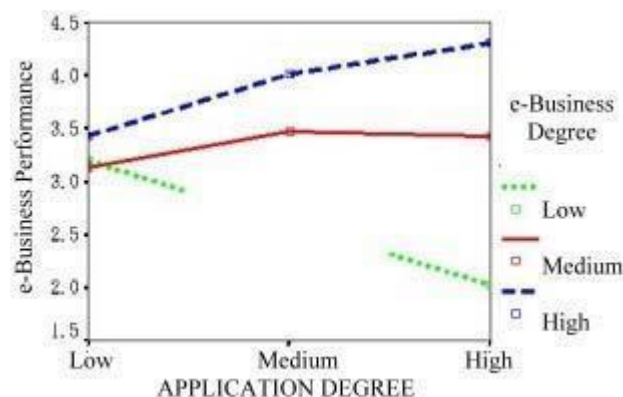


Fig. 4 Application degree and e-Business degree interact on e-Business performance (n=52)

By two-way ANOVA, the impact between implementation type of EIP and e-Business performance will be intervened by e-business degree ($F=2.549$, $p<0.05$), as show in Table 12. Therefore, H6b is rejected.

According to the graph illustrates the interaction of implementation type and e-business degree on e-Business performance, with the exception of omnibearing type of EIP, high e-Business degree has higher e-Business

performance approximately. On omnibearing type of EIP, lower e-Business degree corporations have highest e-Business performance than higher e-Business degree corporations instead because of this group is only has one

sample. It raised the result of e-Business performance.

Table 12 The interaction between implementation type and e-Business degree

Source of Variance	Variables	Sum of Squares	df	Mean Square	F
Implementation type * e-Business degree	E-Business performance	3.469	0.867	2.549	0.041*
	Operation performance	3.908	0.977	2.446	0.048*
	Marketing performance	5.078	1.269	2.099	0.083
	Adaptability performance	2.973	0.743	1.812	0.129

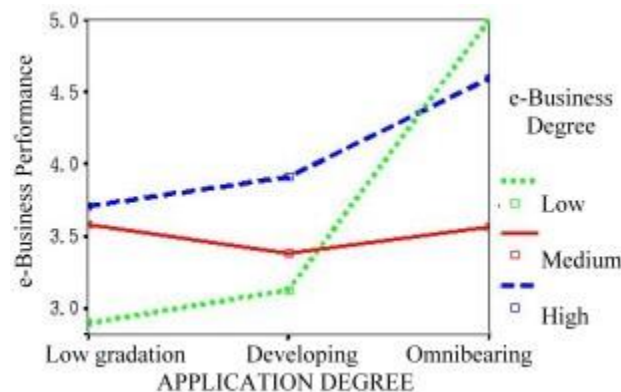


Fig. 5 Implementation type and e-Business degree interaction on e-Business performance

5. Conclusion

The result of our study shows that: (1) Between those organizations have and those have not adopted EIP, there are significant differences in the maturity and familiarity of information technologies, and organizational size; (2) In the way of implementation EIP, the relationship among function application degree, implementation type, integration ability, and e-Business performance are also significantly influence; (3) The impact between function application degree of EIP and e-Business performance will be enhanced by high e-business degree; (4) The impact between implementation type of EIP and e-Business performance will be intervened by e-business degree; (5) The implementation time of EIP has no significant impact on the relationship between implementation EIP and e-Business performance.

The most important reason corporations adopt EIP is "the maturity and familiarity of IT". Thus it can be seen EIP is a new concept of information management, the more IT implementation experiences, and the easier accept the new application system. Secondly, "business size" is another factor influence corporations adopt EIP. In general, the larger size of corporation, the requirement of information is more complex. Moreover, the cost of adopting new information

technology must be expansive. The larger corporation may be more possible to implementation or prepare to start EIP project.

According to the result, more than half corporations implement EIPs since last two years. 52 respondents indicated that they had completed an EIP deployment and 35 respondents were developing. They all start to implement EIP, so we classify 87 (48%) respondents into adoption group. Another 50 respondents were still in the conceptual stage of EIP project, and 44 respondents have yet to plan and establish. More than three fourth corporations had implemented EIP or started to plan EIP project. Thus it can be seen that EIP is available concept and the current trend of information management and e-Business project.

We divided EIP into three types: "low gradation EIP", "developing EIP", "omnibearing EIP". Only 10% corporations belong to omnibearing EIP, 70% corporations belong to developing EIP. It shows the implementation of EIP is immature.

The most important feature of EIP is easy to use and the users increase the familiar of internet environment. For users, EIP has more usability than other e-Business project. For corporations, the difficulty to train users to use EIP is lower the other e-Business performance.

(References are omitted due to page length limitation)

The Application of XML Key Management Specification in e-Business

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Abstract

The technology of PKI can satisfy most of the needs of security in e_Business. But it is restricted to use the PKI technology adequately because applications can not know the PKI System very well without an uniform architecture standard of PKI system. Now, XKMS gives the standard of key management, so applications can use the underlying PKI system transparently by using the standard interfaces. In this paper, we introduce the XKMS Web Services and the client software development kit (brief as CSDK) developed by ourselves. The web services and the CSDK are all in accord with the XKMS specification.. We also have developed an application system about e_Business to see how to call the web services by using the CSDK.

Key Words: XKMS; PKI; Web Services

1. Introduction

Information security has become the very hot topic, especially the rising of electronic commerce make it more important. The Public Key Infrastructure (PKI) can satisfy most of the needs of information security. The using of PKI is restricted because it needs that applications can know the architecture of PKI very well. XKMS^[1] can solve the problem well. In this paper, the research state of XKMS is introduced firstly. Secondly, we introduce the XKMS web

services^[2] and the client software development kit developed by ourselves in detail. At last, we introduce an application of e_Business briefly which is used to demonstrate that the XKMS web service and CSDK can solve the security problem in e_Business or not.

2. Overview of XKMS

2.1 Research Background of XKMS

Information security has become the very hot topic, especially the rising of electronic commerce make it more important. The Public Key Infrastructure (PKI) can satisfy most of the needs of information security. The using of PKI is restricted because it needs that applications can know the architecture of PKI very well, but most of applications, such as database and deal processing software, could know it very poor.

World Wide Web Consortium (W3C) has issued XML Key Management Specification(XKMS) which is proposed by Microsoft, VeriSign and WebMethods. The specification could simplify the integration of PKI and digital certificate by using XML applications. PKI is made to be transparent to any application. So programmer can add the function about XML signature and XML encryption easily in the application of e_Business.

As XML is an extensible language, the information expressed by XML can be known by different systems. It is good at sharing data

between different systems. Furthermore, it will promote the application of PKI widely in internet.

2.2 Present Research Condition of XKMS

W3C had issued XML Key Management Specification(XKMS) which was proposed by Microsoft, VeriSign and WebMethods in November 27,2000. It denotes that the research of XKMS has been a rudiment. W3C issued XKMS version 1.0 in March 30,2001. It includes XML Key Information Service Specification(X_KISS)^[1] and XML Key Registration Service Specification(X_KRSS)^[1]. X_KISS includes “locate service” and “authentication service”. X_KRSS includes “registration service”, “revocation service”, “key recovery service”. In XKMS it gives not only the format of request message of client and response message of server, but also the description of element and compute formula. W3C issued XKMS version 2.0 in August 1,2002 and “reissue service” was added in X_KRSS. W3C is to modify XKMS continually in order to make it more well. The latest working draft is the one modified in April 21,2003. In the meanwhile, W3C issued other specifications, such as XML Signature Specification (XML_SIG)^[3], XML Encryption Specification (XML_ENC)^[4] and XML Query Specification (XML_Query)^[5]. These specifications can provide valid security service for e_Business application.

With developing of XKMS, many large corporations has developed a lot of products to support XKMS. VeriSign corp. gives a XKMS Java SDK which can be used to develop XKMS client rapidly. Entrust corp. has accomplished the function of X_KRSS now. The function of X_KISS will be provided in the near time. Microsoft also supports XKMS in ASP.NET. Evisable corp. has embedded XKMS in their product named as Evisable INK which can link to Trust Web Service transparently.

2.3 Inclusion of XKMS

There are two part of contents in XKMS. One is X-KISS (XML Key Information Service Specification), the other is X-KRSS (XML Key Registration Service Specification). The former includes “locate service” and “authentication service”. The later includes “registration service”, “reissue service”, “revocation service” and “key recovery service”. There are request message and response message in every service. Request message is made by client and analyze by server. Response message is on the contrary.

2.3.1 X_KISS

A protocol to support the delegation by an application to a service of the processing of Key Information associated with an XML signature, XML encryption, or other public key. Its functions include the location of required public keys and describing the binding of such keys to identification information

X-KISS allows a client to delegate part or all of the tasks required to process XML Signature <ds:KeyInfo> elements to a Trust service. A key objective of the protocol design is to minimize the complexity of applications using XML Signature. By becoming a client of the trust service, the application is relieved of the complexity and syntax of the underlying PKI used to establish trust relationships, which may be based upon a different specification such as X.509/PKIX, SPKI or PGP.X-KISS.

By design, the XML Signature Specification does not mandate use of a particular trust policy. The signer of a document is not required to include any key information but may include a <ds:KeyInfo> element that specifies the key itself, a key name, X.509 certificate, a PGP Key Identifier etc. Alternatively, a link may be provided to a location where the full <ds:KeyInfo>

information may be found.

2.3.2 X_KRSS

A protocol to support the registration of a key pair by a key pair holder, with the intent that the key pair subsequently be usable in conjunction with the XML Key Information Service Specification or higher level trust assertion service such as XML Trust Assertion Service Specification [XTASS].

The XML Key Registration Service Specification permits management of information that is bound to a public key pair. The XKRSS service specification supports the following operations:

- z Register

Information is bound to a public key pair through a key binding

- z Reissue

A previously registered key binding is reissued.

- z Revoke

A previously registered key binding is revoked.

- z Recover

The private key associated with a key binding is recovered.

The Register operation does not in itself place any requirement on the Registration Service to communicate that information to any other party. In most applications, however, a Registration Service will provide key information to other trust services such as those described in the XKMS specification or a separate underlying PKI such as PKIX.

3. Main Working

In this section, we will introduce our main working, including the XKMS web services, CSDK and the application of e_Business. All of them are developed by our lab.

3.1 Former Working Flow of our PKI System

Our lab has developed a PKI system. Figure3-1 shows the working flow.

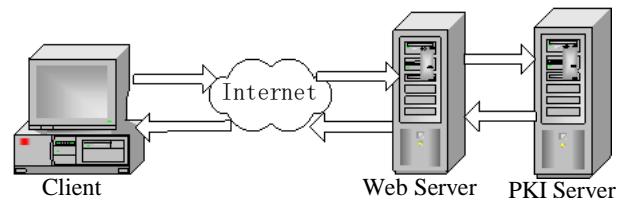


Figure 3-1 former working flow

Without a unified standard of PKI system, so user can visit it only by explorer. The function of PKI system can not be embedded in an application.

3.2 What To Do

In order to make user to use PKI system conveniently, we accomplished the functions of X_KISS and X_KRSS and deployed them as web services. In the meanwhile, we also developed the CSDK which is provided to user. We call the PKI System developed by ourselves as underlying PKI system. The CSDK gives the interfaces to call the web services. The details of underlying PKI system have been hidden and it is fully transparent to applications. Applications can only use the interface functions provided by the CSDK to operate the underlying PKI system by sending XKMS request message and receiving XKMS response message. Applications is not concerned with the architecture of the underlying PKI system .

We deploy the web services into XKMS server. XKMS server receives the request message from client and transmits it to the underlying PKI system. After processing the request message, the underlying PKI system sends the result to XKMS server. At last, XKMS server send the result to client.

In the meanwhile, we developd an application named as Fund Project Appraisal System By Experts Through Internet. We hope that we can solve the security problem of the application by calling the XKMS web services with the CSDK. It is the fact that the application can do it without knowing any detail of the underlying PKI system.

3.3 How To Do

We have developed server software module and client module module. The server software module accomplishes the functions of X_KISS and X_KRSS. All the functions of XKMS are deployed as web services in the server named as XKMS server which is supported by Apache tomcat^[8] server. CSDK gives interface functions to user.

SOAP^[6] protocol is used to correspond between in XKMS server and client. Client uses RPC (Remote Procedure Call) to call the XKMS web services deployed in the XKMS server. Sender packs up XKMS message to SOAP message and sends it to receiver. Receiver gets the valid information form the SOAP message received from sender. In order to make the underlying PKI system not to modify more, XKMS server corresponds to the underlying PKI system with HTTP protocol which can be known by it. So XKMS server should know the architecture and details of underlying PKI system. On the one hand, XKMS server would convert the request message received from client to the one which can be known by the underlying PKI system. On the other hand, it would get the valid information from the processing message returned from the underlying PKI system. After that, it would convert them to XKMS response message and send it to client. The correspondance between them is fully transparent to an user. The user should only know the functions of the XKMS web services in XKMS server. It enlarges the

area to use a traditional PKI system . Figure 3-2 shows the working flow.

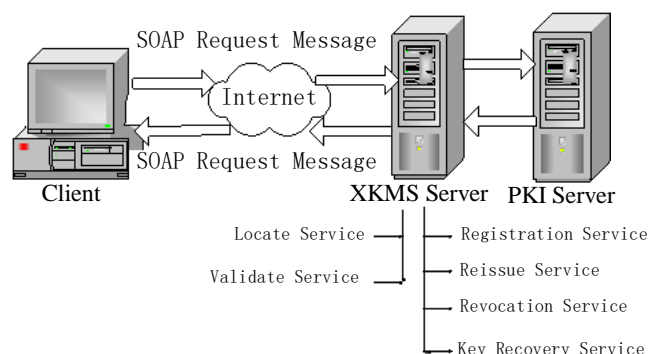


Figure 3-2 working flow

3.3.1 Accomplish X_KISS

X_KISS includes “locate service” and “authentication service”.

(1) Locate Service

“Locate service” includes “locate public key” and “locate certificate”. When an user received a signature document and the corresponding certificate, he would want to know that the signature is valid or not. As client couldn’t analyze the X.509 certificate, he need to send the request message of “locate public key” to XKMS server.. The certificate contains the public key should be included in the request message. Since XKMS server is able to analyze a X.509 certificate, it would analyze the certificate by itself after receiving the request message of “locate public key” from client. There is no any request to be sent to the underlying PKI system. XKMS server sends response message which includes the public key got from the certificate.

When client sends “locate certificate” request message, we add some function to XKMS because there are more than one certificate in the locate result. We divide “locate certificate” into “locate certificate list” and “locate specified certificate”. When client sends “locate certificate” request message, we will

locate certificate list firstly. XKMS server sends a locate certificate request message to the underlying PKI system and the certificate list according with locate condition will be returned to XKMS server. There are certificate serial number, DN, issue date, invalid date, key length, revocation date, certificate status, Email algorithm and certificate type in the certificate list. As HTTP protocol is used in the corresponding between XKMS server and the underlying PKI system, XKMS server should process the response message from the underlying PKI system and find the data demanded by the certificate list. After finished it, XKMS server would send a response message containing these information with SOAP protocol to client.

The user selects one certificate from the certificate list and sends a “locate specified certificate” request message containing the serial number of the certificate to XKMS server. After receiving it, XKMS server sends a locate certificate request message containing the certificate serial number received from client to the underlying PKI system. The underlying PKI system will locate the certificate with the serial number and locate the CA certificate. After that, two certificates will be sent to XKMS server. As the same reason, XKMS server also needs to process the return message and get the two certificates. A response message contains the two certificate will be sent to client from XKMS server.

The method to process the HTTP message received from the underlying PKI system in XKMS server is to look the HTTP message as a string and analyze its structure. The method in other service is the same when XKMS server communicates with the underlying PKI system.

(2) Authentication Service

When client receives some signature Email and corresponding certificate, client need to

authenticate the certificate is valid or not, is revocatory or not, is the sender’s one or not etc. Since client has not the authentication function, it needs to send “authentication certificate” request message to XKMS server. The request message contains the certificate which would be authenticated and its certificate chain. After receiving the request message, XKMS server gets the serial number of the certificate and locates the certificate using the serial number from the underlying PKI system. The underlying PKI system returns a certificate list which contains the certificate. In this certificate list there are a lot of information about the certificate. XKMS server finds the certificate status and the public key of the certificate after processing the return message. The certificate status and the public key are all sent to client.

3.3.2 Accomplish X_KRSS

X- KRSS includes “registration service”, “reissue service”, “revocation service” and “key recovery service.”

(1) Registration Service

The Register request is used to assert a binding of information to a public key pair.. Generation of the public key pair MAY be performed by either the client or the Registration service. Registration service can registry not only a personal certificate but also a server certificate.

The information used to registry a personal certificate are as follows.

Name: CN

Department: OU

Unit: O

City: L

Province: SP

Country: C

Email : E

All the information are binding to the

certificate. Moreover, key length, authentication code and revocation code are all necessary.

Certificate request encoding (refer to the standard of PKCS#10^[7]) is the only required to registry a server certificate. Registration service can get the necessary information from the encoding. Authentication code and revocation code are also necessary

Before registration, client needs to get an authentication code with offline mode from XKMS server. The authentication code is used to authenticate his request. Client selects a revocation code to authenticate itself should be necessary to revoke the registration at a later date. If the key pair is generated by client, client should make a signature of a string with the private key to demonstrate that it owns the private key. If the key pair is generated by server, server should encrypt the private key and send it to client after finishing the registration. In this case, the private key can only be an encryption key. To be a signature key is denied.

After finishing the registration, client will receive a message to show the registration is successful or not. If success, client will save the private key generated by client or received from server to a temporary file. After the RA and CA all pass the registration, the private key stored in the temporary will be stored into a keystore file. In the keystore file the serial number of corresponding certificate will be the alias name of the private key.

XKMS server will authenticate the request is been authorized or not after received a registration request. If the authorization is passed, XKMS server still need to distinguish which type of certificate is registried. The certificate request encoding will be sent to the underlying PKI system directly when it is to registry a server certificate. If it is to registry a personal certificate XKMS server should distinguish how to generate a key pair.. If the key pair is generated by client XKMS server should authenticate that the user own the private key or

not. If the authentication is also passed, XKMS server will get public key, DN and other information from the request message. If the key pair is generated by server, XKMS server will get DN and other information form the request message. XKMS server sends to the underlying PKI system a request message which contains public key, DN and other information. The underlying PKI system will registry a certificate with these information and return a response message to XKMS server to denote the registration is successful or not. XKMS server convert this message to a XKMS message and send it to client.

(2) Reissue Service

The registration service may permit clients to reissue previously issued assertions. The reissue request is made in the same manner as the initial registration of a key. The principal reason a client would make a reissue request is to cause the registration service to generate new credentials in the underlying PKI system, e.g. X.509 Certificates. The key and DN will not vary in the new certificate.

(3) Revocation Service

The revocation service may permit clients to revoke previously issued assertions. Clients should give the revocation code contained in the registration request message to authenticate its identity.

The working flow is as follows.

Client send a revocation request message contains the certificate to be revoked and the revocation code to XKMS server. XKMS server gets the revocation code and the serial number of the certificate form the request message and send them to the underlying PKI system. XKMS server will return to client a response message contains the information about revocation is successful or not after receiving the return

message from the underlying PKI system.

(4) Key Recovery Service

The key recovery service may permit clients to request to recover the backup private key in the XKMS server. The backup private key may be the one generated by server. It also may be the one generate by client. If the key is generated by client, it should be encrypted with the public key of server certificate and sent to XKMS server. Only encryption key can be backup and recovered. XKMS server will revoke the private key whenever key recovery is performed. Client also needs to get an authentication code with offline mode from XKMS server. The authentication code is used to authenticate his request is authorized by XKMS server or not.

The working flow is as follows.

Client computes the digest of the authentication code and makes the signature of the digest with signature private key. The digest, signature and signature public key will be sent to XKMS server. After receiving the request message, XKMS server will validate the signature. If the validation is right, XKMS server will send a request message to the underlying PKI system to request key recovery. XKMS server encrypts the private key returned by the underlying PKI system with the user's signature public key. And sends it to client. Client will decrypt the encrypted private key with its signature private key after receiving the response message from XKMS server. At last, the private key will be stored into the keystore file.

3.3.3 Explanation ff Correlative Computation

(1) Computation of Authentication Code

Computation :

Number "0X1" is as the seed to generate a random key. Algorithm HMAC-SHA1 is used

to compute the digest of authentication code.

The formula is as follows.

$\text{digest} = \text{HMAC-SHA1}(\text{authentication code}, 0X1) \dots \dots \dots (1)$

For example, if the authentication code is "024837". The formula is as follows.

$\text{digest} = \text{HMAC-SHA1}("024837", 0X1) \dots \dots (2)$

Then we will make the signature of the digest with the private key K_{pri} generated by client. The formula is as follows.

$\text{signature} = K_{\text{pri}}(\text{digest}) \dots \dots \dots (3)$

Authentication:

XKMS server decrypts the signature with the public key K_{pub} received from client to get the original digest'. The formula is as follows.

$\text{digest}' = K_{\text{pub}}(\text{signature}) = K_{\text{pub}}(K_{\text{pri}}(\text{digest})) \dots \dots \dots (4)$

Compare digest' with digest firstly. It demonstrates that the signature is right if they are equation. Or else the signature is wrong. Secondly, XKMS server computes the digest'' with authentication code "024837" at the same method. The formula is as follows.

$\text{digest}'' = \text{HMAC-SHA1}("024837", 0X1) \dots \dots (5)$

Compare digest'' with digest . If they are equation, the request is passed. Or else it is not passed.

(2) Computation of Revocation Code

The compute method of revocation code resembles as the compute method of authentication code. But the digest should be computed twice. when XKMS server authenticates the request it is the only step to validate the signature.

Computation:

Firstly, Number "0X1" is as the seed to generate a random key. Algorithm HMAC-SHA1 is used to compute the digest of authentication code. The formula is as follows.

$\text{digetst1} = \text{HMAC-SHA1}(\text{revocation code}, 0X1) \dots \dots \dots (6)$

Secondly, number "0X1" is as the seed to

generate a random key. Algorithm HMAC-SHA1 is used to compute the digest of digestst1. The formula is as follows.

$$\text{digest} = \text{HMAC-SHA1}(\text{digestst1}, 0X2) \\ = \text{HMAC-SHA1}(\text{HMAC-SHA1}(\text{revocation code}, 0X1), 0X2) \dots\dots\dots(7)$$

The digest is the result.

For example, if the revocation code is “I Will Reveal My Key”. The formula is as follows.

$$\text{digest} = \text{HMAC-SHA1}((\text{HMAC-SHA1}(\text{“I Will Reveal My Key”}, 0X1), 0X2) \dots\dots\dots(8)$$

Then we will make the signature of the digest with the private key K_{pri} generated by client. The formula is as follows.

$$\text{signature} = K_{\text{pri}}(\text{digest}) \dots\dots\dots(9)$$

Authentication:

XKMS server decrypts the signature with the public key K_{pub} received from client to get the original digest'. The formula is as follows.

$$\text{digest}' = K_{\text{pub}}(\text{signature}) = K_{\text{pub}}(K_{\text{pri}}(\text{digest})) \dots\dots\dots(10)$$

Compare digest' with digest firstly. It demonstrates that the signature is right if they are equation. It shows that the client owns the private key. Or else the signature is wrong and the client doesn't own the private key.

3.3.4 develop an application

Furthermore, we have developed an e_Business system named as Fund Project Appraisal System By Experts Through Internet. The system includes five main steps. The first step is researcher applys a project. The second step is to authorize by college and technology department. The three step is the subject director selects some experts to appraise this project. The four step is the experts give their appraisal opinion. The last step is the subject director confirms the project is passed or not. All of these operations are doing through internet. It demands that the system can not only encrypt the data transmitted in the internet but also

validate the identity of all kinds of users.

We have embedded our CSDK into the system. The system calls the XKMS web services by CSDK to satisfy the need of security. The fact is the CSDK can solve the security problem easily in e_Business.

4. Further Working

We have accomplished the six kinds of service functions of XKMS. But we should make them more sophisticated in order to adapt new needing because XKMS is developing constantly.

The main working we have done is only adapted for the PKI system developed by ourselves. Our next plan is to make the web services and CSDK adapting for more different PKI system to enhance their commonality. So we will provide a group of standard interfaces for underlying PKI system for the use of sending data to it or receiving data from it. After accomplishing these working, the format of input data or output data of all kinds of PKI system with different architecture is unified and a standard user interface of PKI system is provided for users through our XKMS web services.

5. Conclusion

With the using of PKI in e_Business becoming more and more widely, XKMS would be more important. XKMS could not only develop following the development of PKI, but also promote the development and using of PKI technology.

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Improving R&D Project Collaboration: A Concurrent Knowledge Learning Model

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Abstract

The collaboration issues on research and development (R&D) projects are getting critical. Shorten time-to-market (TTM) of new product is crucial competency of high-tech industries. However, lacks of post-project review, real-time communication and information sharing make barriers to reduce TTM. This would lead to downcast competition in the globalization. In this research, a concurrent knowledge learning (CKL) model is proposed to enhance R&D project collaboration. With the CKL model, R&D collaboration could be improved via the concurrent knowledge reusability and the collaboration mechanism among partners.

1. Introduction

Shorten the time to market (TTM) is the central of R&D projects management. While R&D projects generate artifacts in various forms of knowledge, there should be an efficient knowledge management mechanism so that the R&D projects could be executed efficiently and the TTM could be improved. This knowledge management mechanism should be encouraged by integrating with project management. Through the knowledge learning process, organization can keep continuous improving in the efficiency of R&D projects and shortening TTM [9]. However, most organizations lack post-project review processes. And projects are closed before reviewing the causes of their failures and successes [10]. This can discontinue the organization learning process and restrain the improving of R&D efficiency. The lack of post-project review results in learning discontinuity, knowledge disintegration, and makes barriers to shorten the TTM. Concurrent Engineering (CE) is one of the remedy to shorten TTM. CE was introduced in the late of 1980s to improve collaboration efficiency with team, which highlighted the synchronism of relevant sequential activities of new product development [14]. Also, CE was discussed to be consolidated with process modeling and analyzing. Process modeling made the new R&D projects process to be easily analyzed, and synchronized with the concurrent engineering [1]. With such a concurrent development process, the TTM of R&D projects could be improved for the enhancement of collaboration and concurrent capability.

2. Barriers of R&D Collaboration

R&D projects always have more complexity, difficulties and dynamics [12]. All of them make a higher risk to R&D projects. Nowadays, many companies try to utilize collaboration in R&D projects to share information. However, collaboration itself raises some issues. After literature review, the barriers of R&D collaboration are categorized into two main categories: the information sharing and the organization learning. The barriers of R&D collaboration are summarized in figure 1.

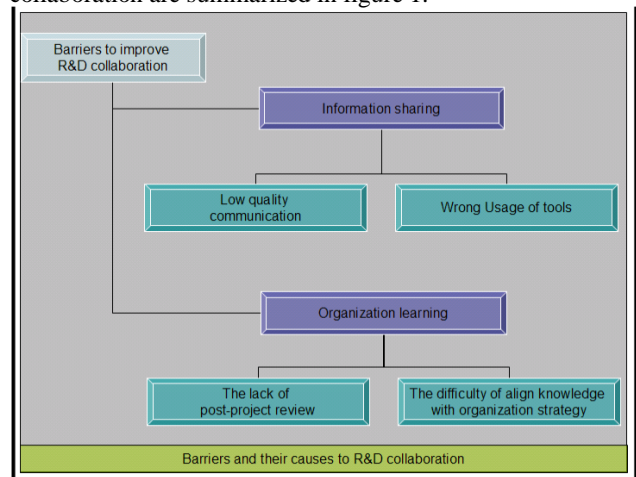


Figure 1: Barriers of R&D collaboration

With the difficulty of establishing and maintaining the communications, R&D project teams are encountering low quality communication. Most communication problem arises from cultural differences as well as roles and responsibility problems. Such problems could lead to downcast efficiency, even mistrust or suspicion [11]. However, information sharing and communication between partners are critical with globalization and collaboration [4]. Wrong usage of groupware or information sharing tools can also limit the learning and innovation in R&D teamwork [3].

Besides, knowledge management has been emphasized for its importance of knowledge reusing and diffusing. Organizations gain knowledge to improve developing process and reduce TTM from the implementation of post-project review [5] [7] [9] [13]. But this is difficult because of the differences in resource,

information, specification among projects and the fragmentation of the team by profession or know-how of team members [10]. An "aging work force" and rapid advance in technology even makes it critical for organization to filter knowledge into its core strategy [6].

Collaboration makes it easy for each R&D team unit (an individual or a subgroup) to focus on its core ability. This could lead to the maximized synergy if the quality of collaboration is made certain. In next section the CKL model will be described, by which above barriers could be overcome by the employing of CE and Knowledge Management.

3. Concurrent Knowledge Learning Model

The Concurrent Knowledge Learning (CKL) model integrates two levels of organization learning, with a central concept of concurrent engineering (Figure 2). The infrastructural level, which is shown in the center of Figure 2, contains one kernel and two shells, the Concurrent Knowledge Engine (CKE) as the kernel, with the Virtual Value Chain (VVC) shell and Knowledge Network shell. R&D project collaboration forms the application level which is based on the infrastructural level and shown as the skirt of the infrastructural level. The CKL model

proposes a framework for R&D collaboration to extract and imbibe knowledge through each activity among R&D projects. By this circulating model, artifacts of variety of knowledge are fed back and diffused concurrently to improve the quality and help decision making of each R&D project. Future more, for the R&D project collaboration, the barriers of information sharing and organization learning could be overcome with its abilities of concurrent information sharing and concurrent knowledge learning. Four major components of CKL model are described as follow.

3.1 Concurrent Knowledge Engine

The central concept of CKL model is the Concurrent Knowledge Engine (CKE), which is shown as the kernel of model in Figure 2. CKE stress the parallelism of the two levels. With the CKE, the valuable artifacts which generated from activities among R&D projects can be shared to each others concurrently, rather than the traditionally sequential ways. In other words, in a CKE based environment, the diffusion of knowledge within an organization is no longer passed one by one, but concurrently radiate to every department, every member, even every stage among different R&D projects. This

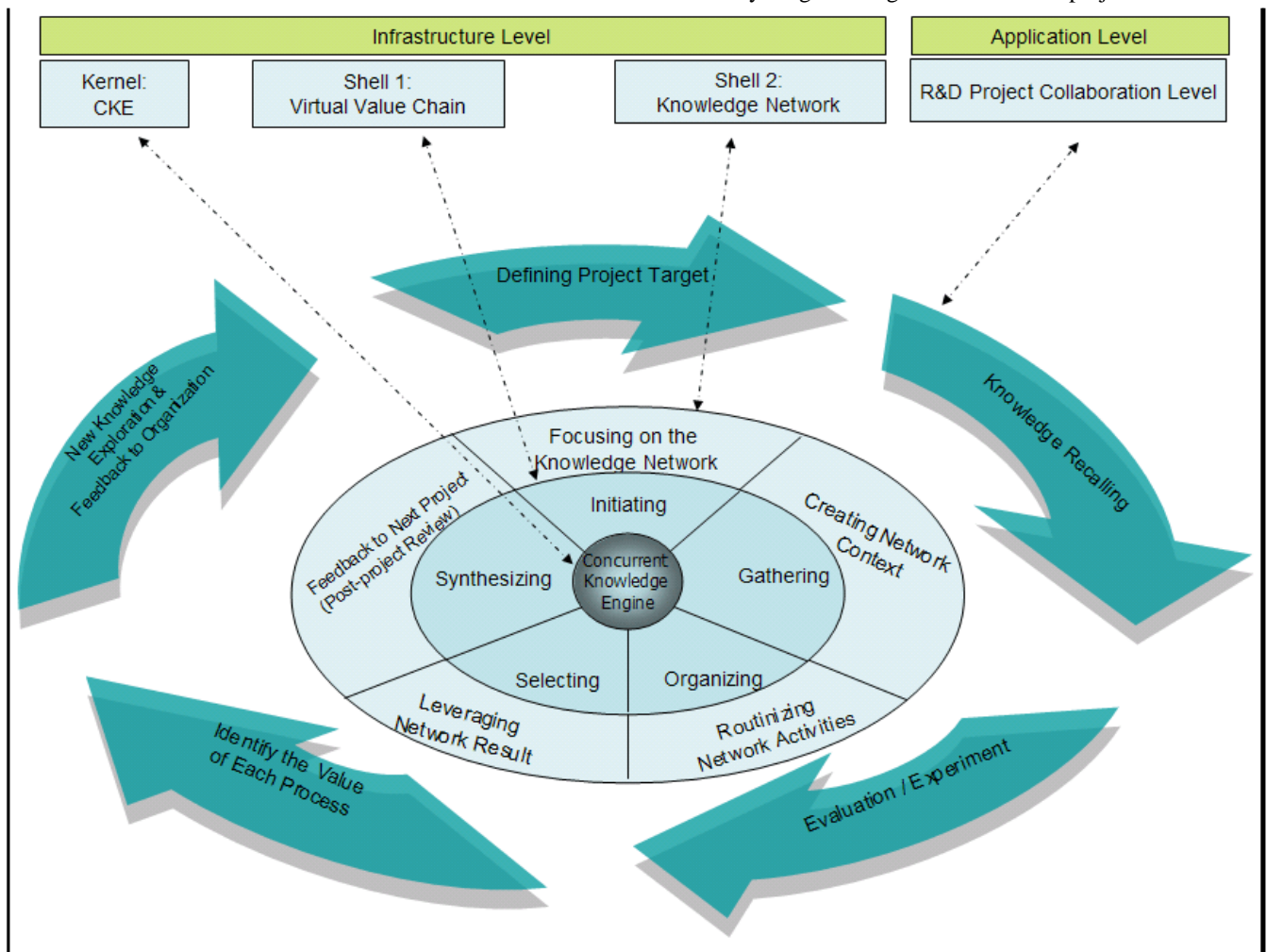


Figure 2: CKL model

could be performed by a centralized knowledge base, which contains knowledge of R&D artifacts and relative value of R&D activities.

3.2 Virtual Value Chain Shell

Virtual value chain was first introduced by Jeffrey F. Rayport and John J. Sviokla in 1994 and described much more specifically in 1995. Five value-adding steps - gathering, organizing, selecting, synthesizing, and distributing - are performed in the virtual value chain (VVC). The value-adding process is fundamentally different from sequential physical value chains. Virtual value chain creates value from extracting information from physical process, organizing the information, selecting and synthesizing valuable ones, finally distributing them into proper destination [8]. The CKL emphasize the concurrent operation of the virtual value adding activities. While each activity adds value to R&D artifacts, the value of new explored knowledge is distributed and shared concurrently to each others.

In CKL model, an initiating stage is added into the VVC shell in order to correspond with the knowledge network shell and R&D collaboration level. In the initiating stage, a new R&D project is getting started and the knowledge network is getting focused. Organization begins to identify related resources and information, including human resource, project specification, even the knowledge fed back by other R&D projects and other tangible and intangible ones. In this stage, value is added onto those information or resources. For example, the configuration of human resource and the project specification are modeled into standard form, making them easier to access and becoming more valuable information during the entire R&D project process. The gathering stage gathers knowledge from organization knowledge base. The knowledge is extracted from activity of every previous R&D projects. By gathering and reusing the knowledge, the value of knowledge is utilized by the on going R&D projects. The organizing stage then organizes the information and the knowledge extracted from organization knowledge base to fit current R&D project. Turning and modifying the knowledge rules are performed in this stage in order to make them more adapted to the situation. Also, knowledge rules are organized and integrated within this stage. In CKL model, the organized knowledge rules are applied to current R&D project, used to select most important and most valuable experiments to be performed. These knowledge rules help R&D team making decision and technology selection and to avoid unnecessary cost, both tangible and intangible, by the support of selecting what activity is need and what is not. In the selection stage, new valuable knowledge rules are selected to be synthesized.

At last stage, the synthesizing, original knowledge and new explored knowledge are compounded and new value is extracted again. These knowledge and value are concurrently fed back to the CKE and diffused through the

concurrent environment to other on going R&D project. For example, at the synthesizing stage of project A, the R&D team might find a better way to allocate limited human resource and fed it back to the CKE. And this value-adding knowledge is extracted through the CKE by the team of project B which is just at the initiating stage. So the project manager of project B now can do a better configuration of human resource with the help of the valuable knowledge and experience from project A, as “concurrently” as possible. This is the concurrent collaboration among R&D projects.

The first four stage of VVC shell in CKL model all attempt to extract new knowledge, which adds value to the organization. At the synthesizing stage, original knowledge and new explored knowledge are compounded to extract new value. The knowledge is then concurrently fed back to the CKE and diffused to other R&D project concurrently.

The reason why the distribution stage of VVC is not shown in CKL model is that the distributing of information and knowledge has been implied within the CKE

3.3 Knowledge Network Shell

Four stages for building a knowledge-creating value network are defined in [2]. In CKL model, one new stage is added in order to utilize the knowledge created through the network and to link all others. That is to feedback the new extracted knowledge to next project or is called post-project review [10]. While knowledge rules diffuse to each R&D projects concurrently, the organization is learning from previous R&D project and related knowledge expands. Therefore, the knowledge network shell becomes a spiral expending loop that the knowledge expends and is shared concurrently with each R&D project. Knowledge network shell can be seen as a more practically expended view of the virtual value chain shell in CKL model. Each stage of the knowledge network shell and the relationship with the virtual value chain shell in CKL model are described as follow.

First stage is focusing on the knowledge network. The knowledge network is initiated in this stage and need to be focused to be aligned to the core strategies of the organization. In R&D project case, the network should be highly supported by the organization and be ensured to organization learning level but not only individual level. And the strategy is to shorten TTM. In the second stage, to create the network context, the activity of “gathering” in the virtual value chain shell plays an important role in this stage. Reliable experts are selected to ensure the accuracy and rank the effectiveness of each knowledge rule, so that R&D team can then trust in what their decision making are supported by. After creating knowledge network context from gathered information and knowledge, the network should be organized for routinizing network activities, in the third stage in knowledge network shell. In CKL model, establishing a “network heartbeat” [2] would be the most

important part in this stage. Network heartbeat decides the frequency of R&D project activities routine. The routine activities of R&D project in CKL model are the reusing of knowledge to shorten the TTM and decrease development cost. In one hand, the frequency that the team recalls the knowledge should be dynamic change with the situation of the project going on. On the other hand, new available knowledge generated from each R&D team should be positively passed to each other via the concurrent knowledge engine. The fourth stage in this shell is leveraging network result. In this stage, the value of each R&D process are considered and ranked in order to perform the selecting stage in virtual value chain shell to extract the knowledge of identifying what are most important process and what might reduce the R&D TTM or so on. The fifth stage of knowledge network shell, feeding knowledge back to next project or called post-project review, is added in order to utilize the knowledge that created through the network and to link all other stages into a spiral expending loop. The knowledge extracted from each R&D project must be fed back to organization through the post-project review process to synthesis its value [10]. While valuable knowledge rules diffuse to other ongoing R&D projects through CKE as soon as the knowledge is extracted, the organization is learning from previous R&D project and the R&D related knowledge expands. Therefore, the knowledge network shell becomes a spiral expending loop that the knowledge expands concurrently with each single R&D project and shared among every R&D projects.

3.4 R&D Collaboration Level

In this level, R&D activities are happening practically. Specifications are defined. evolution and experiments are performed. The most important part, knowledge from previous R&D projects is reused to help current project reducing TTM or avoiding similar mistakes.

In the initiation of a R&D project, the target and specification of the project is defined. The specification defining process could be referred to previous similar R&D project for the allocation of resource, the configuration of schedule and so on. After specification is defined, in the traditional way the project should be start. But in CKL model, the project must be start after the process of knowledge recalling. In this stage, knowledge rules are reused by their ranking of helping shorten TTM. With the help of these rules, the evaluating process would be shorten and optimized. This could lead to shorten TTM and decrease development cost.

After the evaluating process, each used knowledge rule is re-scored and re-ranking. A correct rule would be rewarded, but an inaccurate one would be punished. So the ranking of rules might be changed. Finally, a post-project review process reviews the project for the reason of failure and success. These experiences could be then shared as knowledge to other R&D teams via the CKE concurrently. For example, knowledge about how to avoid failure or how

to approach success is recalled. Or some knowledge rules might indicate the most important experiments among all while some others are not so important and might be skipped to reduce unnecessary cost. In the post-project review process, new knowledge rules would be found and synthesized concurrently with the old ones.

3.5 Summary of CKL Model

Table 1 summarizes the CKL model. With CKL model, the two major identified barriers faced by R&D collaboration – information sharing and organization learning – could be overcome by the employment of CE and knowledge management. CE plays a role of concurrent sharing of information and knowledge. Base on CE, the concept of VVC and knowledge network could provide a concurrent environment to extract, organize and refine experience and knowledge. The R&D collaboration could be then enhanced with the concurrent information sharing and organization learning. This could lead to shorten R&D TTM and further more, to increase competency of high-tech industries in the globalization.

4. Conclusion & Future Work

The CKL model integrates various artifacts and enhances the concurrent knowledge refining and diffusing, so that the R&D project collaboration could be improved continuously with the concurrent knowledge learning environment. In other words, the CKL model is itself an experts system with dynamic and grow-able knowledge base. The knowledge of CKL model will expand with new artifacts generated from every R&D project, and are refined through knowledge selection during every R&D projects. This is the key to shorten TTM.

The future work of this research is to implement CKL model as a web-based environment and validate it in the industry. The CKL methodology and the implemented environment would be introduced to the world-class high-tech industries in Taiwan. The semiconductor or optoelectronics industries are the first priority. Through the cooperation of industry and academics, the expected benefits are as follows:

- 1) The TTM of R&D projects could be shortened by the capability of knowledge and experience recalling in CKL.
- 2) The quality of real time information / knowledge sharing could be improved through the employment of CKL.
- 3) The efficiency of R&D project collaboration could be continuously improved by CKL model for the improvement in concurrent knowledge reusing and information sharing.

In addition, CKL model delivers the reference model for the R&D projects and knowledge management to shorten the TTM. Besides, this research proposes a suggestion for the refinement of the virtual value chain [8] and the knowledge network [2] by integrating them with the

concept of concurrent engineering [14]. These could contribute to the field of new technology innovation and

knowledge management.

Table 1: Summary of the CKL model

Component		Description	Major Function
Kernel	Concurrent Knowledge Engine (CKE)	CKE is the kernel of the CKL model, served as a knowledge base which collects and diffuses knowledge concurrently.	<ul style="list-style-type: none"> | A centralized knowledge base | Diffusing knowledge and information | Enabling a real-time knowledge sharing environment
Infrastructure Level	Shell 1: Virtual Value Chain (VVC)	VVC is the basic concept of extracting value-adding knowledge from physical process.	<ul style="list-style-type: none"> | Defining the five value-adding stages | Extracting “virtual value” from “physical process”
	Shell 2: Knowledge Network	Knowledge Network forms a method to extract, utilize, and refine knowledge which extracted from physical process.	<ul style="list-style-type: none"> | Linking the virtual value chain concept and physical R&D processes | Defining the standards for knowledge formation, reusing, ranking, and refining.
Application Level	R&D Collaboration	This level defines a looping process for R&D collaboration, which is not as the traditional sequential way. Concurrent knowledge reusing and post-project review are the major method to enhance R&D collaboration.	<ul style="list-style-type: none"> Collaborating different R&D projects by mutual knowledge reusing Recalling knowledge to shorten TTM and decrease cost Refining knowledge as an organizational learning process through the post-project review

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Optimal Scope and Length of Software Patents

A Simulative Approach

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Abstract

Traditionally, only technical inventions such as light bulbs or pharmaceuticals were protected by patents. Nowadays software patents are a widely discussed topic in the U.S. and in Europe because of their proposed impact on national innovation rates. Based on an analysis of the determinants of successfully developing software, we use a bipartite probability model to compare a deregulated market without patents to a market using a patent system. Applying computer-based simulations, we analyze different scenarios to test the impact of different patent duration and width on the innovation behavior of the software market. We can show that strong patent protection is globally efficient only in markets with a relatively low profit potential.

1. Introduction

Traditionally, patent protection was awarded only to technical inventions, such as light bulbs, shavers, or pharmaceuticals. After computer programming became viable, and protection of computer programs became desirable most countries decided that software was too abstract or intangible to be patentable, and copyright became the dominant form of protection. In the last years firms were going to demand patents on software-related inventions, which drove an intense public and academic discussion regarding the use of patent systems to protect software.

Software consists of functional as well as expressive attributes. Functional attributes describe special instructions and expressive attributes their representation [7]. This hybrid structure made it difficult for patent officials to assess the technical character of inventions, which is a prerequisite for patenting inventions. Another problem is the lack of qualified patent inspectors and the associated difficulty to assess the novelty. This has resulted in quite a number of patents being granted for inventions considered to be obvious by experts in the field.

The goal of this paper is to answer these questions:

1. How do scenarios with and without patent system differ in terms of the endemic propensity to monopolize?
2. In which scenario can we expect a higher level of innovation?

After an overview of specific characteristics of the software market (section 2.1) a survey of economic and

legal patent issues (section 2.2) is given. Based on this, an economic simulation model incorporating individual patent incentives and their implications on (aggregate) system behavior is recapitulated from an earlier paper (section 3). Section 4 presents the simulation results as well as the arising conclusions. Section 5 gives a short summarization of the paper and proposes future research.

2. Literature Review

2.1 Special Issues of the Software Market

Market topology: The market for software products is embedded into the IT market, which is part of the Information and Communication Technology (ICT) market shown in Figure 1.

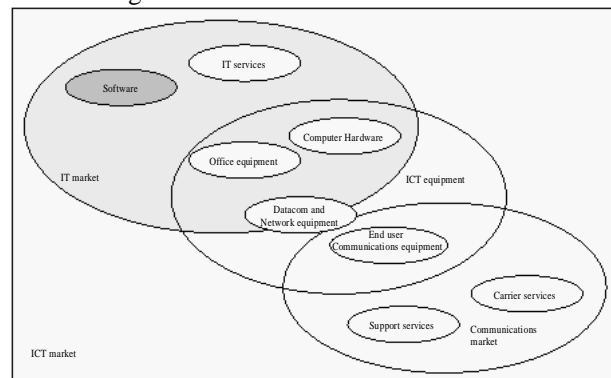


Figure 1: Complexity and different submarkets of the ICT market

Beside a high momentum in technical innovations and strong competitiveness in the ICT market, leading to constantly shorter product cycles and even higher pressure towards innovativeness, one can also identify paradigm shifts that lead to fundamental changes of business rules in general [5]. The wide application of ICT has led to a rapid decline in prices and costs in the computing and telecommunications sector with positive repercussions for a variety of other products, like aircrafts, automobiles and scientific instruments. Table 1 shows the forecasted revenues in different regional software markets [12].

Cost structure: It is relatively costly to produce the first copy of a software product while the costs of additional copies are very low (e.g. CD-ROM) or even negligible (e.g. if distributed via download from the Internet). From an economic perspective this means high fixed costs and very low marginal costs leading to substantial

economies of scale [29]. Compared to the chemical market with fixed costs for developing one product amounting to € 300 million [6], the fixed costs are low. Since software is immaterial, the distribution costs also are significantly lower than for physical goods.

Instant scalability: Closely related to the cost structure is the phenomenon of instant scalability in software markets. Since it is very easy to reproduce and distribute copies of software, suppliers can respond very quickly to an increase in demand. Therefore, once a software product is recognized as superior, the particular vendor might be able to gain a significant market share in a short period of time [25].

Pricing: Cost structure and instant scalability influence pricing strategies in software markets. Of course it does not make sense to apply marginal-cost-based pricing if the costs of reproduction are close to zero. Pricing is more likely to be determined by consumer value, leading to differential pricing [29]. Because of the importance of the installed base due to positive network effects, dy-

namic pricing (and in particular penetration pricing) is one of the most important strategies in modern software markets.

Positive network effects: It is common in many markets that a consumer's buying decision influences the others' decisions. Interdependencies such as the bandwagon, snob, and Veblen effect are broadly discussed in the economic literature (e.g. [8]). Beside these general effects, which apply to all consumer decisions, software markets are determined by positive network effects, the so-called demand-sided economies of scale, deriving from the need for product compatibility. This means that the willingness to adopt a product innovation correlates positively with the number of existing adopters. These effects mainly originate from two different areas, the need for compatible products to exchange data or information (direct network effects) and the need for complementary products and services (indirect network effects) [11] [14] [23].

Table 1: Total Revenue of the ICT market (Million €) [12]

2003	Western Europe	Eastern Europe	USA	Japan	Rest of World	World
ICT equipment	211,544	12,236	208,721	119,759	216,815	769,077
Software	81,856	1,845	135,606	22,813	45,070	287,189
IT services	158,773	2,876	262,536	73,276	85,203	582,664
Carrier services	278,381	19,244	293,541	111,801	338,207	1,041,173
Total	730,554	36,201	900,404	327,649	685,295	2,068,103

Tippiness: Supply-sided economies of scale, instant scalability, and positive network effects can result in a specific dynamic structural change in software markets referred to as tippiness. If the diffusion of a certain software product gains sufficient momentum the market might tip meaning that a particular product takes over the entire market in a short time. The phenomenon is analyzed analytically in [2] and empirically in [25].

Start-up problem and critical mass: Due to the existence of network effects, early technology adopters bear the risk of buying a product which might not succeed in gaining the expected market share. This can lead to excess inertia even if the product is seen as superior [2]. Related to the start-up problem is the critical mass, being the threshold number of users needed to overcome the start-up problem. Reaching this point in the diffusion process might then again result in rapid acceleration and in tipping of the market.

Propensity to monopolize: Network effect literature states that multiple, incompatible technologies can only rarely coexist in markets with network effects, and that instant scalability results in an additional tendency to monopolize. Empirical observations show monopolistic structures in some of the modern software markets like the market for office suites, word processors, or spreadsheets [25].

Utilization and availability of open code: Open code is one of the most important external factors for software development (up to 20%) [15]. The strongest usage ema-

nates from independent developers, but recently the reuse of open source software by medium-size and large companies has increased as well [15]. Open source has a generic character, i.e. in many cases it is functional input which makes software development more effective. There is no significant argument for utilizing open source, but a relatively well balanced set of motives (e.g. adaptability, state-of-the-art, costs and quality). Disclosure of code is used mostly as strategy to diffuse information about one's own performance.

2.2 Special Issues of Patents

2.2.1 Legal Perspective

Until the US Supreme Court's decision *Diamond vs. Diehr* in 1981, patent protection for software was almost non-existent. In this instance, the Court ruled that a computerized process for curing rubber was patentable even though the process involved an algorithm which by itself was not patentable [27]. The distinction was that the algorithm was applied to a process, as opposed to attempting to patent the algorithm [27]. Computer programs are patentable in the USA today. It is even possible to patent business methods. Basically, the requirements for patentable items (inventions) are ruled in part II, chapter 10 of the U.S. Patent Act [31]: "Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefore, subject

to the conditions and requirements of this title” [31, § 101]. The criteria for granting a patent are:

The person is the inventor [31, § 102], the invention is the proper subject matter for a patent: machines, articles of manufacture, compositions of matter, and processes [31, § 101], and the invention is "useful", "new", [31, § 102] and "unobvious" [31, § 103].

For most types of inventions, the first two requirements usually present little difficulty. Generally speaking, an invention is useful if the invention has an utilitarian or commercial value; an invention is new if it is the first embodiment of the idea in a useful thing or process; and an invention is unobvious if it would not have been obvious to a person reasonably skilled in the pertinent art, given what already existed in the particular field. This last requirement often is the most difficult barrier for patenting a new invention since often it is very subjective to determine whether the differences between the new invention and the prior state of the art are obvious solutions to known problems. The four mentioned categories (process, machine, manufacture, or composition of matter) have - together with the requirements of utility and novelty - the function to restrict the set of patentable inventions; explicit prohibitions do not exist. The process for obtaining a patent on an invention typically starts with a patent attorney preparing and filing a patent application for the inventor and owner of the invention with the United States Patent and Trademark Office (USPTO). The first inventor is entitled to the patent over any subsequent inventors - even if the subsequent inventor applies first - as long as the first inventor can prove the earlier date of the invention.

Table 2: Patents granted by class in the years 1997-2001 [32]

Class	1997	1998	1999	2000	2001	Amount
700	349	660	536	465	660	2670
701	329	510	684	824	1253	3600
702	350	517	512	517	574	2470
703	224	297	301	285	275	1382
704	365	611	627	534	610	2747
706	202	305	128	130	157	922
707	580	1189	1283	1131	1256	5439
716	191	269	246	236	404	1346
717	128	306	406	370	467	1677
Amount	2369	4004	4187	4027	4996	Total: 22253

The application must be filed not later than one year after: public use of the invention, the placing on the market of the invention for sale in the U.S., or the publication of a description of the invention anywhere in the world. Table 2 clarifies granted patents in the field of „Data Processing“¹ in the U.S. between 1997-2001 [32]. A detailed

overview of positive and negative patenting decisions involving software is given in [27].

2.2.2 Economic Perspective

Patents and the incentive problem: The standard economic rationale for patents is to protect potential innovators from others' imitation, thereby providing incentives to incur the cost of innovation. The innovator receives a temporary monopolistic position [3]. The usage of the patent system therefore has two essential advantages:

- The patent owner (monopolist) is able to claim higher prices and larger market shares.
- The time frame for skimming the market will be artificially extended.

The patent owner has the possibility to offer licenses and the chance to participate in the development or improvement of future innovations by licensees [28]. Since the patenting process is expensive (one application in Europe can cost up to € 50.000 [1]), small and medium-size enterprises (SMEs) in particular are discriminated. As a consequence, scarce financial resources constitute substantial barriers to patenting among SMEs. Hence, nondisclosure can be an optimal strategy [15].

Jaffe suggests that patents inhibit other innovation activities, for example by preventing access to licenses needed for improvements. This is characterized as negative after deductions effect [22]. Furthermore Kortum & Lerner point out that despite decreasing R&D expenditure, the number of patents in the U.S. is increasing quickly. They substantiate these correlations with company-wide advanced innovation management [24]. The same perception is represented by Bessen & Maskin. Moreover they discuss about trivial patents which conduct knowledge that is considered common knowledge and therefore not patentable [4].

Patent race and cross licensing: Because each innovation can only be assigned once, innovators often find themselves in a patent race. Although the losers face R&D and patent application costs, they attain no revenue. In this context Dasgupta & Stieglitz speak of a socially unwanted situation [10]. At the same time, the licensing process offers a possibility for reducing future innovation costs of other innovators [26] [28]. The winner normally is not engaged in offering licenses. Licensing implies competition and endangers the patent owner's monopoly position. This leads to the inhibition of R&D by other inventors with concepts for improvements on a patented product [4].

If, for example, another actor has invested in developing an improvement to a product, the firm holding the original patent may use its monopoly position to appropriate some of the value created by the complementary innovation. This can occur even if a second firm ob-

¹ Class 700: Generic Control Systems or Specific Applications, Class 701: Vehicles, Navigation, and Relative Location, Class 702: Measuring, Calibrating, or Testing, Class 703: Structural Design, Modeling, Simulation, and Emulation, Class 704: Speech Signal Processing, Linguistics, Language Translation, and Audio Com-

pression/Decompression, Class 706: Artificial Intelligence, Class 707: Database and File Management, Data Structures, Or Document Processing, Class 716: Design and Analysis of Circuit or Semiconductor Mask, Class 717: Software Development, Installation, and Management.

tains a patent on the improvement. If the second firm can market its innovation with the consent of the first firm, the first firm can increase its profits on the second's account by bargaining to license the complementary technology at less than full value. This holdup problem reduces R&D in complementary technologies through inventors reducing the expected return on their investment [9]. Although it appears as though licenses will never be as-

signed in such situations, it still happens. Nowadays patents offer the function of currencies. If a company needs another firm's license for its own activities, it tries to exchange its own license with that of the other license holder. This operation is referred to as cross licensing. Patents are used as weapon in competition and play a decisive role second to negotiations [20].

Table 3: Positive and negative aspects of patents

Positive aspects	Negative aspects
Microeconomic perspective	
Imitators are discouraged through the consequences of infringement. Patents also hamper piracy. An extended time frame for skimming the market is given.	Substantial costs: Costs of patent description and of patent agents, patent application and the costs of assignation of patents, costs of the extension of a patent.
Patents enforce the first mover advantage and therefore the de-facto-standardization (positive feedback loops).	Patent infringement is difficult to control, especially in embedded systems. Moreover discovery of infringement is very expensive.
Patents represent assets strengthening the relative competitive position.	The liability of disclosure (6 months) opens the ideas for others and gives them the chance to market the ideas earlier.
The liability of disclosure (6 months) opens the ideas of others for own developments.	Development costs increase, because of licenses or bypass of patented developments. Improvements are only possible on a complementary way (low rate of code re-using). Risk of market exclusion.
Expending of development costs through the chance of being monopolist and claiming higher prices.	Patents can hamper interoperability.
Licensing and cross licensing are possible.	
Macroeconomic perspective	
Patents are an important incentive for spending capital in R&D.	Decrease of development efforts (holdup problem), cannibalizing the own network.
	Decrease of product variety.
	Inhibition of technical progress through the denial of licenses.

Patents, sequentiality, and complementarity: Sequentiality describes each successive invention being built on the preceding one. The rate of re-using code is very high [4] [3]. Complementarity means that each potential innovator takes a somewhat different research line, thereby enhancing the overall probability that a particular innovation goal will be reached within a given time [4]. The sequential and complementary nature of innovations is widely recognized, especially in high tech industries [17] [18] [9]. Analyses of many innovations found that most of the productivity gains are achieved via improvements to the original innovation (e.g. [13]). Empirical evidence for innovative complementarities is provided by [30] [19].

Table 3 summarizes positive and negative aspects of patenting software. We distinguished between the view of an individual actor (microeconomic perspective) and the macroeconomic perspective.

3. The Model

In the following our model for investigating the economic impact of patents will be introduced. The main difference to existing work in this research field is the approach of a simulation model to augment the small analytical models, proposed by Bessen/Maskin 2000, Green/Scotchmer 1995, Chang 1995 etc. about the impact of additional key factors like different levels of complementarity, cost structures, and multiple periods. The increased complexity, triggered by these parameters circumvents the applicability of analytical methods.

The following assumptions are based on the preceding literature review:

1. The software market is characterized by short innovation cycles. Improvements emerge frequently in a cycle of less than 12 months.
2. The software market is characterized by a high rate of incremental progress. Innovations in this market are profoundly sequential.
3. The market is characterized by a high degree of complementarity.

4. Research and development efforts in one generation become obsolete after a few (3) periods.
5. R&D-efforts have an extensive impact on finding future innovations (3 periods).

Based on these assumptions, we developed a bipartite economic multi-period model comparing a deregulated market without patents to a market using the patent system. The basic model was developed in [21] so only the main elements are presented here. In this paper we focus on simulation results regarding the impact of the length and scope of a patenting system on the firms' innovation behavior. The model encompasses I actors, representing software manufacturers in a particular segment of the software market (e.g. text processing). The model considers three different company sizes. Based on the topological data of the German software market the actors are organized into sectors of small (80%), medium-size (15%) and large companies (5%) [16]. In each period t one or several parallel innovations lead to the economic profit v_t which is assumed to be constant over time and will be split between the successful actors (analogous to [4]). Therefore, the actors compete with each other for the same innovation in one period. The planning horizon of the model is T .

Another parameter influencing the expected profit are the development costs c_{it}^d . The greater the efforts the smaller the profits, but the higher the probability of success. The amount of c_{it}^d depends on the company's size. The larger the company the higher the possible development costs. If patenting is possible the companies taking part in the patenting process further have to spend patent process costs c_{it}^p .

Based on the assumptions presented above the core of the model is formed by the innovation probability p_{it} which determines the innovation success of actor i finding the innovation in period t . p_{it} is functionally dependent of the following factors:

- A: The development costs, spent in t and in the former 3 periods (assumption 5).
- B: The innovation success in the preceding 3 periods, represented by the binary variables $x_{it-1}, x_{it-2}, x_{it-3}$. x_{it} is equal to one, if actor i found the innovation in period t (assumption 2).
- C: The patenting activities of the other innovators, represented by $\varepsilon_{it} = \{0;1\}$. If patenting without licensing is possible, incremental improvements of others in earlier periods (T_p represents the current time of patent protection, which actual amounts 20 years) have to be found in a complementary way, diminishing the chance of success. This effect decreases the probability, if the innovation in period t was patented by an actor $j \neq i$. The nearer ε_{it} is to 1.0 the lower is the difficulty for finding a complementary way (assumption 3) and therefore the smaller is the scope of patent protection.
- Various weighting (α, β, M) and discount factors (w_d, w_x) (assumption 4) assess the influence of the several parameters, as can be seen in equation 1.

The aggregates A and B are normalized by dividing them to the regarding maximum values. The derivation of equation 1 can be found in [21].

$$p_{it} = \frac{\alpha \frac{A}{A} + \beta \frac{B}{B}}{M} \cdot C = \frac{\alpha \cdot \frac{\sum_{\tau=t-3}^t c_{it}^d \cdot w_d^{(t-\tau)}}{\sum_{\tau=t-3}^t c_{it}^d \cdot w_d^{(t-\tau)}} + \beta \cdot \frac{\sum_{\tau=t-3}^{t-1} x_{it} \cdot w_x^{(t-\tau)}}{\sum_{\tau=t-3}^{t-1} w_x^{(t-\tau)}}}{M} \cdot \prod_{\tau=t-T_p}^{t-1} \varepsilon_{it}^{(\tau-t+T_p+1)} \quad (1)$$

with $\alpha, \beta \geq 0$; $\alpha + \beta = 1$ and $M \geq 1$

The innovation and patenting process consists of four activity steps in each period:

- I. Actor i has to decide whether or not to participate in the innovation process, i.e. spending development costs c_{it}^d .
- II. His research process turns out to be either successful or not, according to his innovation success probability p_{it} .
- III. If research is successful, the actor has to decide about taking part in the patent race.
- IV. Only one actor can win the patent race. The winner is determined randomly with the same probability for every actor participating in the patent race.

Steps III and IV only occur in the scenario which possesses a legal patent protection system. A risk-neutral actor i will only invest in R&D in period t if his expected net benefit $\text{Exp}[v_{it}^{\text{net}}]$ is positive. The expectation depends on the individual innovation probability, on the elevation of effort, and on the network size. The bigger the network, the more actors will find the innovation resulting in a reduced part of the economic profit.

$$\text{Exp}[v_{it}^{\text{net}}] = \frac{v_t}{\text{Exp}[\sum_{i=1}^I x_{it}]} \cdot p_{it} - c_{it}^d \quad (2)$$

As an estimator for $\text{Exp}[\sum_{i=1}^I x_{it}]$, the number of ac-

tors who found the innovation in the period before will be used. The expected value does not include resulting future benefits, because technological progress is difficult to predict and the complexity of the model would increase superproportionally. If the actors can take advantage of an installed patent protection mechanism, the model comprises an additional decision function (3) for evaluating the benefits of patenting, including the probability to win the patenting race. An innovator agrees to the patenting process if the expected actual economic profit minus the patent application costs c^p and plus the expected future benefits $\text{Exp}[BW_i^{\text{PZ}}]$ of establishing a temporary monopoly is positive. The detailed derivation again can be found in [21].

$$\text{if } \frac{v_t}{\sum_{i=1}^I x_{it}} - c^p + \text{Exp}[BW_t^{pZ}] > 0 \quad (3)$$

\Rightarrow actor i takes part in the patent race

4. Results

4.1 Parameterization

The following results are based on simulations, which emulate the behavior of 100 software developers in a particular market segment. The actors are grouped into three sectors of company-size (small = 80%, medium = 15%, large = 5%), resulting in different exemplary chosen ranges of development costs. The concrete values are equally distributed within the ranges given in table 4. Every simulation was run about 50 periods ($T = 50$). The total economic profit per period amounts to $v_t = 100$ resp. $v_t = 1500$ monetary units.

Table 4: Distribution of development costs

Company sector	Large	Medium	Small
c_{ti}^d upper bound	60	40	30
c_{ti}^d lower bound	30	20	10

We used the parameterization of the weighting and discount factors in equation 1 as shown in table 5. These values are based on no empirical evidence yet and are only chosen as a starting point for later sensitivity analyses. Using these values the different influence factors are weighted equally within the innovation probability.

Table 5: Constant probability parameters

Further parameters determining the innovation probability		
Weight of prior development costs	w_d	0.9
Weight of prior successful innovations	w_x	0.9
Relative weight of development costs	α	0.5
Relative weight of successful innovations	β	0.5
Market difficulty	M	1.0

4.2 Simulation Results

The following simulation results are shown for two different environments ($v_t = 100$ or $v_t = 1500$ in every period) to analyze markets with low and high profit potential. Both environments are simulated without (scenario I) and with (scenario II) the availability of a legal patent system. To analyze the impact of different system configurations in all cases the patent length T_p is varied from 1 to 20 periods (20 years is the actual current protection time), and the patent protection scope ε is varied from 1.0 (= no protection) to 0.9 (values lower than 0.9 would result in such a high patent scope, that no innovation activities, except by the first patent owner, were possible).

The first question of our paper focuses on the endemic propensity to monopolize. To examine this question the

Herfindahl index is applied. This index is commonly used to measure market concentration in industrial economics. The index is calculated by summing up the squared market shares of each innovator. In order to measure the stability of temporal monopolies we constructed an intertemporal Herfindahl index HKI which represents the distribution of the different patents (over time) in the network. $HKI = 1.0$ means every patent within the simulated periods was held by the same actor, while lower values represent changing patent owners over time.

Figure 2 shows the resulting values for $v_t = 100$ and $v_t = 1500$. The higher the patent scope and/or patent length, the higher the tendency of intertemporal monopolization, i.e. at low ε and high T_p rather only one actor will gain all innovations and patents over time. The trend of monopolization is much more distinctive in the low potential market ($v_t = 100$).

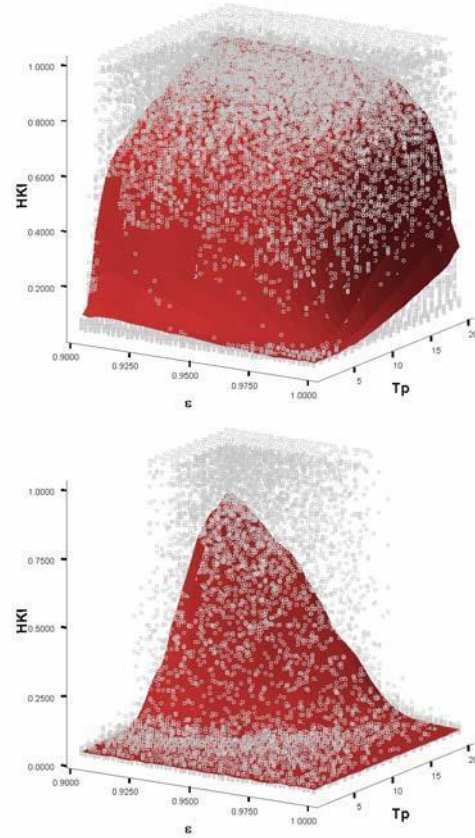


Figure 2: Market concentration index for $v_t = 100$ (upper diagram) and $v_t = 1500$ (lower diagram)

The second research question focuses on the relation between patentability and overall innovation rates. In order to answer this question, we measured the number of periods in which at least one actor found the innovation. We again compared the different market potentials ($v_t = 100$ and 1500) and did four views at two different scopes of patent protection (wide protection ($\varepsilon = 0.9$) and small protection ($\varepsilon = 0.99$)) and two different current times of protection ($T_p = 5$ and $T_p = 20$) while varying the other parameter (abscissa). Figure 3 and 4 show the results of the different constellations for a small market value ($v_t = 100$).

The upper diagram in figure 3 shows that by varying patent duration ($T_p=1$ up to $T_p=20$) with a constant small protection width ($\varepsilon = 0.99$) the scenario with patent protection performs better with a patent current time between 6-15 periods. Below 5 periods both scenarios have on average 25 periods with innovations found. (Caused to the low possible profit the decision function (eq. 2) leads to oscillations in decision and innovation behavior.)

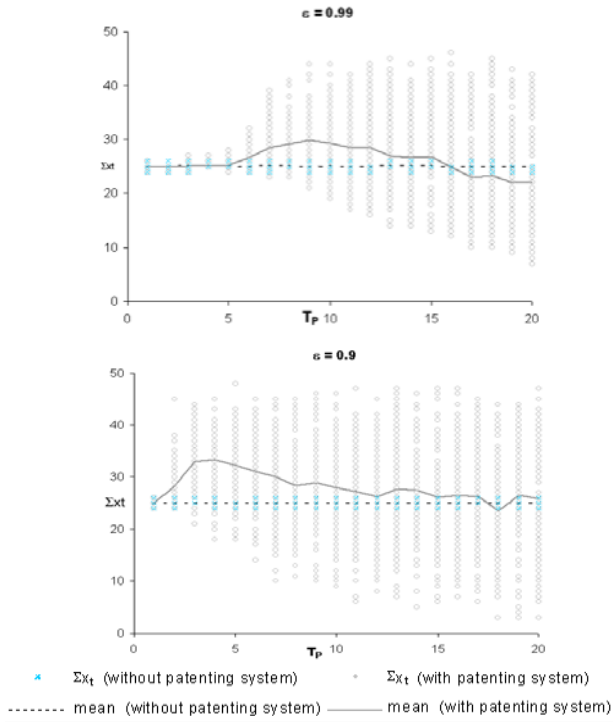


Figure 3: Number of innovations found with $v_t = 100$ (varying patent length T_p at two different levels of ε)

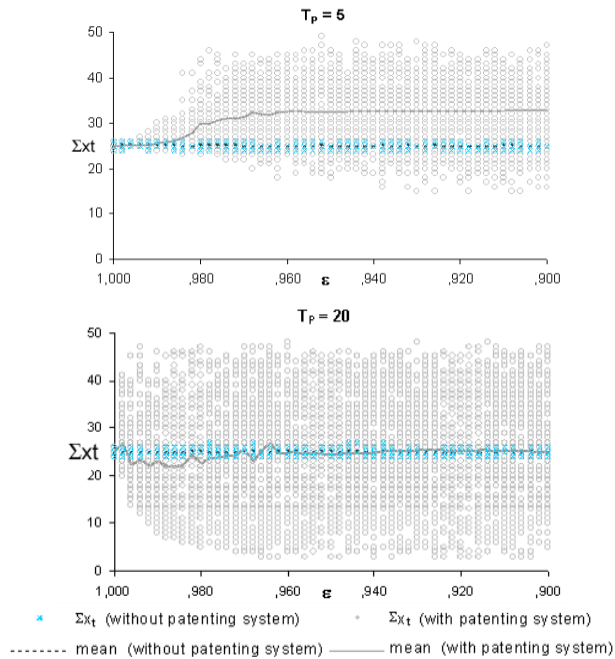


Figure 4: Number of innovations found with $v_t = 100$ (varying patent scope ε at different levels of T_p)

Figure 5 and 6 represent the corresponding results for the same parameter constellations in a high value market ($v_t=1500$).

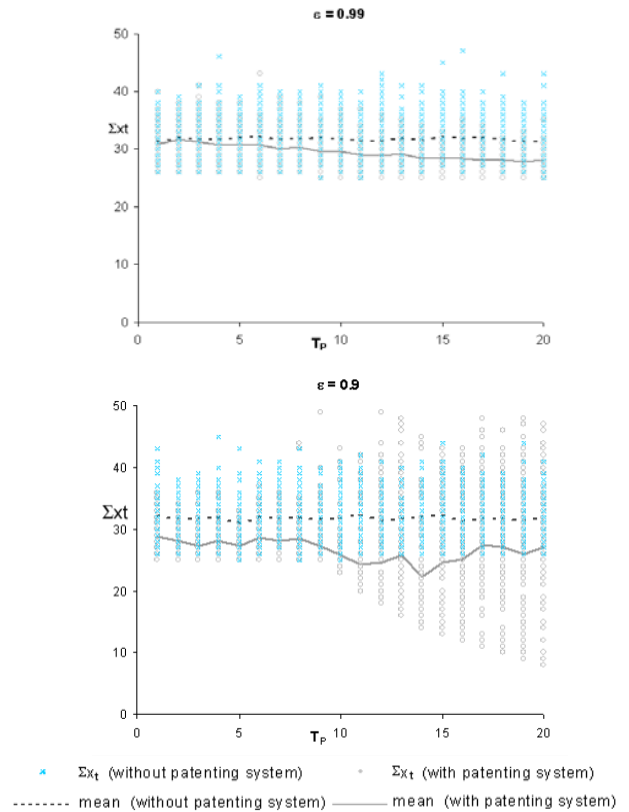


Figure 5: Number of innovations found with $v_t = 1500$ (varying patent length T_p at two different levels of ε)

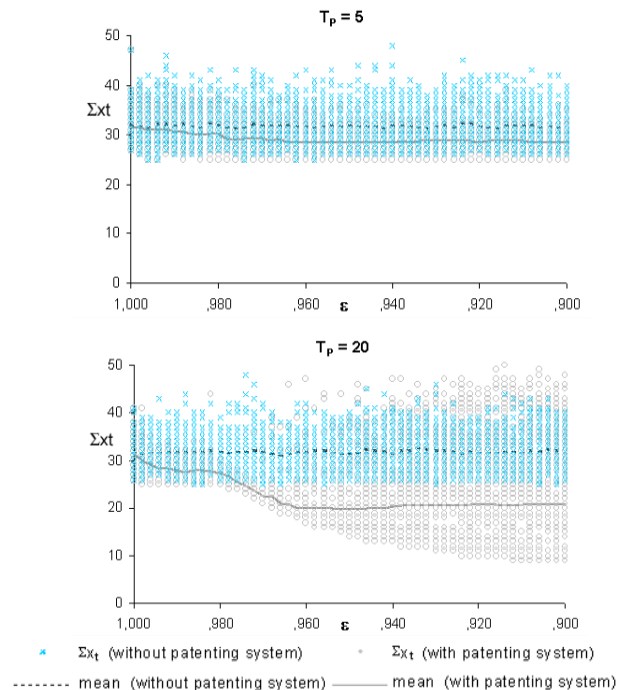


Figure 6: Number of innovations found with $v_t = 100$ (varying patent scope ε at two different levels of T_p)

In this situation the results have changed. The overall level of “innovative periods” is higher because the larger market potential provokes more actors to invest in R&D. The scenario without patent protection dominates in all cases. The innovations found on average always are higher. The longer the run time the bigger the difference in favor of the scenario without patents. With constant patent lengths ($T_p=5$ and $T_p=20$) the same results occur. It is noteworthy that at $T_p=20$ the patent protection system performs very badly between the patent scopes of $\varepsilon=0.98$ and $\varepsilon=0.9$. In this area only 20 innovations on average could be found. In markets with a high innovations value, the no-patent scenario dominates the patent scenario in every case. This is more with long patent current times and less with short run times. Comparing these results it can be summarized that within a low market potential combinations of rather high patent scope and rather short patent duration (3-5 periods) a legal patent system provides worse results (see figures 3&4) while it always results in positive effects in high value markets (figure 5&6).

In a next step, we analyzed the innovation success of the different market sectors in more detail, i.e. the relative innovation success between small, medium-size and large companies. For that purpose, the total number of innovations (including simultaneously found innovations) was counted and divided by the market share of the regarding company sector (i.e. small, medium or large companies). This success index was normalized to a value between 0 and 1.

$$\text{successindex(sector)} = \frac{\sum_{t=1}^T \sum_{i \in NW_{\text{sector}}} x_{it}}{\text{share(sector)}} \quad (4)$$

$$\forall \text{ sector} \in \{\text{small, medium, large}\}$$

As can be seen in figure 7, only in the $v_t=100$ environment the relative success of the respective sector changes with the patent length and scope. Without patent protection (the outer left dataset in each chart) in most cases the small companies are the most successful actors followed by the medium companies. In the case of a rather low patent scope ($\varepsilon=0.99$) and patent length of 6 to 10 periods the large companies reached relatively more innovations. At low ε the relations evolve inversely. Of course these results depend on the chosen cost structures, but it could be shown that in particular constellations and especially with constant cost structures the variation of patent system properties influences the success in a different way. This phenomenon has to be taken into account when designing welfare efficient patenting systems.

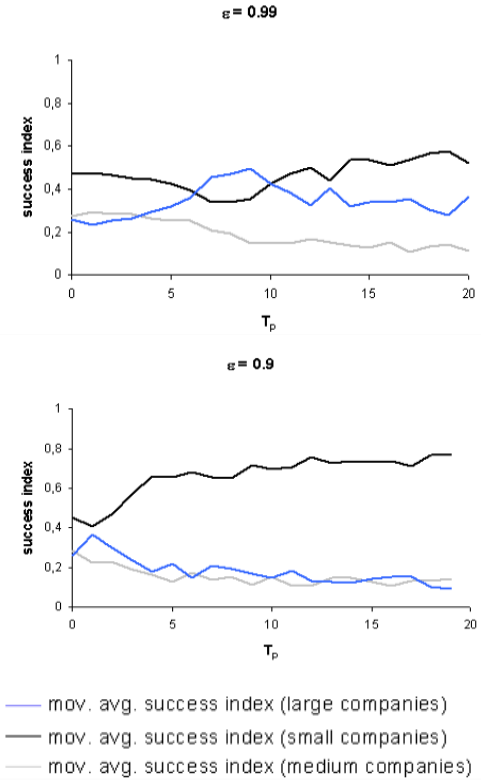


Figure 7: Innovation success by company's size for $v_t=100$ (different levels of ε)

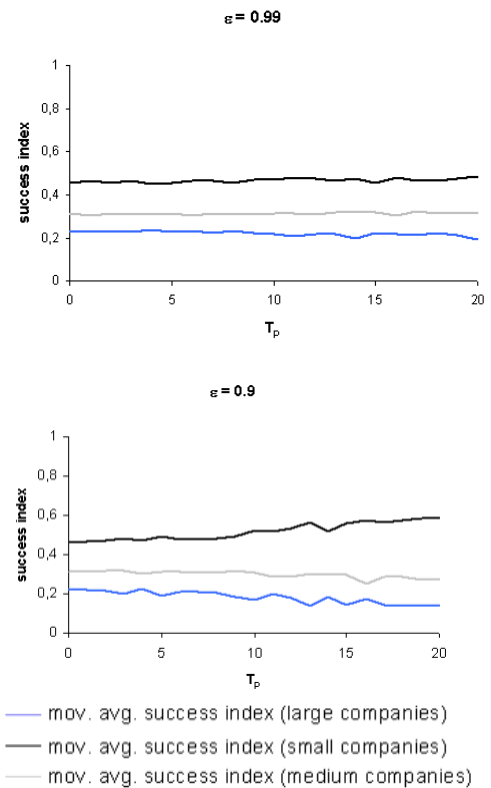


Figure 8: Innovation success by company's size for $v_t=1500$ (different levels of ε)

5. Conclusion and Further Research

The goal of this paper was an analysis of the impact of software patents on the innovation activities of the software market. In this context, software development was characterized by its sequentiality, complementarity, utilization and availability of open code as well as the necessity to ensure interoperability. We developed a bipartite model for comparing environments with and without a legal patent system. Based on the characteristics (e.g. sequentiality and complementarity) we identified the development costs and the existence of previous innovations as the two key factors for innovation success. In the patent scenario the patent itself will have an additional effect. Computer-based simulations revealed that patent protection within low-potential markets outperforms the scenario without patenting system while the opposite holds for high-value markets. For both systems there is a propensity to monopolize, which is more distinctive in the low value market. The quantitative results of course are only interpretable within the chosen environment (parameterization, modeling of decision functions etc.). Nevertheless from the model the following general findings can be derived:

Patents lead to more or less intertemporal monopolies. Both the patent width and the patent length as key determinants of a legal patent system from a macroeconomic view can not be determined independent of the particular market properties (innovation difficulty, cost and market structure, market potential).

In some parameter constellations (lower market potential) a patent system leads to structurally different outcomes for the different market sectors.

As a next step, we will validate the findings using empirical data (esp. development costs and incentives for software producers) from conducted cases of software companies. Based on this research a sensitivity analysis of all parameters is necessary to determine the validity area of the made conclusions. Further the model will be extended about the possibility for cross-licensing and the actors' development costs will be endogenized to gain more favourable results about the individual incentive structure. Based on these steps of validation and extension the model could support in determining the necessity of a patent system or evaluating the optimal length of patent protection subject to the particularities of the software market.

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Impact of Knowledge Management on the Value Addition Process of the Enterprises

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Abstract

The concept of knowledge management (KM) is relatively a new one. But this concept has been widely discussed these days as it has been recognized that knowledge management is one of the important components of intangible assets of any business or non-business organization. In the business world, the earlier concept of knowledge has been changed where data, information etc. were treated as knowledge. Knowledge is now treated not as some data or information but this is power – a strategic (created) asset. Firms around the world are looking mainly for strategic assets rather than tangible resources. As a result, management of such an asset has become a challenge to the present world. There are controversies also exist across countries because of the fact that it is not objectively verifiable whether knowledge management adds value to the organization.

This paper attempts to conceptualize knowledge, its different types and the notion of knowledge management. This has been mainly done by the survey of literature on the basis of research work carried out around the world. However the main contribution of this article is that it has taken the Porter's Value Chain Model (1985) to evaluate if there is any relationship between this model and knowledge management or whether knowledge management adds value to the organization or not. A null hypothesis has been drawn assuming that there is no relationship between them. It has been found that the null hypothesis is not true and hence rejected. This indicates that KM adds value – the acceptance of alternative hypothesis (H_1).

1. Prologue

In the present day business world, organizations are constantly striving to create mechanisms for gaining competitive advantage over their competitors by differentiating their products or services in a common

market place. In this context, business enterprises are trying to optimize the exploitation of corporate assets. These assets can be categorized as financial, tangible and intangible assets. Financial assets comprise of cash, stocks, bonds etc.; plant, equipment, inventory etc. can be considered as tangible assets whereas core competencies & technologies, management skills, organizational culture, brand image, consumer loyalty, patents, distribution channels and the like are intangible assets. Knowledge is treated as a valuable intangible asset, which can be used as a strategic weapon in this turbulent environment of global economy. Such intangible assets are often called "Knowledge Capital" or "Intellectual capital" (Stewart, 1994) [20].

Knowledge Management is the systematic process for acquisition, distribution and utilization of knowledge in order to achieve the knowledge goals of the organization. It is the management of business, customer and process knowledge and its application for adding value and competitively differentiating product and service offerings [21]. As information technology revolutionizes today's businesses, flow of information is increasing through the technologies such as Internet and Intranets. Business processes and activities becoming more transparent and information asymmetries are blurring. Organizations are depending more and more on knowledge management to be competitive.

The Value Chain Model (Porter, 1985) [14] views the firm as a chain of some basic activities. Value addition refers to the difference between the products or service value before and after an activity is performed. All of these value chain activities are significantly adding value to a firm. This paper investigates the link between knowledge management and value addition to the enterprises through value chain activities in contemporary business world. An attempt is made to find whether knowledge management has any significant impact on the value chain activities of the firm so that it gives an advantage over competitors to business organizations. In this paper, A function is developed describing the relationship between value addition to the enterprises and

impact of knowledge management on value chain activities of the enterprises. A hypothesis is drawn about the impact of knowledge management on the value addition to value chain activities i.e. value addition to the firm. The impact of knowledge management on each of the value chain activities is logically tested without empirical analysis. An inference is drawn on the relationship between knowledge management and value addition process of the enterprises.

2. Conceptualizing knowledge and knowledge management

Knowledge is the whole body of cognition and skills which individuals use to solve problems. Knowledge can be defined as the sets of propositions that we are certain to be true. This certainty comes from the rules, standards and procedures that are embedded in and define natural, social and cultural sciences. Knowledge is based on data and information but it incorporates individual judgments that are influenced with experience, creativity and various social and cultural factors.

Understanding the concept of knowledge requires clearing the definition of data and information. Data represents raw facts that are out of context. Facts can be numbers, characters, character strings, text, images, voice, video and any other form in which a fact may be represented [2]. Information is data with a meaning, purpose and relevance. Mere information is not knowledge. Although knowledge is based on data and information, but unlike these, it is always bound to persons [17.p.24]. Understanding the underlying principles transforms knowledge into wisdom. The following figure might help to understand the concept of data, information, knowledge and wisdom.

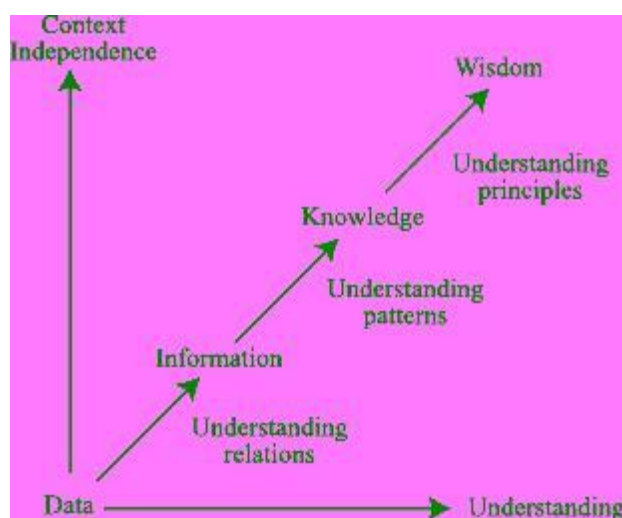


Figure 1: Showing the relationship among data, information, knowledge and wisdom. [5]

Above figure shows that Merely the collection of data does not provide us any benefit until the relationship with the purpose is understood which lead us to information. When the pattern of this relationship is understood, it can be called knowledge. So knowledge is actionable information for intelligent decision-making. As we move from data to wisdom, context independency increases and better understanding is achieved.

Organizational knowledge resides in the organizational environment and information systems, which can be collected from databases, web sites, employees, business partners, strategic alliances etc. Such knowledge becomes not only embedded in documents or repositories but also in organizational routines, processes, practices and norms [21.p.35]. Utilizing these knowledge helps organizations survive and thrive in the volatile business environment.

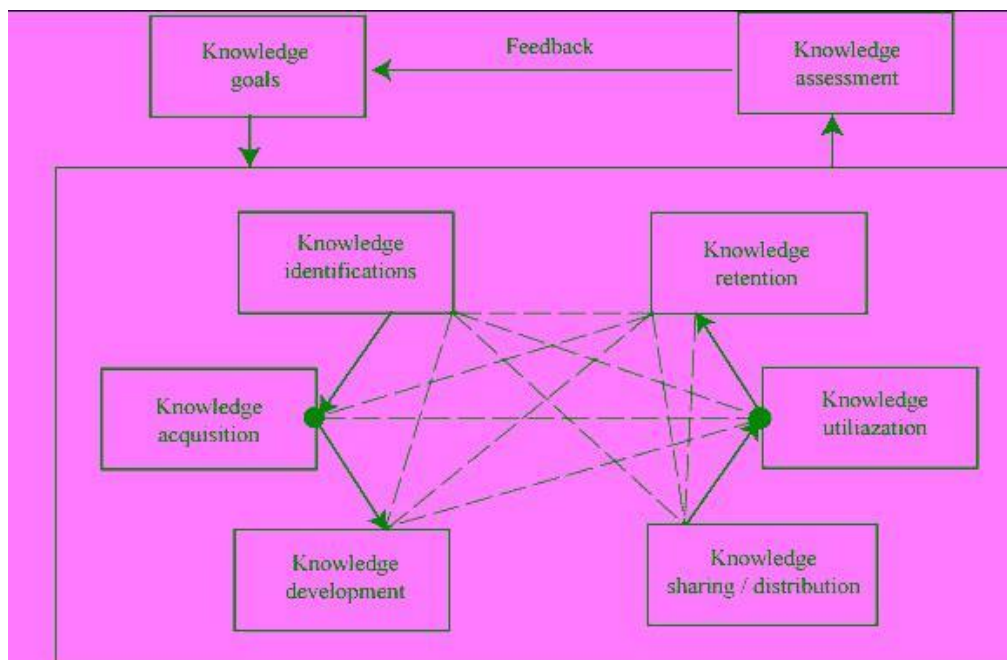
Knowledge can be divided into two major types - Explicit or codified and Implicit or Tacit knowledge [15][16]. Explicit knowledge can be expressed in words and numbers and shared in the form of data, specifications and the like. Explicit knowledge can be shared using Information & Communication Technology (ICT) like Internet, Intranets etc. Lubit (2001) [8] observes that the explicit knowledge is codified and stored in the "Organizational memory" and is available to employees throughout the structure. Documents, reports, databases, web pages, e-mails, charts, etc. holds this type of knowledge. Present information systems can easily support explicit knowledge.

On the other hand, tacit knowledge is highly personal and difficult to formalize, making it difficult to communicate or share with others. It exists in the mind of employees and deepens with attention, motivation, commitment, creativity and innovation over time. So, tacit knowledge is hard to manage (record, encode or articulate) using existing information systems. It is often deeply embedded in corporate culture and influenced by norms and values. It is unique to organizations and considered as the most valuable corporate asset. Because of formalization difficulty, inter and intra organizational transfer of tacit knowledge is very hard. In this volatile business world where globalization and digitization creates information symmetry, no organization can achieve sustainable core competencies that may act as competitive advantage for long. Tacit knowledge can make the difference among organizations because only 'knowing, how they are doing' may not blur the advantage that one has. It can be compared with swimming. A swimming instructor may help one to learn how to swim using email, manuals or even with photographs or videos, but the trainee will not be able to swim until he is in the water with the instructor. Tacit knowledge is hard to copy. That's why it is considered the most valuable asset for competitive advantage in this "knowledge era" of business.

Knowledge management is the set of systematic and disciplined actions that an organization can take to obtain the greatest value from the knowledge available to it [10]. It is a strategic weapon for gaining competitive advantage. Knowledge capital is composed of three elements; human capital, customer capital and structural capital (Saint-Onge, 1998) [18]. Human capital is defined by Saint-Onge as “the capabilities of the individuals in an organization that are required to provide solutions to customers”. Structural capital is defined as “The organizational capabilities of the organization necessary to meet market requirements” and customer capital is defined as “The depth (Penetration), width (coverage) and profitability of the organizations franchise”. According to Peter A. C. Smith (1998), human capital comprises transient knowledge and capabilities in the sense that they are free to walk out of the organizational door at close of business day [19]. Structural capital comprises the captured knowledge and capabilities that remain behind. So we can summarize that, knowledge management is the management of organizations human capital, structural capital and customer capital to develop the core competencies of the organization.

The major objective of the KM in the organization is to use knowledge as the productivity and efficiency enhancement strategic weapon to gain competitive advantage in the industry. Probst (2001) [12] considers it as a cyclical process, which consists some functional blocks.

All Building blocks of knowledge management should be directed towards the utilization of all organizational knowledge because without proper utilization, goals of knowledge management could not be achieved. This knowledge has to be preserved in an easily accessible format as much as it is possible. Knowledge measurement involves checking of all parts of knowledge strategy and whether they have succeeded in implementing these at the



Explaining the above figure, it seems that knowledge goals define what skills are to be developed in the firm and at what levels. There are three levels in developing knowledge goals – Normative, Strategic and Operational

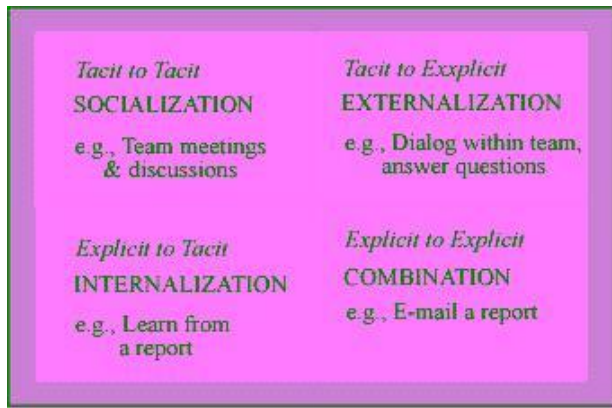


Figure 3: Conversion of knowledge between tacit and explicit form after Nonaka. [10].

In this process, assessment of knowledge outcomes provides constant feedback to knowledge goals of the organization. This feedback may refine the knowledge goals if necessary. In the "New World of business" with high levels of discontinuity and inability to predict the future, highly routine and structured forms of knowledge management should incorporate behavioral dimensions of human decision-making process to harvest the fruitful outcome of it.

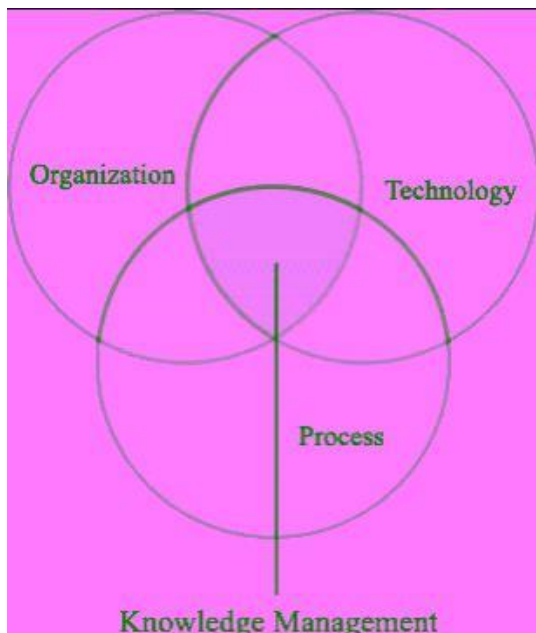


Figure 4: Knowledge management solutions. [6].

Knowledge management solutions (figure 4) consider three key issues for successful implementation. These are Organization, Process and Technology. Within organization, knowledge needs, sources, organizational structure, culture and its barriers are considered. Business process includes product and service design and development, customer management, human resources management, business planning and forecasting. Technology addresses the computing and communication

technology for knowledge sharing, distribution and retention. Effective knowledge management solution is achieved where these three issues are properly melted.

3. The Value Chain Model

In the Value Chain Model, Porter (1985) [14] describes businesses as a chain of some activities where competitive strategies can be applied best. These activities are categorized into two types; primary activities and support activities. Primary activities are directly related to the production and distribution of the firm's products or services that create value for the customer. According to the value chain model, there are five primary activities; inbound logistics, operations, outbound logistics, marketing & sales and service. Inbound logistics are those activities that are required to receive and store raw materials for distribution to production system. Operations transform raw materials into finished products or services. Outbound logistics involve all processes of replenishing retailer inventory. Marketing and sales includes product promotion, market creation and expansion and selling activities of products and services. Maintenance and repair of the firm's products are the service activities.

Support activities are necessary for successful completion of primary activities. These activities include firm's infrastructure related activities, human resources management, technology related activities and procurement. Firm's infrastructure related activities are administration and management of the organization, human resources management activities are employee recruiting, hiring, training etc. Technology activities are related with improvement of products and processes. Procurement is about gathering the inputs.

Value addition refers to the difference between the products or services value before and after an activity is accomplished. Value addition can take place either by reducing the cost of any activity than competitors through better management, superior design or process or by increasing the revenue through product differentiation or other means. These nine strategically relevant activities adds margins of value to a firms products or services, which may gain competitive advantage to the firm.

4. Impact of knowledge management on value addition: A hypothesis

We can formulate the following hypothetical function where value addition to the enterprises depends on the value addition through knowledge management in the value chain activities.

$$Va = f(KMi) + g(KMj) \quad (1)$$

Where,

Va=Value addition to the enterprise.

KM_i=Value addition through KM in ith primary activity.

KM_j=Value addition through KM in jth support activity

i = IB, OP, OB, MS, SV; the primary activities of value chain: inbound logistics, operations, outbound logistics, marketing & sales and service respectively.

J = AD, HR, TH, PR; the support activities of value chain: administration & management, human resources, technology and procurement respectively.

Value addition through knowledge management will happen as long as

$$\frac{\partial f}{\partial KM_i} > 0 \text{ and } \frac{\partial f}{\partial KM_j} > 0 \quad (2)$$

i.e. The marginal value addition through knowledge management in each of the value chain activities is greater than zero.

So we can draw the following null hypothesis,

H₀: There is no difference in the value of the enterprise before and after KM is incorporated in the value chain activities.

motivation, commitment, creativity etc. Incorporating behavioral issues in knowledge management is necessary because without it KM generates mostly static outcome, which may be sufficient for businesses in continuously changing environment but not for 'new world of business' of discontinuous changing environment which requires dynamic adjustments in decision making. As quoted by Malhotra (1998), "Essentially, it (KM) 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" [9]. According to this model, 'the world of re-everything', which challenges the assumptions underlying the "accepted way of doing things".This world is contrasted from the 'old world' by its emphasize on "doing the right thing" rather than "doing things right" [1.p.11].

Inbound logistics and procurement activities are related to the purchase, storage and distribution of necessary materials and inputs for production. Since we are in a demand-based economy, consumers determine what product will be produced and delivered to them. So inbound logistics and procurement activities are driven by market needs. For gaining competitive advantage by reducing cost businesses are managing inventory using systems like 'stockless inventory' or 'just in time'

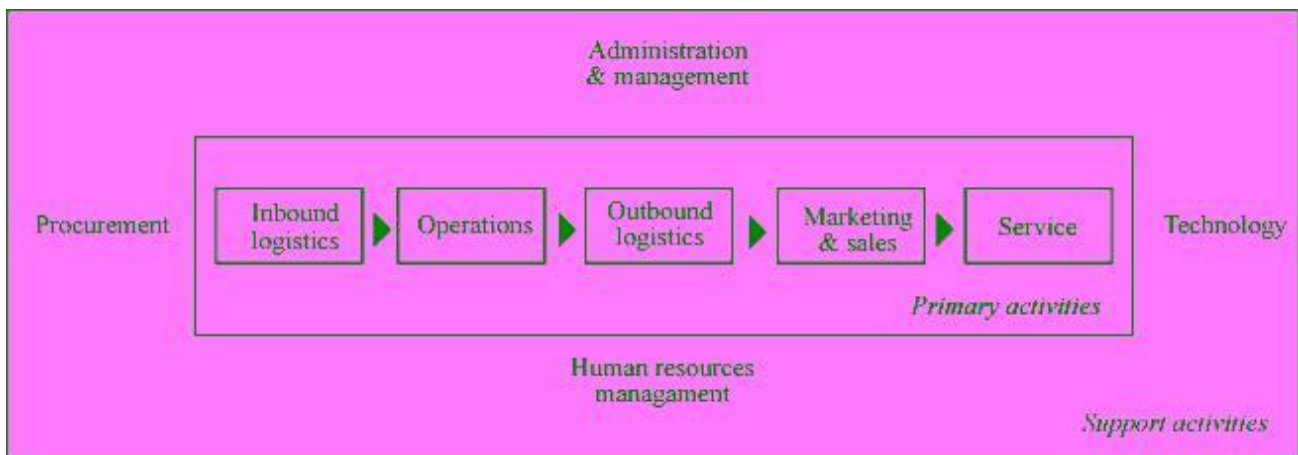


Figure 5: The Value Chain Model

5. Hypothetical analysis

In order to test the hypothesis, we will consider each value chain activities and try to find whether knowledge management has any impact to enhance the quality of the value chain activities so that it can add more value to the firm's products or services. This hypothesis is tested non-empirically using literatures and evidences.

To aid the testing of hypothesis, we can use the model of knowledge management of 'new world of business' [1.p.12]. In this model it is shown that, knowledge factors have shifted from highly routine structural forms to partly unpredictable behavioral factors like attention,

systems. This type of systems require synchronized flow of information along with proper knowledge sharing about the market nature and demand between supplier and manufacturer. As an example, Wal-Mart's (One of the largest retailer in the USA) 'Continuous stock replenishment system' sends orders for new merchandise directly to suppliers as soon as customers pay for their purchases in front of a point of sales (POS) terminal [7. p.54]. Another KM aided inventory management technique is vendor-managed inventory where supplier is responsible to make inventory replenishment decisions based on information supplied by sales transaction in POS terminals or any other means. It is based on the theory that, suppliers are the product or category experts and thus can do the best job of making sure that supply meets demand [7. p.59]. This expertise comes from the intimate knowledge sharing between supplier and

Summarizing the old version and new version of knowledge management models of Malhotra (2002), the following model for effective knowledge management can be drawn.

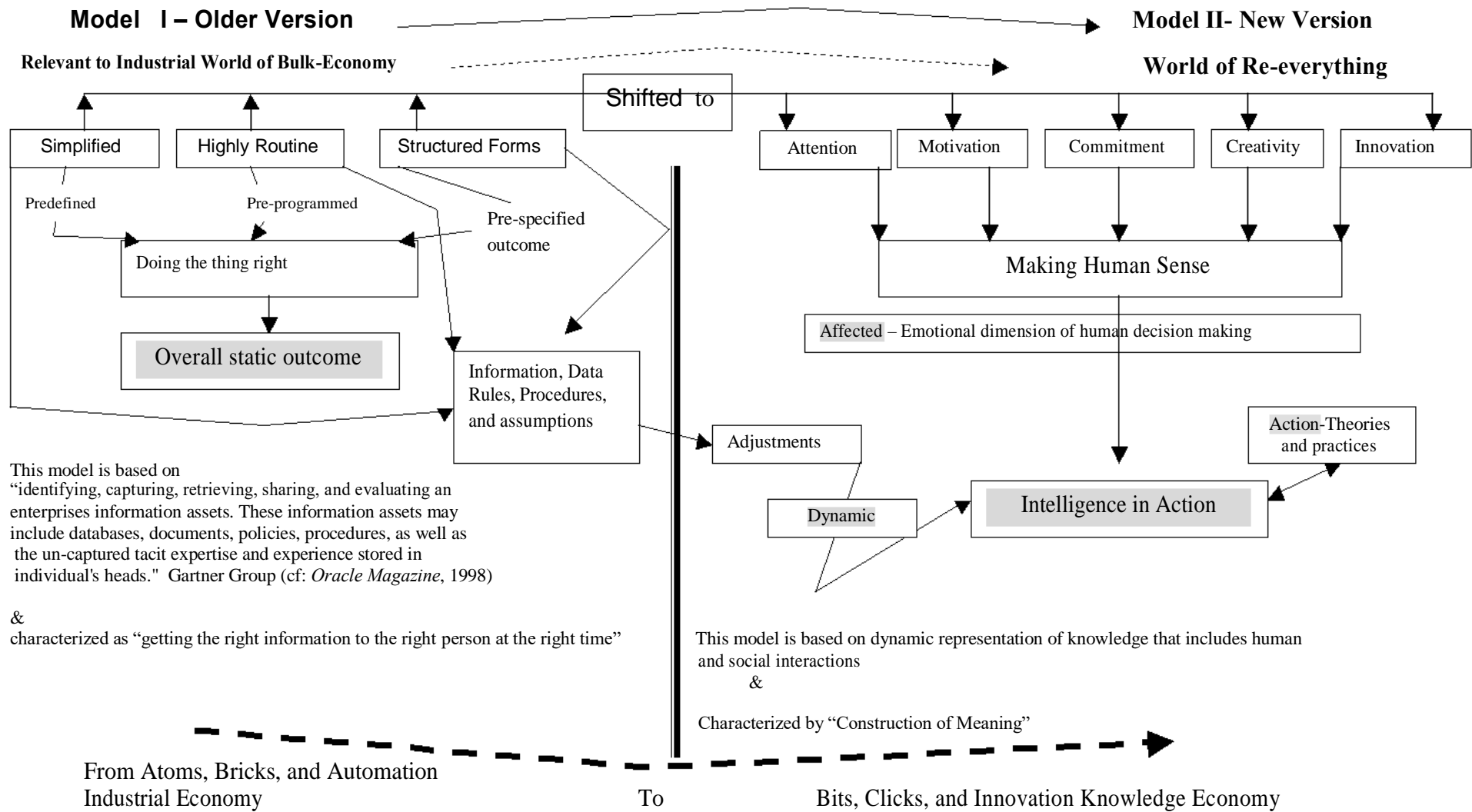


Fig. 6 – Shows the shifted model of knowledge management.[1. p.12]

manufacturer through successful knowledge management system. But the mere information does not add any value until this information is properly understood and the behavioral factors of knowledge management are incorporated for intelligent action. According to Yogesh Malhotra, founding chairman and chief knowledge officer for the BRINT Institute in Syracuse, New York, "Inert and static information lying in any kind of repositories including intranets and portals alone does not result in business performance. Even within stable business environments, users' commitment and motivation to effectively use that information is critical" [23].

Procurement information is very easily and cheaply available in this cyber business world. Large amount of information can be collected within a very short period of time very cheaply. Finding the right information for the business is a cumbersome and time consuming process. Content management can play a vital role to rescue us from the world of 'info-glut'. Content management is a primary component of knowledge management and a major issue for organizations because it brings to light the need to retire content when it becomes outdated and to hold someone accountable for maintaining accurate and up to date information. [22]. Knowledge management technology like Natural Language Processing (NLP) portals can generate meta-data (knowledge map or taxonomy; a hierarchically organized set of categories. exp. Yahoo!) of a particular domain. This type of technology may help in finding the appropriate and accurate explicit knowledge for procurement and inbound logistics. In the push process of raw material procurement cycle, inventory is replenished in anticipation of customer demand. This anticipation requires understanding and experiences about human behavioral pattern (tacit form of knowledge) along with proper information.

Operations are the activities performed to transform inputs into finished goods and technology is the aiding tool for improving products and production processes. Computer aided product design is a technology based new product creation performed by the knowledge workers of the organization. Products are getting more and more complex by adding more features due to competition. It is knowledge workers responsibility to add more value to them. According to Peter F. Drucker, "Productivity of the knowledge worker is not – at least not primarily – a matter of the quantity of output.quality is the essence of output." [3. P.142-143]. To do the task of adding quality, Drucker thinks, continuous innovation, continuous learning and continuous teaching have to be built into the knowledge worker's job [3 p.146]. Embedding knowledge in products, services and processes helps deliver higher quality individualized offerings that can lock in customers [21 P.41].

As quality adds more value to products or services, knowledge creation through innovation and creativity and knowledge sharing among knowledge workers can create

new products or services with better quality and can demand better payoff than competitors. So knowledge workers are the unique assets of the organization. "To be productive knowledge workers must be considered as capital assets", Drucker says [3. p.148]. As an Example, The Gillette Company, the famous grooming and oral care product manufacturer, produces value to the firm by raising quality of Gillette razors and blades. They are producing new types of products like Sensor Excel, Mach3 by adding new features and differentiating their products in the market place for competitive advantage. [7. p.42].

Knowledge creation can also enhance the production process, which adds value to products or services. Intel Corporation switched to new 130 nm technology from older 180 nm technology of producing processors to produce more cooler and speedier desktop processors than its competitor Advanced Micro Devices (AMD). But after a short delay AMD quickly followed Intel to blur that advantage.

Modular innovation (innovation and breakthroughs that are achieved by recombining and reconfiguring existing technologies in novel ways) [21. p.10] and knowledge-based individualization facilitated by KM, may create value and group of loyal customers. MP3 players and Levis custom fitted jeans can be two examples of these two techniques. Knowledge is a unique asset to organization but sometimes confinement of knowledge within the organization might not be profitable for the organization as well for the industry. Example can be taken from two knowledge intensive industries – PC and biotechnology industry- that emerged in the 1980s. The PC industry blossomed by giving away its secrets, with the singular exception of Apple, which guarded its designs only to lose out. The biotechnology firms on the other hand still exist, but unlike the multi billion-dollar PC industry, most of these companies have never turned a profit despite all their patents and legal forms of protection. The only way to protect your business knowledge is to apply, reuse, update, evolve and outdate it too fast for competition to be able to copy it. [21. p.8]. So knowledge management is important for value creation.

Outbound logistics are activities related to storage and distribution of finished products. Knowledge about customers buying patterns and buying characteristics can reduce the necessity of bulk storage. Necessary information might be collected from various repositories such as data warehouses and incorporating supply chain managers experiences with this information, business organizations can produce in depth knowledge about storage requirements and distribution patterns of the goods and services. Airlines yield management system can be a good example of management of explicit knowledge to gain competitive advantage. Yield management is the process of wringing the most profit out of every airline seat and determining when to drop or

increase prices to offer promotions. Rather than offer cut rate fares to fill up the plane, this system examines the historical pattern of that flight and determines how many seats the airline should set aside for executives willing to pay full fares at the last moment. [7. p.55]. 'Cross functional platform teams' combine expertise of different functional area such as product design and development, manufacturing, distribution, marketing and sales etc. Combination of cross-functional tacit and explicit knowledge can enhance the outbound logistics of the organization. Malhotra says that the synergy of 'Smart minds' and 'Smart technologies' also provides a basis for defining agile and adaptable supply chain networks that can withstand the challenges of a radically changing business environment. [22].

As we have stated earlier, human capital is an important element of knowledge management. It is the capability of human resources of the organization to solve problems. Same problems can be solved by different organizations differently. "No two executives organize the same information the same way" [3. p.126]. In order to add value through problem solving and meet customer needs, executives should incorporate innovation, creativity, motivation and experiences with the available information. Since much of the administrative and managerial activities require tacit type of knowledge, it is difficult to provide any hard and fast procedures for solving this kind of problems. Drucker says, "Innovation should be organized as a regular part of every unit within the enterprise and every level of management the test of an innovation is that it creates value" [3. p.85-86].

Through interactions with others, tacit knowledge is externalized and shared. [12]. Socialization (team meetings, informal discussions) and externalization (FAQs) help tacit knowledge to be shared around the organization. Shared knowledge can create collaborative expertise which can help to solve problems more accurately and efficiently using less time which can create economic value to organizations.

As we are moving from product to service oriented industry, leveraging knowledge is more important than ever for adding value to organizations. Firms require employees with experiences and in depth knowledge to survive and thrive. Human resources management activities (training, recruitment, hiring etc.) could be facilitated by horizontal knowledge transfer techniques such as twinning (organizing social or other visits) and secondments (temporarily transfer to other jobs from their responsibility). So incorporation of knowledge management techniques in human resources management activities could increase organizational efficiency and hence value to the firm.

Marketing activities create the awareness about the product or services of the firm. Identifying the customer needs and supplying necessary utility is the major task of marketing. Traditional marketing activities research,

strategy, planning, collateral development, lead generation are all done in vain if marketing can't effectively identify the organization's current and future customers, segment them, forecast accurately against those segments and inform the product development process so that the right product mix arrives in the marketplace at the right time for the right customer groups [4]. Click stream analysis (analyzing a series of mouse clicks of an individual in cyberspace to understand the buying pattern) can help to identify a potential customer. Knowledge enabled businesses can anticipate changes in customer preferences – an evolving social trend, a new management practice, a nascent technology rival innovations or economic development in a potential foreign market. KM tracks and maintains knowledge regarding the validity of assumptions about markets, customers, and business environments before critical decisions are made based on flawed ones [21. p.41.]. Knowledge enabled customer relationship management (KCRM) manages customer knowledge to generate value creating lock-ins and channel knowledge to strengthen relationships and collaborative effectiveness. [21. p.12]. KCRM treats customer as a value co-creator. Customer knowledge integration can create loyal customers who are willing to pay justifiable cost but not the least cost. As an example, 70 percent of *Amazon.com* customers return to pay more when many of them know of other places on the web where they can find same item for less [21. p.13]. Sales function records the transaction information, which can be fed to knowledge-based marketing system for producing better quality products and loyal customers. In this highly competitive business arena where switching cost is very low, knowledge-enabled marketing and sales activities can add value to the enterprises.

Service activities can generate huge amount of information through complaint reporting and resolutions. Service activities can add value by improving the quality of the products as this information can be used to develop better products and services. Software industry is using this type of approach. Service employee's experience can be a unique asset for the organization. A classic example of knowledge enabled service system is Xerox Corporation's Eureka system.

Eureka system enables the organization's 23,000 service engineers from around the globe to input product solutions into a knowledge base. When a machine problem arises with a Xerox product, the service engineer can access the knowledge base to find a product solution. The knowledge base currently holds 55,000 problem/solution entries. If it's a unique situation where a solution doesn't exist in the knowledge base, the service engineer will voluntarily input the solution into the system once the machine problem is solved. Xerox estimates savings between \$12 million and \$15 million per year as a result of its Eureka system. Much of the motivation lies behind having his or her name attached to the solution and becoming an author, and then having that solution tip validated by a senior manager.[22].

From the above example it is evident that, a knowledge base of service problems and resolutions can help firms to provide better and prompt service and it also converts the tacit knowledge into explicit form, which reduces the fear of non-existence of that expertise as the employee leaves the organization.

From the above discussions, we see that, knowledge management can significantly enhance the value chain activities: both primary and support activities. Enhancement in each of these activities adds margins of value to the enterprises in this volatile business environment. Using knowledge management techniques, enterprises can have unique advantages over competitors. So we can reject the null hypothesis and accept the alternative hypothesis i.e. knowledge management in value chain activities has positive impact on the value addition to the enterprises.

6. Conclusion

In this paper we have seen the differences between information and knowledge. We have also seen the creation and management process of knowledge along with its different dimensions and types. There has been a gap in understanding whether knowledge adds value to the firms or not. To evaluate this proposition, we have taken the Porter's Value Chain Model. In the model, there are two types of activities –primary and support. As we did not have numerical figures to test it mathematically, we have tested the proposition on the basis of different research works, our best judgments and different examples cited by various authors. To formulize it, we have drawn a function taking one dependent and some independent variables. At the end, it has been found that there is a relationship between value addition and knowledge management, that is, knowledge management adds value to the firms. We expect that potential researchers will statistically and mathematically prove the hypothesis in coming days.

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An Application of the Balanced Scorecard as a Strategic IT-Controlling Instrument for E-Business Development

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Abstract

This paper presents a Balanced Scorecard (BSC) based approach for strategic IT-Controlling in the context of e-Business development. As today's first generation's e-Businesses implementations show, there is need for more IT- and Business Infrastructure Management to fit rapid changes in business strategy with the development of e-business. The theoretical deliberations done in this paper provide a step by step development of a BSC and illustrates a variety of goals, links of cause and relationships, evaluation criteria, and measures within the context of an Austrian beverage producing company's strategy regarding its e-Business strategic positioning. The e-Business deployment was an overall success with a few minor shortfalls in the areas of content actualizations and system downtime, both due to technical problems, and expected end consumer utilization. The calculated BSC was regarded as suitable for supervising the e-Business environment and the associated strategic goals by business management.

1. Introduction

The Balanced Scorecard (BSC) was first proposed in 1992 by [9] and soon after applied [11]. Today the BSC is a well established measurement method which links strategic objectives and performance measures across four different perspectives. In addition, the application of the BSC 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, 18].

The usefulness of the BSC method was shown in a variety of different settings such as for university [12], national health service [18], banking [13], public [7], and other sectors [3, 5, 20, 21]. Furthermore, [22] conducted a systematic comparative research to relate the value of the BSC, and the value of specific elements of it, to the context of the application. They concluded that the BSC appeared to be of value to all ten organizations analyzed (although in varying degrees). A critical reflection of the BSC can be found in [2, 17]. Some scientists question the concept itself [24]. They are pointing out that the BSC is not an elaborated system but a framework, respectively

diagnostic system, of performance measurement.

The BSC was also applied in the IT area, e.g. for strategic information systems [14], and in the ERP context [19].

This paper seeks to analyze an e-Business development, which is a task characterized by business process integration and automation issues [4, 8], and its performance with a BSC adapted to the special situation faced in the underlying company. Firstly, we will present an adoption of the general purpose BSC to the case of analyzing an e-Business implementation. Thereafter, the adapted BSC is calculated with the empirical data of the underlying case study. We conclude with implications on the usefulness of the BSC for e-Business performance analysis and the results of the BSC calculation for the case study.


2. An e-Business BSC

The original BSC proposed by Kaplan and Norton consists of four different perspectives: the financial perspective, the internal business process perspective, the customer perspective, and the learning and growth perspective [9].

Attempts to adapt the BSC to evaluate e-Business, either as a system or subdivision of an organization, have extended the traditional perspectives [6, 15, 16]. An important extension is the partner viewpoint, which takes into account the special role of diverse partners in e-Business environments, especially for e-Procurement. Another addition can be an implementation perspective, where project based evaluation criteria are pooled. This extension accommodates the complexity and difficulties observed, when introducing e-Business solutions to companies.

Table 1 shows the mentioned perspectives and illustrates the cause and effect relationship between them. Apparently, all e-Business aspects should ultimately have an effect on financial measures. Because the e-Business solution was already implemented in the case study, we have excluded the introduction perspective in the following analysis.

Table 1. e-Business perspectives, and cause/effect relationship

	e-Business System Implementation and Usage	Introduction/Implementation Perspective
	e-Business Potentials	Learning and Growth Perspective
		Internal Business Process Perspective
	Financial Effects	Partner Perspective Customer Perspective Financial Perspective

3. Case Study

In our case the BSC was calculated ex post 2.5 years after the e-Business system was deployed. All relevant information for this time period was available. In future, the BSC will be applied as an IT controlling instrument.

3.1 Company Background

The analyzed enterprise is a large Austrian beverage producer. The different brands are either distributed by food chains such as Billa or Merkur, or by catering companies. Thus the enterprise depends to a considerable degree on the successful co-operation with these partners. Sales are enforced by expensive marketing strategies especially to sustain and further improve the image of the corporation.

3.2 e-Business Deployment

The initial e-Business system was launched in the year 2000 and represented an internet-based information system for partners and customers as well as and an area dedicated only to business partners. The information on products and the company itself was stored in up to 10 different languages and can be edited by an overall editorial system.

The deployed e-Business system therefore supports Business to Business (B2B), Business to Consumer (B2C) and Consumer to Business (C2B), and Intra-business (Organization Unit to Organization Unit) communication.

3.3 Discounted Cash Flow (DCF) Analysis

A DCF analysis was undertaken prior to defining the BSC and 2.5 years after e-Business deployment for a time period of five years. Therefore, most of the considered factors were quantified exactly for the past 2.5 years, while all of them had to be estimated for the next 2.5 years.

The purpose of the DCF analysis was to identify and evaluate the predicted future cash flows resulting from the E-Business investment and discount them with an appropriate interest rate. The DCF analysis can of course not take into account important intangible benefits, such as an improvement of the company's image. Nevertheless, the application of the DCF analysis showed us

the criteria and their observed, respectively estimated, values which directly influence the financial aspects of the underlying investment. Two main areas of application potentials were identified: The level of e-Business utilisation by end consumer and business partners as well as improved process efficiencies. It was assumed that the level of achievement for each potential rises over time starting by 60% in the first year.

The DCF analysis yielded a negative net present value of the e-Business investment of -10,000 €, which would have suggested a rejection of the investment. Recent papers have shown, that the use of DCF based analysis alone does not suffice to assess the benefits involved IT decisions [23]. Newer IT applications such as e-Business solutions seek to provide a range of benefits including many intangible factors which can not be fully assessed by traditional methods such as the DCF based analysis [18].

3.4 Strategic Goals

The company aimed to achieve its competitive advantage by both operational efficiency and strategic positioning. The company defined the following primary objectives while making the e-Business adoption decision:

- Elimination of the e-Business gap to competition
- Establishment of a technological base to enable future e-Business developments
- Improvement of the image and awareness of the enterprise in the market place
- Creation of a permanent contribution to an increase of sales
- Improvement of communication (more efficient, error free, easier)

3.5 Strategic Goals for each BSC Perspective

The strategic goals determined by the company prior to e-Business adopting need to be extended for every BSC perspective. It is essential to have a common understanding of the company's strategy and the e-Business technology to achieve profound and well-defined goals related to each BSC perspective.

For the Learning and Growth Perspective the following goals were defined:

- e-Business system is „state of the art“
- High quality of e-business operations
- Low level of e-Business operating costs
- Up-to-date content through regular revisions
- High staff participation and accumulation of know-how

For the Internal Process Perspective the following goals were determined:

- External inquiries go directly to the correct internal contact

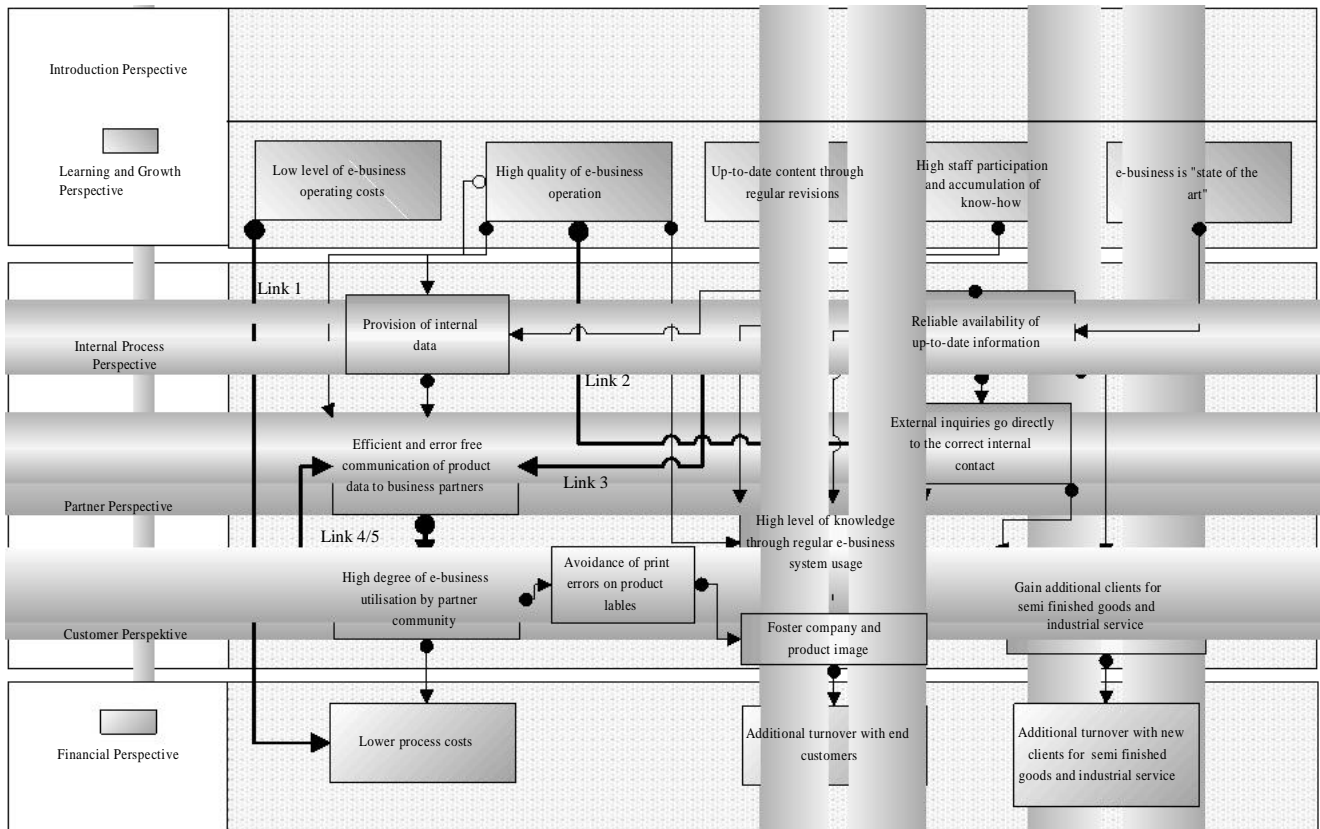


Figure 1. Chains of cause and effect between the determined e-Business goals

- Reliable availability of up-to-date information
- Provision of internal data

For the Partner Perspective the following goals were stated:

- High degree of e-Business utilization by business partner community
- Efficient and error free communication of product data to business partners
- Avoidance of print errors on product labels

For the Customer Perspective the following strategic goals were defined:

- Foster company and product image
- High level of knowledge in the end customer community through regular E-Business system usage
- Gain additional customers for semi finished goods and industrial service

To the Financial Perspective three final goals were added:

- Lower process costs
- Additional turnover with end customers
- Additional turnover from new clients for semi finished goods and industrial service

3.6 Chains of Cause and Effect

The BSC analysis also involved the forging of chains of cause and effect between the previously determined goals. Figure 1 illustrates the resulting network. Below we have extracted a few examples of the essential links identified:

Link 1: E-business processes are supposed to cause lower process costs than traditional business processes. Therefore by substituting traditional processes for e-business processes the overall process costs are reduced.

Link 2: It is assumed that high quality e-business solutions allow to redirect customer inquiries directly to the correct internal contact, represented in this case by a specific e-mail addresses.

Link 3: Only through reliable availability of the e-business system and information provided, it is possible to communicate product data to business in an efficient manner.

Link 4/5: The efficient and error free communication and the e-Business utilisation level depend on each other. Link 5 indicates that only if the system works properly it will be accepted by business partners as an alternative to sending printed product catalogues, e-mails or CD's. At the same time Link 4 assumes that the potentials of the e-business system can only be fully exploited if the system is used by nearly all business partners.

Table 2. Goals, their assignment to different perspectives, metrics, and levels of achievement

Perspective	Strategic Goals	Measures	Achievement
	Low level of e-Business operating costs	e-Business supplier costs	Green
		Errors with content updates in the business partner area	Yellow
	Up-to-date content	Amount of update activities	Yellow
	High staff participation and accumulation of know-how	Number of employees with unrestricted entrance to the editorial system	Green
	e-business is „state of the art“	Age of editorial system	Green
	External inquiries go directly to the correct partner	Forwarding of inquiries	Green
	Reliable availability of up-to-date information	Downtime per month	Yellow
	Business partner community: High level of knowledge through regular E-Business system usage	Inquiries with problems and questions as well as unnecessary mailings	Green
		User sessions	Green
		Downloads	Green
		New registrations	Green
	End customer community: High level of knowledge through regular E-Business system usage	User sessions	Yellow
		Downloads	Yellow
		New customer requests	Green
	Lower process costs	Costs for ISDN despatch	Green
		Effort for transmitting product data and pictures over traditional channels	Green
	Additional turnover with end customers	Valuation of end customer sessions	Yellow

3.7 Chosen Measures and Levels of Achievement

In Table 2 the chosen measures to clarify the achievement of goals are presented. Those metrics are linked to the determined strategic goals, which again are assigned to the different perspectives. It has to be noted, that some assignments in the BSC framework could have been defined differently. The chosen measures needed to be quantifiable (by cost-effective means), easy to understand and should reflect the identified chains of cause and effect [10, 18]. Therefore, it was not possible to account for every determined strategic goal in the framework, what can be seen as a drawback of the BSC approach.

For each of the used measures the company had to set the desired targets, which also reflect the final goal level to be achieved at the end of the strategic planning rhythm. For our case the level of achievement (green, yellow, red) is illustrated in Table 2 in the last column. As can be seen, there are no red markings, the e-Business components seemed to be more or less operating as planned. Some

problems were detected in updating and changing product information especially in the business partner section of the system. Those problems were based on data import problems between the AS400 and the e-Business server. Furthermore, the system downtime would need to be reduced to further improve reliability (as suggested by introducing a server cluster). Finally, the end consumers were expected to pay more attention to the new system. This shortfall was identified by a number of measures in the customer and financial perspectives. A possible reaction would be to increase the content extent and quality by more updates on a more regular base.

The achievements of undertaken actions should then be further evaluated and controlled by the continuous application of the BSC.

4. Conclusion

The management of the analyzed company regards the BSC as suitable for supervising their e-Business system and communicating their associated strategic goals. It

will be used as information-gathering tool on a regular basis serving to keep the management informed about the achievements of their system and could be extended for further business infrastructure management in the future.

A clear strength of the BSC is being an easily understood concept, which merges a set of measures contributing to the determined strategic goals under different perspectives.

The main weakness of the BSC is that it does not represent an elaborated, consistent and uniformly applicable system. Applying BSCs applied in other settings implies the risk, that not enough attention is paid to specific strategic goals and in succession to the companies' strategic position. Every BSC is per definition unique to the company involved.

Next, not all goals can be translated into measurable objectives in quantitative terms. Literature suggests, that in such cases, it is important to relate these attributes to other ones that can be quantified. This is not always possible, respectively does not in general uncover the level of achievement for the specific goal. Therefore, not all determined goals could be incorporated in the BSC. For example, the achievement of various quality related goals were too difficult to quantify on a regular basis. Also, the goal of attaining a better corporate image through the e-Business deployment seemed too difficult to assess within the BSC. The assessment of missing criteria will nevertheless be undertaken, outside of the BSC approach, leading to the application of more than one management tool. We have found little research on consolidating the results from different management tools into a consolidated view apart from [1]. It seems that the 10 year old BSC concept is still not fully developed.

Due to the fact, that we have undertaken an ex post analysis, the development of strategic programs based on the selected measures for achieving the strategic goals was not included. The company will define those strategic programs in order to attain the targets for the next strategic planning cycle.

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Customer Participation in E-news Service --- Case Study in Taiwan

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Abstract

Asymmetric information in service sector can be found in PZB model and can be manipulated by service provider and customer. Participation as well as involvement in service is well studied in western literature but less reported in the field of e-news services in emerging economic. The case study via OLS and ANOVA about one of Taiwan's major e-news service provider implies the strong biased political involvement in service participation and provides information structure of the economical-political e-business model in Newly Industry Country. What we need is a rational order beyond the irrational game.

Key Words: Information asymmetric, Participation, Service, E-news, Involvement.

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1. Introduction

Internet is widespread in recent years. Service sector is booming all around the world. Customer participation in the production of goods and services appears to be growing. The marketing literature has largely focused on economic implications of this trend and has not addressed customers' potential psychological responses to participation. The quality of products and services has great impact as well as attractiveness on customer participation. Information economic is well developed by the information service provider and government agencies. On the other hand Porter argues that there is no e-strategy and Greenspan advocates which internet is just one of new technology in 21 century.

The ill-defined empowerment toward customer participation through the service process can be found in the industry that is monopoly or oligopoly. The consumer surplus can be identified through the obstacles of non-tariff barriers. Deregulation in newspaper and development on ICT sector are the trends in the Taiwan. Several media groups extend their services channel toward E-news services beyond the biased free information environment.

2. Literature review

Solveig Wikstrom (1996) indicated buyer-seller interaction in industrial market is a widely applied work logic, which has been thoroughly researched both empirically and theoretically. It is applied in service industry either. Customer perceives services delivered by the provider when he/she participates in the service process. Leone and Bendapudi (2003) exam the effects of participation on customer satisfaction and find when given an identical outcome, customer satisfaction with a firm differs depending on whether a customer participate in production. This study further finds that providing customers a choice in whether to participate mitigate the self-serving bias the outcome is worse then expected.

Stiglitz (2001) advices information economic has changed the paradigm in economic of the market system. Asymmetric information can be eliminated by individual's involvement and participate in the transaction process as well as in the wide power distance political-economic system.

3. Method

The data were randomly collected from the e-news group named "Public Forum" in one of private media conglomerate named "A". In order to evaluate the data effectively and observe if there are manipulations, OLS regression (Table 1) is used on this study and ANOVA (Table 2) is used to detect if there are biased information that may result error implementations. We check the constant variance, independence, and normal populations of three inference assumptions (Figure 2) and find fitted in the model. We conclude that the OLS regression and ANOVA are proper methods for this case study research.

Table 1

Regression Result

Predictor	Coef.	StDev	t-ratio	P
Constant	0.101	1.248	0.08	.936
CustClik	0.055064	0.00202	27.27	.000

s = 7.082 R-sq = 95.4% R-sq(adj) = 95.3%

Table 2

Analysis of Variance

	DF	SS	MS	F	p
Reg.	1	37295	37295	743	.000
Error	36	2806	50		
Total	37	39101			

4. Result

Higher percentage R** were found in our model. We can find a linear relationship between customer click and participation (Figure 1). Outliers were founded in various forms. Some biased information vary from distribution of the samples are political related data.

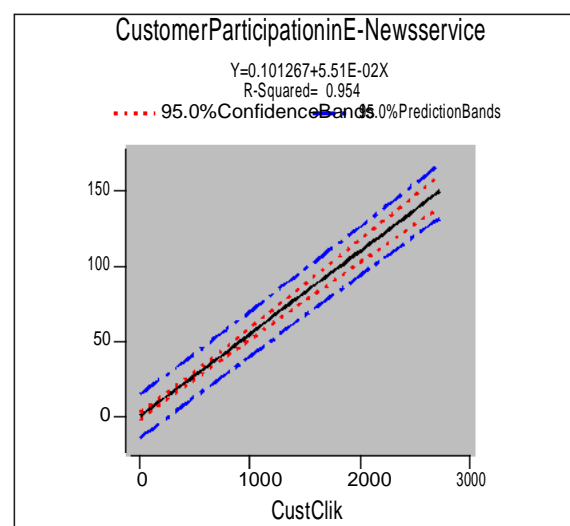


Figure 1

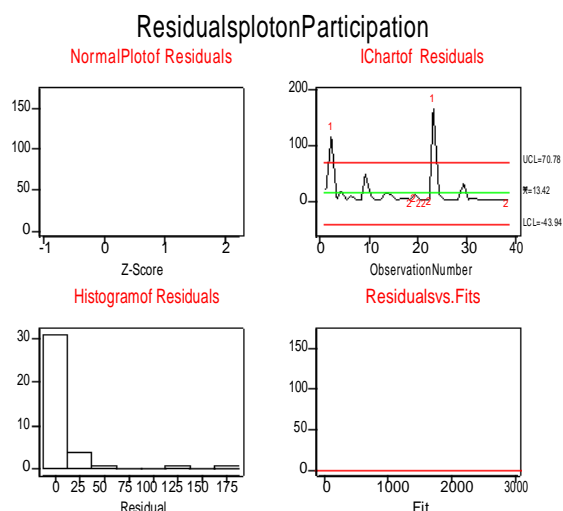


Figure 2

5. Discussion

Based on the analysis of ANOVA we find biased information from the participants who are political preference. Following the deregulation of the media and liberalization of political restriction, the relatively low entry barrier e-news group still confronts the interesting in political environment with biased data.

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Note: The full paper is available from the CD of conference proceedings."

Evaluating the Effect of Communication and Shared Knowledge Between IS and Line Organizations on IS Performance

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Abstract

Intensified competition, splintered mass market, shortened product life cycles, and advanced technology and automation let companies to increase the IT investment to meet the changes. Although IT investment increased, IS did not show the visible outcome. One of the major interests of IS managers is how to demonstrate the business value of the firm's investment in information technology.

This paper proposes the revised model of Nelson & Coopridge[13] that adds communication as an antecedent of regarding shared knowledge between IS and line groups. Knowledge can be shared through mutual trust, mutual influence and communication between these two groups. The revised model including communication is tested empirically using LISREL.

The results show that shared knowledge has an effect on IS performance mediating with mutual trust, mutual influence and communication. Thus, IS managers should develop mutual trust, mutual influence and communication between these groups to achieve more shared knowledge, which proceeds higher IS performance.

1. Introduction

Intensified competition, splintered mass market, shortened product life cycles, and advanced technology and automation increase the requirement of inter-organizational and intra-organizational mutual relationship. These strategic complexities of business and diverse requirement are increasing the importance of information systems and expanding the investment for IT[22].

However, despite the rising investment on information technology, the performance from IS expenditure resulted in no measurable impact. The facing issue of IS managers has become the demonstration the business value of the firm's investment in information technology. Boynton, Jacobs and Zmud[4] said that the primary means to link IT consistently with a firm's daily core business processes is to distribute IT management responsibilities to line managers. In other words, the close relationship between IS organization and line organization is crucial for meeting the organization's particular needs. Even though IS organization may have differentiated technical knowledge, the incorporation from line organization is essential to meet the organization's particular needs. Therefore, IS architecture should be developed according

to each organization's specific requirements [4] [9] [17]. This means the IS managers are facing the pressure of satisfying the requirements of line managers. Many research studies have tried to investigate how IS organizations can understand the requirements of line organization. Churchman & Schaintblatt[6] suggested that the shared knowledge can remove the barriers of communication between IS and line organization. Henderson[10] argued that building partnership between two organizations is critical to resolve the problems, and that this partnership can be developed and maintained through inter-organizational working relationships.

Previous studies simply defined the factors employed to improve the relationship between IS and line organization. On the other hand, Nelson and Coopride[13] proposed and empirically validated that shared knowledge is a key factor in influencing IS performance and building the relationship of mutual trust, influence and shared knowledge. The results show that shared knowledge mediates the relationship between IS performance and trust and influence, and that increasing levels of shared knowledge between IS and line groups contribute to increased IS performance. However, their model overlooked the importance of inter-group communication, even though they stressed it as an antecedent of mutual trust and influence [13]. This paper extends the research model of Nelson & Coopride by adding inter-group communication as an antecedent of mutual trust and influence and tests the modified model empirically.

2. Literature Review

2.1 IT investment and IS performance

IT investment over the last 20 years reaches billions of dollars. While the necessity and substantiality of IT investments have been recognized, the effect of investment on performance has been negative [12].

The Byrd & Marshall's study[5], which used structural equation analysis to empirically test a theoretical model, shows that IT investment does not directly influence organizational performance. This study proposes, instead, that the organizational factors such as relationship improvement between organizational employees and improvement of organizational structure and process should be followed. Kim's study, which classifies the relationship of IT-investment and IS performance into high-medium-low level according to the amount of organization's information requirements, also shows a negative correlation.

However, these two studies only suggest a future direction without specific solutions by solely examining the relationships on the IT investment-organizational performance relationship. Mukhopadhyay et al.'s research[12] provides the solutions defined the IT investment-organizational performance relationship in EDI environment. They suggest that the improvement of communication should proceed to increase IS performance resulting from IT investment. Later study confirms that an organization's communication is a major factor for competitive advantage[20].

2.2 Factors influencing IS performance

Many studies suggest that a good relationship between line and IS group has a positive influence on IS performance. Henderson[10] provides a descriptive model to build partnerships between line and IS managers. According to this model, key determinants of partnerships include shared knowledge, organizational linkage, mutual benefits and commitment. In a study by Aulakh and others, trust is examined as a key contributor for improving the inter-organizational relationship and organizational performance, the relational norms and informal monitoring mechanism are considered ex ante factors for building interorganizational trust and improving marketing partnership. This research proposes

that shared knowledge is an antecedent for organizational relationship improvement, and that interorganizational trust and influence are antecedents for shared knowledge.

2.3 Communication

Previous research confirms that organizational performance has a close relationship with interorganizational relationship improvement, which has major impacts on interorganizational communication. Roger & Allbritton[18] emphasizes the importance of interorganizational communication by demonstrating that facilitated communication due to the advent of such new technology as E-mail increases flexibility and organizational control. Nelson & Coopride[13] describes interorganizational communication as a crucial factor for building interorganizational mutual trust and influence that should precede shared knowledge.

3. Research Design

3.1 Research model

A major task facing managers of information systems organizations is to develop information systems based on effective relationship between IS and line groups. Figure 1 presents the research model of shared knowledge for increasing organizational performance. In addition, this model extends from Nelson's model by inserting the interorganizational communication as antecedents of

mutual trust and mutual influence.

3.2 Research Hypothesis

3.2.1 Communication, mutual trust and influence, and shared knowledge

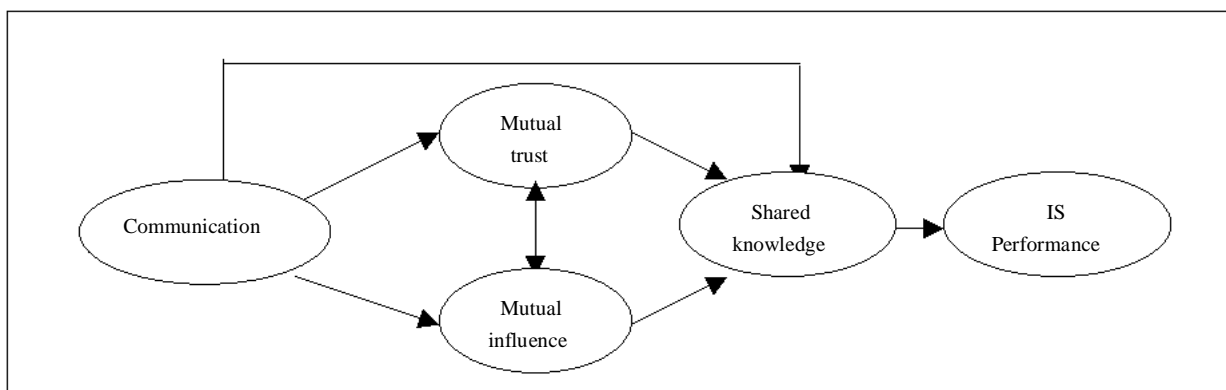
Communication is crucial not only to shared knowledge, but to the establishment of mutual trust and influence between IS and line groups [7]. Also, communication serves to supplement interorganizational shared knowledge, but not to directly influence IS performance[3].

The shared goal and frequent interaction can help build mutual trust, while the frequent communications can lead to mutual influence[19]. In other words, both mutual trust and mutual influence are affected by interorganizational communication, while they themselves somewhat influence each other [13]. Shared knowledge is developed from deeper communication using organizational information systems [20]. Therefore, communication positively influences mutual trust and influence between IS and line organization, and shared knowledge.

H1: Better communication leads to increased levels of mutual trust between IS and line groups.

H2: Better communication leads to increased levels of mutual influence between IS and line groups.

H3: Better communication leads to increased levels of shared knowledge between IS and line



<Figure 0> Research Model>

groups.

H4: Mutual trust and influence between IS and groups has positive correlation.

3.2.2 Mutual trust and shared knowledge

Mutual trust can be defined as shared expectations or interorganizational promises between IS and line groups [1] [8]. Repeated communications develop mutual trust which subsequently leads to sharing of shared knowledge. Mutual understanding gained by interorganizational mutual trust enables the establishment of shared knowledge. Therefore, interorganizational mutual trust has a positive effect on shared knowledge across IS and line groups.

H5: Higher level of mutual trust between IS and line groups leads to increased levels of shared knowledge between IS and line groups.

3.2.3 Mutual influence and shared knowledge

Understanding common goals and forming close working relationship generate mutual influence. Mutual influence is defined as the ability of organizations affecting key policies and decisions of each other [13]. Mutual influence is critical for mutual interests between organizations. Interorganizational mutual influence develops mutual understanding and unity between organizations in different environments by affecting organizational key policies and decisions, and such mutual is pivotal to shared knowledge. Shared knowledge is related to mutual influence derived from frequent and in-depth decision making processes beyond simple information exchange. Therefore, mutual influence between groups will have a positive effect on shared knowledge between IS and line groups.

H6 : Higher level of mutual influence between IS and line groups leads to increased levels of shared knowledge between IS and line groups.

3.2.4 Shared knowledge and IS performance

Communication has an important role for management [16]. But, communication itself cannot fully explain the organizational performance. Sharing knowledge, different from managerial communication in nature, moves beyond the level of simple information sharing. Shared knowledge is built with common language and symbol across groups, and has a positive effect on the level of organizational performance. Shared knowledge is derived from close communication between IS and line groups, and leads to positive organizational performance. For, without sufficient shared knowledge between IS and line groups, IS organization cannot define the business requirements of line groups. Therefore, insufficient share knowledge is negatively related to IS performance [11]. Conversely, shared knowledge between groups will lead to positive IS performance.

H7: Higher levels of shared knowledge between IS and line groups leads to increased levels of IS performance.

4. Methodology

4.1 Respondents

Respondents of the survey research are IS managers from domestic companies registered in public stock markets. They are chosen because of their responsibility for IS performance and their overall understanding and decision-making authority. For internal validity, the broad range of organizations and industry types are considered. In data collection, 200 companies are chosen and distributed for this study according to the proportion of industry. Surveys are provided to the selected companies that agree to participate. Complete surveys were received from a total of 94 peoples for a 47% of respondents rate. <Table 1> shows the industry distribution of firms in the sample.

<Table 1> Industry distribution of participants

Industry	Total	Received
Food & Beverage	13(6.5%)	2(2.3%)
Textile & Cloths	19(9.5%)	10(10.1%)
Chemical & Pharmacy	33(16.5%)	22(22.1%)
Mechanical, Auto, Electronics	67(33.5%)	24(26.2%)
Wood & Paper	8(4%)	4(4.5%)
Construction	13(6.5%)	12(13.1%)
Transportation & Telecommunication	4(2%)	2(2.3%)
Finance & Insurance	30(15%)	14(14.9%)
Others	13(6.5%)	4(4.5%)
Total	200(100%)	94(47%)

4.2 Reliability

Reliability test for each of the constructs measured in the study are performed before testing hypothesis. Reliability assesses the internal consistency of scale items. Cronbach's alphas are used to assess the internal consistency of the scales. As shown in Table 3, the reliability coefficients ranged from 0.65 to 0.84, which is significantly higher than the acceptable level of 0.6 [15]. We therefore conclude that the measures are reliable.

5. Results

The analysis of the model in Figure 1 is performed with a structural equation modeling technique using LISREL. LISREL is an appropriate method for specifying, estimating, and testing hypothesized correlations among a set of substantively meaningful variables. It can evaluate the fitness of the research model as well as the causal relationship among measurement constructs. Data analysis consists of two phases. The first phase is to check the fitness of the research model; the second phase is to verify whether hypotheses are supported in data set.

<Table 2> Reliability Estimates

Construct	Scales	Cronbach's alpha
Communication	6	0.6550
Mutual Trust	4	0.7301
Mutual Influence	4	0.7750
Shared Knowledge	6	0.7470
IS Performance	6	0.8439

While multiple regression, factor analysis or multivariate analysis techniques merely explain the relationship between dependent and independent variables, structural equation analysis technique can extend researcher's explainability and statistical efficiency by examining a set of related variables simultaneously. Therefore, this technique is appropriate in a case where dependent variables later become independent variables later. The correlational matrix for LISREL is presented as Table 4. Using this matrix, the fitness of the model is tested first.

<Table 3> Corelation among constructs

	Communication	Mutual trust	Mutual influence	Shared knowledge	IS performance
Communication	1.00				
Mutual trust	0.6923	1.0000			
Mutual influence	0.6417	0.4155	1.0000		
Shared knowledge	0.6659	0.7954	0.6501	1.0000	
IS performance	0.3071	0.2030	0.2472	0.7871	1.0000

5.1 Model Fitness

The proposed model should be evaluated to determine the fitness of the model. For evaluating the model fitness, the most typical index includes chi-square, GFI(Goodness on Fit Index), AGFI(Asjusted GFI :AGFI), RMSR(Root Mean Square Residual). For the null hypothesis to be true, the model should fit the data well and the probability value should exceed a standard value in the chi-square distribution(such as 0.05 or 0.01). Thus, in a model with good fitting model, the chi-square statistic will have a p-value of at least greater than 0.05 or ideally, above 0.01 [2]. The chi-square for this model with 10 degrees of freedom is significant (chi-square = 12.20, p = 0.067). GFI and AGFI are the next goodness-of-fit measures to be considered. The values for these indices should greater than 0.90 and 0.80 respectively [2]. Table 5 shows that the values of GFI and AGFI for the model are 0.95 and 0.84, which are over the recommended values.

<Table 4> Model fitness

Model fitness	value	DF: 10
χ^2	12.20(P=0.067)	
GFI	0.95	
AGFI	0.84	

5.2 Results and analysis

5.2.1 Communication, mutual trust and mutual influence, and shared knowledge

First 4 hypotheses are established to explain the relationship between communication and mutual trust and influence. The coefficient for the path from communication to mutual trust is 0.66(t=5.77) and has a positive correlation with the significance of 95%. Thus, H1 is directly supported, and this finding indicates that better communication leads to increased levels of mutual trust between IS and line groups.

The coefficient for the path from communication to mutual influence is 0.61(t=5.42) and has a positive correlation with the significance of 95%. Thus, H2 is directly supported, and this finding indicates that better communication leads to increased levels of mutual influence between IS and line groups.

The coefficient for the path from communication to shared knowledge is 0.209(t=1.98) and has a positive relationship with the significance of 95%. Thus, H3 is directly supported, and this finding indicates that better communication leads to increased levels of shared knowledge between IS and line groups.

H4 is established to examine the relationship between IS and line groups. The coefficient for the path from mutual trust to mutual influence is 0.19(t=1.44) and the coefficient for the path from mutual influence and mutual trust is 0.14(t=1.31). This value does not have a positive relationship with the significance of 95%. Thus, H4 is refused.

and line groups.

5.2.2 Mutual trust and shared knowledge

H5 is designed to examine the relationship between mutual trust and shared knowledge between IS and line groups. The coefficient for the path from mutual trust to shared knowledge is 0.31($t=2.02$) and has a positive relationship with the significance of 95%. Thus, H5 is directly supported, and this finding indicates that higher level of mutual trust between IS and line groups leads to increased levels of shared knowledge between IS and line groups.

5.2.3 Mutual influence and shared knowledge

H6 is designed to examine the relationship between mutual influence and shared knowledge between IS and line groups. The coefficient for the path from mutual trust to shared knowledge is 0.35($t=2.34$) and has a positive relationship with the significance of 95%. Thus, H6 is directly supported, and this finding indicates that higher level of mutual influence between IS and line groups leads to increased levels of shared knowledge between IS

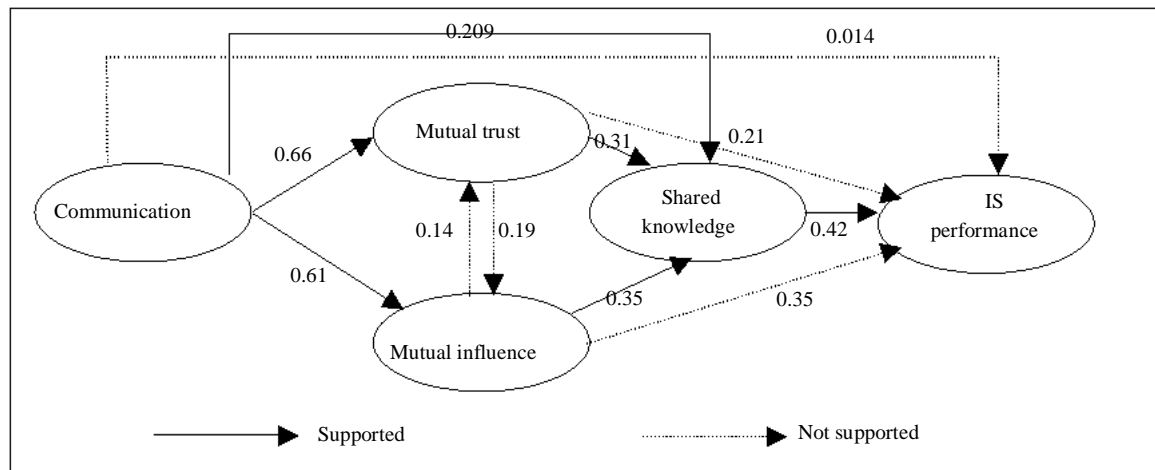
5.2.4 Shared knowledge and IS performance

H7 is examine the relationship between shared knowledge and IS performance. The coefficient for this path from shared knowledge to IS performance is 0.42($t=3.22$) and has a positive relationship with the significance of 95%. Thus, H7 is directly supported, and this finding indicates that higher level of shared knowledge between IS and line groups leads to increased levels of IS performance.

The coefficient for the path from communication to IS performance, the path from mutual trust to IS performance, and the path from mutual influence to IS performance is 0.012($t=0.12$), 0.21($t=0.23$), -0.055(-0.422) respectively. This finding indicates that communication, mutual trust and mutual influence do not have a direct effect on IS performance, although they affect IS performance indirectly through shared knowledge. Above results are summarized in table 6 and figure 2.

<Table 5> Summary of Results

Hypothesis	Path		path coefficient	T value	Hypothesis Support
	From	To			
1	communication	mutual trust	0.66	5.77	support
2	communication	mutual inf.	0.61	5.42	support
3	communication	shred know.	0.21	1.98	support
4_1	mutual trust	mutual inf.	0.19	1.44	Not support
4_2	mutual inf.	mutual trust	0.14	1.31	Not support
5	mutual trust	shred know.	0.31	2.02	support
6	mutual inf.	shred know.	0.35	2.34	support
7	shared know.	IS performance	0.42	3.22	support



<Figure 2> Path Coefficient

6. Conclusion

Demonstrating the business value of information systems is a major issue facing managers of information systems because the performance of information systems is still low compared to increasing IS investment.

This model has implications for both researchers and managers. We propose that good relationship between IS and line organization increases IS performance through shared knowledge, which is affected by mutual trust and mutual influence. Our research model extended from Nelson & Coopride's model[13] by empirically testing the relationships among communication, mutual trust, mutual influence and shared knowledge between IS and line groups. In particular this study includes communication, which is an antecedent of both mutual trust and mutual influence. Communication was excluded in Nelson & Coopride's model even though their model suggested the importance of that variable. The results support our hypotheses in the following: First, good working communication leads to higher levels of interorganizational mutual trust, mutual influence and shared knowledge. Second, higher levels of mutual trust and mutual influence between IS and line groups increase

shared knowledge between two groups. Third, higher levels of shared knowledge between IS and line groups leads to better of IS performance. These results suggest that shared knowledge directly affect IS performance, while communication, mutual trust and mutual influence affect IS performance indirectly.

The findings in this study have contributed to the issue of whether IT investment can bring positive outcomes to Korean firms. Through repeated communications, IS and line groups have the opportunity to develop mutual trust and influence. This interaction generates shared information regarding business and IS opportunity. Still, the current study has several limitations that can be cleared by future studies. First, bias of the respondents is not fully excluded since only one person per firm has responded to the survey. Thus, future studies should include a more comprehensive stakeholders including employees of IS group and user groups. Second, IS performance is measured by the cognition of the respondents. However, the respondents are IS managers who are responsible for IS performance evaluation and strategic decision-making in overall IS processes. IS managers are producers rather than consumers. Thus, the subjectivity of the response can undermine the explanatory power, and the future research has to consider complementary measures for IS performance.

Third, sample size is not large enough for analysis with LISREL, even though this method proposes at least 50 as an absolute minimal value. Future research should examine a larger sample including at least above 200 firms, which is more recommendable range.

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Strategic Use of Electronic Commerce by SMEs: Some Lessons from Cases in Japanese Distribution Channel and Research Framework

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Abstract

Nowadays, e-commerce and its applicability are in controversy throughout the world. Firms in all sizes are facing with various barriers in adopting e-commerce. For case of small and medium sized enterprises (SMEs), there are much more obstacles than large companies have face with, therefore, the model that is fit and effective for SMEs may quite different from large enterprises' ones. This paper takes up case of Japanese distribution channels to illustrate the major impact of information technology on SMEs, finds out the role of e-commerce within SMEs distribution systems in Japanese economy, and then, points out some major barriers that prevent SMEs from entering into e-commerce. Finally, we propose an analytical framework for e-commerce penetration into SMEs as a guideline of future research in this area.

1. Introduction

Recent years have seen a dramatic increase in the role of information technology (IT) over every business activity and business process. Particularly, quick and efficient commercial transactions can be accomplished by exploiting the state-of-the-art internet-based IT, through evolutionary improvements of the present ways of trading in traditional markets and the multitude of internet-based online auctions in emergent electronic marketplaces. Many companies now are in enthusiasm to capitalize on new possibilities offered by IT development and enter the novel business activity, namely electronic commerce or e-commerce.

While the potential of e-commerce is quite clear and luring companies, however, the number of companies, especially small and medium sized enterprises (SMEs), which have gained actual benefit from business-to-consumer (B2C) marketplaces, is rather limited even in the new economy. Recent empirical surveys held by various governments or consulting organizations throughout the world pointed out a number of different reasons such as lack of e-commerce awareness and IT expertise in general,

poor business and IT infrastructure, lack of people with right skills, difficulty getting reliable advices and assistance, no clear business models for e-commerce, lack of finance resource for investment in people and technology, and lack of interest in business growth and development. The barriers that prevent SMEs from entering into e-commerce are also quite different from country to country. Whereas SMEs in the US are in fear of the cultural barriers, international trade barriers, interoperability with complementary companies, and so on, the most frequently considered barriers for SMEs in Japan are privacy and security. The difference among countries is clearly based on the distinctions of market, business characteristics, customer behavior, the limitation of payment system, and incomplete public key infrastructure. Above all, the reason may initiatively stem from the fact that e-commerce now predominantly focuses on the local market, not having a perspective open enough for the global market.

Observations of the real status of e-commerce in different countries, therefore, brought out a universal requirement of finding out the way to improve effectiveness of e-commerce marketing channel. Recently, five business models of e-commerce can be often used to represent various ways of matching trading parties and organizing commercial transactions. They are business-to-business (B2B), business-to-customer (B2C), customer-to-customer (C2C), business-to-government (B2G), and intra-business (organizational) e-commerce of large corporations. In order to do business via internet, a firm may use website, email, electronic data interchange (EDI), or other internet tools to gain a higher profit and other benefits. 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 SMEs. Because SMEs face much more obstacles than large companies do, the model that is fit and effective for SMEs may quite different from ones for large enterprises. This study, in order to construct a reasonable business model of e-commerce for SMEs, will focus on clarify the

characteristics of SMEs in new digitalized economy, referring to some cases in Japan.

2. Existing e-Commerce Distribution Channel Models

With two powerful tools that may help to increase the sales of companies, namely website and email, companies now can select internet as an alternative channel to provide directly products and services to either industrial customers or end-users. The new form of distribution channel through internet is considered as e-marketplace. The name of new distribution channel helps us clearly imagine the initiative activities in e-commerce that are not so different from transactions recurring in the conventional market.

From literature review, there are a number of categories of the so-called e-marketplace. [1] refers to the firm that operates an e-marketplace as the “intermediary”, which may be a market participant (i.e. buyer or seller), an independent third party or a multiform consortium. [9] further differentiates the market participant into a friendly participant (complementary to other participants), a hostile participant (competing against other participants), a single-buyer participant (buy from multi-sellers), or a single-seller participant (sell to multi-buyers). [3] classified e-marketplaces into three categories: the e-broker (cybermediary) model (e.g. amazon.co.jp), the manufacturer model (e.g. Toshiba), and the auction model (e.g. yahoo.co.jp). [4] also looked 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. Technical issues encompass quality-of-service items such as response time, throughput, and reliability. Functional factors include facilitation of product customization, support for negotiation, and access to a similar interest user community.

Getting right back to basics, e-commerce is 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 SMEs benefit from e-commerce, and at the same time can avoid the dark side of digitalized era.

There are several ways that websites can be used as a new sales channel for a business. They are website sales models, sales support websites, e-catalogue and e-marketplace. Website sales model is the part played by a website in the sales process, which depends on the product and service offering, and its value. Many ingenious ways have been developed by businesses to create unique offerings from a website. Nissen.co.jp is one of these sites.

Sales support web sites are developed with the purpose of providing an on-line profile of the business, its product and service offerings. These sites are valuable marketing communication channels, which assist prospects and

customers in researching and evaluating competitive offerings. A typical example of this kind of website is www.kakaku.co.jp. The objectives of these web sites are, to motivate the prospect to contact the business, by either completing an on-line enquiry form, sending an email, or making a telephone call; maintain and develop customer loyalty by presenting new offerings; and increase awareness of the business and provide an easily accessible corporate information resource for prospects, customers, journalists, and shareholders.

The most common approach to selling on-line is to use an e-catalogue, which replicates the main features of the familiar paper catalogue. Offerings are grouped and categorized, with a powerful on-line web site searching facility to assist the visitor to quickly find what they need. Photographs and offering descriptions, with multiple layers of detail available through links to other web pages, are orchestrated to help the visitor quickly make an evaluation and a decision to purchase. An example of this type includes www.amazon.co.jp. Many of the traditional skills of successful retail can and should be mapped to web site.

Other popular ways of buying and selling on-line are e-marketplaces, which bring buyers and sellers together with various rules of engagement. Auction websites, exchanges, sales training websites are typical examples of such e-marketplaces.

Auction websites enable personal traders and businesses of all sizes, to negotiate prices for purchasing and/or selling direct materials, capital, or services. An example of this website is Yahoo! Japan Auctions that is considered as the most profitable internet business in Japan today.

Exchanges offer a similar matching of buyers to sellers, except, usually, the price is predefined by at least one of the parties. Price-line has successfully applied this concept for consumers who want to buy airline tickets, hotels rooms, and car hire. Here, the consumer enters the price they want to pay and other parameters, such as dates, etc., to define their requirements, and if a match is found, the purchase is immediately made, as credit card details are taken upfront. www.castour.co.jp is a typical example.

Sales training web sites can be used to inform sales teams and staffs in remote offices of new procedures, campaigns, products, services, and corporate changes. Information can be updated immediately and accessed globally by all employees at convenient times.

Beside website, another powerful application - emails can be used for generating traffics to websites and supporting the sales process. Firstly, newsletters, special offers and insider information can be sent out cheaply by email to customers and prospects, to maintain awareness or to promote a specific line. The content of each email can be personalized for each individual, using business database records to increase relevancy and produce a higher click-through rate to the web site. Secondly, periodic emails can also be sent out to remind customers of an order action that they need to make, such as renewing a subscription, making a check-up, or even considering what

to buy for a partner's birthday next week, with discounts offered for customer loyalty. Besides, product, literature, plans, reports, proofs, quotations, and orders can all be sent as email attachments, to speed up the sales process. In addition, retailers, suppliers, and sales teams can email feedback on new marketing promotions, techniques, or point-of-sales methods, so that appropriate changes can be made to maximize the effectiveness of a campaign.

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; and (4) characteristics of new model adopted. For SMEs, 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.

3. General Status of SMEs in Japan

As is the case with other countries in the globe, SMEs had played an increasing role in development of Japanese modern economy. SMEs, which are defined in Japan as having less than 300 employees or invested capital of less than 100 million yen for the most cases, account for over 99% of all the companies in Japan and employ 77% of the nation's labor force.

Besides, Japanese SMEs are well-known for their creativity as having come up with many of the ingenious innovations around us. Toothpaste, vacuum packed boil-in-the-pouch food, the vending machine, the bread-making machine, capsule hotels, karaoke, and so forth are typical innovations that proved the plentiful creativeness of SMEs in Japan. With these major participations, SMEs are in the high consideration in every aspect of economic studies including e-commerce as a new motivation raising new economy.

With the implicit potential of creativity and support of the government, Japanese SMEs may be more encouraged to adopt e-commerce than SMEs in other advanced technology countries. However, one of the initiative factors that impulse SMEs into engaging e-commerce is the way to reach customers' needs and wants, and serve them in high level of satisfaction. This factor is not familiar with SMEs, especially in new digitalized economy. Next parts will discover the distinctive characteristics of Japanese distribution systems in order to clarify the way that SMEs use to adopt e-commerce in Japan. At the same time, the paper also answers the question of "are they successful in this new type of retailing channel or not?"

4. Characteristics of Japanese Distribution Channel

Japan is a highly attractive market. However, its multi-layered distribution system is quite complex and costly. That 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 productivity of retail sector is quite low. One of the reasons of this complicated distribution system in Japan stems from Large-Scale Retail Stores Act. The Act imposes social/environmental criteria to limit the entry of large-scale retailers. The Act bears most directly on the density of retail stores in Japan. It is the initiative reason why Japan has far fewer department stores and general merchandise super stores per person than the US, when at the same time it has much more other retailing stores per person. The Large Scale Retail Store Law was the latest in a succession of Japanese laws over the last sixty-five years that imposed bureaucratic obstacles to the establishment of large stores. The Large-Scale Retail Stores Act, whereas lowering the efficiency of department stores, general retail stores, specialty shopping centers and other large-scale stores, and then the efficiency of Japanese whole retailing sector, plays an important role to the thriving of SMEs.

Another potential explanation could be made by the so-called "keiretsu" as one of the most distinguished characteristics of Japanese distribution system. There are two distinctive types of industrial organization seem to have evolved in the world economy. The major difference between them lies in whether the manufacturer or retailer has the upper hand in the distribution channel and bears the major risk.

4.1 Retailer-Controlled Channels

This first type of distribution channel is very popular in the United States and European countries. The retailer determines the specification of the products they wish to sell, and purchase them from the lowest bidder among the manufacturers. The retailers also determine the various after-sale services that accompany their products.

However, the retailer cannot directly control the quality of products they purchases. Without any control, quality will eventually deteriorate and this will hurt retailers. In order to check for quality, the retailers must institute costly inspection mechanisms. They may also be able to persuade their suppliers to invest in expensive machines, which produce more reliable products, by incurring part of the investment cost. Such addition expenses incurred so as to maintain quality are not present in the case of vertical integration.

In this mode of distribution, the major risks are born by the retailers. Well-diversified large retail companies, often equipped with better standings in financial markets than most manufacturers, are capable of absorbing the risk of occasional over- or under- production. It is this capacity to absorb risk that allows the retailers to buy their supplies at lower prices than otherwise, since they implicitly provides insurance for the manufacturers.

4.2 Manufacturer-Controlled Channels

The second type is the distribution channel in which the manufacturer has the upper hand over the retailer. Japan represents for this type of distribution channel with the well-known "keiretsu". Keiretsu refers to a uniquely

Japanese form of corporate organization. A keiretsu is a grouping or family of affiliated companies that form a tight-knit alliance to work toward each other's mutual success. The keiretsu 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 Japanese government.

Keiretsu operate globally and are integrated both vertically and horizontally. They are organized around their own trading companies and banks. Each major keiretsu is capable of controlling nearly every step of the supply chain ranging over a variety of industrial, resource and service sectors. Horizontal keiretsu have been headed by major Japanese banks and include the "Big Five" - Mitsui Sumitomo, Tokyo Mitsubishi, Fuyo, Sanwa, and Dai-Ichi Kangyo Bank Groups. Vertical keiretsu are industrial groups connecting manufacturers and part suppliers or manufacturers, wholesalers and retailers. These vertical keiretsu include car and electronics producers (Toyota, Nissan, Honda, Matsushita, Hitachi, Toshiba, Sony) and their "captive" subcontractors. Distribution keiretsu, a subgroup of vertical keiretsu, control much of Japanese retailing, determining what products will appear in stores and showrooms and at what price.

While some think keiretsu are a threat to trade, others see them as a model for change. Features common to most keiretsu include "main bank", stable shareholding, and seconded directors. Some keiretsu concepts, such as "general trading company", have no American parallels. The keiretsu system is one of the profound differences between Japanese and US business structures.

In reality, of course, both types of industrial organizations coexist in the same economy. Changes in product standardization and reliability may instead cause the distribution sector to alternate between the two models.

In Japan, such complicated distribution system has great impacts on e-commerce adopting process, especially for case of SMEs. Whereas benefit that keiretsu bring to SMEs such as overcoming the difficulties of capital shortages, protecting domestic manufacturers against foreign competitors, and easing customer relationship management (CRM), its affect on e-commerce engaging process is not so clear. Maybe it becomes a tough barrier that prevents SMEs from engaging e-commerce. Maybe it will strengthen advantages of enterprises including SMEs in the new competitive environment. The following part will answer this debate by drawing the real status of SMEs e-commerce distribution channel in Japan with its

distinctive characteristics.

5. e-Commerce as a Competitive Distribution Channel for Japanese SMEs

E-commerce has been appearing in Japanese market for not so long time (since 1995, lag behind US for 5 years), but is showing a great potential prospect. This type of retail will see an up-front increase in the whole market including books, music, computers and auxiliaries, car, apparel, housing service, tourism, and so on. In spite of the slight increasing in sales volume, Japan's e-commerce showed an unbelievably increasing in term of growth rate (B2C increased by 80% and business-to-business (B2B) increased by 34% in comparison with previous year and e-commerce in general increased three times as the number of 1999), which led Japan to the region's e-commerce leader (see Table 1 below).

By the way, the characteristics of Japanese 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 SMEs from adopting and using electronic commerce. And this is also the reason why the adoption and use of e-commerce raise special issues for SMEs.

In Japan, due to the rapid development of technology advance, the diffusion of information and communication technology (ICT), and the custom of buying via telephone or TV, there exists a high motivation enforcing a great number of SMEs to use internet. However, because of their small size, SMEs have less scope to manage the fixed costs and benefits of investing in new technologies. SMEs are also less able to defend themselves against security and liability problems. On the other hand, the adoption of e-commerce prevails in areas such as access to new markets and gathering and diffusing information on an international scale. While almost Japanese SMEs (79.1%) adopt internet and they well know that having a web presence improves business activities, therefore, the majority still uses it only for basic functions such as advertising, exchanging operational data with suppliers, rather than engaging on the practical e-commerce, especially B2C. Among the companies engaging in e-commerce, 77.06% deal with other companies (B2B) and only 38.13% have a contact with final consumers (B2C) as shown in Figure 1. Therefore, it is said that today Japanese SMEs are in the first stage of e-commerce.

Table 1
e-commerce market situation in Japan

Descriptions	1998	1999	2000	2001	2002
Sales*	8,684	12,656	22,424	35,511	48,992
Growth rate (times)**	1	1.46	2.58	4.08	5.64

Sources: Economics and Statistics Administration, *E-commerce 2001 highlights*

* billion of US\$

** as comparison with sale of 1998

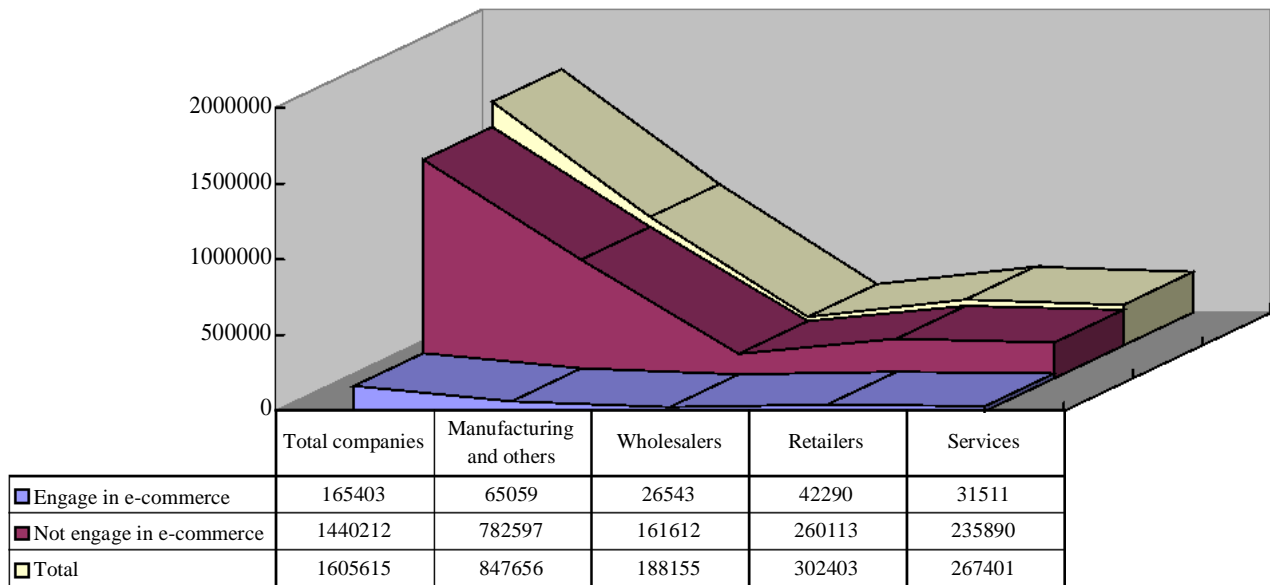


Figure 1
e-commerce status of SMEs in Japan
 (Source: *Census of Commerce*, 2001)

Unlike small firms in the US, which tend to operate independently, Japanese small firms engage in critical business alliances. There are four different types of business alliances in Japan: (1) the keiretsu, a network of large and small companies; (2) sanchi, a cluster of small firms in a related field of business; (3) kyodokumiai, cooperatives of small businesses; and (4) shita-uke, a subcontracting arrangement where many small firms rely on one large company. The purpose of these alliances is to provide support and mutual gain for all involved, and laws are written in their favor. For instance, the cooperatives are exempted from anti-trust legislation and a network of legal and financial assistance supports members (see [2]).

In the subcontracting system, the main fields of outsourcing by large companies include IT; equipment, management and security; general affairs; logistics; receptionist and secretarial services; manufacturing; education of employees; design and product planning; and research and marketing.

To adopt e-commerce as a new high-tech marketplace these business alliances still facilitate SMEs to acquire various knowledge of new technologies and unexperienced business activities. Many kinds of local e-commerce business communities, such as procurement, mall, brokerage and agent type communities have been supported by the government and other organizations. Policies targeting SMEs in Japan have reduced the gap between SMEs and large enterprises by providing immediate support for the self-help efforts.

A mall type e-commerce business community such as Rakuten, which is called a cyber mall, is considered as a typical B2C in Japanese SMEs. The cyber mall is a representation of a marketplace, a department store, or the like on the internet. Visiting virtual mall, consumers can enjoy online shopping, choosing what they want in

webpages with little time. Presenting as a collection of shops, a virtual mall has various advantages including low development costs, ability of grasping customers from both domestic and foreign countries, and being more interesting than conventional market. At the same time, however, it will become increasingly difficult for consumers to find the products and services they want in giant mall. As a result, a system will be necessary to help them find the items that meet their specific needs. For SMEs who are in lack of capital and qualified human resources, e-business communities become a good choice that bring various expected benefits.

It is obviously that although the potential of e-commerce is quite persuasive, however, number of companies, especially SMEs, which have engaged in e-marketplaces, is rather limited in Japan. 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 SMEs. Among the reasons, the most rise-up issue is the trustworthiness of on-line activities. On-line transactions and exchange relationships through internet are not only characterized by uncertainty, but also by anonymity, lack of explicit control, and potential opportunism, which makes reduction in risk and promotion of trust crucial elements of e-commerce, particularly for B2C. On-line transactions often do not involve simultaneous exchange of goods and money. Spatial and temporal separation between exchange partners is common. Consumers are required to disclose sensitive personal information (such as credit card number), although on-line vendors are often located far from consumers, even in different countries and show only a limited history of prior on-line transactions on their websites. Those factors affect opportunities and barriers to

enter into e-commerce and prevent SMEs from developing e-commerce as a strategic distribution channel.

Another difficulty that Japanese SMEs usually face is a financial issue. Today, the trend that SMEs can join and introduce themselves or even sell their products or services in a share website becomes popular in Japan. The famous website of such marketplace where SMEs can exchange their information are kakaku.com, rakuten.com, and so forth. However, for small Japan-based merchants hoping to enter into the e-commerce marketplace, the options are limited, expensive, and generally unprofitable. In the US, small merchants can open an online store for as little as \$25 monthly. In Japan, the cost skyrockets to around \$500 monthly at popular shopping malls like Rakuten, and then goes up to an extremely high level (\$50,000 or more yearly) to run a customized storefront. To make matters worse, small Japanese merchants typically operate on bare-bone margins. This makes them instantly gobbled up by website development or hosting fees and the large amount of per-transaction commissions Japanese e-commerce providers and credit card companies charge.

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6. Conclusion

As a new distribution channel with a great number of prospects, e-commerce may represent a considerable share of total economic activity and improve the quality of distribution system in Japan in the near future. SMEs now cannot further ignore the potential prospects that

e-commerce may bring anymore. However, engaging e-commerce is not an easy work, especially for SMEs, 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 SMEs select the right business model to perform.

As mentioned above, e-commerce in Japan now is just in the first stage for every type of enterprises, including SMEs. Although almost SMEs are using internet, and Japanese government attaches importance to upgrading ICT infrastructure as well as facilitating payment systems, just a few small enterprises do have experiences with e-commerce. They also do not gain much benefit from e-commerce at the same time. However, whereas other distribution channels face with the stagnant demand, e-commerce is still being one of the most effective distribution channels of Japanese enterprises these days with the highest growth rate.

To intensify effectiveness of e-marketplace for SMEs, 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 Japanese SMEs. By engaging in business alliances, Japanese SMEs find a novel way that facilitates e-business. Well-established traditional alliances help SMEs overcome a number of barriers such as lack of investment capital and qualified human resources, their lower known reputation, and/or lack of well-known brands, as well as help SMEs set up effective customer relationships even while they do not learn well about purchasing behavior of the new type of customers.

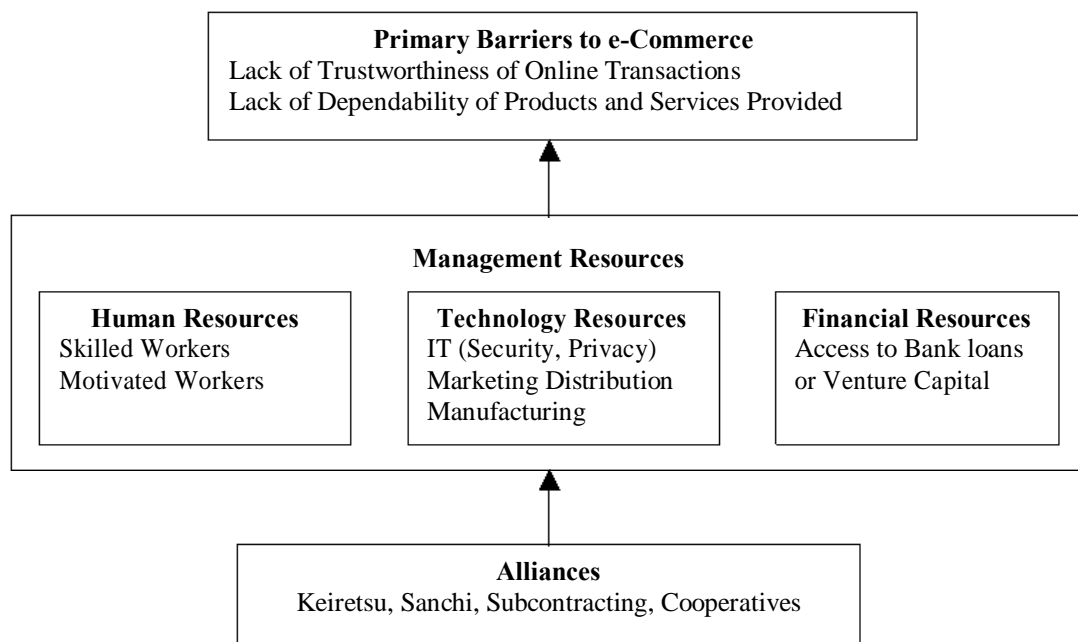


Figure 2
Analytical framework for e-commerce penetration into SMEs

As we know, new start-ups in electronic retailing that are disadvantaged by their lack of an established reputation can reduce consumers' perceived risk of purchase by carrying only well known brands. Consumers derive utility from the shopping experience and are more likely to shop on-line for products/services that are low in purchase risks. They are also more likely to shop on-line for products with well-known brands than lesser-known ones. However, they are less likely to shop on-line from lesser-known retailers who carry well-known brands, than from reputable retailers, even if the latter carry lesser-known brands. Thus, forming new business alliances will take positive effect for SMEs. Selling via a well-known website may help SMEs increase their sale and profit. These considerations lead to a research framework for analyzing e-commerce business models by SMEs, as shown in Figure 2.

In this paper we could not look into the effectiveness of business alliances to e-commerce, but are bounded in pointing out a new model of e-business that may be an effective way to accelerate SMEs performance. From this knowledge of e-marketplace and the practical performance within Japanese SMEs, the further research may explore potential productivity of e-commerce, and then design an effective e-commerce model for SMEs that is now taking notice of SMEs themselves and government of every country.

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Operational Infrastructure Enhancing the Supply Chain Management

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Abstract

The widespread implementation of supply chain management induced company to move beyond the national boarder and enticed the global competition in business. It has been proven that the supply chain management enhances the improvement in terms of cost reduction and other competitiveness. Applying supply chain management on overall organizations, companies generally considered themselves successful in managing their supply chains. However, while they have achieved the improvement in organizational performance, they have not reached the magnitude of improvements or the desired results ascribed to supply chain management [12,38,39]. Supply chain concerns and problems were first studied in the year 2002. The results showed that the most concerned items were Supply Chain Coherence such as lack of cooperation among supply chain members, Information Capability such as lack of sophisticated information system, and Geographical Proximity such as customer and supplier geographical distances. All of these concerns, related to some basic infrastructures of the company, the supply chain knowledge and operational skill before implementation [38,39,41], affected the effectiveness of supply chain practices and performances.

In this research, we study the infrastructures that enhance the success of supply chain implementation, which influence the supply chain and organization performance. In this work, the author adopts 3 categories of infrastructure as the critical success factors of supply chain implementation. Man is defined as people's skills and education. Machines or tools are defined as supporting items for instance software and tools. Management refers to the supporting factors that drive the man or employee to work according to the strategies. The EQS is used to analyze the data collection. Total 114 data were completed and the result shows the significant related of operational infrastructures and success of supply chain management

1. Introduction

Supply chain management addresses the fundamental business of supplying to meet demand in a complex and uncertain world. Supply chain management emerged in the early 1980s due to the rapidly changing and business competition environments in various industries. In order to improve the overall performance towards the ultimate consumer in the marketplace, supply chain management is a consequence of the cooperation between and across

companies' business activities in marketing channels. The significance of supply chain management has been substantial importance since the early 1990s, although the approach or the concept was introduced back in the early 1980s. Supply Chain Management is an influential ingredient in today's literature and thinking in the field of logistics [1,18,38]. Supply chain management is delivering major economic benefits to business as diverse as manufacturing, retailers, Service Company, etc. The competition has become fierce as companies can go beyond national borders. However, the organization realized that the most immediately benefits that businesses can expected from strategic supply chain management are lowered inventory risks and costs, along with reduction in warehousing, distribution, transportation costs, etc. Over the time, firms will also experience sustainable cost savings through increased productivity and streamlined business processes in procurement and purchasing order fulfillment, accounts receivable and payable, and exception management. Subtler benefits can include accelerated product delivery times, more efficient product development efforts, and lower product manufacturing costs. In the long term, the most significant benefits to businesses with advanced supply chain management capabilities will be dramatically improved customer responsiveness, increased flexibility for changing market conditions, improved customer service and satisfaction, increased customer retention, and more effective marketing [7,19,27,32].

However, most of companies implemented the supply chain management can not reap the supply chain benefits expected. The supply chain concerns and obstacles were first studied in year 2002. The results shown that the most concerns items are Supply Chain Coherence such as lack of cooperation among supply chain members, Information Capability such as lack of sophisticated information system, and Geographical Proximity such as customer and supplier geographical distances. All of these concerns impact to the effectiveness of supply chain practices and performances[39]. Most of the concerns and problems are some basic infrastructures of the company as well as the supply chain knowledge or operational before implementation [18,33,39]. The information exchange is consistently mentioned as a key requirement of successful supply chain management implementation, the main premise of supply chain management is that the sharing of information and the coordination of strategies among firms in a supply chain can both reduce total logistics costs and enhance value

delivered to the customer, which can lead to sustainable competitive advantage for the firm [7,13,34]. The organization characteristics, larger organizations tend to be more diverse and complex and the increased availability of resources can lead to more risk taking by management because potential failure is less hazardous to the health of large organization. Some researches found that the larger organizations adopt more innovations [13]. The management commitment is the key critical factor in supply chain implementation, the budget, vision, information are all derived from the management through the employees. As the above basic infrastructures required, we study the critical operational infrastructures enhancing the supply chain practices and performances. The existing researches on supply chain management pay scant directly about the infrastructures of supply chain management and practices. The literature review of *Journal of Business Logistics* and *Journal of Supply Chain Management* from 1970 - 2003, there were no evidence about the studying of the infrastructures enhancing the supply chain practices. In this work, the author adopted the 3 categories of infrastructure of the critical success factors in supply chain implementation. Man is defined as the operational staff worker's knowledge, experiences or etc. Machine is defined as a operating tools for supply chain managing. Management is defined as the commitment from the top level in order to support the supply chain activities and implementations. The supply chain management in this paper, we define the two layers of management. The first layer is the infrastructures level which we define the man, machine and management as the basic infrastructures. Another layer is the supply chain level which we classify as a supply chain practice and a supply chain performance. The research model developed from the Croteau's research model. This research model studies the relationship between basic supply chain infrastructures and the supply chain practices and performances. The research objective is to validate the infrastructures related to the supply chain practices and performance by using the structural equation modeling with - EQS technique.

2. Literature Review

The supply chain company comprises geographically dispersed facilities where raw materials, intermediate products, or finished products are acquired, transformed, stored, sold and transported to the customers. These activities are the connected facilities along the products flow. The facilities may be operated by the company or vendors, customers, third-party providers, or other firms which the company has business arrangements. The company's goal is to add value to the products through the supply chain and transport them to geographically dispersed markets in the correct quantities.

In the 1950s and 1960s, most manufacturers emphasized on the mass production to minimize the unit cost of production, with the low product flexibility. The information sharing to supplier or partnership was

considered risky. In the period, there was a little to find the cooperative and strategic buyer-supplier partnership and it is rare to find the supply chain organization [38].

In the early of 1970s, the emphasis of competitive strategy was shifted from productivity and mass production to quality emphasis and cycle time reduction [4,5,11,38]. The material requirement planning (MRP) was developed and managers realized the impact of huge WIP inventories on manufacturing cost as well as the product quality, product development and delivery lead-time [1,2,21,28]. All of above inconsistency performance of the supplier or partnership direct and indirect effected to the company in term of the cost, customer satisfaction and management issue. In this period, manufactures resorted to new material management concepts to improve the company performance.

In the 1980s, the global competition forced world-class organization to offer low-cost, high quality and reliable products with the greater design flexibility. The JIT was developed to support and improve the manufacturing efficiency and cycle time [8,15,27,37,38] as well as minimize and manage the inventory. In this period, the buyer-supplier relationship was accountability. The supply chain concept emerged as the experiment in manufacturing. Additional, the procurement professional, logistics experts carried the further step in order to incorporate the physical distribution, transportation and warehousing functions [37].

The evolution of supply chain management continued into the 1990s due to the intense of global competition. The higher demanding from customer to get the product, service at the right time in the lowest cost, the organization or manufacturing realized to improve the overall organization efficiency as well as the efficiency of their partnerships both customer and supplier. The long term and closely working relationships are developed to keep the competitiveness within the chain. In this period, the supply chain management was continued from 1980s and further extended best practices in managing corporate resources to include strategic suppliers and logistics function.

In the end of 1990s to 2000s, several developments in material management were emerged. MRPII and ERP were developed as a tool in managing the material. The advanced supply chain management and logistics were studied to improve the efficiency of process such as the lean logistics, agile supply chain, etc. Currently the supply chain is the new business process management in almost organization regardless to the business types or products. The literature review in supply chain management area was conducted in reviewing *The Journal of Supply Chain Management* since 1993 to 2003. And *The Journal of Business Logistics* since the Year 1970 to 1997 that analyzed by Stock in 1997 [2]. There are 1589 citations in total.

Table 1. Supply Chain Revolution

Period	Cooperative Characteristics	Authors
1950s–1960s	-Low cooperative strategy between buyer and supplier -Emphasize on the mass production to minimize cost with low product flexibility -No supply chain developed	Tan 2002
1970s	-Emphasize on high quality product -MRP is developed supporting the WIP managing -Initiate the cycle time reduction, accurate lead time delivery, product development concept	Carter et al 1996, Tan 2002
1980s	- High global competition forced - Market need Low cost , High Quality, Reliable , Higher flexibility - JIT developed to minimize and manage the inventory - Realized the buyer and supplier relationship in cooperate management	Tan 2001, Tan 2002
1990s	-Higher demand of quality product, service in the right time at the lowest cost -Partnership management emerged, the long term, partnership relationships, closely working with the supplier was developed - Supply Chain Management was continued from Period 1980s	Inman and Hubler 1992, Morgan and Monczka 1995, Onge St. A. 1996
2000s	- MRPII, ERP were developed to support the material management - Supply Chain Management is the new business process mgt.	Tan 2002, Elmuti 2002, Li 2002.

The most popular topic is the transportation, purchasing & inventory, logistics, information system, channel of distribution, MRP, DRP, JIT& Kanban, location analysis, supplier management, customer service, human resource & organization, supply chain concept, and others respectively. The number of citation VS the subject area is shown in the following table.

Table 2. Literature Review in Supply Chain

Subject Area	No of citation (s)
Transportation	406
Purchasing & Inventory	384
Logistics	184
Information System	163
Channel of Distribution	132
MRP, DRP, JIT, Kanban	71
Location Analysis	59
Supplier Management	50
Customer Service	42
HR and Organization	34
Supply Chain Concept	27
Miscellaneous	19
Packaging	8
Quality	7
Outsourcing	3

From the literature review, there were very rare the supply chain infrastructure topics. This paper focused on the infrastructure factors that impact on the successful supply chain implementation.

3. Supply Chain Management

3.1 Supply Chain Performance

Managing a supply chain is becoming the important issues for organizations. Several researches mentioned that the competition is no longer between organizations but among supply chains [19]. Wisner and Choon suggested that the intense global competition of the past decade has let organizations to create the cooperative, mutually beneficial partnerships with suppliers, distributors, retailers, and other firms within the supply chain. The objectives of those partnerships are to offer the lower-cost, higher quality products and services with greater design flexibility [3,12,15], cycle time improvement, higher productivity, waste reduction, efficiency of work, and product quality [19,26,27,31]. Supply chain implementation objective is also to achieve the financial and level of firm revenue as to maximize over time ratio of the annual revenue, less operation costs [3,5,36], sales, sales per staff, gross sales, operating income before depreciation, return on assets, net income (Ross 2002), saving, ROE, ROI and margin [1,19,29,33]

Several researchers focused on supply chain performance measurement and firm performance improvement objectives [2,6,8,17,28,29]. In 1995,

Mcmullan studied about the supply chain management practices in Asia Pacific, the researcher investigated the four key areas; management issue, role and responsibilities, competitive strategies and performance management. McMullan [29] also suggested that in order to achieve a competitive advantages, the firm is required to change their organization structures, relationships with supply chain members and performance measurement systems as well as the new information technology to enhance communication throughout the supply chain which will be increased the service levels and reduce the operating costs. Lambert et al described the supply chain is to maximize the profitability at each line, supply chain performance migrates toward management's objectives and maximizes performance[27].

The customer management and satisfaction is the objectives of supply chain implementation [3,14,27,29] in order to deliver the on time delivery product, reduced the customer complaints, provide the inventory accuracy and reduce the total cycle time [29,37]. The supply chain implementation in manufacturing can also reflect to the customer satisfaction by increase sale volume, cost reduction so sell higher margin products, reduce safety stock, improve asset utilization, product development, investment plan, resource effectiveness [16,27,29,]

For the supplier management, many researchers identified that it is the critical success factor in supply chain management [1,7,9,18,23,25]. The objectives expected from the supply chain management program are to acquire the right quality products in the right supplier, time, price and services [10,11,2137]. The impact of supplier selection criteria and supplier involvement can be impacted to the firm performance by reduced the production rework cost, reduced the production costs per unit, decreased the work in progress inventories, material handling and increased the quality of outgoing product and delivery performance from the accuracy in delivery from the supplier [3,12,22,39].

The warehouse and transportation is the one component in supply chain integration, the most common measured in warehouse performance are inventory accuracy, on time delivery, shipping error, warehouse cycle time, etc [16,24,27,32]. Some researchers identified the benefits of supply chain in warehouse and transportation as to lower inventory cost and risk, warehouse cost reduction, cost saving from overtime through increased productivity and streamlined business processes in procurement and purchasing. The logistics system can be saved for the operation cost [19,34] by implementing the freight and transportation management. There are some researchers studied about the third party service provided in helping cost and efficiency improvement.

The warehouse management seems to be related to the Information Technology. Some companies have implemented the software in managing the warehouse and inventory processing, the software in Inventory Management is the most application to supply chain organization [29]. So the Information Technology is one of the key success factors to supply chain management. It

is as the medium for coordination among and within organizations but the larger of IT investment seems not to lead the higher financial performance [22,36]. So the firm should consider the investment level of Information technology in achieve the highest benefit return. Some usage of Information Technology in supply chain such as the Internet which provides the opportunity for demand data and supply capacity data to be visible to all company within the chain [21,35]. Other applications of Information Technology in supply chain management concerned in usage of Warehousing management, fleet management, facility network planning, MRPII, Barcoding, Radio frequency, EDI [4, 29, 26, 27].

Table 3. The Literature Review in the Supply Chain and Firm Performance

Supply Chain Performance	Descriptions	Authors
Financial Performance	The overall profitability or cost reduction after the supply chain implementation in term of ROI, ROE, Profit sharing, etc	Mcmullan 1995, Lee 2002, Elmuti2002, Lambert 2001,
Managerial Performance	The effectiveness and efficiency in overall managing from the first process of purchasing through the final process of transportation and logistics to end customer	Lambert 2001
Competitive Performance	The strength of company in order to win over the competitors	Hewitt 1999,
Customer Relation Performance	The relationship and efficiency in managing to achieve the customer expectation	Hewitt 1999, Elmuti2002, McMullan1995
Warehouse and Transportation Performance	The effectiveness and efficiency in material from supplier and finished product to customer	Mcmullan, 1995, Tan et al 1998,
Technological Performance	The utilization of technological hardware and software in order to maximize the efficiency and effectiveness in supply chain implementation	Ellram 2002
Supplier Relation Performance	The supplier's consistency in delivering materials, components or products as well as developing the long term partner.	Lambert 2001, Power 2001, Talluri 2002,

From these benefits, the advent of information technology and intense global competition has enticed

many world-class manufacturers, service providers [39,40] adopt an integrated strategic approach to supply chain management. To achieve these benefits, the supply chain strategies were implemented and studied by several researchers in how the practices related to firm performance or individual studied the supply chain practices for implementation.

3.2 Supply Chain Practices

The facing of competitive global market, revolution in manufacturers, downsizing and lean in organization, to achieve the competitive advantage the organization need to adapt and implement some value-adding activities. In order to achieve the financial performance, firm should focus on the profit maximization, cost reduction in manufacturing, operating cost, cost of quality, etc [18, 22]. Some manufacturers are practicing the process cutting by adding some processes to supplier capacity [33] such as the part preparation before production.

The most practices in customer management are to identify the customer needs, reduce the customer complaints, full score of delivery performance [4,38]. These activities the firm expected the repeated order in long term. In the other hand, firm also need the strongly support by their suppliers. The supplier will be monitored by the firm since the starting of business, many firms implemented the supplier selection program and set up the team to control the supplier performance as well as the reducing incoming inspection lot at firm's receiving, provide the supplier certification for the excellent supplier performance [32, 38, 39,40]. Currently, the suppliers are treated as the partnership in business, some purchasing roles in organization had been changed such as purchasing from individual plant source in low cost items, decentralized the purchasing, annual price negotiation activities [38,39].

The outsourcing is another premise of supply chain management for the cost reduction, the outsourcing can be applied to transportation function, warehousing function or human resource management [19] and Information technology. Some researchers [17,18] identified the information technology that purchasing and supply management use in 6 items. The cost reduction was initiated in the JIT program to keep less inventory and lower risk as well as the transportation which the consolidated and postponement strategy were selected to perform the cost reduction. Generally, the supply chain practices and activities were emphasizing in internal competencies which it requires greater reliance. In an empirical survey, Tan et al 1998 identified 10 SCM practices and showed that some of the practices affected firms' performance. Later in 2002, Tan studied the 25 supply chain practices related to the firm performances and concerned, the result shown that the "determining the customers' future needs" was the most practice items of the survey respondents and it is strongly to customer service and competitive position performance of the firm. The "use of third party SCM specialist" is the lowest activities rating from the survey respondents and no any

relation to the any firm performances [39,40].

3.3 Supply Chain Infrastructures

From the past researches, there were no supply chain infrastructures found in the literature review. In this paper, the researchers define the supply chain infrastructures into 3 parts as the followings

3.3.1 Man Infrastructures

Man infrastructure is defined as capability of people in supply chain organization. In this research, we focus on the followings

- (a) Skill and experience
- (b) Education and training

3.3.2 Machine Infrastructures

Machine infrastructure is defined as the equipment, tools or necessary things to support the supply chain activities. In this research, we focus on the followings

- (a) Equipment, tools, computers, etc
- (b) Software, computer program, MRP, ERP, etc

3.3.3 Management Infrastructures

Management infrastructure is defined as the management vision to the supply chain management and implementation. Due to the supply chain management is required the investment so the budget for the implementation is significant impacted to the overall success. In this research, we focus on the followings

- (a) Management commitment
- (b) Management strategy

In this research, we study the infrastructures that directly impact to the supply chain practices and supply chain management. The research model categorize into multilevel of supply chain. The basic level is the supply chain infrastructure. The intermediate level is the supply chain practices and the supply chain performance is the latest level.

4. Study Tool

The study tools in this research are the Q Methodology in clustering the basic infrastructure as the classified category. The structural equation modeling is used to validate the research result.

4.1 Q Methodology

Q methodology was invented in 1935 by British physicist-psychologist William Stephenson in 1953 and is most often associated with quantitative analysis due to its involvement with factor analysis. Statistical procedures aside, however, what Stephenson was interested in providing was a way to reveal the subjectivity involved in any situation -- e.g., in aesthetic judgment, poetic interpretation, perceptions of organizational role, political attitudes, appraisals of health care, experiences of bereavement, perspectives on life and the cosmos, et cetera ad infinitum. It is life as lived from the standpoint of the person living it that is typically passed over by

quantitative procedures, and it is subjectivity in this sense that Q methodology is designed to examine and that frequently engages the attention of the qualitative researcher interested in more than just life measured by the pound. Q methodology "combines the strengths of both qualitative and quantitative research traditions" and in other respects provides a bridge between the two [27,37]. Some of the quantitative obstacles to the wider use of Q methodology have recently been rendered less daunting by virtue of software packages which have converted to button presses what before were tedious calculations. One such package, Q Method (Atkinson, 1992), is available as freeware from Kent State University's List server, and the way in which Q Method facilitates Q-methodological inquiries, as well as the way in which such inquiries proceed. The formula for calculating the sample kappa (k) is

$$k = \frac{N \sum X_{ii} - \sum (X_i + X_{+i})}{N^2 - \sum (X_i + X_{+i})} \quad (1)$$

For kappa, no general agreement exists with respect to required scores. Landis and Koch (1977) have provided a more detailed guideline to interpret kappa by associating different values of this index to degree of agreement beyond chance. The following guideline is suggested:

Table 4. Guidelines for Kappa Value

Value of Kappa	Degree of Agreement Beyond Chance
0.76 – 1.00	Excellent
0.40 – 0.75	Fair to Good (Moderate)
0.39 or less	Poor

4.2 Structural Equation Modeling

The growing interest in Structural Equation Modeling (SEM) techniques and recognition of their importance in empirical research, Structural Equation Modeling (SEM) techniques such as LISREL, EQS, Partial Least Squares (PLS) are second generation data analysis techniques that can be used to test the extent to which the research meets recognized standards for high quality statistical analysis. The test is for statistical conclusion validity. Contrary to the first generation statistical tools such as regression, SEM enables researcher to answer a set of interrelated

research questions in Single, Systematic and Comprehensive Analysis by modeling the relationships among multiple independent and dependent constructs simultaneously. This capability for simultaneous analysis differ greatly from most first generation regression model such as linear regression, LOGIT, ANOVA and MANOVA, which can analyze only one layer of linkages between independent and dependent variables at a time. SEM tools are increasingly being used in behavioral science research for the casual modeling of complex, multivariate data sets in which the researcher gathers multiple measures of proposed constructs. Several literatures suggested that SEM has become a tool in validating instruments and testing linkages between constructs. Consistent with [37], the qualifying criteria for the sample were that the article employed either:

- (a) Correlation or statistical manipulation of variables
- (b) Some form of data analysis, even if the data analysis was simply descriptive statistics.

From the above table, it is shown that SEM has been used with some frequency for validating instruments and testing linkages between constructs in two of three widely known Information System Journals. In ISR, 45% of the positivist, empirically-based articles used SEM. In MISQ, it was 25%. From the first appearance of SEM in 1990 in the major Information System journals [37], usage had steadily grown. By the mid of 1990s SEM was being used in about 18% of empirical articles across the three journals, with PLS and LISREL being the two most common techniques. Other SEM tools, such as EQS and AMOS, were used less often, but this is most likely because of the slowness of diffusion of innovation and is not a statement about the power or capability of these particular packages [37].

4.3 Research Model and Hypothesis

In this paper, the multilevel supply chain is integrated. The proposed research model is illustrated in Figure 1. From the statement of the problem, do the Man, Machine and Management infrastructure influence the effectiveness of supply chain management? The model is designed to study the supporting of operational infrastructures in term of man, machine and management in supply chain implementation.

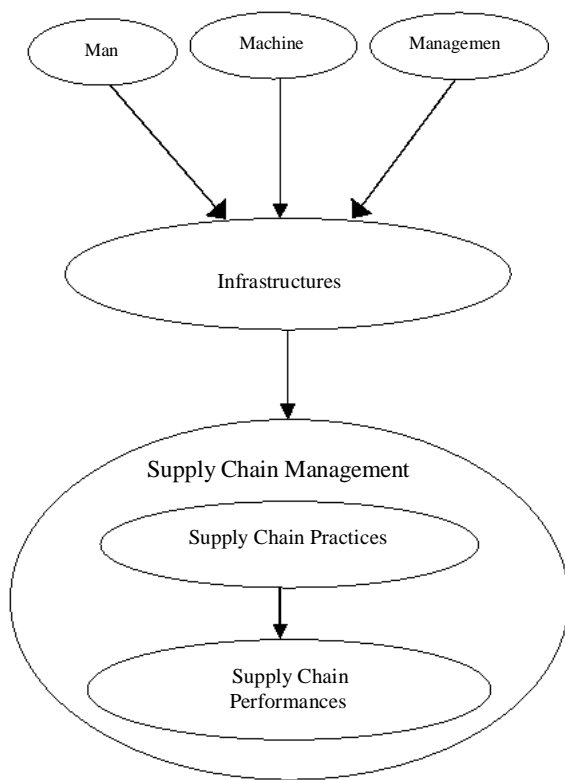


Figure 1. Research Model

The model is analyzed the basic infrastructures need for supply chain activities enhancing the effectiveness of supply chain practices and their performances. The man, machine and management infrastructures are studied the covariation to the supply chain management. From the research model, the hypothesis is established:

H: The higher supply chain infrastructures preparation, the higher effectiveness of supply chain management

We also study the correlation between the infrastructures, supply chain practices and supply chain performances.

4.4 Survey Methodology

A survey instrument in form of a questionnaire was designed based on the integrated model described. The respondents were asked to indicate the level of company practices and performance achievement after supply chain implementation using five-point Likert scale (1 = strongly disagree, 5 = strongly agree). The six infrastructure variables were constructed. The questions about man, machine and management infrastructures were asked to indicate the five-points Likert scale as well as the four group questions of the supply chain practices and performance. This survey data was collected from a single respondent from each target firm, the target respondents are in the purchasing and sale departments because they were assumed to fully involve the company's supply chain activities. The objective in

collecting the single respondent from one firm is to minimize the variation in data bias [41].

The variables were checked the validity by 4 practitioners and academicians, the Q-sort methodology was used to ensure the variables by improving the k values from the first to second rounds. The questionnaire was pre-tested to check the content validity and revised where necessary to ensure the content validity. The surveys were sent refer to the industrial estates list, totally 114 from 986 surveys usable (11.56%). The last wave of surveys received was considered as representative of non-respondents [9]. The 30 survey items were selected for analysis randomly. Each sample was split into two groups on the basis of early and late survey return time, then the t-test were used to analyze. The t-test yielded no statistically significant differences between early and late response groups. The non-affect of non-response bias was recommended. The profile of company and respondents were asked. The firms were mainly from the manufacturing and trading industries. The respondent's profile is shown in Figures 2:

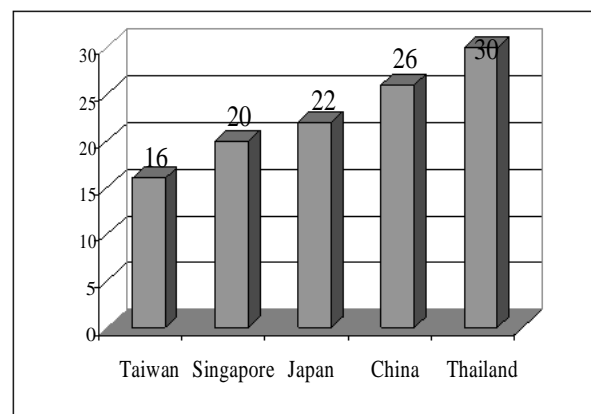


Figure 2. The Respondents' Origin Country

Figure 2 represented the firm's country of origin, they are from Taiwan, Singapore, Japan, China and Thailand, respectively. The Figure 3 shows the driving force of supply chain implementation, the highest driving force is from the customer requirement, cost reduction, delivery management, inventory management accordingly. Figure 4 shows the business function of the supply chain implementation is in electronic industry, plastic industry, trading industry and packaging industry respectively.

4.5 Analysis of the Research Model

The simultaneous estimation methodology is applied to test the measurement and theoretical. All data from 114 firms sampled to obtain the maximum likelihood estimates of the path coefficients (γ), loading (λ), correlations, error variances, and χ^2 goodness of fit test [12]. All of these parameters were derived from the EQS, which it is one program of structural equation modeling program. The advantages of EQS other than other

structural equation modeling are the simpler represented system on two or three sets of parameter metrics. Also, the less limitation in the type of structural coefficients make the EQS easily interpret the statistic result in the small number of variables [12,37].

The reliability, convergent validity, unidimensionality of infrastructure alignment and supply chain practices are analyzed by examining the level of sub model fit and estimated loading [12]. The unidimensional reliability is a model comparison with significant smaller χ^2 in the proposed measurement model with the alternative measurement models. For the model fit is assessed using chi-square statistic estimated for the hypothesized model. However, the χ^2 is sensitive to the sample size so it is a caution to only rely on the χ^2 . The value of χ^2/df can be used to improve this limitation if the ratio is inferior to 5 [12]. In EQS, the Bentler's comparative fit index (CFI) is approached to reflect the fit at all sample sizes. The CFI formula is:

$$CFI = |(\chi_0^2 - df_0) - (\chi_k^2 - df_k)| / (\chi_0^2 - df_0) \quad (2)$$

Where χ_0^2 is the null model and χ_k^2 is the hypothesized model. Model fit is acceptable at CFI is higher than 0.90 level. For the structural equation modeling assessed of this model results in Figure 2. A significant value of 112.4 at $df = 53$, $p(0.01)$ is the chi-square result and confirmed fit is the χ^2/df ratio at 2.18, which this CFI = 0.91 is adequate supported the unidimensionality of alignment and practices.

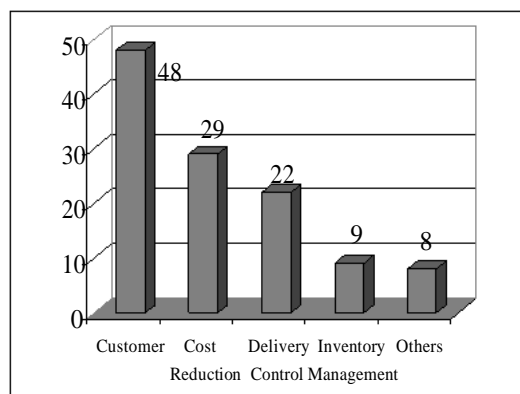


Figure 3. The Supply Chain Driving Forces

For the convergent validity, the underlying construct or trait are described in percentage of variance in term of loading squared. In this model, the loading range is from 0.51 to 0.84. The loading of operational infrastructures Man, Machine and Management are significant in enhancing the supply chain practice. A result higher than 0.5 shown the measurement is captured by the constructed variance [12]. In this model the ρ ranged

from 0.51 - 0.74 that confirmed the reliability of this model. As shown in the Table 5, the correlation ranged from 0.42 to 0.74 at 99% confidence interval. The largest correlation is between the supply chain practice and supply chain performance, the values shown the acceptable discriminant validity.

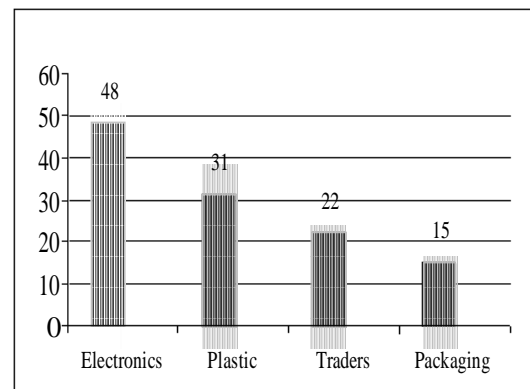


Figure 4. Respondent's Business Function

For the theoretical model, the linked between operational infrastructure to the supply chain practices reflect the terms of competitiveness performance, cost management and inventory control performance. The hypothesis was confirmed by the significant path coefficient of 0.74 at 99% confidence level that enhancing of operational infrastructures of man, machine and management to the supply chain practices support the supply chain performance of organization [12,27,37].

5. Discussion

The tested model shows the significant man, machine and management infrastructures enhancing the supply chain management. The research results indicated the operational infrastructures are highly impact to the supply chain practices that reflect the success in supply chain performance. In this paper the supply chain performance, the inventory control performance is highly significant variable.

For the further research, this model can be analyzed in term of mathematically equation in order to be the indicator of infrastructure preparation before entering the supply chain program as the following;

$$F(x) = \{\text{Man, Machine, Management}\}$$

Where $F(x)$ is the readiness indicator of infrastructure preparation.

The research will be more contribution if linking to the supply chain performance

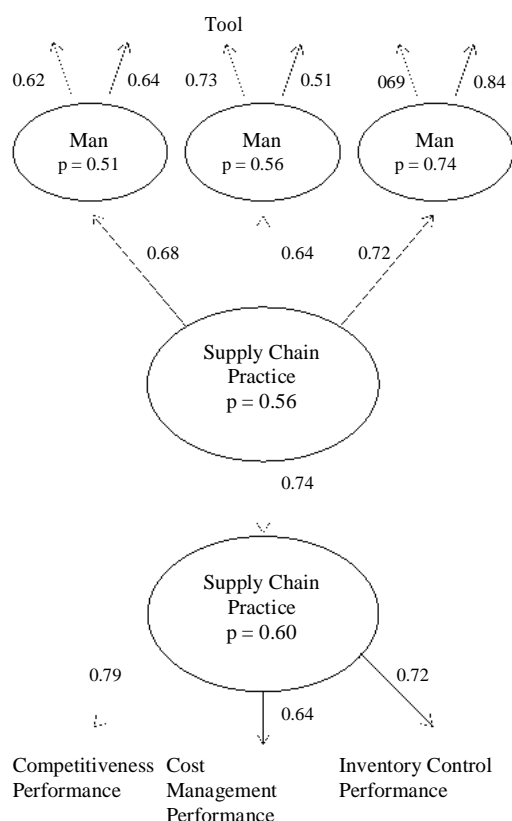


Figure 5. Operational Infrastructures Enhancing Supply Chain Management

Table 5. The Correlation Analysis of the Constructs

	1	2	3	4	5
1. Man	-				
2. Machine	0.46	-			
3. Management	0.51	0.42	-		
4. Supply Chain Practice	0.68	0.64	0.72	-	
5. Supply Chain Performance	0.48	0.49	0.52	0.74	-

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A Methodology for Developing an Integrated Supply Chain Management System

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Abstract

Integrated Supply Chain Management (ISCM) involves the linking of suppliers and customers with the internal supply processes of an organisation. ISCM solutions allow organisations to automate workflows concerning the execution and analysis of planning, sourcing, making, delivering, returns handling and maintenance. Many of today's ISCM systems use primarily web technology as the supporting infrastructure. Undoubtedly, the electronic (Internet-based) ISCM systems deliver the enterprises with a competitive advantage by opening up opportunities to streamline processes, reduce costs, increased customer patronage and more thorough planning abilities. However, there has been significant customer backlash concerning the inability of software vendors to deliver easy integration and promised functionality. Although various researchers have suggested strategies to overcome some of the failures in operating ISCM systems, there was a lack of architectural investigation in the analysis stage. The methodology proposed seeks to resolve these gaps and provides a fundamental framework in analysing ISCM systems.

1. Introduction

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The evolution of Internet technology has enabled enterprises in operating inter-organisational activities efficiently. Given the cost of logistics and its importance in order fulfilment process, organisations may take this opportunity to reengineer their supply chain operations to sustain in the global competitive challenge. With this invigorated growth of e-business, software vendors and consultants have promised the Internet-based supply chain systems, which provide businesses with the capability to respond in real-time in changing product demand and supply, and offer an easy integration functionality with backend information systems [15] [19].

Although a number of Internet-based supply chain systems (or integrated supply chain management systems – ISCM systems) are available for adoption, enterprises are not guaranteed to implement the systems in conjunction with their existing information systems. Furthermore, the ISCM systems may not fulfil the connection and implementation requirements between

participants in the supply chain.

After the e-commerce hype had dissipated, surveys undertaken in 2001 tend to paint a different picture as to the success of these implementations. Smith [17] concludes that at least 15% of supply chain system implementations during 2001 and 2002 were abandoned in the US alone. Although several reasons can be identified as the cause of implementation failure, the main problem rests on the fundamental analysis of ISCM operations and requirements.

The purpose of this paper is to debunk some myths proposed by vendors with regards to the implementation of Integrated Supply Chain Environments (ISCE) and propose an analysis methodology for Integrated Supply Chain Management systems.

Firstly, the paper will examine some of the available literature regarding ISCE. The fundamentals of ISCE – technologies and processes, will be investigated in some detail. Vendors were quick to promote the benefits of ISCE, yet were not so forthcoming as to possible barriers and other issues to watch for. Both of these will also be discussed in this paper.

Secondly, an analysis methodology is proposed, which intends to address some of the issues identified previously, and construct a theoretical model for enterprises to adopt in the analysis phase of developing ISCM systems. This paper concludes with a future research direction in investigating technological issues of ISCM systems operation.

2. Integrated Supply Chain Management Overview

ISCM involves the linking of Suppliers and Customers with the internal supply processes of an organisation. Internal processes would include both vertically integrated functional areas such as materials, sales and marketing, manufacturing, inventory and warehousing, distribution or perhaps, other independent companies, which involved in the supply chain (ie. channel integration). Customers at one end of the process can potentially be a supplier downstream in the next process, ultimately supplying to the end user [9] [19].

2.1 ISCM solutions

Whilst ISCM systems, in many cases are still in its infancy, the concept of establishing information flows between points in the supply chain has been around since the 1980's. Through Electronic Data Interchange (EDI),

customers and suppliers have communicated supply data through direct dial-up interfaces and other mediums [21]. However, the ability for the Internet to create a common communication infrastructure has made integration much more cost-effective. Hence, ISCM has the ability to deliver the right product to the right place at the right time and at the right price.

From the supply chain software development perspective, there are generally 4 large vendors identified, which namely Oracle, SAP, PeopleSoft and Ariba and a multitude of medium-sized vendors in the ISCM solution space [2]. All claim that ISCM will enable the enterprise to respond, in real time, to changes in demand and supply.

For instance, current ISCM solutions allow organisations to automate workflows concerning the execution and analysis of the following business activities [8] [15].

1. Planning: demand & supply planning, manage planning infrastructure
2. Sourcing (buy-side) - strategic sourcing, eprocurement, services procurement, catalog management, collaborative contract / supply management, settlements / vendor payments
3. Making (in-side) - product lifecycle management, demand planning, production management, production planning, flow production, event management
4. Delivering (sell-side) - inventory, order management, promotions management, warehouse management, transportation management, delivery infrastructure management, ebill payment, scm portal
5. Returns handling (from customers)
6. Maintenance

2.2 ISCM systems architecture

Turner [19] quoted that information systems would be the enabler of integrated logistics. Armstrong [2] affirms that Turner's view has come to fruition. Many of today's ISCM systems use primarily web technology as the supporting infrastructure [6]. It is not uncommon in these instances, to develop a 3-tier or n-tier network architecture in order to provide robust support for ISCM systems.

For example, Advanced Software Design Inc. [1] illustrated the 3-tier ISCM integration architecture (Figure 1) in use by the US Department of Defence (DoD). Suppliers and customers alike, access the DoD ISCM through the use of Web portals (the 1st tier of the ISCM). Web portals provide the necessary web services to establish a common Graphical interface for the DoD's stakeholders in accessing supply chain data. Customers, suppliers, distributors and delivery agents can all access custom information and services supplied by the ISCM. Supplier services could include access to business-to-business (B2B) marketplaces, support and other push/pull supplier functionality. Alternately, customers can customise the site in order to access catalogues from the organisation and external suppliers,

customer transaction details and other product, customer and technical support.

The portals are supported by messaging infrastructure (2nd tier), which provides the link to the underlying applications layer (3rd tier). The applications layer is independent of any particular interface (eg. portals) and contains the necessary business logic and data access in order to perform operations. This includes access to SCM functionality, ERP systems and decision support systems. Data and business logic are also independently stored.

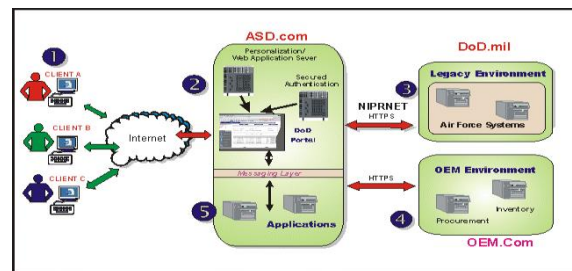


Figure 1. ISCM integration architecture [1]

The software architecture is mostly constructed in web-based environment that involves HTTP, server-side Java and XML. ISCM systems are generally no different than other business applications but still require some interfacing with old technologies such as aging ERPs and legacy systems [21].

2.3 Benefits of ISCM systems

ISCM delivers the enterprise with a competitive advantage by opening up opportunities to streamline processes, reduce costs, increase customer patronage, and more thorough planning abilities [19]. The benefits of ISCM systems are categorised into a number groups including financial, customer, planning, production, and implementation. Each of these groups is further discussed in the following subsections.

2.3.1 Financial

Cost reduction

In some manufacturing organisations, the cost of the supply chain can represent 60-80% of their total cost base [5]. One of the core benefits for driving efficiency through the supply chain is cost reduction. ISCM allows the organisation to maximize profitability through Reduced Customer Service, Administration and Inventory costs. Less staff are required to maintain the supply chain and order/inventory details can be made available to customers directly without human intervention [5] [8]. Some organisations have quoted 25% cost reductions per transaction, despite a 20% increase in orders [19].

Quality financial information

Another benefit is the improvement and reliability of financial information. ISCM systems maintain centralised databases, which are linked to other enterprise systems (eg. ERP, CRM) providing integrity, consistency and real-time

data access to managers so that they can manage the supply chain with an organisational perspective [19].

2.3.2 Customer

Retention

Supply chain systems, through customer portals, provides customers with an instantaneous and holistic view of the progress of their transactions within the organisation. This level of service (coupled with benefits derived from Production) result in higher customer satisfaction levels and in turn, improve the firm's ability to attract new customers and importantly, retain them. Organisations have achieved Customer Service Levels of 97% following the introduction of ISCM systems. This retention translates into greater revenue. [3] [8] [5] [19].

Behaviour

The ability to capture customer transactions and preferences online, provides the organisation with the facility to track their behaviour and in turn, customise products & services to cater for them [4].

Promise

Because of the level of workflow automation and inventory statistics, organisations are able to provide accurate estimates of when orders will be fulfilled at the time of ordering. This is known as 'capable-to-promise' (CTP) capability. This capability allows the organisation's customers to then plan more effectively [8].

2.3.3 Planning

Companies with ISCM systems have the ability to mathematically and graphically observe the performance of the supply chain giving the manager the power to "plan and make things happen" [19]. ISCM systems provide the organisation with the capabilities to derive more accurate demand planning with improved precision, create shorter planning and production cycles, establish one central data repository for the entire organisation and facilitate enhanced communications through rapid information dissemination [4] [8].

2.3.4 Production

ISCM provides the ability to holistically manage the supply chain allowing managers to dynamically respond to any situation that may arise so as to minimise its impact on production.

Inventory Management

By measuring the level of inventory and analysing turnover, supply chain systems can improve turnover by reducing the need for 'safety stocks' and the risk of retailer 'out-of-stocks'. Inventory items need to be consistently numbered to facilitate measurement and tracking. These benefits reduce the overhead required to store high inventory levels [5] [8]. Turner's [19] research claimed a 37% reduction in inventory levels as a result of ISCM implementation.

Efficiency

ISCM systems measure the performance of the supply chain through the generation of supply chain metrics. This allows process quality issues to be tracked and rectified, isolates bottlenecks in the process and measures lead times so that they can be aligned with available capacity to maximise plant utilisation. All of this ensures 'quicker time-to-market' for the firm's products. [5] [8].

Other efficiency benefits include no data rekeying through simplified automated order placement, order status inquiries, delivery shipment and invoicing [4] [8]. ISCM implementations have resulted in a 50% overtime reduction for some organisations [19].

2.3.4 Implementation

Consultants promise responsiveness and 'Plug & Play' integrations. However, documented examples of supply chain failures by organisations such as Siemens AG, Nike, OPP Quimica and Shell are evidence that the implementation of ISCM systems is not as easy as vendors claim. Claims of "rapid integration" and "seamless linking" seem to significantly underestimate the effort required to integrate ISCM with the rest of the enterprise [13].

For Nike, "i2" ISCM software required a significant degree of customisation in order to integrate the software to the rest of the organisation. Customisation to enterprise software comes with great risk and significant cost for ongoing maintenance. Nike's summation of the software was that it "just didn't work". OPP Quimica (a Brazilian Chemicals Company) required the use of 3rd-party integration software in order to assimilate i2 to the rest of the enterprise architecture. Shell's implementation proved problematic with the need to tie 85 ERP sites to a single SCM platform [17].

3. Issues and Barriers in ISCM Analysis

Similar to the hype attached to Enterprise Resource Planning (ERP) applications, there has been significant customer backlash concerning the inability of software vendors to deliver easy integration and promised functionality [17]. Turner [19] believes that "few companies claim to have fully implemented SCM and have sustained the benefits proposed ISCM would create". In fact, Fontanella [7] indicates that only 25% of ISCM users are utilising the full suite of supply chain applications and that only 12% of users are receiving data from inbound suppliers and customers – far from an integrated supply chain.

Many of these issues stem from a failure to undertake thorough analysis in the following key areas.

- Focus on transaction systems over strategic systems to manage supply chains
Organisations are not taking a strategic view of ISCM systems. More so, they tend to only focus on transactions systems (eg. inventory control, order processing etc.), which provide little visibility of the

enterprise [7] [19].

- Failure to pre-empt change to business processes
In a majority of implementations, analysis has focused on the technical aspects of integrating ISCM systems with the remaining architecture. One area that has been neglected has been the effect on business processes. Organisations expect either staff to just “accept change” or “customise” the software – both of these options are generally flawed. In order to reap the cost savings from ISCM systems, significant analysis must be conducted regarding process reengineering in order to ensure collaboration and continue to sustain benefits [7] [11] [19].
- Failure to appreciate geographical, relational, environmental considerations between buyer and supplier

The nature of ISCM (especially with multinational corporations), involves transacting across the world – “24 hours a day, 7 days per week, 360°”. Analysts fail to appreciate the geographical, relational and environmental “inhibitors” for ISCM implementations of this scope [11].

- Cross-borders logistics, culture, language and economic & regulatory climate are just some considerations which can affect the integration of business processes between regional offices & external organisations, creating communication issues throughout the supply chain. One ill-performing participant in the supply chain will affect the performance of the entire supply chain [18].
- Failure to accurately identify the costs and benefits of ISCM implementation

Many implementations have been classed as failures because of ISCM systems perceived inability to reap benefits and produce cost savings as expected. However, in many cases, it is the initial analysis of cost and benefits that have been flawed. Because of the nature and scope of ISCM implementations, it is difficult to accurately quantify attributable cost reductions from ISCM because they could be derived throughout the supply chain and be complicated to calculate. In the same light, determining benefits share similar traits with some having the additional complication of being intangible (eg. benefits of a central database) and therefore, difficult to quantify [12].

- Insufficient Capability
The implementation and support of ISCM systems can be rather complex and therefore demands sophisticated resources and incremental implementations. Unfortunately, during the planning and analysis phases of implementation projects, organisations have failed to properly appreciate the level of complexity involved, resulting in significant under-resourcing. As a result, many organisations have suffered material cost overruns and delayed “go-live” times [7].

4. Proposed Methodology for ISCM Systems

Analysis

Due to the extent of failed ISCM system implementations, it is imperative to construct an appropriate analysis and development methodology, which can be adopted as the roadmap for enterprises flourishing in ISCM systems development and operations. The proposed methodology demonstrates an overall picture for constructing an ISCM system from recognising problems, analysing requirements to the implementation and operation, and it embraces seven phases:

1. Identifying information management structure
2. Identifying connecting components
3. Ensuring appropriate business processes
4. Establishing and developing interfaces
5. Developing new business processes
6. Confirm strategic alignment
7. Implementing ISCM systems

Following is a discussion and culmination of those seven phases within the proposed iterative framework.

4.1 Identifying information management structure

Given the global nature of supply chain systems and its level of required integration, a common ICT (information and communication technology) infrastructure must be able to extend around the globe, be able to support open and rapid communication, and to integrate easily with the architecture of not just the organisation, but also with the architecture of customers and suppliers. This will be conducive to information sharing.

The enterprise’s information systems architecture must be properly analysed to ensure that it satisfies the needs of ISCM systems and can support security boundaries, hugely distributed database operations and event-driven applications. The architecture needs to be durable, flexible and embedded with the appropriate middleware in order to integrate as easy as possible [21]. It must also be sufficiently robust to cater for firewalls and other security measures, 24/7 global access and have redundant systems and processes to handle events when ISCM systems need to be offline for maintenance, emergency and recovery purposes.

In accordance with the criteria specified above, the Internet-based structure can be considered the most appropriate platform to satisfy these requirements. Nevertheless, participants in the supply chain have various capability and maturity levels in information management structure. Hence prior to adopt the Internet technology for integration, the existing information management structure of each participant must be determined.

4.2 Identifying connecting components

One of the most critical functions of supply chain management is to ensure the effective integration of

information and material flows through the system. This includes understanding the value added to products and its related information flows (inputs and outputs) as it progresses through the supply chain [10]. This embraces analysis on the supply chain's real costs, and cost & performance drivers [16].

Turner [19] identifies some of the key components, which need to be 'functionally' integrated. These components are also considered as the connecting components (or connecting business functions) between participants in the supply chain. These components include order management, customer service, invoicing, forecasting, distribution requirements planning (DRP), warehouse and inventory management, manufacturing planning, production control (MRPII) and integrated logistics.

4.3 Ensuring appropriate business processes

In order to enhance the supply chain processes, it is important to understand what happens currently. Generally supply chain processes may include the procurement, production, ordering, delivery and inventory paths, both within the company and external parties.

Firstly, analysts should analyse the supply chain processes and be able to appreciate the company's mix of products, end configurations, volumes, lifecycles, channels, customer segments and delivery outlets [20].

Each process should then be prioritised and broken down into its sub-processes, identifying each of its sources, outputs, transformations, timings, resources utilised and requirements. This would also be an opportune time to gather metrics concerning each of the processes in order to establish a baseline for identifying problems and to measure future process improvement.

Additionally any opportunities to benefit from "quick-wins" should be taken advantage of at this point [10].

4.4 Establishing and Developing Interfaces

Once architectural issues have been resolved and data requirements have been determined, a structure needs to be established to enable common linkages between both data providers and data recipients of the ISCM (ie. customers and suppliers) and linkages within ISCM processes. This will require the need to ascertain whether there are any missing links and determine how the data required will be sourced or provided and in which format.

The emerging technology for interface communications is XML (eXtensible Markup Language). XML uses HTML tags to enable the "definition, transmission, validation and interpretation of data". However, effort for this task should not be underestimated [21]. Significant resources may be required in analyzing sources from ERP and antiquated EDI systems. It has been suggested that 3rd party interface tools (eg. Informatica & Brio) can be used to ease the transition for these types of systems [21].

4.5 Developing new business processes

After conducting detail analysis of existing supply chain processes and identifying any inefficiencies and/or gaps in the process, a proposal should be created for the design of new processes. Not only should new processes cater for anticipated ISCM processing, but should be sufficiently visionary to accommodate for other strategic initiatives (CRM, Supplier Management, Knowledge Management).

The new supply chain should be modelled in a manner so that supply chain "blue prints" can be generated [21]. Tyndall et.al. [20] suggest an iterative approach to process design whereby a process is broken down into stages and then defined, analysed, executed, assessed and then re-defined. This cycle continues until the appropriate performance expectations have been achieved. This process can become quite complex and convoluted once organisations begin to incorporate back-end systems and the processes of other organisations.

Based on metrics determined during the initial business process review, goals should be set for process improvement.

4.6 Confirm Strategic Alignment

At the completion of most of the analytical work, It is important to revisit some of the groundwork that would have been completed during the planning phase activity in the traditional SDLC.

It has been included this framework to highlight the importance of ensuring an alignment between business strategy and expectations with the outcomes of the ISCM implementation – supply chain strategy is interdependent on the business strategic direction.

Analysts need to confirm that 'value' is being delivered through ISCM by conducting critical analysis on proposed benefits and costs to ensure that they are still realistic [20]. So as to prevent misalignment of resources and skillsets, analysts also need to confirm that the business problem can still be solved with its current complement of staff.

4.7 Implementing ISCM systems

This phase involves determining what activities will need to be undertaken to facilitate implementation of ISCM system – creating an action plan.

There are a number of factors should be considered in this final phase of the methodology such as setting up communication standards, developing business operation procedures, and establishing training programmes.

Furthermore, this phase should be expanded to incorporate activities that can assist in the detail analysis of implementation risk of the system. Conducting analysis in areas such as change management is one example. Inability to manage the implementation of change has been a key factor in project failure. Any enterprise systems place great strain on the organisation to adapt to

reap the benefits. Change Management involves more than simply conducting user-training programmes, but involves a continuing consultative relationship with end users to secure buy-in.

5. Conclusion and Future Challenge

This paper endeavours to propose an analysis and development methodology for ISCM systems. The discussion started with review and investigation of the current ISCM solutions and architectures, and identified a number of benefits, issues and problems regarding to the implementation of ISCM systems. Based on the examination of existing ISCM status, the proposed methodology for ISCM systems analysis is constructed by a seven-phase development framework. The methodology tends to illustrate a systematic roadmap for enterprises in developing ISCM systems.

The future challenge for enterprises in operating and maintaining ISCM systems stressed on the overall maturity of technological availability and the flexibility of business processes aligning with the ISCM architecture.

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The Influence of Web Sites and Internet Advertising on Brand Memorability

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Abstract

Internet advertising allows marketers to reach the mass market like any other medium that has preceded it. The two-way dialogue in the Internet permits the personalisation of messages making the promotion element of the marketing mix the component that has the greatest potential for transformation. Companies use a multitude of methods to advertise on the Internet the most common of which is the banner Ad. It is believed that when consumers like an advertisement about a brand they develop positive brand attitudes and willingness to buy the brand. A positive attitude towards a brand appears to improve the consumer's ability to recall the brand. Extending the paradigm of attitude towards the Ad to e-commerce Bruner and Kumar (2000) proposed that attitude towards the web site is positively associated with attitude towards the Ad, the brand and purchase intentions.

This study, therefore, was designed to discern the features of quality web sites, the advantages and disadvantages of web advertising, the influence of web sites on attitudes towards Internet Ads, and Ad recall. Focus groups and a questionnaires administered to 254 respondents were used to gather the required information.

The findings of the study, which include the quality features of web sites that encourage web surfer revisits, the advantages and disadvantages of Internet advertising, the effect of Internet advertising on brand evaluations and Ad recall, are discussed.

1. Growth of Online Marketing

The phenomenon of globalisation is being embraced by most countries and provides endless opportunities to many business enterprises. Innovative managers looking for unique ways to compete in this new environment are turning to technological advances in computers, telecommunications and Internet to make their business dreams a reality. Of the new technologies, the Internet, in particular, provides information on everything imaginable at a very low cost driving the global electronic market [20]. Internet has increased opportunities for firms to increase business by providing 24 hour access for shoppers supporting business across different time zones globally.

Although growing, there is no uniformity in the extent of online shopping across the globe. It appears many factors contribute to this discrepancy. The long tradition of catalogue shopping, faith in technology, and the distance Americans may have to travel to reach a store given the large size of the country, make online shopping more acceptable in America. However cultural influences such as the social values attached to shopping may be an impediment to the growth of online shopping in Asia and Latin America. The low usage of credit cards for shopping in many parts of the world probably restrict retail spending online in such countries.

Companies use e-mail, bulletin boards and interactive advertisements to expand their business through the Internet, which now represents a multi-billion dollar market. Internet enjoys global popularity for marketing as advertisements displayed on it by firms, individuals or organizations can be accessed by anybody with appropriate technology. The capability of the net to compile statistics help companies to track their advertising effectiveness in terms of its reach and frequency. These are some of the many reasons why businesses rapidly adopt Internet as an efficient and economical medium to conduct marketing.

The ease of access, and minimal regulation to go online is another formidable reason that helps to accelerate the rate at which businesses are connecting to the Internet. It allows companies to avoid the regulations and restrictions normally encountered by companies who physically enter other countries to do business. This proliferates the use of Internet for advertising and sales transactions by individuals and companies.

2. What are The Good Web Sites?

Electronic marketing grabbed the attention of commercial enterprises in the 1990s with the advent of the World Wide Web. Bhatt and Emdad (2001), predicting a rapid growth in online sales, forecasted that the value of goods and services traded via the Internet is likely to reach \$1 trillion in the year 2005 [2]. To boost online sales companies should make sure that their site is one of those consumers use prior to making a purchase decision. Online shoppers will visit again and again the sites where they have had positive experiences.

There are the good, the average and the poor web sites. Good web sites that induce consumer revisits contribute to the growth of company sales and profitability. The average and the poor are those designed the way technology dictates without due consideration to online consumer needs and behaviour patterns.

The foray into web site development by many companies is fuelled to a degree by the prospect of doing business online. An increasing number of organizations feel it is desirable for their companies to have a Web presence [9]. Often the justification for development of a Web site is to strengthen the company's competitive position [15]. Web sites developed for such a purpose should not neglect the needs of the audience for which they are developed. Niederst (1996) commented on the need for Web designers to have an understanding of the human-computer interface issues of Web design, which include its function, graphics, and the ease of navigation [18]. Chung (1998) argued that designers could avoid producing messy Web sites by acquiring navigational design skills [8]. The above studies, however, did not address well the issue of the features that should be built into Web sites to meet the user needs. A site that fails to meet its users' needs is unlikely to meet its business objectives. Nielsen (1998b) estimated that 90 per cent of commercial Web sites failed to meet the needs of the users [19].

To gather the required information on prices and the availability of alternatives, a consumer may visit two or three web sites prior to deciding to buy a product. If a web site cannot be accessed quickly, it is likely the buyer will move to another site that downloads faster. A Boston Consulting Group study has found that if a buyer cannot find a product within 5.8 minutes at a site, they move away to another [1]. The ease of navigation of web sites contributes greatly towards positive evaluations by online shoppers. Consumers visit again and again the sites where they have had positive experiences and find that browsing through these sites to gather information is easier and more pleasant than they expected.

A web site is considered to be the public face of a company and should showcase its content in the very best form to the target market. To maintain corporate image the in-built quality features of the web site must exceed customer expectations and outperform the competition. Many web sites continually disappoint customers and fail to meet their expectations. If firms are serious about online marketing they should present their product offerings to customers on user friendly web sites with interactive search utilities on each web page that guarantee easy navigation. The quality of search tools and the time taken to download a web page are two key reasons that influence the return of an online buyer to a web site [25].

3. Online Advertising

Traditional marketing is undergoing a noticeable transformation with the advent of the Internet. This new medium allows marketers to reach the mass market like any other that preceded it. It has an effect on all four components of the marketing mix. The two

way dialogue in the Internet permits the personalisation of messages making the promotion element of the marketing mix the component that has the greatest potential for transformation.

Revolutionary advances in technology have led to huge growth in the use of the interactive World Wide Web forcing marketers to re-evaluate the methods used for communicating with the target audiences. As a result, online advertising has now become an integral part of the communication strategy of most organizations. Tedesco (2000) forecasts online advertising sales to reach \$22 billion by the year 2004, [26]. Cavanagh (2000) reports that traffic to major portals such as Yahoo, Lycos, and AltaVista will increase by 20% by 2004 [6]. This will further foster the growth of online advertising. However, everything is still not bright on the Internet as only a small proportion of advertising dollars are spent on the Internet. But, it is forecasted to be a growing medium, which businessmen and householders will use increasingly for advertising and home shopping with continuing advances in technology [20].

There are many methods of advertising on the Web and Internet advertisements come in many different shapes and forms. New ones emerge everyday. Commonly available among the endless possibilities of online advertising are banner ads, buttons, rectangles, pop-ups, interstitials, sky scrapers, webmercials, e-mail, sponsorship, key words and links. Of these the most prominent method of advertising on the web is the banner advertisement. It provides a link to the company's web site and is usually placed at the top or the bottom of a web page. Full banner, half banner, square banner and vertical banner are some of the many forms of banner advertisements. Briggs and Hollis (1997) found banner ads to be effective in creating awareness and positive brand attitudes, even when e-commerce was at its infancy [3].

Marketers use entertaining or informative messages on the Internet to attract customers to their sites. The final objective of their efforts is to expose the customers to their brands or to strengthen their association or affiliation with the brands. A survey of 500 Internet users found that more people are attracted by informative messages than entertaining advertisements [14].

Companies use online advertising to create brand awareness, preference and choice. Even though companies spend vast sums of money on Internet advertising no universally agreed upon way has appeared to evaluate its effectiveness [7]. There have been very few systematic studies to determine the various dimensions of web advertising effectiveness [11]. Some have raised serious doubts about web advertising effectiveness and its ability to persuade consumers to buy [12]. Hwang and Kranhold (2000) criticised Internet advertising as nonsensical, uninformative, unfocused, forgettable and generally ineffective [13]. Others have described online advertising as ineffective due to low click through rates for banner ads, their dullness, lack of information, its offensive nature and also because at times it causes confusion [16] [5]. Rettie (2001) found that the

disruption in the flow or the enjoyment of using the Internet caused by banners, interstitials, pop-ups and other types of Internet advertisements can create negative attitudes towards online advertisements [21].

In spite of these perceived negative sentiments the impressive growth of consumers surfing the web suggests to companies that the Internet provides an expanding meaningful audience for the promotion of their products and services. Some have suggested that advertising on the Internet is effective because of the interactive nature of the medium [22], while there are others who have found the web Ads to have the potential to be as effective as the Ads in the traditional media [10].

When consumers like an advertisement about a brand they develop positive brand attitudes and a willingness to buy the brand. A positive attitude towards a brand appears to improve the consumers' ability to recall the brand. Mehta (2001) proposed that consumers who have positive attitudes towards an Ad are more able to recall a brand than those with negative attitudes [17]. Extending the paradigm of attitude towards an Ad to e-commerce, Bruner and Kumar (2000) proposed that attitude towards a web site is positively associated with attitude towards an Ad, the brand and purchase intentions [4]. This study, therefore, was designed to discern the features of quality web sites, the advantages and disadvantages of web advertising, the influence of web sites on attitudes towards Internet Ads, and Ad recall.

4. Methodology

The population from which the sample is drawn for this study is the Internet user. Due to difficulties encountered in obtaining a random sample, this study used a convenient sample of tertiary students in New Zealand who were Internet users. The author screened the students for their web use and their ability to remember being exposed to Internet advertisements. The survey questionnaire covered many aspects of Internet use. It included questions that examined which quality features of a web design induced them to visit and revisit sites, the advantages and disadvantages of Internet advertising, and measured the impact of respondents' attitudes towards web sites on attitudes towards the brands advertised, and their recall of web advertising. Additionally, it gathered demographic information on the respondents such as age, gender and ethnicity.

Using a focus group the author at first determined (a) the features of a web site that encouraged visits and revisits to the site, (b) the advantages and disadvantages of Internet advertising, and (c) the brand names recalled from the advertisements seen on the Internet. The approach used in this study was

adapted in a study conducted by Goldsmith and Lafferty (2002) [11].

The quality features of web sites identified by the focus groups were (a) excellent visual presentation of the site (b) attractiveness of web pages (c) moderate use of colour (d) an informative homepage that describes what a viewer may find in the website (e) a homepage that informs the viewer what they could do using the website (f) web pages that explain what they can find and what they can do (g) sites that provide convenient navigational aids in each page (h) accuracy of information (i) Web sites using familiar language (j) download time not excessive (k) clear links to different destinations and (l) easy manoeuvring between related pages.

The subsequent survey that covered 254 respondents evaluated the importance attached to the above features by the on-line purchasers. They rated their expectations on the above features on a 5-point rating scale where the end point "five" was labelled extremely important and "one" labelled not at all important. Their perceptions of the sites used were then recorded using a 5-point rating scale where end points were labelled "5-extremely satisfied" and "1- extremely dissatisfied".

From the focus group discussion on the advantages and disadvantages of web advertising emerged a list of 10 items that consisted of 6 advantages and 4 disadvantages. The 6 advantages were: (1) Easy to find information (2) Easy to make comparisons (3) Enjoyable information gathering (4) Fast decision making (5) Low cost information (6) Helps private assessment. The 4 disadvantages were: (1) Advertising too cluttered (2) Invades privacy (3) Boring (4) Irritating. The respondents to the survey were asked to indicate the advantages and disadvantages in the given list of 10 items that they have experienced when they viewed an advertisement on the Internet as compared to traditional media such as TV, radio and print.

One question asked the survey respondents to indicate how advertisements they had seen on a web site they liked influenced their views about the brand. They were given the following three choices. (1) Improved the evaluation of the brand (2) Had a negative effect (3) Had no effect.

To measure top-of-the mind awareness or ability to recall an Ad, which is an important component of advertising effectiveness, the dependent variable recall of web advertisements was operationalised using a list of 10 brand names (International and New Zealand owned) selected from the focus group study. The respondents were asked to select from the list the brands they could recall seeing on the Internet.

5. Results and Discussion

A total of 254 students completed the questionnaire. The sample consisted of 52.3% males and 47.7% females. Most of the respondents (81.2%) were under 35 years of age.

The positive paired mean differences and the p-values = .000, for 6 (pairs 3, 6, 7, 9, 10, 11) of the 12 items measured (Table 1) indicate that the perceived level of satisfaction of online purchasers is much lower than their expectations for those important quality features of web sites. The high mean expectation values (over 4.6) for excellent visual presentation (Table 1: 4.66),

and moderate use of colour (Table 1: 4.70) confirm that visual presentation is an undeniably important element of a good web design. Many people still use a web site as a source of information, therefore, there is no substitute for accurate content in a web site. Accuracy also refers to the availability of up-to-date information. This is reflected in the high expectation mean value of 4.97 attached to accuracy of information (Table 1).

Table 1 – Mean Levels and Mean Differences of Expectations and Perceived Satisfaction regarding Web Sites

Feature	Mean Level of Expectations	Mean Level of Satisfaction	Paired Mean Difference	Sig (2-tailed)
Pair 1 – Visual presentation	4.66	4.76	-.1	.041
Pair 2 – Attractive web pages	4.59	4.61	-.02	.601
Pair 3 – Moderate use of colour	4.70	4.28	.42	.000
Pair 4 – Informative home page that describes what the viewer may find in the Web site	4.47	4.60	-.13	.013
Pair 5 – Homepage that informs the user what they could do using the Web site	4.55	4.68	-.13	.006
Pair 6 – Accuracy of information	4.97	4.67	.30	.000
Pair 7 – Web pages explain what they can find and do	4.22	3.91	.31	.000
Pair 8 – Sites that provide convenient navigational aids in each page	4.51	4.53	-.02	.716
Pair 9 – Web sites using familiar language	4.52	4.29	.23	.000
Pair 10 – Download time is not excessive	4.96	4.55	.41	.000
Pair 11 – Manoeuvring between different pages made easy	4.33	3.93	.40	.000
Pair 12 – Clear links to different destinations	3.65	3.80	-.15	.036

Most people prefer fast loading web sites (Table 1: expectation mean value = 4.96). The results of the regression analysis (Table 2: $t = 10.840$, $p\text{-value} = .000$) suggest that “download time not too excessive” is significantly related to overall customer satisfaction. This implies the need to design web pages that download in an

acceptable time period through a slow connection, and nearly instantly on a fast connection, as suggested by Rowan (2000) [23]. Sending less data is the key to building a fast loading web page. Reducing the size of the graphics file and building relatively small web pages that connect to the larger web site through hyperlinks are methods recommended to accomplish this.

Table 2 - Results of Regression Analysis – Importance of Quality Features of a Web Site on the Overall Satisfaction of Online Purchasers

Multiple $R = 0.853$ $R^2 = 0.728$		Sum of Squares	Mean Sum of Squares	F	Significance
Adj. $R^2 = 0.711$	Regression	42.296	3.525	41.93	.000
SE = 0.29	Residual	15.803	8.406E-02		
No.	Feature	B	Beta	t	Significance
1.	Accuracy of Information	.541	.475	10.704	0.000
2.	Download time is not excessive	.439	.467	10.840	0.000
3.	Site that provide convenient navigational aids in each page	.147	.147	3.474	0.001

Significant at the 0.05 level

Dropping a GIF file from 256 to 129 will not reduce the size of the image file but sizeable savings can be achieved by dropping from 129 to 128 colours (Sullivan, 2000). Meaningful file size savings can be achieved at 16, 32, 64, or 128 colours. JPEG, a graphic compression technique, enables images to be compressed into a fraction of the original size. All of these will help to reduce the download time.

The other predictors that are significantly related to overall satisfaction are accuracy of information (Table 2: $t = 10.704$, $p\text{-value} = .000$) and the provision of convenient navigational aids (Table 2: $t = 3.474$, $p\text{-value} = .001$). This suggests the firms that provide accurate information could significantly increase customer revisitations by incorporating appropriate navigational aids to ensure that visitors can easily find the useful content on the site. An approach to achieve this is developing Web pages that convey a clear message, which enable visitors to navigate easily, logically, and effectively through the use of buttons, arrows and text.

The results of a regression analysis of the quality features of web sites against the perceived satisfaction of online purchasers, suggest that the "12 item - predictor model" explains 71% of the variance (Table 2: adjusted $R^2 = .711$) of the overall satisfaction rating.

5.3 Advantages of Web advertising

"Easy to find information" was the advantage of web advertising most often checked (61.8%, 157 respondents) by the participants. In the second place was "low cost of information" (50.8%, 129 respondents). Eighty eight (34.6%) respondents selected "fast decision making" as an advantage of advertising on the Internet as compared to other media.

A t-test was conducted to compare the mean number of advantages reported between the two groups that reported that visiting web sites "improved their evaluation of the brand" and those who reported "no effect". More advantages were checked by those who reported, "improved their evaluation of the brand" (mean = 3.2, SD = 1.6) than those who said "no effect" (mean = 2.1, SD = 1.7). A p-value of 0.001 for the t-test suggested that the between group difference was statistically significant.

When the "improved their evaluation" and "no effect" dichotomy was tested using cross tabulation, it was found that the first group disproportionately endorsed the advantages, "easy to find information" and "low cost of information".

5.1 Disadvantages of Web advertising

"Advertising too cluttered" was reported most often (40.9%, 104 respondents) as a disadvantage of

advertising on the Internet. This was followed by "invades privacy" (36.6%, 93 respondents).

The disadvantages reported by the two groups ("improved their evaluation of the brand" and "no effect") were compared using t-tests. A p-value of 0.002 indicated that the difference between the two groups was statistically significant. The group that reported "improved their evaluation of the brand" (mean = 1.4, SD = .61) checked more disadvantages than the group that found "no effect" (mean = 1.1, SD = .64).

5.2 The impact of attitude towards the web site on attitude towards the brand advertised

Of the 254 respondents, 45.7% (116 respondents) agreed that viewing a brand on a web site they liked improved their evaluation of the brand. Fifty per cent of the respondents (127) confirmed that liking a web site had no effect on a brand. According to eleven respondents (4.3%) viewing a brand on a web site had a negative impact on the brand. The majority (243 respondents) response was that web sites they liked either had a positive effect or no effect on the brand advertised.

5.4 Ad recall

A between group study was made on Ad recall using t-tests. The two groups compared were, those who reported that visiting web sites "improved their evaluation of the brand", and those who reported it had "no effect". P-value of 0.001 indicated that there were significant differences in Ad recall capability between the two groups. The recall of advertisements by the "improved their evaluation of the brand" group (mean = 4.3, SD = 1.9) was significantly higher than the recall by the "no effect" (mean = 3.1, SD = 1.8) group.

6. Conclusions

The results of this study have implications for both Web developers and companies who plan to boost online sales by encouraging their customer revisits. This study has established support for the view that visual presentation of Web sites is an important determinant of online customer satisfaction. It will, therefore be beneficial for online marketers to make a deliberate effort to design more inviting Web pages by improving their visual presentation. As too many colours and loud backgrounds are likely to clutter the interface to the dislike of online purchasers, companies could seize greater opportunities to please their customers by taking these factors into account when designing their web pages.

The study has also found accuracy of information to be an important predictor of online buyer revisits. To online marketers this will mean the development of systems and

in-house procedures to carefully upgrade and scrutinize the data at regular intervals to guarantee accuracy. Many online shoppers make in-depth price comparisons before switching retailers at a mouse-click and would inevitably look for accurate price information at each Web site. A more important issue is a buyer's inability to evaluate first-hand the quality and benefits of the products purchased online due to lack of opportunity to physically see and touch them. Under such circumstances, the authenticity of information becomes paramount. Additionally, the Internet allows companies to enter into a dialogue with their customers, and the accuracy and the speed of responses will determine the customers' comfort level to revisit the sites.

Effective Web sites that have accurate content, should ideally complement this with easy navigation and high-speed downloading to further stimulate customer revisits. Online buyers want control over what they do on the Internet. They appreciate every navigational support provided to them. Companies, in order to make navigation a pleasant experience resort to the use of multiple approaches. GIF animations, which are fun when first seen, can be annoying when they delay downloading. Online marketers, therefore, to avoid irritating the online customers need to consider their use wisely.

The companies that continuously innovate to stay ahead of competition in the above areas are likely to be more successful in encouraging customer revisits. Such improvements, which translate acquisition and analysis of information into a pleasant experience, will eventually contribute to gaining quick payoffs on Internet investments.

Respondents reported on both advantages and disadvantages of advertising on the web. Most respondents reported that advertisements on the Internet enable them to get information easily at a low cost. The main disadvantage reported was the clutter of Internet advertising. This suggests that, in spite of its many advantages, marketers still need to deal with the clutter of Internet advertising to improve customer evaluation of the brands advertised on the Internet.

The advertisements on the web sites consumers like appear to improve the brand evaluation of some consumers. A negligible number reported a negative impact after viewing an advertisement for a brand on a web site they liked. This suggests that advertising on web sites mostly contributes to enhancement of brand evaluations.

Another positive finding of the study is that consumers, who enhanced their brand evaluations after seeing an advertisement on a web site, appear more likely to recall the Ad. It may be that good web sites help to improve the memorability of the brands advertised on the web.

A key weakness of the study was the use of a convenient sample, which makes generalisations inappropriate. Another important issue was the restriction of participants' responses to specific questions. This may have reduced the extent of exploration of some issues considered as important by the participants. Nonetheless, the results of the study have provided useful information on web site development and Internet advertising to those interested in e-marketing.

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Changing Transaction Visibility by Information Technologies: A New Framework for E-business

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Abstract

Firms can create additional customer values by changing the visibility characteristic of business transactions. Both visible and invisible transactions can provide distinctive values to the customers. Visible transactions are those that are open to the customer: the customer can see the detailed logic of the transaction and may manipulate specific variables to control the transaction process. Invisible transactions mean that customers have little ability to control the transaction flow and may even be insulated from seeing the transaction.

This paper pursues finding out the contingencies of successful transaction visibility change by answering to the following question; “when does increasing (or decreasing) transaction visibility make sense to customers?” This archival case study finds out that transaction visibility change should fit to the need and capabilities of customers. Increasing transaction visibility makes sense when customers need a certain supplier’s performance and have a confidence in the capabilities of executing the performance. And, decreasing transaction visibility makes sense when customers have substantial troubles in conducting their current transaction actions or when customers don’t feel it necessary to conduct them separately because they can be derived from other action.

1. Introduction

Computers have taken large part in facilitating business transactions. Electronic commerce has evolved in various physical forms from automatic teller machine, to electronic data interchange, and to World Wide Web over Internet. The big change caused by recent Internet-based electronic commerce is the lethargy of traditional intermediaries (travel agents, car dealers, stock-brokers, and industrial-parts distribution). Their turf has been intimidated by the birth of new Web-savvy middleman (like Amazon.com, Buy.com, etc.) and the direct connection has been promoted between end-customers and producers. Hamel & Sampler [12] argued that Internet is shaping re-intermediation not dis-intermediation of retailing industry and asked retailers

to move close to their customers instead of awaiting customers to move to them.

This study proposes a new perspective regarding the role of visibility characteristic of electronic transactions, which has substantial implications for new roles of intermediaries in the electronic environment. The customers come to possess different visibility on new transactions using new electronic media: customers can see more of what they want to bother with during transactions, and also customers can pass to their counterparts what they don’t want to bother with during transactions.

This study makes a couple of contributions. First, this study calls attention to the fact that, during visualizing the underlying actions, information technology can also make some relevant actions invisible. For example, by exposing sales record to vendors, grocery stores can eliminate some transaction actions like writing purchase order or making calls to order. So, people can garner two different (actually, opposite) benefits from the visualizing forte of information technologies. Second, if information technology has double-faced forte regarding visibility, we may well investigate the appropriate conditions for successful transaction visibility change (i.e., increasing or decreasing visibility). Our research question is “when does increasing (or decreasing) transaction visibility make sense to customers?” The answer to this question can help the business organizations “implement” successfully their plans to increase customer values by changing transaction visibility.

2. Theoretical Background

2.1 Transaction

Transaction can be defined as “the act of doing business” (The American Heritage Dictionary, 2nd edition). People conduct a transaction when they need certain performances of others in achieving desirable outcomes because they don’t have enough capacity to conduct these performances by themselves. From the perspective of transaction cost economics [18][19], transaction is not

necessarily confined to the moment when two counterparts conduct the economic exchange.

2.2 Transaction Visibility

Visible transactions are those that are open to the customer: the customer can see the detailed logic of the transaction and may manipulate specific variables to control the transaction process [1]. *Invisible* transactions are those that customers have little ability to control the transaction flow and may even be insulated from seeing the transaction. These invisible transactions will be taken care of only by suppliers, and be regarded as an aspect of suppliers' performances. Thus, transaction visibility can be defined as the degree to which the detailed logic of transactions is open to view and subject to manipulation of customers. It determines not only the amount of *information* about processes, but also the *capability for interacting* with these processes.

2.3 Changing Transaction Visibility

Chatterjee [5] argues that by changing the visibility of business processes from the standpoint of customers, organizations can provide distinct values to their customers, and improve their competitive advantage. Changing visibility from the customer's standpoint takes only two "binomial" forms at the level of transaction components. However, visibility change at the whole business process level is "continuum": i.e., the visibility of the whole business processes can be *increased or decreased* by *making* some components of the processes *visible or invisible*.

Making transactions *visible* invites customers' participation, empowers the customer, and thereby facilitates the customers' self-fulfillment. According to the concept of encapsulation in the object-oriented perspective, *making visible* means moving some of the supplier's implementation activities into the interface of customers (making the scope of interface wider). An example of making visible is Toyota's (in Japan) IS by which customers choose and specify the attributes of their cars as if designing them. Making transactions *invisible* relieves the customer from participation and thereby delivers a sense of freedom to customers. From the perspective of object-orientation, *making invisible* means transferring some portions of the interface to the implementation domain of suppliers.

Two different types of making invisible were identified: connecting the relevant or subsequent services, and eliminating the contact point function from customer's standpoint. The first pattern of making invisible is connecting relevant or subsequent services to the customers' contact point processes by "packaging" some activities within a visible activity. Therefore, if certain transaction actions are related to other actions as derivatives, those derivative actions may well be embedded into the primary actions. For example, filing purchasing orders is a

derivative action when inventory goes down below a certain level. However, inventory level can be calculated derivatively from sales record and purchasing record. Connecting all these relevant actions and minimizing separate transaction actions are the key art of this type of making invisible. The second way of making invisible is more aggressive. It relocates the contact point with the customer further up-stream in the process and eliminates day-to-day customer involvement completely. A typical example is the inventory management system linking Proctor & Gamble (P&G) and Wal-Mart.

3. Influential Factors on Transaction Visibility Change

According to the theory of self-efficacy [2], people take action when they expect given actions to produce desirable outcomes and believe that they can conduct those actions [2, p.24). This theory provides two "conditions" for customers to accept more visibility in transactions: 1) customers' *need for supplier performances*, and 2) customers' *capabilities* in those *supplier performances*. If both of these conditions are satisfied, customers could be better off by being provided more information or by being allowed more participation in what suppliers do. If customers do not need certain supplier performances, customers may not want to bother with transactions. Besides, it may not be appreciated to customers if suppliers try to increase visibility of their performances that challenge customers' current capabilities.

3.1 Customers' Need for Supplier Performances

Why do customers need certain supplier's performances? A performance is desperately needed by customers when the outcome from it is *desirable*, especially when the outcome is critical for customers' overall business. If people believe some information is critical for their businesses, they may intend to even pay money for it. This kind of information can be sold unlike the information that just supports on-line trade [9].

Another reason why customers need a certain performance is that it is *very likely to produce* the desirable outcome [2]. There is no single relationship between performance and outcomes: it depends on how tightly contingencies between performances and outcomes are structured [2, p.23]. If outcomes are not responsive to performances, people turn to protest social practices or to be apathy to such an outcome.

In short, customers may need certain suppliers' performances if customers believe suppliers' performances are critical for their survival, and that those performances are sure to produce desirable outcomes. If anyone of these two conditions is not met, customers may be hesitantly in need of such performances.

3.2 Customers' Capabilities in Supplier Performances

Psychological involvement triggered by necessity does not necessarily mean physical participation, as Barki and Hartwick [3][4] called attention to distinguish between involvement and participation. Bandura's [2] theory of self-efficacy applies here. According to the self-efficacy theory, action occurs when people have high self-efficacy that means the confidence in one's ability to organize and execute given types of actions [2, p. 21]. Asking incapable customers for more participation can work adversely because it only increases customers' frustration with transactions. In this case, suppliers can reduce customers' uncertainties and frustrations by relieving them of the burden of performing those actions. However, if customers have enough capabilities in certain actions, suppliers can improve customers' satisfaction by allowing them more interactions to manipulate and customize the products. A couple of issues need to be elaborated to clarify the concept of the capability in performances.

First, in the context of mutual relationship, the capability in performances should be judged in the *relative* terms: i.e., who is more capable, supplier or customer? It means not just who can do it, but also who can do better. The concept of core competency [11] may fit to this issue. Second, if customers have to endure huge cost inefficiencies in getting new access to supplier performances, they may not believe they possess enough capabilities to run the new change. Therefore, capability is a comprehensive concept that contains various economic concerns in the *present* and *future*.

The following proposition relates to the conditions of increasing visibility.

Proposition 1. It makes sense to increase visibility of the supplier performance actions, when customers need supplier's performances and also when customers have capabilities in those supplier's performances.

Proposition 2. It makes sense to decrease visibility of the transaction actions that customers do not have enough capabilities or that they do not need.

In general, the model suggests that increasing transaction visibility may be a preferred mode. The main reason is that knowledge emerges as the critical asset in an organization's survival and progress [15], and that knowledge acquisition or sharing can be facilitated by making transactions more visible.

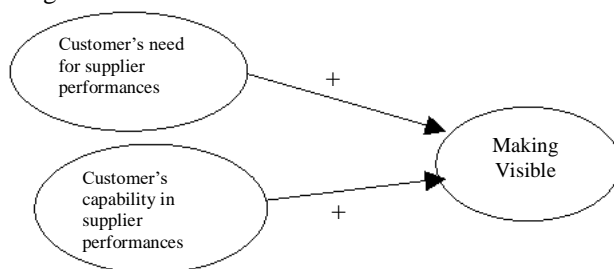


Figure 1. Research Model:

4. Research Methodology

This study takes the case study method to test the propositions generated in the previous section. The cases will be addressed in the narrative forms, so-called in linear-analytic structure. Linear-analytic structure [21] is the standard narrative presentation, which is providing model, hypotheses, and analysis of pattern-matching.

For the number of cases, Yin[21] recommends multiple cases unless a single case is available which is critical, extreme or unique, or previously inaccessible. Through literature review of ABI/Inform and Lexis/Nexus databases, 12 cases were chosen. These 12 cases have been regarded as representative successful SIS cases. They have been reported, cited, and updated extensively through many publications.

Pattern-matching is the most fundamental and powerful strategy for the analysis of case evidences [20, 21]. Pattern-matching compares an empirical pattern with a predicted one (or with several alternative predictions). Ideally, the comparison between rival theories is the most convincing strategy because most case studies eventually aim at identifying which rival theory can explain best the empirical patterns. Rival theories can be either a null hypothesis or an alternative theory. The rival theory of this study is the null hypothesis which means that visibility change occurs by luck or without any regularities. Pattern-matching will be conducted in a valid way, minimizing personal subjectivity in interpretation.

For the sake of valid data interpretation, five more people were hired to make judgments about the propositions at each case. All of them were MBA students at a management school of New England area who have majored in MIS for the last two semesters. Three of them were males of mid-thirties (one Korean, one American, and one Mexican), and two of them were female Chinese students of mid-twenties. Each student was assigned to each one of the five different cases. They were given the brief illustration of research model, and had enough conversations with the first co-author to clear their understanding of the model. And then, cases were given to them with brief explanation of each case. This workshop took about 20 minutes for each person. They were asked to read those cases very carefully, and to assess each proposition at each case. All of those five MBA students were allowed to have a week before we get together to have intense discussions.

Meetings with each student occurred between 7-10 days later, and lasted for about 40 minutes in average. Discussions were focused on the evidences that help assess the propositions of each case. This discussion is expected to decrease the subjective or ungrounded arguments about the support of each proposition.

5. Case Profiles

5.1 Cases of Increasing Visibility

5.1.1 Airline Reservation Systems

The airline reservation systems provide a case of increasing visibility, which opened the internal management information of airline companies to their customers, travel agencies. Travel agents needed to streamline their transactions with airline companies because they had to deal with abundant air-flight information in a very efficient way. Due to the Airline Deregulation Act of 1978, travel agents could not maintain their conventional ways of transaction practices for airline reservation because the Deregulation opened up pricing competition and made travel agencies swamped with too much information about airfares and schedules. Effective and real-time reservation of air-flight seats became critical for the business of travel agency. Even after the Deregulation rule, travel agencies were still familiar with what airline companies were providing over the information systems. In other words, travel agencies could still give consults or connect flights for their patrons to satisfy idiosyncratic travel schedules and styles. Travel agencies just needed some efficient instrument that helps deal with abundant air-flight information and reserve air-flight seats. Airline companies were able to satisfy these needs of travel agencies by exposing their internal management information of air-flights to travel agencies.

5.1.2 The Union Bank Of Finland (UBF)

UBF launched the first electronic banking system (EBS) in Finland, which covered the entire range of banking operations. Using a chare card, customers could access from any terminal linked to the public banking services network. Through electronic banking, it was possible at any time to pay bills, transfer funds from one account to another, and monitor the status of accounts. After banking hours, information could also be accessed regarding the status of loans. Stocks and shares services were also available, including the instructions for buying or selling, and the real-time access to share indexes and company information. For the personal clients, ATM (Automatic Teller Machine) services can also take some credit in improving business efficiency. Collaboration among the Finnish banks in the use of ATMs was also progressing: by 1990, all the banking chains in Finland joined a single network.

The UBF case provides an example of increasing visibility, which allowed patrons to manage various financial accounts and financial transactions in person. The patrons of UBF used to go through intermediary clerks in conducting transactions. UBF recognized the reengineering the entire operating processes by information technologies could help the organization not only by reducing its operating costs, but also by improving its service to customers. The new reengineered process was to replace

manual works of staffs with computerized self-account maintenance by customers. Customers could benefit from this change because they needed banking services anytime (even after banks are closed) and effectively. Customers already knew where to use their money (such as on stock investment and on various other financial products), and how to manage their account (such as balance management, paying money by gyro). To these customers, it made sense to pass the responsibility of managing account from UBF to customers.

5.1.3 Federal Express

FedEx Ship allowed customers to complete entire shipping transactions electronically from their desktop PCs, including printing out the shipping labels. In November 1994, FedEx launched its Internet home page (<http://www.fedex.com>) on the World Wide Web that allowed customers to check the status of a FedEx package over the web. In 1996, the company introduced FedEx InterNetShip, the first automated shipping transaction available on the Internet. By entering a valid FedEx account number, customers could complete the entire shipping function directly from the Web page. That included preparing all paperwork on-line, printing a bar-coded label, scheduling a courier pick-up, and uploading the billing information to FedEx. The site also enabled users to download FedEx software such as FedEx Ship, FedEx Tracking software, or FedEx Document Preparation software.

The FedEx case provides an example of increasing visibility, which allowed FedEx's patrons to check out the package delivery status. Since the inception of its business, FedEx managed to check the delivery status at every node of logistics chain for internal management purposes using sophisticated information systems. Capabilities required for this transaction (i.e., checking out the delivery status by getting access to information systems) are not that hard for customers: i.e., they just had to remember their delivery service ID number. Therefore, it really made sense to customers if they are allowed to access to the delivery information systems directly.

5.1.4 Dun & Bradstreet (D&B)

D&B began developing electronic delivery systems in 1976 to give customers direct access to the data-base and to increase revenue. In 1978, the company announced the first of these services, DunsDial. DunsDial allowed subscribers to call an 800 number and get on-line access to the database through an operator. To bring the electronic message directly to users' desk-top computers, D&B developed DunsNet, a packet-switched telecommunications network that became available in March 1985. The system originally targeted financial departments. Using this network, subscribers could pull reports from the D&B's mainframe to the remote terminals through DunsPrint.

The D&B case provides an example of increasing visibility, which allowed their patrons to get in and manipulate their data. Patrons depended on D&B for business credit and financial information. They appreciated the data mines that D&B stored, but not the ways D&B reported to its patrons. D&B used to satisfy their customers by collecting huge amount of data and generating report in a certain format. Customers just received the report that they wanted, but the contents and format were decided by D&B. Customers, most of whom were financial departments, already knew what kind of data they needed. Therefore, the best way to resolve their dissatisfaction was to allow direct access and manipulation of data. To maximize its change, D&B itemized data rather than bundling data at the report level.

5.1.5 National Bicycle Industrial Company (NBIC)

The first mass customization factory was built in 1987 and named the Panasonic Ordering System (POS). This factory was directly linked to customers via retail outlets. The factory directly received a customer's selection of options, colors, patterns, and models. The firm estimated that a customer could choose from about eight million possible variations based on model types, color, frame size, and other features. In this factory, the production process began only after the arrival of the customer's order and specifications. Craftsmen on the factory floor were very agile in setting up each machine required to complete each order. Customer service, appropriate pricing, and extensive communication had to be all an integral part of the NBIC's mass-customization strategy.

The NBIC case provides an example of increasing visibility, which allowed their customers to design bicycles in person. Customers needed to purchase bicycles that fit to their preferences in terms of style, color, size, and features. Some proficient customers had to shop around the market or spend substantial amount of time by intense searching until they could find what they wanted. NBIC did not lose this niche and developed an information system that allowed customers to design what they wanted. This new business process was not possible if NBIC was not equipped with flexible manufacturing capabilities to deliver the item in 2 weeks. NBIC had manufacturing capabilities, and customers knew what they wanted. The new business process was arranged to take advantage of relative strengths of both sides. Therefore, it made sense to open designing module to customers.

5.1.6 Netscape: Software Giveaway

Netscape announced that it would post the Communicator source code on the Web under the aegis of a Netscape developer group known as Mozilla.org. on January 22, 1998. Netscape's giveaway had only one major condition: Anyone who downloads the code and modifies it has to make his or her modifications available to Netscape and the world. Developers would now be able to

modify Netscape's code and incorporate it into their own products. In return, they would be required to submit all modifications to Netscape so that Netscape could decide which changes to be incorporated into the next official Communicator release. The software giveaway was a bold effort to stave off failure by tapping the energy of tens of thousands of technologists, inside and outside the company, who were loyal to Netscape's products.

To manage the process of incorporating outside work, Netscape set up an internal team called Mozilla and posted its source code on the mozilla.org Web site. In mid 1998, the group consisted of eight engineers (six developers, one IT person, and one tester) and one customer support person. Most contributions from outside developers were features or bug fixes on existing features. In those cases, the Mozilla team consulted with the original Netscape developer or the current Netscape person overseeing that area for the check-in. Three senior developers on the Mozilla team made most of the final decisions on whether or not to accept an outside contribution to the code.

Netscape retained the rights to the Netscape, Navigator, and Communicator brand names and logos, as well as the rights to distribute future products based on the code. But others could now build or distribute their own browsers based on Netscape's source code. And unlike most other free software, Netscape allowed companies to sell products based on the modified or unmodified code. The Mozilla Public License was free forever.

Software developers apparently welcomed this move, downloading some 250,000 copies of the Communicator 5.0 source in the first month. Moreover, Microsoft's decision to tie Internet Explorer more tightly to the Windows operating system in 1998 made it virtually impossible for Microsoft to respond in kind. If Microsoft revealed its source code for Internet Explorer, it would risk undermining its proprietary technology in Windows.

The Netscape case provides an example of increasing visibility, which opened the source programs and allowed patrons to customize the programs. There were many computer geeks who love to manipulate the source programs to customize them to their applications or systems. A couple of well-known cases (Apache and Linux) encouraged Netscape to open their source programs of Communicator 5.0. Customers already appreciated the innovation of Netscape, and had enough capability to customize the programs. Therefore, Netscape's decision to open the source codes off Communicator 5.0 was welcome by the customers. This new business process cannot succeed if patrons do not have enough capabilities to customize the source codes of Web browser.

5.2 Cases of Decreasing Visibility

5.2.1 ASAP (Analytic Systems Automatic Purchasing)

AHSC (American Hospital Supply Corporation) was a health-care distributor company and ran the ASAP system (Analytic Systems Automatic Purchasing). ASAP was

initially developed in the 1960s to solve AHSC's operational problems, such as incomplete orders and late delivery, especially with one of its major customers, Stanford Medical Center. By 1980, a quarter of the company's incoming purchase orders came through ASAP. After Baxter bought out AHSC in 1985, Baxter transformed ASAP to a multi-vendor universal distribution system and competed with other electronic distribution channels. The ASAP system eventually transformed into strategic collaboration with its customers, redefining the conventional relationship with customers.

This strategic transformation was marked by the deployment of Baxter's ValueLink program in 1990. The focus of information systems shifted from the efficient distribution of products through automated order entry toward the integrated materials management service to guarantee product availability and information-based logistics services. Previously, customers of Baxter (i.e., hospitals) had to check out inventories, search for appropriate items over the market (or computerized ordering systems), make orders, and wait for deliveries. All these transaction actions became eliminated by JIT (Just-in-Time) inventory systems of Baxter. Baxter committed to providing a 100 percent fill rate and to lowering inventory levels, associated operating, and fixed costs by developing customized delivery procedures to each user department (e.g., operating rooms, laboratories, X-ray units, etc.).

ASAP provides a case of decreasing visibility, which passed the burden of inventory management of certain brands to the supplier, Baxter. The customers of ASAP, hospitals, still concerned about inventory management, but did not sway a good command of it. They had to deal with too much information of products after many rivals of Baxter (such as Abbott, 3M, and Johnson & Johnson) withdrew from ASAP and launched open-protocol information systems. The economic logic for the inventory management had shifted from economies of scale (i.e., automating the purchasing order activity) to economies of scope (i.e., customized materials management), which required more intensive information searching and management. In addition, hospital did not feel the value in traditional ways of inventory management such as checking out inventory levels, writing and mailing purchase orders, and inquiring order status. Those transaction actions were regarded cumbersome, time-consuming, and non value-added. Hospitals were lack of capabilities to manage inventories in new business environment but also could not sustain the old methods. By the new change, inventory management was passed from hospitals to their supplier, Baxter.

5.2.2 McKesson Corporation

Economost was launched in 1976, and was the genesis of McKesson's family of information systems. It was an electronic system for direct customer order entry, but also helped pharmacists and drugstore operators keep track of

current selling records, reorder the right time, and have their orders delivered with the price and shelf location tagged on the products.

Customers of Economost systems made orders by a hand-held order entry device, noting from the available stock on his shelves. Customers transmitted the order information in hand-held device to McKesson's national data center. The same or following day, McKesson delivered the items ordered. The requested items were delivered in cartons that matched the aisle arrangement and major departments of the drug store, so no sorting was required and the shelves were restocked with a single pass. Electronic order entry was extremely welcome by McKesson's retail customers, well evidenced by the fact that more than 99% of McKesson's orders came in electronically.

The more dramatic improvement was opening McKesson's up-to-date sales information to its suppliers. McKesson recognized that the up-to-date sales information had immense value to the manufacturers. They used it to make more timely shipments to McKesson in much the same way as McKesson had done with the drugstores. Meanwhile, suppliers could schedule production more efficiently and streamline their inventories. This new system eliminated previous transaction actions of McKesson's customers (drug-stores): checking out inventories, making purchasing orders, and inquiring delivery status.

McKesson provides a case of decreasing visibility, which passed the burden of inventory management and insurance claim from McKesson's customers to McKesson's suppliers. Customers of McKesson – independent retail drugstores – did not feel the value in traditional ways of those two processes.

The more capable approach for inventory management came from McKesson's JIT (Just-in-Time) that restocks products at the last minutes when customers' inventory was almost gone. This new system could be completed by the involvement of McKesson's suppliers because it is McKesson's suppliers who actually manufacture and deliver products. McKesson's suppliers used to be segregated from their end-consumers (independent retail drugstores), and could only reach them by the mediation of McKesson.

5.2.3 Wal-Mart and Procter & Gamble (P&G)

1987 was the big year for both Wal-Mart and P&G to launch this remarkable project for streamlined inventory management systems. In the early 1990s, the project was finished and started to produce tangible benefits to both companies. EDI took an important part in P&G's strategy of CRP. But EDI alone could not take the whole credit in improving this process because the organizational linkage was much tighter than the relationship with non-CRP customers using EDI. In 1992, Wal-Mart declared to do business only with vendors that invested in customized EDI

(electronic data interchange) technology and put bar codes on their products. Because of the volume and growth Walmart delivered, manufacturers had little choice but to fall into line. The combined changes in systems, strategy, organization, and policies also resulted in a dramatic improvement in total order quality at P&G. Billing errors decreased by more than 50% from 1992 to 1994, and the percentage of billing disputes resolved to P&G's favor increased by more than 300% during the same period.

The Wal-Mart and P&G case provides an example of decreasing visibility, which passed the burden of inventory management from Wal-Mart to P&G. In 1987 when Wal-Mart and P&G started to discuss and embark on their JIT inventory systems, Wal-Mart did not possess such a fabulous inventory systems. Eventually, Wal-Mart could improve their inventory management system by asking P&G to take over this responsibility. Until 1987, P&G was only reactive to the request of Wal-Mart. To implement JIT successfully with Wal-Mart, however, P&G needed access to the sales and inventory information of Wal-Mart.

5.2.4 Saturn

The Saturn Dealer Information Systems is a network of several subsystems: SALESLINE, SERVICELINE, and various transaction processing systems. With SALESLINE, the salesperson can use a microcomputer to connect to other dealerships computers and search their inventories for the desirable car and features. SERVICELINE allows customers to promptly receive information about anything that has to do with the car: new or used cars that the customer may want to purchase; service for the current vehicle; the availability of a car with specific features; and the availability of a certain part.

SALESLINE also provides the dealers with inventory management services similar to MRP. The dealers can carry only minimum levels of parts for serviced cars, because they can connect directly to the parts factory via satellite. Through the inventory information systems connected directly to suppliers, dealers could place replacement orders automatically when those parts were running low. Suppliers received daily electronic transmissions regarding how many parts had been used in completed cars, and once a month received payment over the electronic network. The formula of the system was simple: no purchase orders, no invoices, no checks, lots of trust. There was huge cost saving such as no receiving department and no clerks to handle purchase orders, invoices, and billing. And with everything done electronically, audits were simplified. By such partnership, Saturn could reduce the purchasing cost by 5% annually.

The Saturn case provides an example of decreasing visibility, which passed the burden of inventory management from Saturn to its suppliers. U.S. car manufacturers needed the function of inventory management, but did not like the traditional ways of inventory management. In other words, car manufacturers

could not maintain robust inventory management systems with the traditional capabilities. They learned from Japanese companies that JIT (just-in-time) technique can improve the inventory management function substantially.

5.2.5 CMA (Cash Management Account)

Merrill Lynch offers a broad range of services to meet the financial and investment needs of individuals, corporations, and institutions. Merrill Lynch made an arrangement with Banc One Corp. in 1976, a processor of Visa card, to expand and diversify its business domains. In 1977, Merrill Lynch announced its innovative Cash Management Account (CMA), an information-system-based product that provided under one umbrella three appealing services to investors: credit service through a standard margin account; cash loan by check or Visa debit card; and stock investment for dividends and transaction margins. This product can relieve patrons from the traditional transactions for financial account management: withdrawing and depositing money clumsily and repeatedly.

This one-stop account let a qualified person, who could afford to open an account with \$20,000, enjoy a combined checkbook and securities margin account. For \$4.17 a month, an account holder could buy and sell stocks, write checks with no minimum, and use a supplied credit card under the CMA umbrella. CMA account holders were given checks with a Banc One code number, even though they did not actually have an account there. CMA account holders could have their checks processed by Banc One. But it was not the bank that actually cancelled the checks, only Merrill Lynch did for Banc One. Merrill Lynch maintained a zero-balance account by borrowing money daily to cancel the millions of dollars of checks. All transactions appeared on one monthly statement. And all cash in the account earned money-market rates. The computer swept daily through the received card charges, checks, securities, and deposits to deliver an updated credit limit for each account holder.

The CMA case provides an example of decreasing visibility, which passed the burden of money account management from customers to Merrill Lynch. There was a couple of attractiveness in CMA. First, Merrill Lynch recognized that their customers do not want to bother with redundant and cumbersome transaction actions for financial account management. For that purpose, Merrill Lynch planned to provide the flexible money movement services between checking account, credit account, and stock investment account. Therefore, the burden of account management was passed from customers to Merrill Lynch. Second, CMA clients could take advantage of both high interest rates in the money market, and investment in stocks: i.e., they could benefit from both stock market and high interest rates just by CMA. The burden of moving money for better investment was removed from individual customers.

5.3 Cases of Both Increased & Decreased Transaction Visibility

5.3.1 MSAS Cargo International

MSAS provided air and sea forwarding services for international trade. Since the mid 1980s, MSAS recognized the world-widely increasing challenges of the cost pressure from both carriers and shippers, the increased competition triggered by the collapse of the boundaries between trade-related transportation businesses, the consolidation of freight forwarding industry, and increasing partnership of forwarders.

To handle with these changes effectively, MSAS started to develop UNITEL 21 since 1991, new integrated information system for managing airfreight operations. UNITEL 21 automatically documented 16 different control points for each airfreight shipment. As the shipment moved through a control point, information on the system was updated automatically or by station personnel. If there was any delay in the shipment, MSAS could immediately notify the customer why the delay occurred. Everyone was able to know the location of every item of freight at any time: i.e., the system permitted clients to track specific shipments, a task that used to be very difficult even for MSAS personnel. The system could also make it possible to accept initial bookings automatically, schedule the transportation automatically, and obtain customs preclearance on the documents before the merchandise arrived at its destination. There were useful accounting features as well. For example, because of its global operations, MSAS used 45 different currencies. The new system automatically translated all currency transactions into a common company standard. Therefore, at any point in the shipment process, MSAS could see how much that shipment cost.

The MSAS Cargo case provides an example of decreasing visibility, which reduces all the various contacts with many different transportation-related companies (such as customs brokerage, consolidation, packing, currency hedging, insurance, labeling) to a single contact point with MSAS Cargo. To make orders and check out delivery status, cargo entrusting companies needed to contact each of transportation companies. It was such a cumbersome job to contact all the relevant transportation companies individually. MSAS Cargo realized it could create substantial values by working as a close partner of customers by providing a comprehensive package of transportation services across all the value chains of its clients' business activities (from receiving orders to delivery to the final destination). Thanks to this comprehensive service, cargo entrusting companies were able to reduce lots of inefficient bottlenecks in international transportation (such as insurance, declaration, and mis-carriage).

This case also relates to the increased transaction visibility because MSAS's patrons got direct access to the delivery status information without intermediaries. MSAS

Cargo could increase customer values by taking over the cumbersome job of coordinating all the transportation activities, and providing direct access to the information of package delivery status. This new comprehensive service made visible the package delivery status, and also made invisible all the chores of contacting each transportation company.

6. Discussion

Proposition 1 is supported by all the seven cases of making visible. So, we can conclude that it makes sense to increase visibility of the supplier performance actions, when customers need supplier's performances and also when customers have capabilities in those supplier's performances. Proposition 2 is related to the case of making invisible. The proposition is supported by all the six cases of making invisible. So, we can conclude that it makes sense to decrease visibility of the transaction actions that customers do not have enough capabilities or that they do not need.

The same kind of problems can be resolved either way of increasing visibility or decreasing visibility. The choice of solution depends on the context, which is the need and capability of customers. For example, in helping customers deal with information overload, airline companies took the approach of increasing visibility, whereas Baxter (ASAP) decreased visibility using JIT technology. In designing a new financial accounts management systems, Merrill Lynch and UBF also took opposite approaches: CMA of Merrill Lynch relates to decreasing visibility, whereas EBS of UBF relates to increasing visibility. The key difference in each pair is whether customers had need and capability for certain actions in dealing with the problems. Travel agencies needed air-flight information, but was swamped with too much information because they did not have an appropriate instrument to deal with it. They had a capability to understand air-flight information. In that case, exposing air-flight information on line to travel agencies made sense. Meanwhile, hospitals did not have enough capability to improve their inventory management because there were too many different products in the market. Rather than being provided with more market information, hospitals could be better off by passing the inventory management to Baxter. Merrill Lynch could successfully liberate customers from financial account management efforts because customers were sick of such chores. On the other hand, UBF could successfully implement EBS because their patrons knew how and where to use their money and to manage their accounts.

7. Conclusion

When does changing transaction visibility make sense? As for this question, customer's need and capability were

found important: i.e., making visible makes sense when customers have need and capability for supplier performance, and making invisible makes sense when customers do not have need and capability for their own transaction actions.

This study produces important implications for electronic commerce over Internet. The first implication is that retailing is not displaced, but will be more important in electronic commerce. Retailing companies can produce added-value by changing visibility of the supplier or product information. Sony's web site, where customers only can buy Sony CDs, languishes, whereas CDNow.com, which offers 250,000 titles from all five major labels, grows because customers have more choices of CD products [12]. PcOrder.com, Inc. allowed PC dealers to scan and choose 600,000 different parts from 1,000 manufacturers, considering availability and price. PC dealers then electronically pass the order to the distributor, and eventually their orders will be forwarded to the PC maker. This system made a surprising success because PC dealers can get the computers that they want to sell [15].

Both success stories (Cdnw.com and PcOrder.com) provide the examples of increased visibility, by which customers can collect and use more information from more sources. In both cases, customers needed suppliers (for CD and PC manufacturing), and also possessed substantial knowledge about these products. In this case, increased visibility can be an attractive feature in transactions between customers and suppliers. Hagel & Singer [10] expected the burgeoning of new type distribution channel, *infomediary* (meaning the information intermediary). They anticipated this new distribution channel will replace the existing middle-men. The above rules of this study can give a hint regarding what are the niches for infomediaries and how they should run business.

Another implication to electronic commerce is that there should be some considerations in interface to embrace diverse levels of users' capabilities. For example, instead of just letting customers access to a certain web site, computer interface can provide intelligent agents that help customers filter information and support decision making. In this case, the interactivity at interface should be allowed to users as much as they can handle. For others, let the intelligent agent take care. Comparing the success of AOL and the demise of Netscape, Cusumano & Yoffie [7] concluded Netscape missed huge amount of gap existing between web browser and end-users, which was filled in by AOL. PcOrder.com contains artificial intelligence inside that recognizes which of the thousands of computer parts will work together best [13]. Various technical frills may well be supplied as options so that customers can adjust their current capabilities in conducting electronic commerce.

The third implication to electronic commerce is that the concern of visibility should not be confined to the contents of information, but be extended to the structure or organization of information. Information accessibility is

regarded as one of the important features of successful information systems [8][20][21]. However, information does not just mean the contents of some topics, but also includes the index of those contents. Accessibility of those indices would improve customer's overall satisfaction over the contents of information. For example, customers of Farcast can use a search engine named "droids" to search a variety of information sources. Farcast's value is not just showing web-sites but rather organizing an index for the web-sites to visit. Farcast sells this service for about \$13 a month. The Farcast case tells well that sometimes the content is free but the organization is valuable [16].

Visibility can also work as a new perspective in identifying strategic opportunities by information technologies. Especially, changing visibility can be used for business process reengineering. Business reengineering is related to changing visibility because it is actually reshuffling the location of actions between customer domain and supplier domain. Reengineering requires adaptation of traditional internal processes to the new system, which must cause substantial costs [14]. Therefore, reengineering with visibility change relates to the change in coordination mechanisms between customers and suppliers [6]. Again, the same rules apply: "Suppliers release some of their functions if customers want and can conduct them. Suppliers take over the customer's functions if customers do not need them, or cannot perform properly."

There are limitations in this study. First, only successful cases have been considered in this study. All the 12 cases are the successful anecdotes of using information technologies for competitive advantage. But, those 12 cases may not be large enough. The difficulty of collecting data was aggravated because the failure cases are hard to get in general. Using only published data could be a problem, too. Any extra interviews or unpublished data were not included in this study.

Second, only the representative case of each organization was reviewed. For example, Wal-Mart must have implemented many similar transaction visibility changes with other organizations. However, only the case with Procter & Gamble was discussed in this study.

The transaction visibility model will be continuously developed in the future study. The biggest challenge is to test whether changing visibility helps organizations improve. Success measures have been defined differently in many studies: profit, revenue, psychological measure of customer satisfaction, usage of information systems, to name a few. Different success measures may have different causal factors. More detailed break-down of success measures and causal factors may well be considered in the future study. Another agenda is to apply transaction visibility onto knowledge management: e.g., what kind of knowledge emerges visible, and what kind of knowledge tends to disappear as organizations learn.

Capability in actions can be a candidate for future research, because it is an important factor in changing

visibility. Bandura[2] put more emphasis on the confidence in capabilities rather than capability itself. Recent TV commercial of Excite.com promotes Internet usage by introducing nutty Internet users. That commercial could increase the self-confidence of TV viewers in Internet if they believe they must be better than such nutty people. Capabilities may not necessarily mean the absolute amount of knowledge or experience embodied in people: rather, it's a matter of attitude. Therefore, an insightful study could be produced if theories of attitude are combined with studies of self-efficacy in figuring out how to improve capabilities.

Last, relational factors can be included to give a better explanation of transaction visibility change. Especially, trust must work critically in the case of making invisible. Customers may not allow to pass their activities in their authority to their counterpart unless they have enough trust. If more comprehensive factors are included in the model, the possible clash or trade-off between factors need to be investigated as well.

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Web-site Acceptance Model (WAM): Perceived Social Influence on the Usage of a Web-site

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Abstract

The Internet has grown explosively since its inception in early 1990s. In this study, we investigated the psychological mechanism to explain Internet usage. Web-site Acceptance Model (WAM), which is extended from Technology Acceptance Model (TAM), is presented by including the construct of perceived social influence (PSI). We investigated the relationship between PSI and two major belief constructs in TAM – perceived usefulness (PU) and perceived ease of use (PEU). Using a structural equation modeling, we found that (a) PSI does not have the significant direct effect on WWW usage, (b) PSI has stronger indirect effect on WWW use through PEU than through PU. These two results show that PEU is a complete mediator between PSI and WWW usage, and that WWW usage can be explained and predicted with the affect-related factors rather than the task-related issues.

1. Introduction

The Internet has grown explosively since its inception in early 1990s. The total value of goods and services traded in the US alone is estimated around US\$327 billion with an average annual growth rate of 110% (Forrester Research, 2000). However, despite the hype of the Internet technology, Internet adoption is not as smooth sailing as many business organizations assumed it would be [34]. Therefore, understanding the influential factors for web site usage is a timely important issue in the IS research area.

Studies and models are abundant in explaining and predicting IS acceptance or use. One of the popular frameworks is the Technology Acceptance Model (TAM) [13][14][15]. TAM is an individual psychological model to predict individual's adoption and usage of information technologies. And, perceived ease of use (PEU) and perceived usefulness (PU) are two major variables explaining attitude and intention of IS use. The subsequent TAM studies established the robustness of TAM through several applications and replications [1][15][21][31][44][50]. Although a few studies have already investigated influential factors for the use of

WWW, the robustness to explain Internet usage is not proved yet[2][10]928][33].

Internet usage is different from automation tool such as spreadsheet and word processor. While these programs are often used to conduct task, web sites are being used not only as a "tool" to conduct tasks, but also as a "media" to communicate [4][39]. According to media selection theory, social influences have an effect on individual's adoption of web sites. Therefore, our study proposes and tests empirically the modified TAM, which is called Web-site Acceptance Model (WAM), including the perceived social influence constructs to explain and predict of Internet usage.

2. Perceived Social Influence (PSI)

Social influence can be defined as "an individual's internalization of the reference group's subjective culture, and specific interpersonal agreements that the individual has made with others, in specific social situations" [48]. A recent longitudinal TAM study by Venkatesh & Davis [51] found that social influence is changeable; its impact is significant in the early stage of IS adoption, whereas its impact dissipates as IS usage gets matured. However, they conceptualized social influence only as subjective norm without considering other dimensions of social influence.

In an effort to operationalize social influence, we focus on the following three issues. First, aligned with other psychological models regarding IS adoption, social influence should be perceived prior to any features which has effect on individual's IS usage. So, we call this construct as perceived social influence (PSI). Second, PSI is a multi-dimensional construct including subjective norm (social norm), visibility, and image from the related IS adoption theories such as TAM, TRA, TPB (Theory of Planned Behavior)[3], the decomposed TPB [45], and innovation theory[33]. The subjective norm of TRA is the representative construct. It is defined as "the individual's perception of a referent other's opinion about the individual's performance of the behavior." [18, p.302]. Although Davis et al. [15] insisted no significant relationship between social norms and usage, they attributed this unexpected finding to the weak psychometric properties of their social norms scale and

the particular IS context of their research (i.e., use of a word processing system). Davis called for further research to assess generalization of this finding, and to investigate conditions and mechanisms effecting on social influences[15].

Two other dimensions of PSI are from Moore & Benbasat's[33] study: image and visibility. Image is defined as "the degree to which adoption/usage of the innovation is perceived to enhance one's image or status in one's social system." [33, p.195]. This is close to Chau's[9] long-term PU and Tornatzky & Klein's[47] social approval. Chau[9] proposed that near-term PU is related with functionality of computer systems on improving job performance or enhancing job satisfaction, whereas long-term PU is related with improving one's social status. Tornatzky & Klein[47] identified social approval is addressed most frequently in over 100 innovation studies.

The third dimension of PSI is visibility. Visibility means "the degree to which the innovation is visible in the organization": i.e., the more a potential adopter can see an innovation, the more likely she/he is to adopt it [33, p.195]. Visibility is the very close concept to "critical mass"[29] and "network externality"[39] that assert the usefulness of a network is primarily a function of the number of participants in the network.

3. The Research Model

Figure 1 is the research model including PSI, PEU and PU. In this model, like other studies of TAM[1][9], the attitude construct is excluded to simplify the model. And, Internet use, not behavioral intention, is chosen for the dependent variable because it may be the more appropriate measure of technology innovation diffusion rather than the early adoption or acquisition [17].

3.1 Impact of PSI on PU & PEU

In TRA, all the external stimuli are assumed to influence behavior only indirectly via attitude or subjective norm [18, 396]. TAM inserts two cognitive factors (PU and PEU) between external stimuli and attitude, and insists that external stimuli influence a person's attitude toward a behavior indirectly through PU and PEU.

In TAM, external stimuli have been defined diversely such as the various individual differences, situational constraints, managerially controllable interventions [15], the task and user characteristics and so on [44]. While TAM is focused on individual psychological features, media selection theories also argue that the characteristics of media depend on the perceptions of the user, and the meaning of media is socially constructed [8]. These perspectives insinuate that individual's beliefs are socially constructed through interactions with others. Thus, we predict that these social influences must have an effect on the PU and PEU.

H1: PSI will have significant effect on determining PEU of the Internet.

H2: PSI will have significant effect on determining PU of the Internet.

3.2 PEU and PU

Davis [13] proposes that PEU influences PU, but not vice versa." [13, 477-8]. This theoretical relationship has been supported by numerous empirical studies even though some studies argue the opposite relationship [9][12][13][14][31][44][45][50]. Like previous theoretical and empirical arguments, our study also assumes that PEU influences PU, not vice versa, under the Internet environment.

H3: PEU will have significant impact on determining PU of the Internet.

3.3 Influence of PU & PEU on Internet Use

Traditionally, TAM research has argued that PU influences IS use, whereas PEU does not [2][9][12][14][44]. Davis[12] assumed that PEU does not influence on IS use, even though it influences PU. Adams, Nelson & Todd[1] warned not to focus on PEU in identifying the antecedents to IS use. However, several TAM studies empirically suggested the significant influence of PEU on IS use[46][47]. All these empirical findings and theoretical arguments imply that PEU could also influence the Internet use.

H4: PEU of a system will have significant impact on Internet use.

H5: PU of a system will have significant impact on Internet use.

3.4 Impact of PSI on Internet Use

Adams, Nelson & Todd[1] and Subramanian[43] reported that PU and PEU explain only explain around 30% of the variance of IS use. These results imply that there must be additional factors that influence individual usage of IS. We can find a possible answer (i.e., missing factor) from other IS use theories: TRA, TPB, and Innovation perspective. Commonly these alternative theories include the "social influence" factors as an antecedent of IS use. Moore & Benbasat's[33] innovation perspective includes two important social influence constructs – visibility and image. Agarwal & Prasad [2] found that the current usage is influenced by perceptions of visibility. Numerous studies also reported subjective norm is an important determinant of IS adoption or use [12][22][27][45]. Some studies delicately tested the influence of subjective norm by differentiating IS use in terms of chronological diffusion of technology, and identified that subjective norm influences only early IS adoption[22][26]. Media selection theories have consistently insisted the direct impact of social influences on the selection of media. Our study includes visibility, image, and subjective norm as three dimensions of PSI, and tests how this composite construct, PSI, works with other individual perceptions.

H6: PSI will have significant impact on the Internet use.

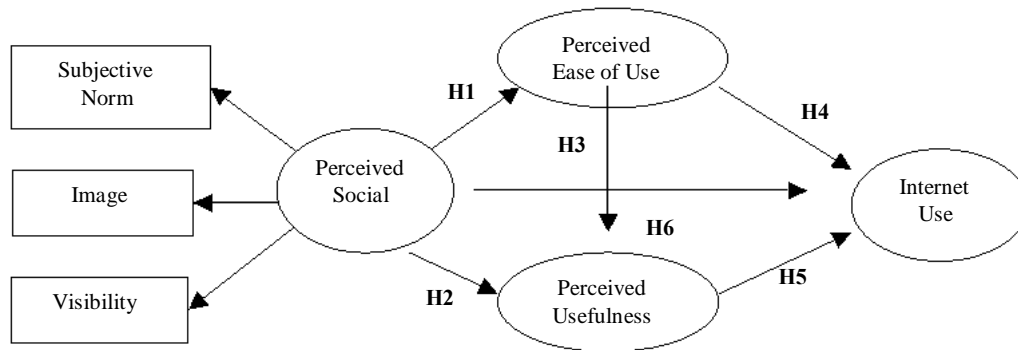


Figure 1. Research Model

4. Methodology

4.1 Data Collection

A total of 420 questionnaires are distributed to under-graduate students who major in MIS in a college of management in New England area. Samples are homogeneous in terms of demographic features such as age, grade, and major. We explain the objective of this research and the meaning of each measurement item. Students are asked to fill out the survey anonymously on the voluntary basis. In total, 206 valid questionnaires are returned out of 420 handouts, recording 49.0% of return ratio.

4.2 Reliability and Validity

Reliability assesses the internal consistency of scale items[35]. Cronbach's alphas are used to assess the internal consistency reliability of the scales. As shown in Table 1, the reliability coefficients ranged from 0.65 to 0.96, which is significantly higher than the acceptable level of 0.6 [36].

Table 1. Reliability Estimates

Construct	Items	Cronbach's alpha
PU	4	.9571
PEU	4	.9065
Image	4	.9188
Visibility	3	.7985
Subjective Norm	2	.8415
Internet Use	2	.6485

Table 2. Factor Analysis of Scales

	F1	F2	F3	F4	F5	F6
PU1	.891	.157	.161	.110	.125	.004
PU2	.904	.195	.192	.010	.010	.005
PU3	.913	.196	.105	.005	.108	.005
PU4	.892	.009	.179	.103	.009	.107
PEU1	.160	.815	.008	.119	.007	.149
PEU2	.197	.844	.009	.126	.009	.002
PEU3	.117	.877	.104	.001	.118	.150
PEU4	.125	.861	.002	.102	.137	.156
IMG1	.208	.004	.858	.104	.109	.002
IMG2	.229	.112	.862	.005	.008	.002
IMG3	.006	.005	.852	.003	.152	-.008
IMG4	.010	.008	.921	.005	.010	.006
VS1	.195	.004	.001	.876	.152	.010
VS2	.151	.007	.005	.890	.156	.006
VS3	-.004	.008	.227	.734	.003	.005
SN1	.182	.164	.227	.219	.832	.108
SN2	.180	.263	.160	.142	.851	-.001
USE1	.008	.001	.120	.008	-.001	.862
USE2	.009	-.002	.250	.009	.009	.800
Eigen Value	6.587	2.771	1.187	1.920	2.044	0.994
% of Variance	34.669	14.583	6.245	10.107	10.758	5.232

* PU = Perceived Usefulness, PEU =Perceived Ease of Use, IMG = Image, VS = Visibility SN = Social Norm

Convergent validity is assessed by factor analysis of the scales. The factor loadings are shown in Table 2. Through Varimax rotation, the 25 items are cleanly loaded onto 6 factors - PEU, PU, image, visibility, subject norm, and IS use.

5. Data Analysis

Our empirical test consists of two phases. The first phase is to check the fitness of the model and examine the support of hypotheses in our dataset.

5.1 Test of the Proposed WAM model

Some measures are suggested to test model fitness [5][6][19][23]. The chi-square for this model with 22 degrees of freedom is not significant (chi-square = 17.309, $p = 0.746$). However, for large samples, the chi-square statistic frequently indicates poor model fit even though the model fits the data well [7][30][38]. Instead, Chi-square divided by degrees of freedom is recommended with the value below 5 [53]. In our dataset, the value of Chi-square divided by degrees of freedom is 0.787, which satisfies the criterion value. GFI and AGFI should be greater than 0.90 and 0.80, respectively, and RMSEA should be lower than 0.08 [7][25]. In our dataset, GFI is 0.983, and AGFI is 0.964, and RMSEA is lower than 0.08. These four measures indicate that our model fits to the dataset (Table 3).

Table 3. Fit Measures for the proposed model

Fit Index	Fit Measures
Df	22
χ^2	17.309
P value(>0.05)	$p=0.746$
$\chi^2/df(<5)$	0.787
GFI(>0.90)	0.983
AGFI(>0.80)	0.964
RMSEA(<0.08)	0.000

5.2 Results and Analysis

Test results of our hypothesis 1-6 are summarized in Table 4 and figure 2. The results are not entirely consistent with our hypotheses.

Table 4. Summary of Results (path coefficient)

		Path Coefficient	Remarks
H1	PSI -> PEU	0.39**	Supported
H2	PSI -> PU	0.51**	Supported
H3	PEU -> PU	0.25*	Supported
H4	PU -> USE	0.05	Rejected
H5	PEU -> USE	0.44**	Supported
H6	PSI -> USE	0.02	Rejected

* $p<0.1$, ** $p<0.05$

The paths from PSI to PU and PEU are significant with 0.51 and 0.39, respectively. Therefore, both hypothesis 1 and 2 are supported: i.e., PSI has an effect on PEU and PU. The path from PEU to PU is marginally significant, supporting hypothesis 3. Hypothesis 4 and 5 get the partial support: i.e., PEU influences WWW adoption, whereas PU doesn't. These two results suggest more on PEU than PU in WWW usage. The relative importance between PU and PEU on IS use has been a long argument in TAM studies. Our result suggests that the conflicting results can be attributable to the nature of the technology itself. The Internet is for personal purposes such as fun and sympathy. Also, it is being used to communicate with virtual community or to search personally useful information [4][39]. Our results address that WWW usage goes through different psychological mechanisms from those of task-related usages. Perceived ease of use promotes revisiting of web sites more than task-related usefulness does. Finally, the path from PSI to IS use (hypothesis 6) is not supported in our sample.

This result implies that people do not use computer systems blind-folded. Even though they may refer to someone else's opinions, but their decision for a web site is based on personal recognition of functional ease-of-use. We can conclude that PEU influence on WWW usage mediating Perceived Social Influence.

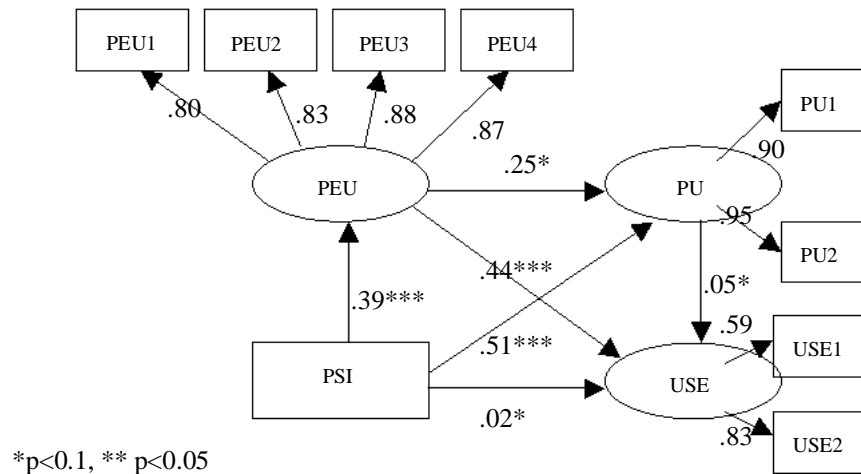


Figure 2. Path Coefficient of Internet Usage

6. Discussion and Conclusion

TAM is a parsimonious framework that explains and predicts individual's voluntary adoption of technologies and tools. We combined this framework with the media selection theory to explain individual's adoption of web sites (not the WWW technology itself). We found that individual psychological procedures of adopting tools and technologies are different from those of adopting web sites. Most noticeably, WWW use is more influenced by PEU than by PU. Also, PSI has only indirect effect on WWW usage through PEU on mediating with PSI. We could draw the following three generic implications from these results. First, the findings of traditional media trait theories are also effective in explaining the adoption of web sites. Media theories have insisted that ease-of-use and accessibility are more important than the quality of information and task-support in media selection. This coincidence verifies our argument that we cannot understand the web site usage enough as long as we presume WWW as a technology. Second, web site is not just about information, but about the way information is communicated. Users will choose information of inferior quality just because acquiring it requires less work than high quality information. Currently, web usability is one of the promising research agenda. We argue that it is not surprising to tap this issue from the standpoint of ease-of-use. Even though all the web sites run on the same IT

infrastructure (Internet, WWW, multimedia, etc.), the longevity and popularity of web sites depend on how much they can make users feel comfortable. Third, we may well be more attentive to the affect-related stimuli if we intend to enhance PEU of web sites. The current usage of web site is more related to the personal fun or curiosity reasons rather than the task-oriented reasons. This "emotional personalization" may be ascribable to the perceived ease-of-use of selected web sites. This analogy proposes that the features or designs of web sites should be based on users' affective responses not on the task-related performances or technical productivities. Web site is not just an instrument to procure information, but also a communication media to exchange personal emotions and privacies. Personalization techniques have been used as an enhancement of transaction processing systems. Emotional personalization is a new domain where new techniques should fill in.

Like other social studies, this study has several limitations. First, we used only perceptual measures of IS use. Many studies have shown that individuals' perceptions of IS usage are sometimes quite different from their actual usage pattern [11][16][42][49]. Second, our results might be exacerbated by our sample characteristics. The subjects in our sample are undergraduate students. They use the Internet for personal purposes such as chatting and searching information for fun or simple curiosity. Besides, their major (MIS) may have aggravated the sample bias. Considering the

background of our sample data, our study confirms that social influence turns weak as users become experienced with information systems. Organizational issues are not considered in our study. IS implementation studies have emphasized the importance of organization issues (such as structure, size, industry, support, change management, etc.). These issues may have to be considered in the future study. Third, since we used a cross-sectional data set, with both independent and dependent variables collected contemporaneously, the results are susceptible to the same method bias. That is, the correlation between independent and dependent variables, and the explained variance of the dependent variable, might have been inflated because these were all measured at the same time within the same questionnaire. Fourth, a more detailed WAM should be developed. As we conceptualized web site as the combination of technology and media, more psychological constructs other than PEU, PU, and PSI could be included. Furthermore, antecedents to PEU of web site should be investigated comprehensively and intensively.

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Effect of Information Technology and Buyer-Supplier Partnership on E-business Environment

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Abstract

This study explores the effects of IT on buyer and supplier partnerships in the Taiwan e-business environment. The survey data reveals that the integration of IT and partnerships into supply chain management applications can improve e-business performance. Specifically, the study finds that IT utilization as well as buyer and supplier partnerships within supply chains are matured in the participating firms, as evidenced by their enhanced productivity, reduced cost and increased profit. Keywords: information technology, IT strategy, buyer and supplier partnership, e-business performance

1. Introduction

Due to the continuous innovation of technology and the characteristics of e-commerce, many companies have introduced the enterprise resource planning (ERP), supply chain management (SCM), customer relationship management (CRM), e-business and related electronic operating systems to upgrade their competitive advantage. All companies utilize IT to facilitate communication and data sharing between subsidiaries and the parent company in order to earn the greatest profit within the shortest time. In Taiwan, globalization and entering the WTO have made companies compete with not only other local firms, but also international competitors.

The manufacturers invest in advanced manufacturing technologies (AMTs) to smooth their production scheduling, standardize the production process, achieve punctual delivery and reduce costs. The information technology (IT) is evolving as a powerful force in the new marketplace where the nexus of competition has changed from individual firms to efficient supply chain networks both between firms and within industries. Among various channels, the supply chain has the closest partner relationship, because the interactive buyer-supplier relationship among companies is a mutual relationship instead of the traditional cooperation method.

This paper studies how advanced technology and IT applied by manufacturers will affect the partnership relationship and supply chain (SC) performance. We use a questionnaire sampling from manufacturers to collect information related to the degree to which firms use advanced technology, IT strategy models, partnerships with upstream suppliers and downstream buyers, as well as supply chain performance evaluation of the firm.

Statistical analysis is applied to evaluate the correlation and significant deviation and investigate whether advanced technology and IT strategy models will improve the partnership relationships and the supply chain performance.

2. Literature Review

2.1 IT and e-business

With the popularity of the Internet as a low-cost and easy-to-use media, e-business methodology helps companies reduce cost, as well as improve service quality and efficiency [6].

E-business transforms the conventional business process into a supply chain management and establishes a more dynamic buyer-supplier relationship and a strategic partnership [10]. The influence on customer relationship management includes the factors of accelerated information exchange, high degree of interaction and flexibility, as well as removal of time and geographical barriers [1].

According to the International Data Corporation [5], the number of Internet users will soar from 100 millions in 1998 to more than 500 millions in 2003. The open and global characteristics of the IT allow companies to provide e-business to users anywhere at any time with unprecedented width and depth.

A high level of IT capability has been shown to provide a clear competitive advantage, and it can be a differentiating factor in terms of company performance [7]. Bowersox and Daugherty [2] identified IT as one of the common factors associated with advanced logistics practices.

Specifically, the type of IT used largely determines the nature and quality of interactions the company has with customers, suppliers and trading partners. Prahalad and Krishnan [9] referred to IT as the company's "digital nervous system". However, although IT is a critical element of SCM, IT is not a source of value by itself. Rather, the proper selection of IT supports and enhances the functioning of value-added processes.

Managers are often faced with the challenge of selecting appropriate IT applications and setting realistic expectations of performance measures. Exacerbating the difficulty of this process are rapid changes in technology, proliferation of software intended to improve SC functioning, and a plethora of self-proclaimed success

stories [4] [13].

2.2 The partnership of buyer and supplier

Wong [17] showed that a real partnership should consider mutual requirements, the capability and target of each partner, as well as creating clear and definite vision. Vokurka [15], Maloni and Benton [8] described the supply chain partnership as the mutual relationship of two independent business entities, normally the supplier and the customer or buyer, in order to accomplish some certain target and profit. These entities share information with each other, improve the financial and operation performance of both sides via cost and inventory reduction, and undertake the risk together.

(1) The power of the partner

The relationships between buyers and suppliers are moving towards a reduced number of suppliers, long-term relationships, reduced inventories and involvement of suppliers in design. The power of the partner includes relationship between players and how the relationship is managed. The existence and position of power in the SC is an example of SC relationship. Chow et al. [3] concluded that there were related variables, like SC formalization, SC intensity, SC frequency, SC standardization and SC reciprocity.

(2) Supplier involvement

Vonderembse and Tracey [16] evaluated the correspondence between the supplier involvement and manufacturer performance. The suppliers were involved in product design and continuous improvement activities. Tracey and Tan [14] studied the relationship of supplier involvement with the customer satisfaction and performance. They also noted that the supplier involvement included the participation on product design and continuous improvement activities.

(3) Information exchange

Sandhya and Mrinalini [12] pointed out that the connections between manufacturer, supplier and buyer improved the efficiency of data transmission, and caused the information to be transmitted and shared immediately. Sanders and Premus [11] investigated the application IT to supply chain management, finding that the utilization of e-technology made the information flow smoothly, and made the firm or organization perform better in many ways. Collaboration of supply chain goes beyond mere exchanging and integrating information between suppliers and customers, and involves tactical joint decision making among the partners in the areas of collaborative planning, forecasting, distribution, and product design.

Sanders and Premus [11] also found that the investment and application of IT assisted the company or organization to perform better in terms of quality, flexibility, innovation capability, product entrance opportunity and new technology. The Supply Chain Council of the US also developed 12 indexes to measure the supply chain performance. Therefore, this paper

proposes the following hypotheses: with different IT portfolios, the performance of e-business will be affected by a supplier or buyer partnership.

H1: IT portfolio will affect the supplier or buyer partnership.

H1a: Higher involvement with IT will lead to closer supplier partnership.

H1b: Higher involvement with IT will lead to closer buyer partnership.

H1c: IT strategy model will affect the supplier or buyer partnership.

H2: IT portfolio will affect the performance of e-supply chain.

H2a: Higher involvement with IT will result in better performance of e-supply chain.

H2b: IT strategy model will affect the performance of e-supply chain.

H3: The supplier or buyer partnership will affect the performance of e-supply chain because of different IT portfolios.

H3a: The supplier partnership will affect the supplier performance on e-supply chain because of different IT portfolios.

H3b: The buyer partnership will affect the buyer performance on e-supply chain because of different IT portfolios.

3. Survey Methodology

This paper empirically investigates the relationships among variables and Figure 1 illustrates the architecture of this study. The major variables used have included: (1) the independent variables of supplier and buyer partnerships, which include the power of the partner, supplier involvement and information exchange; (2) the medium variables of the degree of e-business/IT, which includes the level of involvement with IT and the IT strategy model; (3) the dependent variable, which is performance evaluation of e-business, including information management, order fulfillment, inventory, distribution, product development, supplier management, customer satisfaction and after-service.

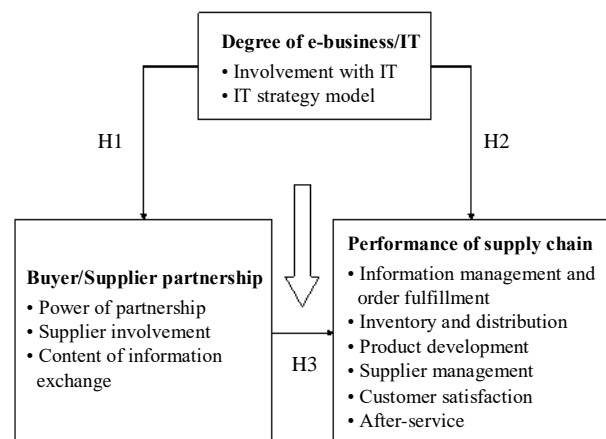


Figure 1 Architecture of this study

The questionnaire design has four parts: (1) the degree of e-business, (2) supplier partnership and its performance, (3) buyer partnership, and (4) the background of the company. The objects are sampling from the purchasing departments of 1000 major manufacturers in Taiwan, including food and drink, textile and garment, chemistry and petroleum, construction materials, pharmaceuticals, metals and machinery, as well as electronics and electric industries. Of the 945 questionnaires sent out, 22

questionnaires were returned due to change of address or failed e-mail address. Of those returned, 4 responses could not be used. There were 113 questionnaires returned, not including the invalid ones, for a valid response rate is 12.29%. The returned questionnaires were received from companies of different industries that is compliant with the spirit of sampling.

Table 1 Performance evaluation of e-business

Object	Dimension	Mean	Standard deviation
Supplier	Information flow management	3.457	1.992
	Order fulfillment management	3.681	2.075
	Inventory and distribution	3.555	2.038
	Product development and feasibility	3.454	2.018
	Partnership management	3.746	2.056
	Customer relationship management	3.673	2.005
	After service	2.296	1.292
Buyer	Information flow management	3.657	2.835
	Order fulfillment management	3.527	2.043
	Inventory and distribution	3.555	2.057
	Product development and feasibility	3.790	2.106
	Partnership management	3.725	2.000
	Customer relationship management	3.921	2.762
	After service	3.823	2.069

Table 2 Degree of IT application by industry

Dimension	Sub-dimension	Electronics & Electric industry	Traditional industry	Trading industry & others
IT application degree	Network establishment	60%	55%	48%
	Network method	30%	26%	18%
	Website establishment	100%	100%	100%
	Product inquiry service	83%	82%	75%
	Information outsourcing	27%	17%	26%
	Sharing information with partnership	35%	23%	29%
	Procurement management	23%	28%	17%
	Sales management	32%	30%	28%
	Production management	20%	24%	22%
	Logistics management	32%	30%	27%
	Communication and support service	60%	58%	55%
Supplier involvement	Product development/ design	32%	29%	26%
	Technology resource/information sharing	32%	38%	35%
Sharing information with supplier	Price	40%	37%	34%
	Delivery	61%	59%	60%
	Quality	41%	46%	37%
	Quantity	43%	36%	39%
	Sales planning	45%	36%	40%
Sharing information with buyer	Price	44%	32%	38%
	Delivery	60%	56%	58%
	Quality	38%	35%	31%
	Quantity	28%	37%	29%
	Sales planning	54%	47%	50%

Table 3 Supplier performance vs. supplier partnership

Industry	Dependent variable	E-business degree	Prediction variable	R ²	β	t value	p value
Electronics & electric industry	Supplier performance	High	Supplier partnership	0.704	0.799	10.543	0.000***
		Low		0.477	0.305	2.675	0.000***
Traditional industry	Supplier performance	High	Supplier partnership	0.506	0.754	9.452	0.000***
		Low		0.384	0.296	3.068	0.000***
Trading industry & others	Supplier performance	High	Supplier partnership	0.604	0.706	8.643	0.000***
		Low		0.393	0.231	3.172	0.000***

* $p \leq 0.1$ (close but does not reach the level of significance); ** $p \leq 0.05$; *** $p \leq 0.01$.

Table 4 Buyer performance vs. buyer partnership

Industry	Dependent variable	E-business degree	Prediction variable	R ²	β	t value	p value
Electronic and electric industry	Buyer performance	High	Buyer partnership	0.501	0.602	6.013	0.000***
		Low		0.302	0.502	6.011	0.010***
Traditional industry	Buyer performance	High	Buyer partnership	0.492	0.701	5.017	0.040**
		Low		0.328	0.304	3.026	0.024**
Trading industry & others	Buyer performance	High	Buyer partnership	0.502	0.601	5.74	0.005***
		Low		0.387	0.259	3.016	0.030**

* $p \leq 0.1$ (close but does not reach the level of significance); ** $p \leq 0.05$; *** $p \leq 0.01$.

4. Data Analysis

Table 1 illustrates the relative performance of different operation areas of the supply chain. Among the surveyed entities, 28 companies are coming from electronics and electric industry, 69 are from traditional industry and 16 are from trading industry or others. The important items include customer relationships, after-service, product development, supplier partnerships and order fulfillment. Table 2 shows degree of electronic IT application in the electronics/electric industry, traditional industry and trading industry. The comparison indicates that the electronics/electric industry has greater IT application in the e-business environment.

From the survey, we find that IT strategy (product and marketing innovation strategy, manufacturing innovation strategy and operation efficiency improvement strategy) has no significant correspondence with either supplier or buyer. However, "manufacturing innovation strategy" is significantly correspondent to "supplier performance". For the partnership, Table 3 and Table 4 illustrate the significant effect between performance and buyer/supplier partnership for different degrees of e-business application.

5. Conclusions and Suggestions

Surveying IT application degree, partnership and the performance, we conclude as follows:

(1) The correspondence analysis indicates that "IT

application degree" has positive correspondence with "supplier partnership" and "buyer partnership", which also means that "IT application degree" has positive correspondence with "supplier involvement" and "content of information exchange". Furthermore, "IT application degree" and "partnership" have positive correspondence with "e-business performance", namely, either supplier or buyer partnership will have positive correspondence with e-business performance.

- (2) "High degree of IT application" has stronger impact on supplier partnership than on buyer partnership, whereas "Low degree of IT application" affects buyer partnership more than supplier partnership. Supplier performance and buyer performance also have the same trend.
- (3) The impact of supplier partnership, supplier involvement and information exchange on the performance of e-business is affected by the degree of commitment to IT. A higher degree of commitment indicates better performance. Different IT portfolios will also affect the performance of the e-supply chain.

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Effectiveness and Efficiency of Information Technology and Information Systems in Supply Chain Management in Hong Kong

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Abstract

This study explored the effectiveness and efficiency of information technology (IT) and information systems (IS) in supply chain management (SCM) in Hong Kong firms.

The research model is comprised of three parts. The first part relates to the relationship among the three different functions of IT/IS utilized in a supply chain. The second part demonstrates to the relationship between IT/IS utilization and supply chain performance. The third part relates to relationship between organizational factors and different roles of IT/IS utilization. Several hypotheses have been set up for the model.

In the research, 36 measurement items extracted from literature to specify the characteristics of information systems utilized in supply chain management and structural relationship between these latent variables. Factor analysis, reliability test, correlation matrix, path analysis were used to analyze the data and model testing.

The results justify the acceptance of the proposed research model and some of our hypotheses, they are, IT/IS for organizational value creation management has significant contribution to SCM performance. IT/IS for logistics operations and value creation management have significantly mutual influences each other. IT/IS for organizational infrastructure only influences the value creation management. In addition, they also confirm the contributions of IT/IS in SCM performance, and further this study develops and validates a measurement scale for IT/IS utilizations on SCM performance. The scale provides a preliminary foundation for facilitate research and in IT/IS utilizations in logistics operations in wider spectrums.

This research also empirically justifies that IT/IS for infrastructural support and logistics operations has indirect effects on SCM performance through value creation management. This gives an insight that IT/IS is fundamental for organizational value management, through value creation and growth, SCM performance, and further organizational performance can be enhanced. Finally, knowledge of IT/IS utilization and organizational factors can be contributed to their consideration and planning for IT/IS strategy and adoption.

Recommendations for further research and organizational IT/IS strategy are suggested based on these outcomes, such as supply chain integration, and consideration for implementation of IT/IS. IT/IS utilizations with strategic planning are believed to be more efficiency and effectiveness in SCM performances for the organizations.

Keywords: Information Systems, Information Technology, Logistics, Supply Chain Management

1. Introduction

1.1 General Background

Many firms today were effective management of logistics and supply chain activities both as a prerequisite to overall cost efficiency and as a key to ensuring their ability to competitively price their products and services. Information systems (IS) and information technology (IT) are being used by leading-edge firms to increase competitiveness and developed a sustainable competitive advantage [9]. Although capabilities relating to information systems and information technology have traditionally regarded also as key strategic resources, expertise in these areas is now thought to be among the most valuable and essential of all corporate resources.

In the previous studies, the introduction of information technology by a firm for integrated supply chain management could lead to better efficiency and effectiveness [21]. Integrated supply chain management utilizing information systems can enable the company to identify optimal inventory levels, reduce warehouse space, and increase inventory turnover [23][24][39]. Porter and Millar [33] suggested the utilization of IT has significant influence on the relationship among value chain activities and Porter and Millar believes that management of information systems focusing on cost reduction.

IS must have a potential to be a strategic weapons for improving supply chain management performances. In Hong Kong, a great numbers the companies focus on their efforts on value-added activities such as international marketing, product planning product R&D so on. Hong Kong companies also concerned about how information technology/information systems can enhance the competitiveness and efficiency of supply chain. [25]

This paper is organized as follows. First, previous research on the role of functional information systems for supply chain management is discussed. Next the characteristics of information systems utilized for supply chain management are identified, based on factor analysis of sample data from 71 of Hong Kong firms. Third, a conceptual model and hypotheses relating to utilization of information system and supply chain management (SCM) performance and tested using path analysis. A set of discussion and recommendations are explained and based on the results.

1.2 Objectives of study

The objectives of study are to 1) to test a research model of organizational factors with IT/IS utilization in SCM performance; 2) to develop recommendations for companies in Hong Kong to establish IT/IS utilization strategy for SCM performance; 3) to find out the critical factors of IT/IS in SCM; and 4) to establish the performance measurement criteria for using IT/IS in SCM.

2. Literature Review

2.1 Supply Chain Management

Supply Chain Management (SCM) deals with control of material and information flows, structural and infrastructural process relating to transformation of the materials into value added products and delivery of finished products through suitable channels to customers in order to maximize customer value and satisfaction. [34]. As Council of Logistics Management noted that: Logistics is that part of the supply chain process that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customers' requirements.[31] By Integration of internal functions within an organization (e.g. marketing, manufacturing, product design and development) and effectively linkage them between suppliers and customers, SCM can help to enhance competitive performances and meet the customers' requirements.[34] The benefits of SCM can be obtained through the information linkage among various supply chain activities utilizing information technology and construction of integrated supply chain information systems. [9]

2.2 Information Systems and its Roles in Supply Chain Management

Information systems in logistics and supply Chain can be defined as: an interacting structure of people, equipment and procedures that together make relevant, timely and accurate information available to logistics manager for purpose of planning and implementation and control. [29][41]

According to Computer Sciences Corporation [15], suggested that the highest priorities of critical current issue in information systems are on customers, productivity, and performances. These issues show that they can affect the use and function of information systems in SCM. Information systems were viewed as

providing infrastructural support to the value chain and having impact on competitiveness of products. Companies started to utilize information systems to directly influence the processes comprising the value chain [37] [45].

Earl [18] classified the scope of information technology into following categories according to whether information technology is widely used in the value chain or used for only information processing and whether it is applied for value creation or applied for connection of value chain activities: 1) Information Technology (IT) that automates or improves every activity; 2) IT is used for connecting each value activity 3) Information systems facilities support, management and implementation of value chain activities, and 4) Information systems optimize or adjust the connection of each value activity. Earl can be applicable to internal value chain, but also be extended to the company's supply chain.

Porter and Millar [33] suggested that utilization of IT has significant influence on the relationship among value chain activities as well as on the physical aspects of individual value chain activities. The following proposition can be made: 1) Competitiveness comes from creating customer value; 2) value creating activities are interdependent in the value chain 3) Firms can optimize or integrate their value chain through IT to improve their competitiveness and efficiency. Porter and Millar suggested that proper use of information minimize the costs while maximize the value, optimizing value chain activities and improve the efficiency.

From the work of Earl, Porter and Millar, the utilization of information systems shows the enhancement of competitiveness and improving efficiency in the value chain. To better understand the utilization of IS, the general research questions should be considered. How can IS applications support through information processing, value creation management for improving the value activities and logistics operation connection of activities? What are the performance measures for proving that IS influence in the supply chain? Porter and Millar believe that management of information systems focusing on cost reduction. The ability to pursue the cost reduction should be criterion of IS utilization.

2.3 Performance Measurement

Apart from the cost reduction, performance measures can be used to indicate the SCM performance in order to illustrate the IS utilization influence. According to University of Tennessee Logistics Survey[44], a list of measures varying degrees of utilization among companies. "Outbound Freight Cost", "Inventory Count Accuracy", "Order fill" are the highest three priorities for performance measures capturing on a regular basis within the company. Logistics Metrics suggested to use to measure the performances with Logistics Key performance indicators (LKPI). [20] The logistics Metric was divided into four categories: Finance (Cost), Productivity, Quality, Response Time.

2.4 Organizational Factors

The role of individual and organizational factors may also be played in the benefits of SCM. These Factors highlights the importance of organization's experience to implement information systems to enhance the competitive advantages and efficiency. [38] A creativity framework has been adapted from organizational literature will be used to illustrate the implementation effort of IS in the company. The individual and organizational characteristics used to improve the implementation of IS. [46] Amabile [1][2][3][4][5] conceptualizes individual creativity from the framework. The framework includes three major components – domain relevant skills (task knowledge), creativity (cognitive abilities) and task motivation (intrinsic and extrinsic). Intrinsic motivation is individual baseline attitude toward to the task and extrinsic motivation is individual perceptions of undertaking the task in a given instance. Organizational characteristics create the contextual influences that operates whole organization members to influence creativity. Organizational creativity is group of creativity influences such as leadership, reward, availability of information and so on. [46] Kartz and Allen [27] indicated that the importance of leadership and management is influenced on the interaction of other components of organization and acquisitions of resources. Another way to improve organizational creativity is through the structure and culture. [10][11][32]. More organic structure, lack of formalization and high levels of complexity establish an linkage between high level of organizational creativity.

2.5 IS in Supply Chain Management in Hong Kong

In Hong Kong, a great numbers the companies focus on their efforts on value-added activities such as international marketing, product planning product R&D so on. Hong Kong companies also concerned about how information technology/information systems can enhance the competitiveness and efficiency of supply chain.[9] In the meantime, Hong Kong SAR Government proposed the development of Digital Trade and Transportation Network (DTTN) for companies which provide a neutral e-platform and IS for facilitating information flow and service integration locally and globally.

In summary, influence of IS utilization (i.e. effectiveness and efficiency) can be shown through different roles of IS applications in supply chain value-creation management, logistics operation and infrastructural support through using different performance measures, such as financial and non-financial indicators.

3. Research Model, Hypothesis and Methodology

3.1 Research Model

The research model is comprised of three parts. The first part relates to the relationship among the three

different functions of IS utilized in a supply chain. The second part demonstrate to the relationship between IS utilization and supply chain performance. The third part related to relationship between organizational factors and different roles of IS utilization.

3.2 Hypothesis

This research model is derived from prior studies discussed in the literature review section [13][30][33]. Information systems for information processing provide the basis for establishing strategic competitive advantage. IS utilization makes it possible for achieving strategic competitive advantage. IS plays roles as infrastructural support for direct IS utilization in supply chain functions

H1: IS/IT utilization for infrastructural support has a direct influence on IS use for value creation management.

H2: IS/IT utilization for infrastructural support has a direct influence on IS use for logistics operation

Prior research on the process of supply chain integration illustrates show that internal integration with the company should precede external connection with suppliers and customers. [9] To identify the casual relationship between IS for values creation management and IS for logistics operation, we should consider the reciprocal relationships between two variables.

H3: IS/IT utilization for value creation management has a direct influence on IS use for logistical operation.

H4: IS/IT utilization for logistical operation has a direct influence on IS use for value creation management.

The pervious studies introduce the relationship between IS/IT utilization of IS/IT in value chain processes would eventually enhance the company's supply chain activities. [9][13][30][33] The focus of IS utilization should shift form information processing to value creation and value connection. The change of IS/IT utilization focus would make it possible for IS/IT utilization have a direct effect on supply chain competitiveness and efficiency.

H5: IS/IT utilization for value creation management has a direct influence on supply chain performance.

H6: IS/IT utilization for logistical operations has a direct influence on supply chain performance.

According to Legare [38], organizational factor is contributed to the implementation of IS/IT in order to enhance competitiveness and efficiency of work. Organizational factor is contributed by individual characteristics and organization characteristics within an organization[46]. So the following hypothesis can be assumed:

H7: Organizational factor for an organization has a direct influence on IS/IT infrastructural support.

H8: Organizational factor for an organization has a direct influence on IS/IT utilization for value creation management.

H9: Organizational factor for an organization has a direct influence on IS/IT utilization for logistics operations.

3.3 Research Methodology

3.3.1 Measurement

a. IS/IT utilization level

Based on prior research, [34] which classify logistics activities in integrated supply chain management and functional information systems for logistics management, 12 traditional uses for information systems in supply chain management were identified: plant and warehouse location selection, order processing, resource management, production plan and process control, inventory and warehouse management, distribution and transportation management, sales and price management, consumer service and customer management, and forecasting. network planning and design system, office information system, and accounting information system.

b. SCM Performance Measurement

The approach to measuring SCM performance has been used by previous researchers [9][20]. Measures [8][20][43][47] consisted of cost reduction, cycle time reduction, on-time delivery of materials from suppliers and customers, product quality, response time for customers and suppliers, the speed of suppliers' order processing, the reduction degree of response time of suppliers and customers, the accuracy of order processing for customers, the speed of order handling, and perfect order fulfillment.

c. Organizational Factors

The measurement based on the vision, sense of business urgency, authority and responsibility, reward, skill knowledge, cognitive abilities, motivation, resources, structure and culture [38][46]. Knowledge, cognitive abilities, motivation are items for individual while resources, structure and culture are the items for organization.

3.3.2 Questionnaire Design

The questionnaire is composed with two parts. In part I, it consists of three general questions. First, respondents were asked to whether they have experience of using information systems in logistics before. Secondly, respondents would answer the current business type for their company. Finally, the position the respondents are. In Part II, it consist of 36 measurement items that used to measure the extent to which items described are information systems application, organizational issue and supply chain management performance. The scale ranges from Strong Disagree (1) to Strongly Agree (7). Respondents are needed to rank them.

3.3.3 Sampling

Target Corporations to be sampled were large and small-medium corporations which can carry out or provide value-added activities in a supply chain to other company in Hong Kong. The data were collected through questionnaires sent to supply chain managers. In order to raise the reliability of measurement, respondents will be requested to consult with others in

the SCM department or functional executives to answer the questions.

The group of respondents is from randomly selected the companies under web directory and company directory in Hong Kong Trade Development Council's official website.

3.3.4 Data Collection

For the replied respondents, 72 copies of paper questionnaire have been collected in the total of 200 copies of distribution (36% response rate), 1 of them were invalid due to missing data contained (35.5% useable response rate), so that sample size of respondent was 71.

4. Research Findings

4.1 Descriptive Analysis

Of the 71 questionnaires from the respondents' company, all of them had experience to use information systems applications in logistics. In current business type, A quarter (25 %) of them was logistics service providers, 22.5% of them were distribution and transportation, nearly 20 % of them are retailers. In the current position of respondents, nearly half of them (49.3%) are information technology or information systems manager, and while nearly 41% of them are operation managers. Less than 10% of them are general manager. Neither of them are Chairman nor Chief Executive Officer. In Organizational factors, Authority, responsibility and policies have a higher means in the factors. In SCM performance, Perfect Order Fulfillment, Accuracy of order processing, and reduction of response time from customers have a higher means in the factors.

4.2 Factor Analysis

Factor analysis by Varimax rotation was used to assess the constructs of 12 measured degrees of functional IS utilizations. The eigenvalues and the cumulative variance were shown in Table 1. According to Bryman and Cramer, factors that have eigenvalues greater than one were selected and extracted for further analysis. As a result 3 factors were extracted, with 68.417% of total variance.

All 12 variables were found to be loaded on one of 3 factors with factor loading greater than 0.5 which is consider significant.

The 12 functions identified can be divided into 3 major utilization areas. The detail discussion about classification of characteristics of IS for supply chain management will be founded in the discussion part.

Table 1: Convergence/divergence of extracted factors

	Components (Extracted Factors)		
	1	2	3
Distribution and transportation management.	.904		
Resource management	.870		
Forecasting	.848		

Order processing	.810		
Plant and warehouse	.707		
Accounting		.895	
Networking planning and design system		.827	
Office management		.784	
Sales and price management			.743
Inventory and warehouse management			.722
Service and customer management			.703
Production plan and process control			.650
Cronbach Alpha	0.8991	0.8149	0.7299
Eigenevalue	4.357	2.414	1.439
Cumulative variance %	36.309	56.428	68.417

4.3. Reliability

The reliability test result shows that the alphas of factor 1 to 3 are already greater than the reliability ratio (0.7)

4.4 Path Analysis

The multiple regression analysis technique was used to model the interrelationship among the latent variables. The R^2 were shown in Table 2.

Table 2: Path coefficients of all variables

Variables	IS for Infrastructural Support	IS for Value Creation Management	IS for Logistics Operations	SCM Performance
Organizational Factors	1.868x10 ⁻²	0.199	-2.756x10 ⁻²	0.445*
IS for Infrastructural Support	---	0.227*	-3.422x10 ⁻³	0.445*
IS for Value Creation Management	---	---	0.448*	0.445*
IS for Logistics Operations	---	0.333*	---	0.445*
R2	0.00	0.260	0.180	0.180

P < 0.05

To conclude, the organizational factors do not have a significant direct effect on the IS for Infrastructural support, Value Creation Management, and Logistics Operations respectively. IS for Infrastructural support has a significant direct effect on the IS for Value Creation Management. IS for Value Creation Management has a significant direct effect on the IS for Logistics Operations and SCM Performance. IS for Logistics Operations has a significant effect on the IS for Value Creation Management.

After that, the total effect of each variable was calculated by sum of the direct effect and indirect effect

of variables. So total effect of IS for Value Creation Management was 0.560 (0.227+0.333 = 0.560). The total effect of IS for Logistics Operations was 0.550 (0.448+ 0.448 x 0.227=0.555). The total effect of SCM performance was 0.694 (0.445 + 0.227 x 0.445 + 0.333x 0.445 = 0.6942).

5. Discussion and Implications

5.1 Discussion

a. The classification of the characteristics of IS utilized for supply chain management

The 12 functions identified can be divided into 3 major utilization areas. The first is the IS/IT utilization for logistics operations that focuses on the connection among value chain activities within and outside of a corporation (plant/warehouse location, resource management, order processing, distribution and transportation management, and forecasting). The second is IS/IT utilization for value creation management that focus on automation and improvement of the physical aspects of individual value chain activities (product/process control, inventory/warehouse management, sales/price management, and consumer service/customer management). The third is the IS/IT utilization for infrastructural support which provides infrastructural foundation for the effective operation of value chain activities (network planning/design system, office information system, accounting information system).

The above classification into 3 clusters of utilization areas has validity in light of the previous studies on the classification of logistics activities and functional information systems for logistics management [6][9][14][22][31][36][41]. The functional information systems comprising the same factor has high-level factor loadings on the factor, thus a high validity.

The result from the research model confirms H1, H3, H4, H5, but do not lend support for H2, H6, H7, H8 and H9.

b. IS/IT for infrastructural support

First, IS/IT for infrastructural support does not have a direct effect on SCM performance. However IS/IT utilization for infrastructural support has a direct effect on IS/IT utilization for value creation management, and IS utilization for value creation management has a direct effect on supply chain management performance. This means that IS/IT utilization for infrastructural support may play an indirect effect in enhancing supply chain management performance through IS/IT utilization for value creation management. The validity So it can be served as the foundations for IS/IT utilization for infrastructural support provides the basis for establishing strategic linkages that direct IS/IT application to value chain activities which can help increase the supply chain performance and consequently gain competitive advantage [13][17][18][33]

c. IS/IT for value creation management

Second, It is about the structural relationship among the three IS/IT latent variables showing IS/IT

utilization in a supply chain. The paths that are statistically significant indicating the structural relationship: infrastructural support \rightarrow value creation management \rightarrow logistics operations. This implies that IS for infrastructural support enhances the utilization level of IS for value creation management brings about use of IS/IT for logistics operations. The result shows that IS utilization for value creation management is a precondition for the utilization of IS/IT for logistics operations. In other words, IS/IT utilization for value creation management should be established in order to make sure that utilization of IS for logistics operations work properly. This coincides with the previous studies, which emphasize that improvements of each internal function should be preceded by the external connection with suppliers and customers, IS/IT utilization strategy should be step by step in the processes [9][12][40].

d. IS/IT for logistics operations

Thirdly, the relationship between use of IS/IT for logistics operations and supply chain management performance. The result shows that the path coefficient is not statistically significant. This can suggest that benefits of IS/IT for logistics operations on supply chain management performance are not supported in the study sample. Partial explanation for this result was shown in the previous studies. The majority of the items related to aspect of supply chain over which the logistics function does not exercise direct control. Another explanation could be that IS/IT utilization for logistics operations and its influence could be related to the firm's stage of supply chain integration. That means it can be speculated that IS/IT utilization for logistics operations is more beneficial in firms that are pursuing external integration than in firms that are pursuing internal integration [40].

Fourth, the relationship between utilization of IS/IT for logistics operations and IS/IT for value creation management. The relationship was not shown in the previous studies, especially utilization of IS for logistics operations \rightarrow IS for value creation management. The path coefficient is statistically significant on these utilizations. This situation can be explained that the logistics operations in several areas such as order processing, resource management, distribution management which can support the IS/IT for value creation management. Functional support of logistics operations serve as a factor for value creation management such as inventory and sales which give provide the value-added service to customers. The recursive relationship between utilization of IS/IT for logistics operations and IS/IT for value creation management shows that the both functions of IS should not be ignored in the supply chain activities and well-established in order to utilize both functions. Although the relationship between use of IS for logistics operations and supply chain management performance is not valid, IS/IT for logistics operations can be served as an indirect effect on supply chain performance, so the logistics operations have some degrees of effect of the performance such as time and costs.

e. Organizational Factors

Finally, the relationship of organizational factors with IS utilization of infrastructural support, IS for value creation management and IS for logistics operations. There are no statistically significant effects on these IS utilizations. Some reasons can be explained in the following:

First of all, the respondents were mainly small and medium enterprises in Hong Kong. The size and structure of the organization are small. The functions of IS and IT are limited for their current business. Functions of IS and IT can be accepted if the sales and revenues can be generated and recover the revenue. The functions and scope of IS and IT are limited due to size of organization and amount of investments. A small group of staff are responsible for all functions in the business. Organizational factors, such as leadership, motivation, policies, skills and knowledge may not fully be utilized and concerned by top managements in the companies.

Secondly, the respondents are from different business in Hong Kong, and from the descriptive analysis, there is no dominated business groups in the study, so that no clear dominated organizational factors can be found in the study. This may minimize the effect of organizational factors to different functions of IS utilization.

f. SCM Performance

From data analysis, respondents mainly concern about supply chain performance. Perfect order fulfillment, accuracy, reduction of response time have a higher ranking which mainly concerned by the management in the company. The major concerns for the company are customer-orientated measurement.

To conclude, the companies mainly concern about customer orientated performance measurement because customers are sources of generating revenue and sales. Because of limited customer resources for small and medium enterprises, if they lose the customers, they suffer the loss on sales and profits. This can motivate them to provide an excellent customer services with IS utilizations to gain their competitive advantages.

5.2 Implications

First of all, this research develops and validates a measurement scale for SCM performance on IS utilization in Hong Kong enterprises. This scale will give a preliminary foundation for facilitating research and analysis on SCM performance in Hong Kong, and examines its casual relationship and its effect on SCM performances. Research model adapted by previous studies will enrich current findings and clarify the IS influences on SCM performances thus enabling the further studies and theory development.

Secondly, this research provides empirically justified studies so that Hong Kong companies can understand that IS utilization are likely effect on SCM performance. From result of data analysis, IS/IT for infrastructural support and logistics operation has an indirect effect on SCM performance through value creation management while value creation management

has a direct effect on SCM performance. This gives an insight that IS value creation management is supported by infrastructural support and logistics operation in IS/IT functions and in order to provide an improved SCM performances.

Finally, knowledge of IS/IT utilization and organizational factors can be contributed to their consideration and planning for IS/IT strategy and adoption. IS strategy requires system preparations in term of gathering information about supply chain processes organization, environments, user and customers requirements [17]. Through these processes, company can understand the user requirements and customer requirements on IS/IT functions in order to full utilized the systems and improve SCM performances, i.e. efficiency and effectiveness of supply chain activities.

6. Recommendations

6.1 Supply chain integration

In order to full utilization of information systems in the supply chain management, top management should consider development of integration of supply chain. The existing study on supply chain management emphasize that supply chain integration should be accomplished sequentially from internal integration to external integration. [40]. In the sense, Stevens presents the integration process of supply chain management comprehensively starting with integration of related function to internal integration and on to external integration. Internal Integration is characterized by fully system visibility with a focus on tactical rather than strategic issues and emphasis on efficiency rather effectiveness. External Integration is characterized by completely sharing information on products, processes and specification changes; technology exchange and design support; a focus on strategic rather than tactical issues and long term planning. Management should have operational, tactical and strategic issue in the processes and IT development.

6.2 Continuous support on IS/IT development

Government and SMEs should cooperate together for continuous development of IT/IS in Hong Kong. According, to Hong Kong Logistics Council, Digital Trade and Transportation Network study completed in December 2002 confirmed the strategic value of the initiative and the importance of jump-starting the project so as to enhance HK's competitiveness as an international logistics hub. It is kind of e-platform for logistics system to facilitate information flow and sharing amongst the trade and logistics industry stakeholders. These features can be suggested to implement through Digital Trade and Transportation Network in Hong Kong for SMEs provided by Hong Kong SAR Government. This can increase the efficiency and effectiveness of processes and organization, which can enhance the competitiveness, and SCM performance of the company.

6.3 Considerations of implementing the IS utilization

The utilization of IS can actually have an effect on SCM performance, but how can we make sure that IS can be fully utilized? The several suggestions can be raised as consideration before implementing IS utilization which fulfill the organizational requirements and performance requirements.[16]

- a. It is important to have a scientific as well as an intuitive understanding of customer and supplier requirements, as well as all supply chain participants. Information systems and technology should be flexible and adaptable, depending on specific sets of needs.
- b. It is important to see that logistics organizational strategies move from a functional to a process orientation. Emphasis on the latter assures a more meaningful measurement of relevant processes and assures more timely and accurate process feedback and process knowledge.
- c. It is necessary for firms to create opportunities for interaction and team efforts among logistics managers and those others most knowledgeable about information technologies. Logistics managers need to know more information systems and information specialists must develop greater insight in to types of problems faced on the daily basis involved in managing in the logistics process.
- d. Financial resources are needed to assure a smooth, full implementation. The employees' cooperation and make use the systems also are very critical.

7. Conclusion

This research also empirically justifies that IT/IS for infrastructural support and logistics operations has indirect effects on SCM performance through value creation management. This gives an insight that IT/IS is fundamental for organizational value management, through value creation and growth, SCM performance, and further organizational performance can be enhanced. Finally, knowledge of IT/IS utilization and organizational factors can be contributed to their consideration and planning for IT/IS strategy and adoption.

Recommendations for further research and organizational IT/IS strategy are suggested based on these outcomes, such as supply chain integration, and consideration for implementation of IT/IS. IT/IS utilizations with strategic planning is believed to be more efficiency and effectiveness in SCM performances for the organizations.

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A Stage Model of Knowledge Management Systems Diffusion Process: Findings From An Australian Study

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Abstract

This study presents a stage model of knowledge management systems (KMS) diffusion process. It then provides empirical test of the sequence of KMS diffusion process in Australia. Structural equation modelling (SEM) using LISREL is used as the analytical tool for the empirical tests. The results show that all the hypotheses related to the sequence of the KMS diffusion process are significant. This is an important and significant finding. It clearly demonstrates how KMS adoption and diffusion phenomenon should be planned in Australian organizations. The results of the study add value to the literature of knowledge management. Also, the results provide practical and applicable suggestions to those companies, which are embarking on the adoption and diffusion of knowledge management system in Australia or elsewhere.

Key words: Knowledge Management Systems, Adoption and Diffusion, Structural Equation Modelling, LISREL

1. Introduction

As a result of the tough competition in the market place and the shift from resourced-based economy to knowledge-based economy, companies are looking at more and more in gaining competitive advantage through managing and maximizing their most valuable asset – “knowledge”. Although knowledge and knowledge management are not new concepts, knowledge management systems (KMS), which involve the application of IT systems and other organizational resources to manage knowledge strategically in a more effective and systematic way (Alavi & Leidner 1999), are relatively recent phenomenon. While the KMSs (or some variations) are widely applied in organizations, the topic of KMS has not been well explored by the researchers and scholars in an empirical way. Among the limited literature on KMS, which centers on cases of successes and failures of KM project applications and/or presents factors of successes and/or failures, there is a scarcity of empirical studies of KMS, especially in the area of adoption and diffusion of KMS. This paper reports the findings of an Australian study of the factors impacting on the diffusion of KMS in organization.

The paper is organized as follows. Section 2 presents relevant background to the study on knowledge management systems and model of innovation diffusion. The research method, which combines exploratory filed study, empirical pilot study, and national survey, is presented in section 3. Section 4 presents the development of the proposed hypotheses tested in the study. Results are presented and discussed in section 5 in detail. Finally, conclusions are presented in section 6.

2. Background

Knowledge Management System (KMS) is a broad way or approach to deal with the generation, preservation, and sharing of both tacit and explicit knowledge within and outside of the organization, which essentially involves the applications of Information Technology systems and other organizational resources (Alavi & Leidner, 1999). While the publicity related to organizational learning, intellectual capital, and knowledge management may pass with time, the need to effectively and systematically manage the knowledge will not diminish. Knowledge is more and more recognised by the organization as a key organizational asset for sustaining its competitiveness in the market place (Huber 2001). At present, applying computer-aided knowledge management system and the aggressive acquisition and retention of knowledge workers are two major knowledge management activities (Huber 2001). Companies are embarking on knowledge management systems to seek competitive advantage (Gottschalk 1999).

Alavi and Leidner (1999) report a survey regarding the issues, challenges, and benefits of knowledge management systems by collecting data from 109 participants of an executive development program, who are chief information officers (CIO), information systems managers, and general functional managers, representing a range of countries (Australia, Canada, Germany, Israel, Luxembourg, the Netherlands, Saudi Arab, South Africa, Spain, Switzerland, and the United States), industries, and organizations. The results of the survey indicate that, given the fact that knowledge management systems are only recent phenomenon, more and more companies were

adopting knowledge management systems. 44.63% of the respondents indicated that their organizations either have an existing KMS or are considering developing a KMS. Meanwhile 10.91 % of organizations are developing a KMS. The survey also uncovers some other interesting findings of the characteristics of KMS: (1) KMS were most commonly initiated by senior management (such as senior general managers, senior IS managers, and senior functional managers), (2) the range of investment on KMS was from US\$25,000 to 50,000,000. But KMS budget was related to size of the organization, the current level of infrastructure, and the scope of knowledge management initiative, (3) the most common KMS technologies were browser, electronic mail, and search retrieval tools. The authors also report that KMS were designed to gain the benefits in the perspectives of process results and organizational outcomes. The perceived KMS benefits for organizational outcomes included increased sales, decreased costs, higher profitability in financial area, improved customer services, better targeted marketing in market area, and improved project management, personal reduction in general areas. Meanwhile, the perceived benefits of KMS for process were primarily referred to the improvement in the communication (i.e., enhanced communication, faster communication, more visible opinions of staff, increased staff participation) and enhanced efficiency (i.e., reduced problem solving time, shortening proposal times, faster results, faster delivery to market, greater overall efficiency).

Some of the common applications of KMS are: (1) organizing and sharing/transferring of internal benchmarks/best practices (2) constructing corporate knowledge directories, such as corporate yellow pages, people information archive, etc. (3) creating knowledge networks and knowledge maps; among many others (Alavi & Leidner, 2001). In the past, many information systems (IS), such as management information systems, executive information systems, decision support system, knowledge-based systems, etc., have been focusing on the codified/explicit knowledge. Knowledge management systems provide the opportunities to extend the operating scope of information systems through facilitating organization's effort in managing both tacit and explicit knowledge (Alvi & Leidner, 2001).

Some examples of KMS applications in organizations include: Beckman Laboratory's "K-Entex" to share and disseminate knowledge (Pan & Scarborough, 1999); Xerox's "Eureka" to allow its 25,000 service representatives to share their collective technical wisdom (Bowen, 1999); Ernst & Young's "Ernie", an Internet based consulting service, resulting in a complete redefinition of the consulting industry and lead to what could be called "retail consulting" (Sarvary, 1999); AMP's "AMP Connect", a multilingual Internet catalogue of AMP products, to allow customers to access the information 24 hours a day; British Petroleum's

"Virtual Teamwork Project" using videoconferencing to speed up the solution of critical operation problems by saving millions of dollars in travel costs and downtime each year; Anderson-consulting's "Knowledge Exchange" to assist its clients in using knowledge to improve their operations and develop long-range strategies; Kim's "K-World" to manage knowledge globally (Thierauf, 1999); among many others.

Although KMS has been studied widely over the last several years, it has not received considerable scholarly attention. The existing research and studies on KMS consist primarily of general and conceptual principles of KMS and case descriptions of such systems in a handful of leading organizations. Those case descriptions also mainly focus on the issues of the process of implementing KMS (e.g., Davenport 1998, Ernst & Young, 1999), objectives of KMS (e.g., Davenport, 1998; Thierauf, 1999), critical factors of the successful KMS (e.g., Davenport, 1998; Skyrme & Amidon, 1998; Brand, 1998; Pan & Scarbrough, 1998), the characteristics of KMS leaders and laggards (e.g., Skyrme & Amidon, 1998), KMS applications in various business areas (e.g., Thierauf, 1999). The majority of research, (such as Thierauf, 1999; Chait, 1999; Pan & Scarbrough, 1999; and Sarvary 1999), have only covered the general and conceptual principles of building/creating and implementing knowledge management systems. Literature on the KMS diffusion could not be found at present, except the work by Scarbrough & Swan (2001). The authors used management fashion model to explain the diffusion of knowledge management.

In this paper, we focus on the diffusion process of KMS in Australia. Specifically, we want to identify the sequence of stages of KMS diffusion process.

Literature suggests that past research on diffusion of innovations have focused on the relationships of various factors (i.e. what factors influence and determine diffusion process) (the factor approach) or on understanding the various stages of diffusion process (the stage approach). Research on the factor approach generally resembles the typical diffusion studies which examine some form of adoption of innovations by individuals, which is the dependent variable. While research on the stage approach has studied the processes by which new technologies and systems are created and incorporated into the organizations (Prsecott & Conger 1995; Wolcott et al. 2001).

It is believed that KMS adoption and diffusion is a multifaceted phenomenon that takes place in a variety of ways over time (Wolcott et al. 2001). Rogers (1995) suggests a five-stage of innovation diffusion model: agenda-setting, matching, redefining/restructuring, clarifying, and routinizing. The five stages model can be simplified into three broad phases: Initiation, Adoption,

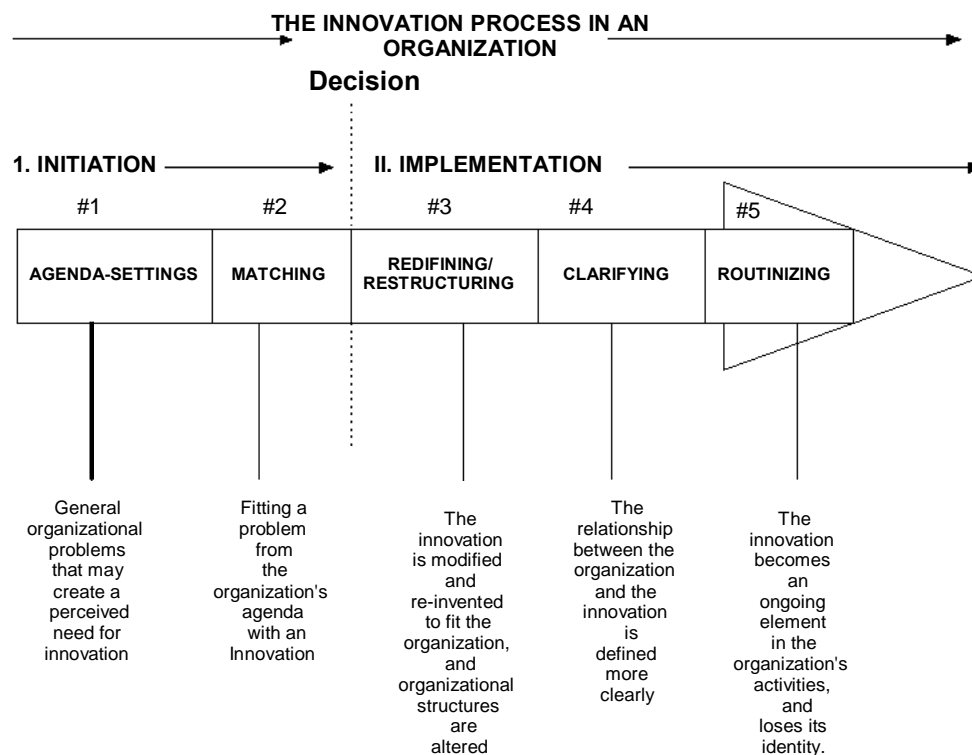


Figure 1: Five Stages of the Innovation Diffusion Process (Rogers 1995)

and Implementation. The initiation stage deals with the information gathering, conceptualizing, and planning for the adoption of an innovation, leading up to the decision to adopt (adoption stage). In the implementation stage, all of the events, actions, and decisions involved in putting an innovation into use are executed (see Figure 1).

At the same time, past studies, such as Kwon & Zmud 1987; Huff & Munro 1985; Cooper & Zmud 1990; Nilakanta & Scamell 1990; Brancheau & Webtherbe 1990; Gerwin 1988; Cash & McLeod 1985; Lewin 1952; Nolan 1973; Kanter 1988; Walton 1989; Applegate 1992; Grover & Goslar 1993; Rogers 1995; Rai 1995; Carter et al. 2001, among many others, have provided some various stage models of innovation diffusion, but they basically start with the initiation stage and finish with the diffusion stage. For example, Kwon and Zmud (1987) report such a stage model for innovation implementation process of initiation → adoption → adaptation → acceptance → use → incorporation. The study reported in this paper tested a six-stage of KMS diffusion process of initiation → adoption → pilot implementation → organic growth → organizational implementation → diffusion (sustained use), which is part of a comprehensive KMS adoption and diffusion model (see Figure 2) and is derived from field studies and literature review (Xu 2003).

3. Research Method

This study uses a mixed methodology approach. The research was carried out in three stages: field study, pilot survey, and national survey (top 1500 companies). In the first stage, a comprehensive model of KMS diffusion in organizations through a combination of literature review and qualitative field study was produced. Six companies took part in this phase, which resulted in eight interviews with key person(s) in the companies. The interviews were transcribed by the researchers and the contents were analysed thoroughly using a structured process. The content analysis and further refinement resulted in 16 factors and 72 unique variables. Company specific individual diffusion models were first developed which were then combined to develop a comprehensive KMS diffusion model. In the second stage, a questionnaire was developed based on the combined model. Twelve West Australian companies were randomly selected for the pilot study. The questionnaire was distributed to 125 functional and senior level managers in these companies. 25 valid responses were received. The results of the pilot survey proved the effectiveness of the questionnaire. Finally, the data of the study is collected through surveying the top 1,500 organizations (based on revenue) in Australia. The questionnaires were distributed to 1500 managers in those companies, who appeared to be most relevant to our study. In the end, there were 285 valid responses. The data of the national survey was analysed

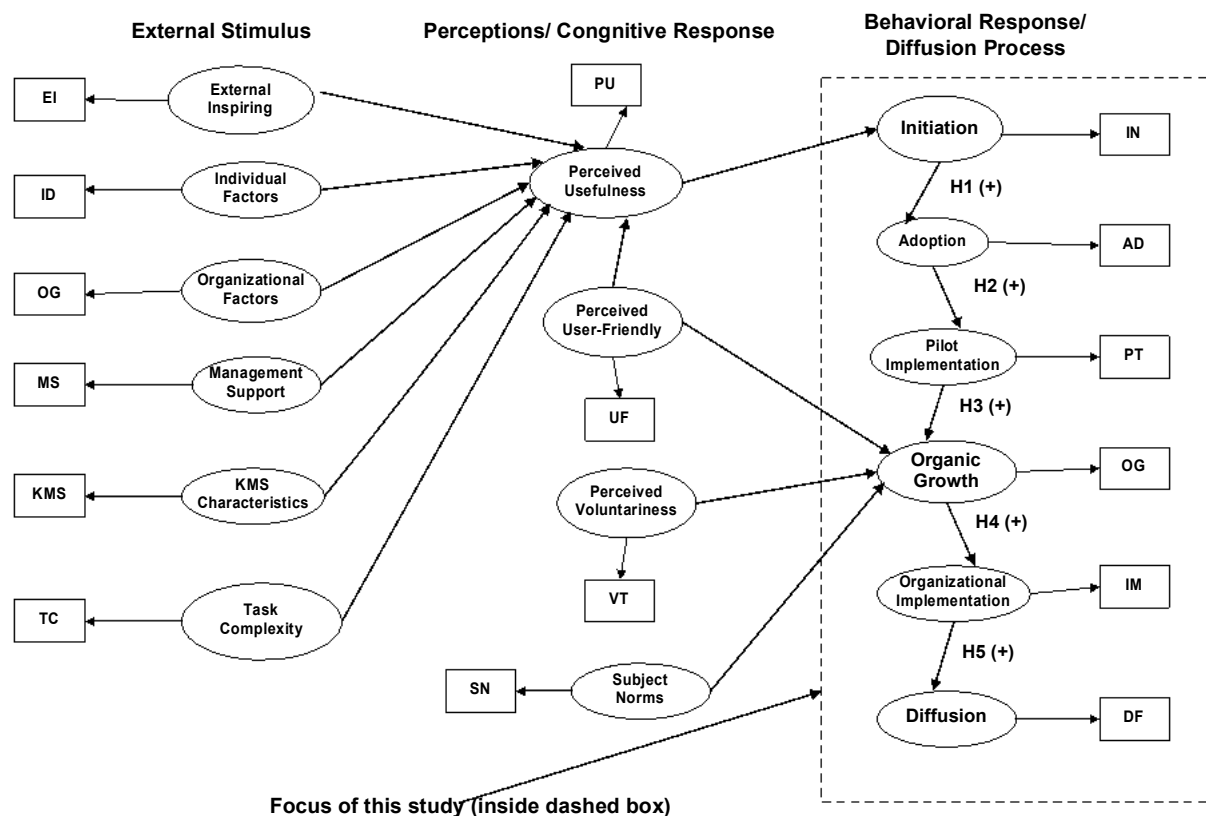


Figure 2: The Research Scope of This Study

through Structural Equation Modelling approach using LISREL, which resulted in a valid KMS adoption and diffusion model. The details of the three phases of the study can be found in Xu, Quaddus & Wood (2001); Quaddus, Xu & Wood (2002); and Quaddus & Xu (2002), respectively.

4. Hypotheses Development

During the field studies many participants talked about their organizations' dream of knowledge management system. There exists a shared opinion among the interview participants that organizations should have a knowledge management system to manage and control their knowledge in a more systematic and effective way. Brooking (1999) suggests that the best way to initiate a knowledge management system is to look at the real knowledge resource in the organization and see how that resource can be best managed.

After organization's effort in scanning the alternative solutions to effectively manage knowledge and researching in people's knowledge needs as well as available applications, a decision is made whether to adopt a KMS or not. In the case of successful initiation of

KMS, which is reflected by that KMS meets the organization's needs to manage knowledge and KMS is the best solution to control its knowledge assets, organization will make an adoption decision.

Organization should go through pilot tests until satisfaction of people's knowledge management needs is met (Phillips Fox 1998). Organizations should build their knowledge management systems with the users. When they are developing their knowledge management systems, they should listen to the users and act on what they suggest. That will help enhance the value of the systems and facilitate the users' 'buy-in'/acceptance of the systems.

When an organization is implementing a knowledge management system, it has the option to try and test the knowledge management system in smaller subset of users to begin with, instead of targeting all the potential users in the entire organization. The organization may limit the initial use of KMS to a single function (i.e., production, marketing, R & D) to a single division, and expand the use of KMS into the whole organization after having adequate experience with the system (Bansler & Havn 2002). The process of pilot-testing of a KMS with smaller and usually more homogeneous subset users may greatly facilitate the success of starting up the system. Benefits of

going through pilot-testing stage in a smaller and more homogeneous group users are: Firstly, it enables the system designers to better address individual users' interests and needs and achieves a good "fit" between the system and organizational context. Secondly, it can entice and educate the users to use the system by allowing organization to focus on certain part of the organization and thus take into the local characteristics of that specific part of organization, such as circumstances, values, etc., into consideration when the organization is planning to implement the system. Thirdly, the success of the first implementation in one part of the organization will have a positive influence on perceptions of the system in other parts of the organization, which will in turn lead to subsequent implementations. Fourthly, in the worst scenario, even the pilot implementation is eventually not successful in spite of careful planning and intensive efforts in achieving the critical mass of KMS use, the losses are more limited and in a smaller scale (Bansler & Havn 2002).

Meanwhile, organizations should persuade and educate people to use the knowledge management system. The most difficult part in knowledge management systems from cultural perspective is making people to understand that sharing knowledge and using the systems will bring benefits not only to the organization but also to themselves (Brooking 1999).

Pilot implementation is important in putting a knowledge management system into organization since it provides organization opportunities to optimise their knowledge management system and make adjustment on their structure and culture to facilitate the successful implementation of knowledge management system in organization. Meanwhile organic growth plays important role in putting a knowledge management system into organization, since it makes people interested in knowledge management system. Also, it gives people the capability to use the system.

Following the stages of pilot implementation and organic growth, it is time to implement the knowledge management system in the whole organization since both organization and individuals are ready for the knowledge management system. Organizational implementation deals with putting knowledge management system in every corner of the organization and every one in organization is expected to use the system. In organizational implementation stage people normally try to use all the functions of the system instead of limited usage in the stage of pilot implementation. It is noted that, factors such as optimized knowledge management system, pro-knowledge management structure and culture, people's willingness and interests in using the knowledge management system, and people's ability to use the system, can not guarantee the success of organizational implementation of knowledge management system. In order to successfully implement knowledge management system in the whole

organization, organizations should take pro-active actions.

One of the most frequently asked questions about knowledge management systems is "how do you know people will use them"? (Brooking 1999, p.128). Instead of compensating employees for sharing their knowledge, organization should make people understand that use of knowledge management system is part of their job to comply and is a part of culture - "the way we do things around here" (Brooking 1999, p.128).

After organizations implement the knowledge management system in the whole organization, people in the organization start to use the system. At this stage, organizations face another challenge - how to make sure people's sustained use of knowledge management system. Sustained use of knowledge management system means that people will use the system and using system has become a part of business as well as a part of people's life. For the purpose of achieving people's sustained use of the system, organizations should promote best practices of knowledge management and knowledge management system, keep on providing what people want in knowledge management system, encourage people's more usage and involvement in knowledge management and knowledge management system, make using the system as a part of the business, and make using the system a part of people's life in organization.

Gray (2000) suggests that increased number of employees specializing in knowledge management arising from the use of KMS will result in more increased use of the system. The author proposes that increased solution effectiveness through the use of KMS will lead to the enhanced perceptions of usefulness of KMS, which links to the higher level use of KMS.

As per the above the discussion, the following five hypotheses, related to the sequence of the KMS diffusion process, are suggested:

Hypothesis 1: Successful "Initiation" of KMS positively influences the "Adoption" of KMS in organizations.

Hypothesis 2: Successful "Adoption" of KMS positively influences the "Pilot Implementation" of KMS in organizations.

Hypothesis 3: Successful "Pilot Implementation" of KMS positively influences the "Organic Growth" of KMS in organizations.

Hypothesis 4: "Organic Growth" of KMS positively influences the "Organization-wide Implementation" of KMS.

Table-1 Results of Hypothesis Testing

Structural Relations Independent → Dependent Variables	Hypothesis	Standardized Path Coefficient β (t-value)	Significance of Hypothesis (5% level)
Initiation → Adoption	H1	0.872 (20.291)	Yes
Adoption → Pilot Implementation	H2	0.915 (20.429)	Yes
Pilot Implementation → Organic Growth	H3	0.171 (2.101)	Yes
Organic Growth → Organizational Implementation	H4	0.994 (26.816)	Yes
Organizational Implementation → Diffusion	H5	0.995 (28.018)	Yes

Hypothesis 5: “Organization-wide Implementation” of KMS positively influences the “Diffusion” of KMS in organizations.

5. Results and Discussions

5.1 Hypothesis Testing

The set of hypotheses (H1-H5) deals with the diffusion process of KMS and is tested using the t-value. The path is statistically valid or significant at the level of 5% if the t-value is greater than ± 1.96 . Results of the structural model analysis in LISREL are presented in Table-1. A number of previous studies have dealt with various stages of the diffusion process in general and in specific applications (see Rogers 1995 and Quaddus 1995; among many others). To the best of researchers' knowledge no empirical test of the sequences of these stages are available in the literature. Almost every diffusion process starts with initiation of some kind and ends with the large scale spread in use of the technology. In this study similar approach in determining the diffusion stages of KMS had been taken. However, it is noted that the diffusion stages in this study are first determined from the literature and then further refined during the qualitative field study process. The results show that all the hypotheses related to the sequence of the KMS diffusion process (H1 – H5; Table-1) were significant.

5.2 Further Analysis by Examining Direct, Indirect and Total Effects

After testing hypotheses, the model of KMS adoption and diffusion is further analysed by examining the total (i.e., direct and indirect) effects of structural part of the model. Total effect is the sum of direct effect and indirect effect. Direct effect is between two latent variables, which are connected or linked by a directed line or one-way arrows. In LISREL, a direct effect is measured by structural coefficients. An indirect effect between two latent variables, where there is no single straight line or arrow directly linking them, is defined when the second latent variable may be reached from the first latent variable through the mediation of one or more other variables. An indirect effect is reflected by the product of the structural

coefficients of all involved latent variables (Joreskog & Sorbon 1996a; Schumacker & Lomax 1996).

The effects among stages of KMS diffusion process are reported in Table-2. Initiation of KMS had significant direct effect on adoption (H1, $\beta = 0.872$ with $P < 0.001$). Initiation had significant but indirect effects on pilot implementation (0.798 with $P < 0.001$), organic growth (0.136 with $P < 0.05$), organizational implementation (0.135 with $P < 0.01$), and diffusion of KMS (0.135 with $P < 0.05$), mainly through adoption. The total effect of initiation on adoption (0.872) is greater than its total effect on pilot implementation (0.798), organic growth (0.136), organizational implementation (0.135), and diffusion of KMS (0.135). This implies that Adoption is the best choice after the initiation in the KMS diffusion process rather than pilot implementation, organic growth, organizational implementation, and diffusion of KMS. In other words, when an organization embarks on the adoption and diffusion of KMS, it is necessary to go through the stage of initiation before it proceeds to other stages of KMS diffusion process. Similarly adoption had significant direct effects on pilot implementation (H2, $\beta = 0.915$ with $P < 0.001$) and significant indirect effects through pilot implementation on organic growth (0.156), organizational implementation (0.155), and diffusion of KMS (0.155). The total effect of adoption on pilot implementation (0.915) is greater than its impact on organic growth (0.156), organizational implementation (0.155), and diffusion (0.155). This indicates that pilot implementation is the next stage of adoption in the KMS diffusion process rather than organic growth, organizational implementation, and diffusion. While pilot implementation had significant direct effect on organic growth (H3, $\beta = 0.171$ with $P < 0.05$) as well as significant indirect effect on organizational implementation ($\beta = 0.170$ with $P < 0.05$) and diffusion (0.169 with $P < 0.05$), organic growth is the best candidate for the subsequent stage after pilot implementation in the KMS diffusion, since its total effect on organic growth (0.171) is greater (even slightly) than its total effect on organizational implementation (0.170) and diffusion (0.169). Organic growth had significant direct effect on organizational implementation (H4, $\beta = 0.994$ with $P < 0.001$) and significant indirect effect on diffusion (0.989 with $P < 0.001$). Organizational implementation is

Table 2: Prediction of Stages of KMS Diffusion Process

Independent Factor→Dependent Factor	Direct Effect	Indirect Effect	Total Effect	Tested Hypothesis (Accepted ?)
Initiation → Adoption	0.872***	0	0.872***	H1 (Yes)
Initiation →Pilot Implementation	0	0.798***	0.798***	
Initiation →Organic Growth	0	0.136*	0.136*	
Initiation →Organizational Implementation	0	0.135*	0.135*	
Initiation → Diffusion	0	0.135*	0.135*	
Adoption →Pilot Implementation	0.915***	0	0.915***	H2 (Yes)
Adoption →Organic Growth	0	0.156*	0.156*	
Adoption →Organizational Implementation	0	0.155*	0.155*	
Adoption → Diffusion	0	0.155*	0.155*	
Pilot Implementation →Organic Growth	0.171*	0	0.171*	H3 (Yes)
Pilot Implementation → Organizational Implementation	0	0.170*	0.170*	
Pilot Implementation → Diffusion	0	0.169*	0.169*	
Organic Growth →Organizational Implementation	0.994***	0	0.994***	H4(Yes)
Organic Growth → Diffusion	0	0.989***	0.989***	
Organizational Implementation → Diffusion	0.995***	0	0.995***	H5 (Yes)

*P < 0.05, ** P<0.01, ***P<0.001

the better immediate linking stage after organic growth than diffusion in the KMS diffusion process, since the total effect of organic growth on organizational implementation (0.994) is higher than the total effect of organic growth on diffusion (0.989). Finally, organizational implementation had significant direct effect on the diffusion of KMS (H5, $\beta = 0.995$ with $P < 0.001$). In summary, KMS diffusion consists of six stages: initiation, adoption, pilot implementation, organic growth, organizational implementation, and diffusion in that order.

6. Conclusions

This research identified six stages of KMS diffusion based on the results from selected Australian companies as: initiation, adoption, pilot implementation, organic growth, organizational implementation, and sustained use/ diffusion of KMS. The identification of six-stages of KMS diffusion process is an important finding. In prior studies, researchers have come out with various stage models of innovation diffusion. But this study brings out a new stage of diffusion -organic growth, which reflects the individual learning and use of KMS. It also highlights the need for pilot implementation before the whole organizational implementation. The KMS adoption and diffusion model shows the detailed stages of KMS diffusion from “initiation” to “sustained use”. The direction of arrow indicates the sequence of the KMS diffusion stages.

The results have both managerial and research implications. The results of this study will add value to the literature of knowledge management. Organizations, which are practicing knowledge management or are

preparing to embark on knowledge management system should plan the process carefully in accordance with the sequence of these six stages. A clear planned sequence, as follows, can be adopted for the effective diffusion process of KMS.

- ⇒ Research the organization’s challenges and people’s needs regarding knowledge, i.e., identify the important knowledge domains for organization.
- ⇒ Search for suitable applications for KMS.
- ⇒ Develop a KMS plan/strategy.
- ⇒ Allocate a budget for KMS.
- ⇒ Appoint a Knowledge Manager or a Chief Knowledge Officer.
- ⇒ Build up/ Set up KMS.
- ⇒ Test KMS through pilot implementation on a limited basis in the organization and optimise the system according to feedback.
- ⇒ Work on the organizational culture and structure to facilitate the implementation of KMS.
- ⇒ Entice and educate people to use the KMS.
- ⇒ Provide people with continuous training and support to encourage their use of KMS.
- ⇒ Encourage people to go through the process of self-learning.
- ⇒ Implement the KMS throughout the organization.
- ⇒ Cut off people’s old means of accessing knowledge.
- ⇒ Develop organizational wide interest in using a KMS.
- ⇒ Monitor and check people’s usage of KMS.
- ⇒ Keep on providing the knowledge people want in the KMS.

- ⇒ Promote best practice.
- ⇒ Develop and encourage people's sustained use of KMS.
- ⇒ Make KMS and using KMS a part of business.

Finally, even though the research was conducted in Australian organizations, its results will apply to different organizations in various countries across the globe because of its generic approach.

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The Impact of Electronic Business on the Organisation

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Abstract

E-business is fast becoming an important initiative for companies to consider, one that impacts every aspect of how a business is run. This report investigates the impact of e-business implementation on various aspects of the organisation including; strategy, human resources, customer relationship management, the IT department, technology, the business environment, trust, service management and performance metrics. Implementing e-business applications will require process redesign, organisational restructuring and alignment, new job descriptions and reviewed and revised policies. Organisations will also have to examine tax, legal and security issues. E-business is changing all the rules and models. An organisation's ability to embrace new technology and business models is key to increasing the organisation's productivity. The Internet economy necessitates a fundamental transformation of traditional organisations. The true benefit of e-business is achieved through the digitisation of the entire value chain. For a successful e-business implementation it is important that decision-makers understand the nature of these changes, their potential impact, plan for them and manage the entire process in such a way as to ensure buy-in of all the relevant stakeholders. The decision to implement an e-business initiative should not be undertaken lightly and the benefits that can be gained from such a venture must be investigated thoroughly before deciding to go ahead.

1. Introduction

Timmel [24, p.22] quotes W. Krenz, Vice President of A.T. Kearny as saying "In 1999, the best chemical company had the best chemists. In 2005, the best chemical company will have the best e-professionals." This is true not only for companies in the chemical industry, but for all companies in all industries. E-Business is fast becoming an important initiative for companies to consider, one that impacts every aspect of how a business is run. This report investigates the impact of e-business implementation on various aspects of an organisation. The way in which companies and end-users conduct business will change, ultimately driven by the emergence of new business models brought on by the evolution of the Internet.

Hecker [10] defines e-business as any process that a business organisation conducts over a computer-mediated network. It includes buying and selling, as well as a wide range of customer-, production- and management focused processes carried out by for-profit, government or non-profit entities. E-business is based upon the processing and transmission of digitised information, including text and visual images from one computer or some other electronic device to another. E-commerce is that part of e-business which involves buying and selling goods and services. According to Agarwal, e-business is any net-enabled business activity that transforms internal and external relationships to create value and exploit market opportunities driven by new rules of the connected economy. Furthermore, e-business involves the continuous optimisation of an organisation's value proposition and value-chain position through the adoption of digital technology.

Implementing e-business applications will require process redesign, organisational restructuring and alignment, new job descriptions and reviewed and revised policies. Implementing e-business applications will also require organisations to examine tax, legal and security issues [13]. E-business is changing all the rules and models. An organisation's ability to embrace new technology and business models is key to increasing the organisation's productivity.

E-business impacts the value-chain processes in the exchange of goods, money, services and information. Basic market elements – who, what, when, where, how and why – are being radically altered by e-business. As companies incorporate e-business into their processes, a number of unique secondary effects are taking place. These effects include customers becoming more empowered, product development processes becoming more collaborative and marketing techniques becoming more targeted [12].

E-Business is focused on improving business performance through connectivity by deploying new technologies in the value chain to achieve transparency / visibility and also by connecting the value chains between and across external businesses and between business partners in order to obtain competitive

advantage, generate top line growth, reduce overall costs and open new channels. This definition of e-business extends well beyond the buy-sell relationship to include a transformation of the way to do business. If properly implemented, e-business can help an organisation to improve relationships with customers, increase revenues and cut costs.

E-business influence on an organisation can impact business efficiency and should be felt across the organisation ± from the time the sales force initiates a transaction, through the manufacturing and service cycles, right up until the time when the customers pay their bills. The impact of e-business on a company's effectiveness is found in its overall financial well-being. E-business is not just about buying over the Internet; it is about increasing the value of the organisation by improving the way it operates.

According to GMT [9] and Dalton [6] using ICT technology businesses can achieve significant improvements and cost reductions in several key functions in various departments, including

- Human resource services such as benefits, retirement planning and job postings.
- Internal communication.
- An executive information system.
- Purchasing.
- Sales force automation and management.
- Product development teams.
- Knowledge management.
- Improving relationships with partners.
- Improving time to market.
- Reducing operational costs.
- Increasing employee communication and satisfaction.
- Maintaining a competitive edge.
- Improving customer satisfaction.

The Internet economy necessitates a fundamental transformation of traditional organisations. The true benefits of e-business are achieved through the digitisation of the entire value chain [2]. Some of the most common benefits of e-business include streamlined sales processes, enhanced customer relationships, reduced operating expenses and dramatic improvements in productivity and operating efficiency [26].

2. Strategy

The implementation of an e-business has a significant impact on a company's existing strategy as well as strategy formulation. The basis for an effective e-

business strategy is an understanding of the company's business goals ± not its e-business goals. E-business is a way to facilitate improvements in a company's processes, in addition to allowing a company to expand market penetration, geographical markets, etc. Therefore, the processes that will be integrated into the e-business infrastructure must be both known and ready for integration. To implement e-business without understanding the company's business goals or processes is likely to lead to e-business failure [15]. Much like long-range business planning, e-business plans must be re-evaluated and adjusted on a regular basis. An e-business strategy is not a one-time event. It is an iterative process. In today's e-economy traditional planning horizons tend to be too long for the very fluid state of e-business. Continuous planning with feedback has evolved as the strategy of choice for the fluid and volatile e-environment [23].

In a survey conducted jointly by Information Week and Business Week, IT and business executives from all industries agree that generating new sources of revenue isn't the main goal of deploying e-business initiatives. In fact that ranked well behind creating or maintaining a competitive edge, improving customer satisfaction and keeping pace with the competition [6].

The ability to react and change direction is critical. Speed is everything. Grounding the organisation with sound, winning strategies is key [1]. E-business enabled organisations must be ready and able to adjust their business and IT strategies rapidly, depending on unpredictable competitors and market pressures. Today's e-business climate requires the continuous optimisation of an organisation's business and IT strategies. Because IT now has such a significant impact on every business process ± from order taking to inventory to billing ± both business and IT strategies are now developed in parallel.

The lack of a well-thought-out e-business strategy has led to some disastrous missteps [18]. In the past, businesses had the luxury of developing business strategies in the boardroom and information technology (IT) strategies in the IT department. They then brought these strategies together to run the overall business. A company implementing an e-business strategy cannot afford this luxury. Technology is no longer an afterthought in formulating business strategy, but the actual cause and driver [23].

According to Agarwal strategy and execution are key to developing and sustaining a successful e-business initiative. Only those organisations that successfully integrate key business strategy and processes dramatically increase their efficiencies. To be successful, organisations must also form the right strategic relationships and develop efficient business processes with robust back-end solutions that are able to meet users' demands for real-time service today and into the future. According to Barua, Konana, Whinston & Yin [2]

the achievement of e-business operational excellence will lead to improved financial performance. Based on this premise, the central task for senior managers lies in understanding what drive operational excellence in the e-business realm, and then committing the necessary resources to the development of the drivers.

E-business plans must be devised as part of the corporate strategy and must take into consideration the impact e-business will have on processes, governance and people. It is important that companies create a single coherent plan, formalise decision-making procedures and communicate e-business initiatives across the organisation and integrate the e-business plan with corporate goals [21].

An e-business implementation will also result in a company redefining their partner relationships, resulting in more cohesive, mutually beneficial partnerships [21] and management having to re-think all channels (Internet, telephony, store, mail order, etc.) and redesign how and who delivers their product or services [21].

Developing and communicating a strategy has become essential to realising the benefits that e-business can provide. Regularly reviewing and updating the e-business strategy is equally important because the competitive landscape and Internet environment are constantly changing [18].

According to GMT [9] the following must also be considered once a company has decided to embark on an e-business initiative.

1. Industry and company readiness: Is our company or industry prepared for e-business? Should we rapidly develop e-business capabilities? How will our internal processes and skills need to be altered to make a successful transition to e-business?
2. Channel conflict: How will our channel partners react to our entrance to the e-business realm? How large a risk is channel conflict? What steps can we take to mitigate that risk?
3. Prioritising e-business initiatives: Which elements of e-business need our immediate attention? Which projects should be funded and which need to be placed on hold?
4. Market models: Which models are successful for an organisation such as ours? What considerations need to be made before adopting a market model?
5. Organisational design: What changes need to be made to our existing internal structure to facilitate our e-business initiative? Which organisational structures work and which do not? How can we ensure employee buy-in?

Wilder [25] reports that the Internet and communications technology have changed the way

companies view their IT investments. For many companies launching e-business initiatives that advance strategic goals are more important than getting a hard-dollar return. As companies launch electronic-business projects, many are discarding their conventional thinking about the need for a return on investment and focussing on how the initiatives advance their overall business strategy ± whether it is to improve customer satisfaction, increase brand awareness or open new sales channels.

2.1. Assessment of company operations.

Implementing e-business requires that managers assess a company's operations by looking at both traditional and e-business measures. While most companies have a handle on the former, many are less focused on tracking e-business measures, including the percentage of an organisation's total business that has been transacted online, the percentage of goods purchased online from suppliers, the number of existing customers doing business online, the number of new customers acquired online, and the percentage of customer service requests handled online [2]. In order to achieve e-business excellence, managers must focus on three areas, namely e-business processes for customers and suppliers; IT applications for customers, suppliers and internal operations (all of which must be integrated); and the e-business readiness of customers and suppliers [2]. To achieve operational excellence and subsequent financial gains, managers must evaluate how processes align with e-business transformation, while encouraging the participation of suppliers, customers and internal constituents [2].

2.2. Major success factors for e-business

The following major success factors identified by Phan [17] must be incorporated into a company's strategy to ensure success:

- Internet technology fully integrated into the company's overall strategy.
- Competitive advantage maintained in both operational efficiency and distinctive strategic positioning.
- Basis of competition not shifted from traditional competitive advantage such as cost, profit, quality, service and features.
- Company's strategic positioning well maintained.
- Support from top management.
- Buyer behaviour and customer personalisation.
- Quick time to market.
- Right system infrastructure.
- Good cost control.

- Good e-business education and training to employees, management and customers.
- Customers' and partners' expectations well managed.
- Good products and services offered by e-business.
- Current e-business systems expanded to cover entire supply chain.
- New competitors and market shares tracked.
- Website of high quality that meets or exceeds user expectations.
- Company's virtual marketplace established.

2.3. Requirements for a sound e-business strategy

Ernst & Young reports that without a clear e-business strategy, there is a real risk that the link between the existing business strategy and any e-business initiatives will be unclear or even non-existent. It is likely to be difficult to define and measure how initiatives will benefit the organisation if the strategic goals they support have not been defined. Ultimately this means inefficient use of both funds and talents. In addition, development of a strategy typically forces consideration and acceptance of risks. E-business presents greater uncertainty. This reinforces the need for formal risk management strategies, which regularly assess and monitor the profile of new and identified risks whether internal or external. Ernst & Young has identified the following eight steps to a sound e-business strategy:

1. Develop an e-business strategy that is part of or fits with the main business strategy. The time horizon is likely to be shorter than those in the past. There may be a greater number of options considered and initiated, often referred to as a portfolio approach. The strategy may need to be expanded from the traditional content to consider risk around confidentiality and availability of information.
2. Assess the impact of e-business initiatives on existing internal and external processes and channels to ensure they are complementary and not counter-productive. A good website can be let down by inefficient or poorly interfaced supporting business processes. Evaluate options and be realistic about benefits and costs.
3. Consider the business organisation and the competitive landscape. Rapid changes force frequent review of goals and potentially require greater courage to discontinue less successful initiatives and start new ones.
4. Apply the same rigor and challenge to your e-business strategy as you would to other business programmes and initiatives. Use robust project

management to monitor costs and timescales on projects that typically have shorter timescales. Honest reporting is key to making tough decisions and halt projects if necessary.

5. Reassess your current risk culture to assess whether it meets the needs of a business model that is open to third parties through enhanced connectivity. Develop an enabling risk management strategy and framework that robustly consider the real likelihood and impact of risks.
6. Consider the impact of others on your brand and reputation, as well as the impact of your organisation on their environment.
7. Build in security at the outset \pm the common guidelines about it being significantly more expensive to add controls after implementation still apply.
8. Be innovative, but don't make unfounded assumptions. While you should not ignore your usual processes and controls, you should not be resigned to them.

3. Human resources

It is important to have the right people in place to take on the significant changes demanded by e-business [21]. Because of the fast change e-business related technology is going through, more is expected of employees than before, and today's expectations won't be the same tomorrow [3]. In this evolving economy, workers are constantly asked to update and expand their own skills sets, much as companies are shifting business processes to meet market demands. Cross-functional training and empowering employees are techniques that can be used to improve employee skills sets. Boomer [3] reports that 76% of IT professionals feel that e-business facilitates cross-functional work teams, which has a significant impact on employees' workloads and the company culture. Cross-functionality also provides many employees exposure to new issues. The E-business Agenda survey conducted by Information Week and Business Week reported that 82% of IT professionals surveyed agree that growth and change are making more work for all employees, up from 77% 18 months ago. Employees have more tools at their disposal to help complete daily tasks. There are intranets to simplify internal issues, the Internet to do outside research, and word processing programmes that virtually write letters and reports on their own.

The survey conducted by Information Week and Business Week found that e-business is having a significant impact on most employees. 80% of surveyed companies said that employees are burdened by new skills requirements, 73% said that e-business has spurred additional employee training and 55% of respondents said that e-business has forced individual employees to take on more responsibilities. IT and business executives reported that e-business increases the need for technology

skills, employee training and the need to work cross-functionally.

Setting up cross-functional groups is easy, getting them to operate smoothly is not; the challenges are enormous. Different members of a group may have conflicting ideas about how to code certain documents and regulate access to them via the company's intranets or extranets. Resolving problems requires a common view of the organisation from the perspective of the customer base [6]. Fostering cross-cultural operations may require formation of a hybrid group in the IT department consisting of employees who have both technical expertise and business acumen. Each person should be aligned with various business functions such as fulfilment, supply chain, and finance and work with process advisors from those areas to help leverage technology to improve productivity. Today, cross fertilisation between business and IT is happening at the most senior levels. Historically this did not happen [6].

Because of its increasing pervasiveness, e-business may be affecting output per worker and employment in virtually every industry. E-business is leading to the automation of some job functions and replaces others with self-service operations, raising output per worker and dampening employment requirements in some occupations [10]. E-business which automates many administrative support functions or makes them self-service, is expected to have a dampening effect on employment in administrative support occupations such as secretaries, general office clerks, human resource assistants, order clerks, bookkeepers, accountants, auditing clerks and word processors and typists. The reason is that much of the information that administrative support workers collect, manipulate and distribute can be digitised and transmitted over networks. Self-service systems permit an organisation's employees, customers, business partners and others to input and retrieve information from the organisation's computers without involving administrative support workers. This means that fewer workers are needed to answer questions, look up or enter computerised information, make reservations, produce and process documents and prepare mailings [10].

E-business applications in Human Resources are rapidly progressing toward an electronic delivery concept sometimes referred to as eHR [11]. The eHR model takes advantage of IT technology as a catalyst to redesign processes, empower employees at all levels and develop HR strategies that favourably impact the bottom line of the organisation. Initially eHR starts with putting content, transactions and modelling tools on the web (intranet). Ultimately an eHR organisation functions in real time where interactions are completed online through an aggregated and personalised portal. In an eHR model, technology drives capabilities out to the end users, enabling them to make fact-based decisions. The

technology also changes what is required of HR professionals and can support them in their new role.

4. Customer relationship management

The Internet has radically changed the notion of value as perceived by customers. Businesses have realised that today's consumer requires convenience in the shopping process: they require personalisation, want competitive prices and expect speed in service. Each business needs to evaluate how it can deploy technology in order to tip the value equation in its favour [23].

E-business is having an impact on customer relationships on various levels. The concept of customer sovereignty and the absolute necessity of firms satisfying customer needs is becoming a reality and it is changing marketplace behaviour. Furthermore a breakdown in specialised economic role of producers and consumers is occurring. Additionally, a system is emerging in which firms and customers increasingly interact and participate together in the design and delivery of offerings. Finally, as a consequence of both the process of interactivity and the development of "smart" or information-intensive goods, successful companies treat consumers as individuals and not as parts of larger aggregates or segments. Customer relationship management, one-to-one marketing and valuing the customer as the "new asset" ± as opposed to the product ± are becoming paramount to the organisation in the growing Internet world [12]. Customer relationships are becoming a more important factor in differentiating one business from another. In order to stay competitive, companies with e-business initiatives in every industry have begun to analyse these relationships with customers. Customer relationship management enables an organisation to adopt a comprehensive view of its customer to maximise the customer's relationship with the organisation and the customer's value to the company.

While e-business is reshaping the corporate landscape, it is also changing customer behaviours and expectations. This is specifically relevant for organisations involved in B2C e-commerce because the Internet has created an extremely demanding and information-sensitive customer [19]. Never before have so many value alternatives been available with such a level of convenience [26]. Organisations selling products or services online must be prepared to offer customers the best of both worlds: the ease of use of the Internet, combined with the high service levels they receive from brick-and-mortar retailers [9].

In a survey conducted by Information Week and Business Week, improving customer satisfaction ranked second only to creating a competitive edge as the best reason for an e-business initiative. Also, three out of four respondents said that as a result of their company's e-business deployments, they are listening more closely to their customers [6]. Technology not only increases the

ability of customers to communicate with companies, but free up customer-oriented personnel for more intensive responsibilities. As companies interact with their clients through electronic means, salespeople have increased face time and improved relationships with customers because many administrative tasks such as checking the status of orders are done on the Internet. However, as companies move many of their operations to the Internet, customers have easier access and insight into their inner workings. That means it is incumbent on businesses to know what they're doing. If fulfilment systems and procedures, for example aren't integrated with online storefronts, customers will be able to see that from the Web.

E-commerce is changing the way companies and their customers interact with each other. Traditional distribution channels, especially in the business-to-business sector, are being challenged. The Internet allows manufacturers to sell directly to their end-users. Buyers and sellers who used to rely on brokers, dealers, wholesalers and field salespeople now deal directly with each other [22].

4.1. Efficient consumer response

Until now the efficient consumer response (ECR) strategy has stressed the need to increase the end-to-end efficiency of the value chain in order to meet consumer needs better and faster. It has emphasised the importance of new replenishment processes, such as continuous replenishment programme (CRP), cross-docking and direct store delivery, as well as the need to establish electronic communication links in order to support them. The e-business paradigm goes well beyond that, relying not on the mere existence of electronic links between companies, but on the integration of processes at an inter-organisational level. It requires that information should flow continuously across the value chain in both directions, so that demanding operations at the interface with the consumer, such as home delivery, personalised service, lower prices, etc. are met faster, better and at less cost. This need becomes even greater for traditional companies in the sector, which have to compete with new distribution channels as well as cope with new competitive structures and new dynamics in the value chain [19].

The Internet forces companies to work directly with suppliers and customers in order to respond rapidly and intelligently to change. In addition e-commerce forces streamlining of the physical supply chain. In order to deal with change, companies and autonomous business units need an effective business design that allows them to react rapidly and continuously, innovate ceaselessly, and take on new strategic imperatives faster and more comfortably. In striving to succeed in the digital economy and gain a market advantage, companies must exploit the potential of successful partner relationships [19].

5. IT department

E-business is fundamentally changing the way IT departments function resulting in a realignment of the department's role within the business hierarchy [16]. This change is inevitable because the notion that e-business tools and concepts can be bolted onto current practices is a fallacy (Habershon in MacMillan 2000). IT and business must work together seamlessly, instantly updating inventory, processing complex orders and manufacturing on the fly. This represents a big change from the traditional manufacturing model.

e-business is placing increased pressure on IT by causing IT departments to reengineer and making greater demands on all workers in terms of job responsibilities and expanding skills [6]. As a result IT departments are hiring people with a mix of backgrounds and skills. Dalton [6] reports that regardless of industry, CIOs agree that achieving the right balance of skills in their departments is one of their toughest challenges. This is complicated by the fact that e-business increases the need for staff training.

Many IT managers have aspired to a greater role in the strategic business decisions of their organisations ± and thanks to e-business they are getting that wish. Due to e-business IT is becoming more tightly associated with business decisions. This is different from the past, when IT was simply given a project and left on its own to deliver it. IT needs to be part of business strategy sessions, both in terms of where the Web can take a company and delivering what customers want. Technology managers are expected to be more aware of the alternatives and opportunities for change and to enlighten business people about what they see evolving. In a survey conducted jointly by Information Week and Business Week, more than 70% of the 250 IT managers surveyed say that e-business has thrust their departments into a business decision-making process, almost 60% say e-business has forced IT to lead business-process engineering, 61% say that e-business has forced the IT department to reengineer and 60% said e-business has significantly changed the role of the IT department [6].

The survey also reported that 58% of IT executives say their staffs feel more empowered to engender change in the organisation due to the increased involvement of IT in the business reengineering process. The bad news is that 60% of IT respondents say that the constant change wrought by e-business increases job stress. Jim Noble, global head of IT strategy at General Motors Corp reports (in Dalton 1999) ^a that a sense of urgency pervades our IT function. We have to think in much shorter time cycles because the business wouldn't tolerate the latency we used to have.^o

While offering many advantages, e-business is creating a lot of challenges for IT managers, relating mainly to internal change and increased workload. It is

also requiring IT managers to communicate more effectively with staff and with the business side.

6. Technology

E-business is causing a change in how companies think about technology. This change is inevitable as the notion that e-business tools and concepts can be bolted on to current practices is a fallacy [16]. IT and business must work seamlessly. No longer relegated to the back office, technology has become an integral part of e-business enabled business processes. Reengineering is a tall order in any company, but integrating business and technology functions is especially difficult.

In trying to bring about e-business transformation, companies have generally focused too much of their attention on technology. But systems do not work in a vacuum, and senior managers must recognise the complementary nature of technology, business processes and e-business readiness throughout the value chain. By taking a more holistic view, managers can turn those facets of a company's operations into the drivers of e-business excellence.

Companies implementing an e-business initiative will have to replace or integrate formerly disparate systems and applications to improve decision-making capabilities and minimise redundant data entry and maintenance. Without seamless interfaces to administrative systems from Internet-based applications an e-business initiative will not succeed. As a result companies must address how e-business applications can be quickly be integrated with what already exists with minimal disruption to everyday operations and pre-existing investment [13]. It is critical to ensure that a company's technology and infrastructure competencies are adequate to support the planned e-business initiatives [21].

In an e-business initiative, technology shouldn't just be used to create the product. Technology must be used to innovate, entertain and enhance the entire experience surrounding the product, from selection and ordering to receiving and service [23].

7. Financial evaluation

According to Cohan [5] their research has found that large organisations are finding that traditional capital budgeting methods are difficult to apply to projects that employ Internet technology. E-commerce forces executives to adopt a non-traditional approach to measuring the payoff of a project. In traditional financial analysis, managers project the cash out- and inflows associated with projects. Discounting for the time value of money, managers calculate the net present value (NPV) of the project. If the NPV is positive, then managers should fund the project because it will generate value for the company in excess of the cost of the capital required to fund the project. If the NPV is negative

managers should decline to fund the project because it will subtract from the company's value.

If managers attempt to apply this traditional approach to analysing e-commerce projects they run into some practical difficulties. While the cash outflows associated with the project may be quantifiable, it is virtually impossible to estimate cash inflows that the project will generate. In the case of e-commerce for service provision, the future "cash inflows" are estimates of the number of people that will not need to be hired because the e-commerce application will perform a traditional process more efficiently. In the case of e-business for selling and distribution, the "cash inflows" may be measured in terms of the value of not falling behind competitors who are pursuing e-business initiatives. Because of these difficulties in estimating the cash inflows associated with e-business initiatives, Cohan [5] found that executives are developing new ways of measuring the payoff that leads to the decision whether or not to fund e-business initiatives.

Cohan's [5] research found that many executives view the cash outflows of an e-commerce initiative to be relatively small. Executives in established companies appear comfortable spending a relatively small amount of money to learn and experiment. With the experimentation come ideas for modifications to the original e-commerce project. These modifications also cost a relatively small amount of money, and result in an ongoing cycle of modest spending that generates useful insights for how to improve the e-commerce application. So the financial evaluation of the cash outflows for an e-commerce project has evolved into a process of quantifying the costs of a sequence of small learning experiments.

Similarly, the financial evaluation of the cash inflows from an e-commerce site has evolved into a process of estimating the likelihood that using the Internet to solve specific operating or competitive challenges facing the company would ultimately translate into some form of quantifiable value at an undetermined point in the future. This is a far cry from the traditional process of estimating future cash inflows and discounting them back to the present using the appropriate annuity discount factor.

8. Change management

In the modern e-business environment traditional change efforts don't work anymore. The speed of today's business environment means that companies must replace sequential change processes with parallel processing. That is, organisations must create strategy, build business and technical architectures and develop new cultures, skills and measures simultaneously. Strategy requires experimentation rather than months of analysis [4].

9. Business environment

E-business is changing the business dynamic and at the same time the Internet changes the traditional landscape of the business environment from that of being a marketplace to one that is more of a marketspace. This marketspace is an information and communication-based electronic exchange environment occupied by sophisticated computer and telecommunication technologies and digitised offerings (Berkowitz in Singh). The impact of this digitisation is evident in the following changes:

- The content of the transaction is different \pm information about the product often replaces the product itself.
- The context of the transaction is different \pm and electronic screen replaces the face-to-face transaction.
- The enabling infrastructure of transactions is different \pm computers and communications infrastructure may replace typical physical resources especially if the offering lends itself to a digitised format.

In marketspace the constraints of time, place, and geographic boundaries are completely eliminated [23].

10. Function lines in company

According to Rosen [20] the creation and maintenance of an e-business initiative can defy traditional functional lines within an organisation. The sales, support, operations and information services operations are directly affected by the e-business initiative. The likely effect on these operations is:

- Sales: Orders can be processed directly by customers. Sales cycles shorten and the number of customer calls decrease and their nature change. Customers don't require brochures, specifications and support sheets by mail since they can access this information from the company web site.
- Customer support and product service: Due to online shopping, the nature of questions will change. So will the access method, since customers will be asking questions through e-mail. Customers who shop online expect to be supported online. The support department needs staffing that can provide a quick response to e-mail questions.
- Operations: Traditional methods of ordering and fulfilling product orders will need to be integrated with new procedures developed to support the e-business.
- Information technology: Critical to the success of an e-commerce initiative is the integration of

e-commerce with existing computers and the identification of new processes and services. Web servers and web-enabled applications will need to be developed and supported. The IT department needs to be involved from the beginning to identify technologies and then integrate current and future systems.

Online shopping and purchasing affect the workings of the sales, support, operations and IT departments. In most traditional organisations these functions work apart from each other. An effective e-commerce service is the intersection of these departments.

11. Trust

E-business requires a greater degree of trust between a business, its partners and customers than in the traditional business model. Many businesses are therefore reluctant to fully embrace e-business. They feel uncomfortable in this new environment, and are concerned that better safeguards are required to protect against emerging, unfamiliar risks [14]. Even firms currently participating in e-business exhibit a fundamental lack of trust in many e-business processes. They worry about the confidentiality and authenticity of transactions conducted online and they have serious concerns about the fate of personal and confidential information once it enters cyberspace. Despite the tremendous growth projections for e-business, its full potential will only materialise if business partners truly trust e-business transactions. Trust is a fundamental component of any e-business strategy. Among e-business partners, trust is the product of each organisation's history, reputation, track record and patterns of behaviour [14]. Businesses that fail to assure third parties of the integrity, security and reliability of their operations run a very real risk of failure in their e-business initiatives. When deciding to embark on an e-business initiative it is therefore important for a company to address the trust and security issues in detail.

12. Service management

The concept of service management doesn't necessarily change in the e-business environment. Rather, the fundamentals become more crucial than ever and should be expanded to include all facets of the organisation. According to Habershon (in MacMillan 2000, p.6) ^a service management really does underpin e-business^o. E-business is forcing IT to stretch service management practices [16]. IT enabled service management (e-ITSM) should be based on processes that ensure the business runs successfully rather than on technical issues. What is different in an e-business environment is the scope of service management. To that end comprehensive risk and problem management should be conducted across the enterprise. e-ITSM should be equipped to handle quick changes and scalability issues. Service management must be uniform across all departments accessible through a common interface.

With respects to selecting service management tools, it is advisable to follow the best of breed approach.

13. Supply chain management

Integration of supply chain management (SCM) functions is emerging as one of the greatest challenges of companies embarking on e-business initiatives. SCM is the integration of business processes from end user through to original supplier. The goal of SCM is to create an end-to-end system that automates all the business processes between suppliers, distribution partners and trading partners. In an effective e-business initiative, the following SCM independent processes must be highly integrated: demand management, supply management and inbound/outbound logistics [1]. The digital economy has forever transformed the role of SCM. E-business and supply chains have merged, creating a network of immense opportunities. Supply chain structures have changed, and improving the performance of these supply chains is dependent on the use of e-business technology and innovation. Today's supply chain management systems, relying on technological breakthroughs, will propel the 21st century organisation into the digital world, where it's both a buyer's and seller's market. The companies who capitalise will have a dynamic, sophisticated supply chain aligned with their e-business strategy.

When implementing supply chain management, a company's management team must:

- Recognise the benefits an organisation can experience by incorporating the Internet and other IT technologies into its supply chain operations.
- Recognise the benefits of effective supply chain activities in an e-business environment.
- Match the business changes resulting from the use of technology and the Internet to organisational practices that reflect each.
- Match the three areas of impact to the value each adds to an e-business' supply chain.
- Identify the strategies for using technology to improve a supply chain's effectiveness.
- Use technology to effectively influence customer demand and fulfilment within an organisation's supply chain.
- Identify the strategies for effectively using technology to improve supply chain performance.
- Apply strategies to use technology within a supply chain to improve its performance in a given scenario.

14. Performance metrics

Although business fundamentals still exist and apply, companies that choose to change their business to utilise new technologies should be prepared for the fact that they will be judged and measured under a whole new set of rules. With technology and electronic transactions comes an expectation of immediate fulfilment. Managers, buyers and vendors believe that "all information is in the computer" and expect immediate status reports, reconciliations, etc. The electronic environment is real-time. Timeframes to produce and measure the success and failure of an E-business initiative are much shorter. E-business by nature is not entirely business as usual [15].

15. Conclusion

Incorporating electronic business in an organisation invariably has a significant impact on various operations and aspects of the organisation, causing changes in areas such as human resources, strategy planning, technological infrastructure and customer service. For a successful e-business implementation it is important that decision-makers understand the nature of these changes, their potential impact, plan for them and manage the change process in such a way as to ensure buy-in of all the relevant stakeholders. The decision to implement an e-business initiative should not be undertaken lightly and the benefits that can be gained from such a venture must be investigated thoroughly before deciding to go ahead. E-business plans must be devised as part of the corporate strategy and must take into consideration the impact e-business will have on processes, governance and people. It is important that companies create a single coherent plan, formalise decision-making procedures and communicate e-business initiatives across the organisation and integrate the e-business plan with corporate goals.

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A Fuzzy Clustering Model of Information Appliance

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Abstract

The purpose of this study is to propose a fuzzy clustering model of information appliances (IA). There are two sub-models, saying information appliance cluster engine (IACE) and user interactive model (UIM), in this model. The function of IACE is to process the users' recognitions of IA devices. The UIM is the interface of IACE with the IA intelligent agents (IAIA). Via the proposed model, the IAIA can be more humanistic, and convenient for user. Also, via the implementation of this model, we can have the analysis of the optimal effectiveness.

1. Introduction

Along with the prosperity of internet, information appliance (IA), plays an important role for the future. The IA devices can be expanded to related information products. A satisfactory IA control mechanism can promote the integrity IA facilities, also, it enable the home network system more comfortable and convenience.

Lee and Huang [1] proposed an IA controlling model (IACM), which can control IA devices through home management broker. Chang [4] proposed the controlling mechanism of UPnP network under client-server architecture. Lee and Chen [2] presented IA intelligent agents (IAIA) to ensure the security and convenience of home environment. Wu and Jan [3] proposed home network management system integrating WAP and SMS by mobile communication devices. The home network has been expanded from local control to remote control, and from physical control to wireless control.

In this study, we propose a fuzzy clustering model of IA (FCIA). Via the proposed model, the IAIA can be more humanistic, and convenient for user. Also, via the implementation of this model, we can have the analysis of the optimal effectiveness.

2. FCIA

We proposed the fuzzy cluster model of information appliance (FCIA) is in information appliance control model (IACM) as shown in Figure 1. FCIA can promote the group capability of IA intelligent agent for managing IA devices to receive the user's requirements for clustering of IA devices and response clustering results.

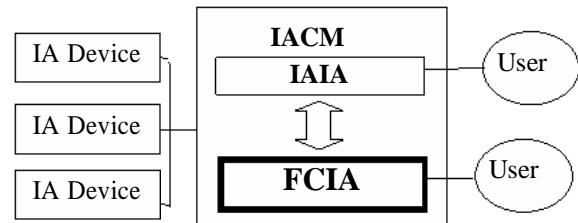


Figure 1 IA controlling model

There are two sub-modules, saying IA clustering engine (IACE) and user interaction model (UIM) in FCIA, as showing Figure 2. Also, there is an IA device database (IADD). The functions of these components are as the followings:

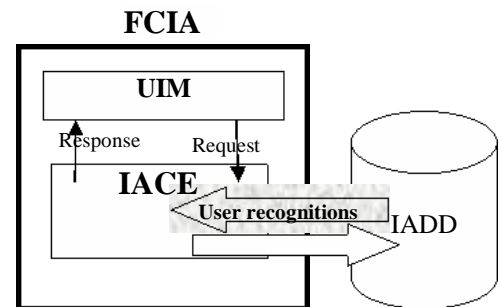


Figure 2 Fuzzy clustering model of IA

- IACE: IACE is the core of this model. The users' recognitions of IA device are clustered through fuzzy cluster.
- UIM: UIM plays the interface among users, IAIA, and IACE. The various operating parameters of IACE can be defined via UIM.
- IADD: IADD stores the individual user's recognitions of IA devices and the clustering results of IACE.

According to user's submission, UIM will request the clustering demands to IACE, then, IACE will response clustering results to UIM.

2.1 IACE

The IACE is responsible for clustering works of IAs. It processes user's recognitions of IA to cluster IA devices, and it facilitates the management of remote control. The Figure 3 illustrates the operation flow of IACE:

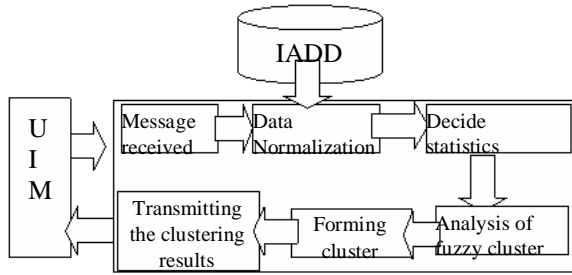


Figure 3 The operation flow of IACE

When the recognition of user are put into the IACE, the input and output will be transmitted to user through UIM. The format of data input, which is accepted by IACE, is shown in figure 4:

User_Name	Group_Numbe	λ-Valuee	Mode
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Figure 4 The Format of Data Input for IACE

User_Name represents the user who enters the engine. Group_Number is the cluster quantity of definition result. λ-Value is used for analysis of fuzzy cluster and the size of λ-Value will decide the number of cluster's category. The value of λ is between 0 and 1, larger the λ, less general the category, and smaller the λ, more refined the category. The Mode is responsible for distinguishing the mode of IACE used the current time, for example, 0 means proceeding clustering for all factors, 1 means proceeding clustering only for user's recognition with devices, 2 means proceeding clustering for data of hardware equipments.

As the user's recognition data are put into the IACE, the input and output will be transmitted to user through UIM.

After IACE receiving data, the step of entering IACE is – message received. The data received in the message format will be analyzed on this step, and then the command will be transmitted to the data normalization. The data will be acquired from IADD according to the command received. After acquiring the user's data from IADD, the procedure will enter into the step of data normalization, the data acquired from IADD will be normalized. The data format of IADD is shown in figure 5, $X_i (i|j>0)$ represents the category of IAs, and $Y_j (j|j>0)$ represents the conditions of measure. For the data normalization, we employ the formula (1) [7] to proceed normalization:

$$X_{ij} = \frac{X_{ij} - \{X_{ij}\}_{\min}}{\{X_{ij}\}_{\max} - \{X_{ij}\}_{\min}} \quad (1)$$

{Xij} Min represents the minimum of actual measurement value in row j
 {Xij} Max represents the maximum of actual measurement value in row j

After normalization, the data will be transmitted to the step of deciding statistics. The normalized data will be used to calculate the similarity of respective measurement attribute among IAs, consequently the fuzzy similar matrix is generated. For the IACE's deciding statistics, we apply the max-min method [7] as shown in (2):

$$r_{ij} = \frac{\sum_{k=1}^n \min(X_{ik}, X_{jk})}{\sum_{k=1}^m \max(X_{ik}, S_{jk})} \quad (2)$$

The fuzzy similar matrix is transmitted to the step of analysis of fuzzy clustering. The fuzzy similar matrix is clustered via the fuzzy clustering. We apply the netting method [7] and the maximum number method [7] for fuzzy clustering.

Finally, the clustering results are transmitted to UIM via transmitting procedure. IACE will generate the cluster of IAs.

	Y ₁	Y ₂	...	Y _n
X ₁	R ₁₁	R ₁₂	...	R _{1m}
X ₂	R ₂₁	R ₂₂	...	R _{2m}
...
X _n	R _{n1}	R _{n2}	...	R _{nm}

Figure 5. The storing method of IADD

2.2 The Weighing Factors of FCIA

This research incorporates the recognition conditions of security, entertainment, information acquiring, necessity for life, communication, comfort and convenience of devices and the recognitions of individual user of IA devices, as shown in Figure 6. The clustering information is acquired through IACE. Due to the different recognitions of individual user, the clustering results are different.

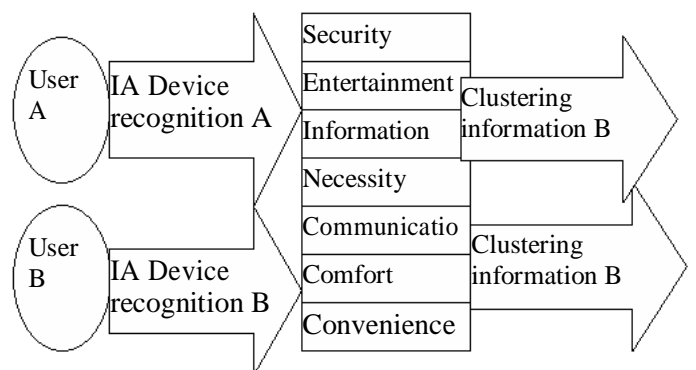


Figure 6 User's recognition

We ranged the user's recognitions of IA into seven grades, as shown in Table1. In many cases, we cannot express uncertainty problems simple by using the concept of probability. With the availability of concept of fuzzy set theory, we can solve the problem under fuzzy circumstances. Moreover, fuzziness can be quantified by using the properties of fuzzy numbers. We made the

linguistic values 1, 2, ..., 7 into corresponding reasonable fuzzy numbers with triangular membership functions.

Table 1 The Table of comparisons for semantic and fuzzy number

Fuzzy Number	Grade of relevance
$\tilde{A}_1 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_1 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$
$\tilde{A}_2 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_2 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$
$\tilde{A}_3 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_3 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$
$\tilde{A}_4 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_4 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$
$\tilde{A}_5 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_5 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$
$\tilde{A}_6 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_6 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$

Table 2 IA device of user's recognition

Device	Grade of relevance
$\tilde{A}_1 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_1 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$
$\tilde{A}_2 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_2 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$
$\tilde{A}_3 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_3 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$
$\tilde{A}_4 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_4 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$
$\tilde{A}_5 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_5 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$
$\tilde{A}_6 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_6 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$

The data will be stored in IADD. After normalizing user's recognition with IA devices, the data is presented in Table 3.

3. Implementation of IACE

In this section, we detail the practical environment for the model, and calculate the acquired data that describe AI's fuzzy clustering model by steps illustrated in Figure 6. Two clustering models are analyzed by maximum trees and netting mode, by substituting different λ interceptive value, different clustering models and the corresponding λ interceptive value can be obtained to represent the relationship between the clustering results. UIM's Web interactive Main interface will be presented at the end of this section.

Table 3 Normalization of user's recognition with IA devices

Device	Grade of relevance
$\tilde{A}_1 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_1 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$
$\tilde{A}_2 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_2 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$
$\tilde{A}_3 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_3 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$
$\tilde{A}_4 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_4 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$
$\tilde{A}_5 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_5 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$
$\tilde{A}_6 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_6 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$

3.1 Practical Environment

For the purpose of ease manipulation, cross-platform, and remote-control capability, we have applied Java Server Page (JSP) and Java Servlet written Web Server structure, and Java 2 Platform Standard Edition v 1.4.2 API Specification is utilized for constructing FCIA's model. This model is constructed upon Tomcat server software that employs browsers as its interface; above-mentioned are done with a Pentium III 700GHz Notebook that is powered by OS Windows Professional and Microsoft Access 2002 database.

3.2 Calculating Procedure of Empirical Data

IACE's fuzzy calculation is illustrated in this part as shown in Table 2. The diversity recognitions based on users' recognition on IA machine that may give a relevant level for machine and assessment factors.

Table 4 Matrix of IA device's fuzzy relation

Device	Grade of relevance
$\tilde{A}_1 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_1 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$
$\tilde{A}_2 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_2 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$
$\tilde{A}_3 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_3 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$
$\tilde{A}_4 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_4 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$
$\tilde{A}_5 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_5 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$
$\tilde{A}_6 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$	$\tilde{A}_6 = \{ \langle 1, 0.5, 1 \rangle, \langle 2, 0.3, 0.7 \rangle, \langle 3, 0.1, 0.9 \rangle, \langle 4, 0.1, 0.9 \rangle, \langle 5, 0.3, 0.7 \rangle, \langle 6, 0.5, 1 \rangle \}$

After data normalized, the similarity between each data would be calculated. This study would employ max-min method for showing the distance between each data, as in Table 4.

In addition, we show two fuzzy clustering methods as netting mode and maximum trees by fuzzy relation matrix R , and substituting different λ interceptive value, the compared and contrast diagram is shown in Figure 7.

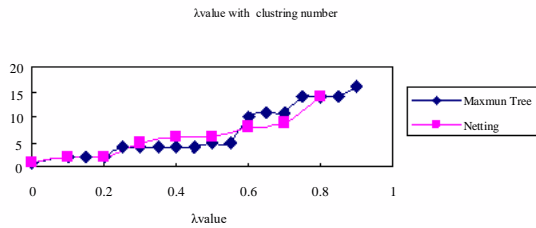


Figure 7 Diagram of with different λ interceptive value

With maximum numbers method and $\lambda=0.5$, then we obtained cluster result as in Table 6.

Table 5 maximum trees and $\lambda=0.5$ interceptive value

Cluster 1	Digital Washing Machine, Digital Microwave, Digital Fridge, Digital Deco Lamps, Digital Light,
Cluster 2	Home Server, PDA
Cluster 3	Digital TV, Notebook, Set-top Box, mobile phones.
Cluster 4	DVD Player, Game station
Cluster 5	Digital Air Condition
Cluster 6	IR Sensor, Temperature Sensor, Smoke Detector

3.3 System Prototype

This study designs the Fuzzy Clustering Models, as an UIM screenshot in Figure 8, which facilitate user's ease interactivity with IACE. Since it is web base, it is even more user-friendly.



Figure 8 Prototype of FCIA System

4. Conclusion

This study presents a prototype for FCIA model, and shows its feasibility empirically with the result analytically assessed. We made some comments about this model.

- (1) It would be more convenient to provide quantities of clustering instead of applying λ interceptive value.
- (2) As Figure 7, the suitable clustering results for two methods are between $\lambda=0.4$ and 0.6. In this range, maximum number method of clustering is more stable

than netting clustering method. Besides, maximum trees method is more economical in terms of calculating system data. Therefore, maximum trees method is preferable in this model.

- (3) As in Figure 6, the model presented in this study can cluster AI devices according to user's recognition. Clustering results may be assigned for different types of users.

As above mention, the FCIA makes IAIA be more humanistic, and convenient for user.

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Extending an E-Learning Model into Enterprise Resource Planning (ERP) Curriculum

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Abstract

The expansion of global education has created a new market for the e-education industry. Many universities have introduced distance learning programs and are trialling e-learning tools to support this expansion. Certain curriculum is more suited to the application of e-learning. The curriculum associated with the teaching of Enterprise Resource Planning (ERP) systems is one such area.

ERP systems offer a software-based system that handles an enterprise's total information system needs in an integrated fashion. Many universities have joined alliances with ERP vendors to allow the integration of ERP systems into their programs. This paper outlines the experiences of Victoria University in offering ERP education through a strategic alliance with the ERP vendor, SAP. The University is extending its offshore programs by offering ERP education in the Asian region and has developed an E-learning model to assist this expansion. The ERP e-learning model blends synchronous and asynchronous content. Asynchronous e-learning does not involve the presence of a teacher. Typically the learning content is located on a web server that students can access using the Internet. 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. The model uses four technologies to facilitate teaching: application service provision (ASP), web-CT, computer-based training and virtual classroom technology. The ERP e-learning model provides an innovative and efficient means to deliver ERP curriculum. It is able to provide greater flexibility in offshore subject delivery and to maximise student learning outcomes. This is particularly relevant in light of recent international medical (SARS) and terrorists incidents.

1. Introduction

The expansion of global education has created a new market for the e-education industry. Many universities have introduced distance learning programs and are trialling e-learning tools to support this expansion. Many studies have

been carried out on the effects of e-learning on a university's education strategy. Chan and Welebir [4] 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 [6] 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.

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 [9]. 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 [7] and its ERP product is called SAP R/3.

SAP R/3 is based on an overall business model that makes possible a uniform view of all data and business processes in a business. SAP R/3's integration allows information to be entered into the system only once; this information then becomes part of the entire business's information system. SAP maintains a presence in all kinds of organizations such as: automotive, consumer products, chemical, manufacturing, oil and gas, high-tech pharmaceutical, and communications.

The variety and extent of ERP systems throughout the world offers university graduates having knowledge of ERP systems viable employment opportunities and career paths.

2. ERP Curriculum in Universities

Many universities have identified the value of incorporating ERP systems into university curriculum. ERP systems can be used to reinforce many of the concepts covered in the business discipline [2]. The systems incorporate “state of the art” technology providing a comprehensive teaching tool for computer science and information systems subjects [10]. Universities that have successfully incorporated an ERP system into their curricula find unprecedented student demand for those subjects.

Even though the value of including ERP systems into the curriculum has been identified, there are a number of barriers preventing this from happening. One significant hurdle is the limited knowledge and experience of academic staff charged with the responsibility of integrating ERP curriculum into their courses. ERP systems are complex and the time required by staff for developing curriculum is far in excess of the time experienced for curriculum development in other areas. The shortfall of academic skills and experience is further compounded by the limited access to relevant ERP professional development activities and the continual upgrade of software.

Another significant barrier to the use of ERP systems in universities is the perceived need for students to gain “hands-on” experience to master the concepts inherent in these types of systems [15]. In the past, if a university decided to incorporate a major software product into its curricula, it would have purchased the software and set up the necessary infrastructure to support it. ERP systems themselves are expensive but there are the additional associated costs of hardware and professional development for the computer support staff together with the necessary incentives to retain these people once they are skilled. Many universities find that the barriers associated with introducing ERP systems are just too great!

An increasing number of universities are investigating strategic alliances with ERP system vendors to provide the support for incorporating ERP knowledge into their curriculum [8]. 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 [4] 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.

3. The SAP Alliance at Victoria University

The Faculty of Business and Law on behalf of Victoria University joined the University Alliance Program in 1998. Up until then university alliance members had focused SAP R/3 around one particular department rather than an overall faculty. The faculty approach was believed to be a better method to facilitate the incorporation of SAP R/3 into curriculum. ERP systems support the various business processes within an organization. The respective departments within the faculty teach these processes and therefore the faculty approach enables each department to focus on the aspects of the software which is relevant to them.

Since joining the SAP University Alliance Victoria University 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 3000 students from Malaysia, Singapore, 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 [13]. 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 western 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 addition an agreement has been signed to commence our ERP masters program at the Northern Jiaotong University, P.R. of China in 2004.

4. ERP E-Learning Model

Many e-learning models have been developed and trials conducted in recent years. Neubauer and Lobel [11] describe a highly structured synchronous model for teaching and doing research on medium to large sized groups over the Internet. Arnone [1] 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 [5] describe examples of virtual classrooms that use the Internet to create new kinds of collaboration and learning. Tansley and Bryson [14] evaluate the implications of replacing traditional modes of small group teaching with “virtual seminars”.

Victoria University has developed an e-learning ERP model to facilitate the teaching of ERP systems in our offshore ERP programs. This model uses a number of e-learning technologies that 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. 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:

4.1 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.

4.2 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.

4.3 iTutor

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 iTutor 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 iTutor 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 iTutor 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.

4.4 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 [12]. 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.

5. Conclusion and Future Directions

The four e-learning technologies that blend synchronous and asynchronous content are not unique but combining these technologies to present ERP education is unique. They provide an avenue for ERP e-learning using a variety of methods to cater for students' differing needs and learning styles. The e-learning model has become increasingly relevant in light of recent issues such as SARS and terrorism that have acted to inhibit and disrupt offshore education.

We are using the ERP e-learning model with our partners in Singapore and Hong Kong. We are still in the early implementation stage. Once fully implemented we will carefully analyse the effectiveness of the model. If we find it successful we plan to extend our ERP e-learning model to include our other partnering universities throughout the Asian region. Beyond this we would explore the possibility of offering ERP education to anybody who enrolls online into any of the subjects on offer. This would be true e-learning as it provides the accessibility and flexibility to overcome the geographical barriers, ideologies, work commitments and traditional course structures that have prevented people from acquiring ERP knowledge and skills.

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Antecedents of Mobile Data Services Acceptance: Insights from the Young Singaporean Market

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Abstract

This paper presents preliminary findings from work-in-progress that examines the attitudes of young Singaporeans toward mobile data services (MDS), focusing on the factors influencing their adoption of these emerging services. In-depth focus group interviews provided data for qualitative analysis. The analysis reveals that participants are generally receptive towards these technological services, based on their perceptions of the benefits of MDS and their expectation that MDS will deliver functional utility and satisfy hedonic influences. However, potential barriers to adoption include insecurity regarding MDS service providers, the reliability and security of MDS applications, their costs, loss of human touch, difficulty of use and a lack of social support. The authors conclude by discussing the contributions of their research to knowledge of technology acceptance and managerial practice.

1. Introduction

The surge in adoption of mobile digital devices worldwide [31] generates a keen interest by industry players to expand their profitability by offering mobile data services (MDS) to supplement voice telephony. To date, huge investments in Third Generation (3G) networks show disappointing results largely because network operators are unsure which 3G services consumers want and will pay for [12]. From the supply perspective, operators are reluctant to commit the fixed costs needed to develop new MDS unless they are certain that demand exists. From the demand perspective, wary Singapore consumers accept services such as text messaging and downloading ringtones and pictures, but do not actively seek new MDS [17].

Further, the demand for MDS is a moving target: each new MDS technology creates new possibilities to create consumer value, while consumer awareness of and preferences for MDS evolve. This dynamism in the MDS environment underscores a need of extending the scope of traditional adoption theories. From the practical

perspective, operators need to understand the drivers and inhibitors of MDS adoption.

This paper presents work-in-progress, focusing on our preliminary findings as we seek to understand the factors influencing adoption of mobile applications. The paper first reviews literature on adoption behavior, and discusses our methodology. Next, the paper reports the insights gained from in-depth focus group sessions conducted with young Singaporeans. The last section discusses the implications of these preliminary findings and presents recommendations for industry players.

2. Literature Review

Research on innovation diffusion and technology acceptance has examined various variables influencing the adoption of new innovations and technologies. These variables include activities of industry players, beliefs about using the new technology, perceived needs and past experience.

2.1 Activities of Industry Players

Gatignon and Robertson [14] posited that the actions of industry players, including their competitive activities, play a role in affecting the pattern of adoption and rate of diffusion. However, few studies have explained or empirically examined this role.

2.2 Beliefs about Using a New Technology

Based on the theory of reasoned action (TRA) [13], the technology acceptance model (TAM) [7] posits that two specific beliefs of using a new technology, namely, perceived ease of use and usefulness, affect people's acceptance of technology. Perceived ease of use is an indicator of the cognitive effort needed to learn and to utilize a technology whereas perceived usefulness is a measure of an individual's subjective assessment of the utility offered by a technology in a specific task-specific context [15]. The effect of these two variables on technology acceptance is supported by many empirical studies (e.g., [8] [24] [27]).

Most existing studies on technology acceptance focus their investigation on the functional utility of a new technology. Few studies have looked into people's evaluation of the costs and risks of using a new technology. The evaluation of costs and risks could be fairly complex as it may require an assessment of transaction costs, switching costs and opportunity costs. For example, in adopting a new computer software, a user generally must undertake a substantial change in the approach and the procedures involved in performing a task, which represents switching costs [11]. Further, the user must also consider the uncertainty concerning the performance of the new system functioning as advertised. In addition to attitude, subjective norms and perceived behavioral control were posited to influence intention to adopt the new behavior in the extended theory of planned behavior [1] [3] [27]. Researchers concur that beliefs about the normative expectations (normative beliefs) of other people and motivation to comply with these expectations influence a person's intention to adopt a technology.

2.3 Perceived Needs

The advantage that a new behavior creates basically reflects how well it helps satisfy certain innate needs of a user. Researchers studying uses and gratifications of technology postulate that adopters seek different gratifications in technology based upon their individual "needs" [9] [21] [22] [23] [26]. These needs may include social interactive, affective, cognitive, personal integrative and diversion needs [20].

2.4 Past Experiences

In deciding whether to use a new technology, an individual will compare the benefits, effort, costs and risks between adopting the new technology and continuing the use of an existing technology. Even when people are eager to change, there are forces that encourage the maintenance of existing behavior [30]. Although studies in this area have been modest in number, researchers report that past behavior has direct effects on intentions and/or behavior (e.g., [2] [29] [10]). For example, Venkatesh and Davis [29] found that direct experience with the software examined in their experiment affects technology acceptance, and explained this finding by saying that people essentially form self-efficacy beliefs from their own direct experience in a similar situation. Eastlick and Lotz [10] examined the influence of existing behaviors such as consumers' prior experience with computers, cable television and shopping from other non-store retailer categories on the adoption of interactive shopping. Their results showed that respondents with prior experience of similar innovative shopping activity (such as catalog shopping) were more likely to adopt interactive shopping.

In short, our literature review shows that the role of certain variables in the adoption decision process, such as the activity of industry players, perceived risks and past

experience have not been well investigated. Using MDS as an example, our research attempts to uncover various variables affecting technology adoption and the role that they play in the adoption process.

3. Methodology

The research presented in this paper represents the first stage of an ongoing project concerning MDS adoption in Singapore. Focus group interviews, which are beneficial for understanding attitudes and perceptions that are developed through interaction with other people [19], were used for generating insights in this stage. The interviews conducted help us specify the content area of MDS adoption and identify factors affecting the adoption.

The scope of this research is limited to three specific MDS: messaging (short text messaging or SMS and multimedia messaging or MMS), mobile gaming and non-voice mobile transactions. SMS refers to the delivery and receipt of messages that include only text over existing mobile networks, whereas MMS messages also incorporate images, sound or video. Mobile gaming refers to individual play of interactive games over mobile networks, or play of games that have been downloaded onto mobile devices. Non-voice mobile transactions refer to the non-vocal exchange of value between parties over existing mobile network based communication. These range from accessing information and downloading of free pictures and ringtones to payment for online goods and services, making donations, payment of bills, and purchases at the point of sale (such as retail stores, car parks, or cinemas).

The three specific services were selected because these types of applications are often the most profitable [4]; therefore, the work will be of interest to practitioners. Singaporeans are also more likely to be able to relate to these kinds of services because of the widespread adoption of SMS (80 percent), single-user gaming on mobile phones (12 percent) [17] and the Internet (nearly 60 percent in 2000) [18] as well as non-voice transactions (such as ATMs). Finally, some of these applications, especially mobile transactions and mobile gaming are recently launched. Thus, we may be able to gain insights into the reasons for variation in receptiveness towards MDS.

While small, the Singapore market is an interesting research site: at 78 percent, Singapore has one of the highest mobile phone penetrations in the world [5]. As the standard of living and economic condition in Singapore is generally good and the education standard is relatively high [18], subscribers have the digital literacy and disposable income needed to try out new services. Finally, a mix of cultures in Singapore provides a test-market for many innovations which diffuse to regional markets [28]. Thus, our findings will interest industry players.

3.1 Data Collection

The guidelines for the focus group discussions were derived from our literature review and research objectives. Participants were invited from several sources: convenience sampling of friends and acquaintances of the researcher, and invitations posted on online forums (such as Yahoo!) and in the public folder of a local university. The first session included tertiary students from local technical institutes, polytechnics and universities. The second session tapped young working adults in their twenties, who have been working for ten months to three years. Each session took approximately two hours, and began with general discussion of the participants' knowledge and sources of information about mobile technology and MDS. A deeper discussion ensued, focused on factors influencing adoption, past experience with mobile applications (if any), perceived barriers to the adoption and use of existing MDS, and their opinions about service providers. All sessions were videotaped for later analysis.

3.2 Data Analysis

Consistent with the "annotating-the-scripts approach" [16], we read the transcripts of the video-recorded sessions, and then re-watched the tapes, before interpreting the data. This enabled us to view each experience as a whole and to re-experience the group discussion, interpreting not only the transcript, but the body language and the tone of the discussion as well. We then analyzed our interpretations and highlighted the themes that emerged.

4. Findings

This section explores responses to uncover the motivations and barriers for the adoption of MDS. Our findings indicate that the tradeoff between perceived costs, risks and benefits, and subjective norms about the use of MDS influence the intention to adopt. Figure 1 portrays links among the main themes revealed during our research.

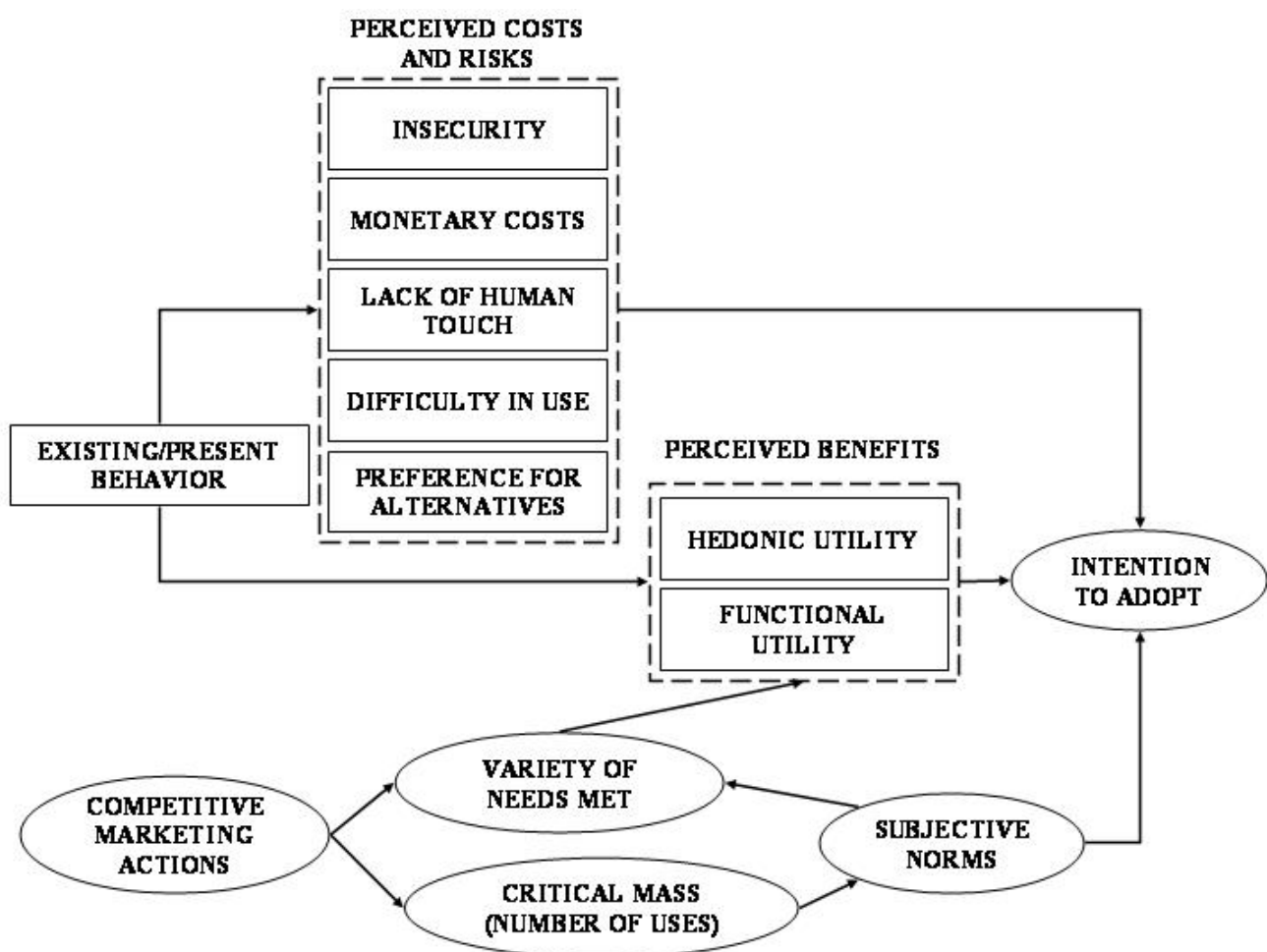


Figure 1 Main themes revealed in the focus group interviews

4.1 Drivers of MDS Adoption

Competitive marketing actions by industry players influence the pervasiveness of use of MDS within the society when they launch new services and improved affiliations. These actions help attract a critical mass of users, which then drives the formation of subjective norms. The norms in turn help generate the variety of needs met by using MDS, which subsequently influences consumers' perceptions of the benefits of using MDS, thereby affecting intention to adopt MDS.

4.1.1 Competitive Marketing Actions

Our findings show that participants rely on the mass media for information. They trust, to some extent, the information provided by the mass media and are attracted to new behaviors because of the media. This is evident from repeated comments by participants about the usefulness of MMS for real estate agents (which was portrayed in advertisements advocating the use of MMS by Nokia and the service providers in Singapore.)

Student E: ... "I find it very useful, let's say if the other party has the phone, then you can message him, the client, no need to go down and see, can get some kind of rough idea, ... You like, you can go down and see..."

4.1.2 Critical Mass

The use of the mobile device in our daily lives, coupled with messaging capabilities and installed games, captivates us and replaces the existing behavior of reading and sleeping while we wait or travel. In fact, this is also one reason for the massive success of SMS, which all our participants confess to be reliant upon.

Participant A¹: ... "there is a very strong expectation when you send a SMS is that you have to reply, everywhere. ... Even if that certain remark doesn't require a reply, you would still expect some kind of response."ⁱ

Student C: "Even when I'm asleep I'll keep my phone on. ... If I come to a state when I forget to bring my phone, I'll feel lacking, handicapped."

The excitement of competing with other people in playing games also helped in creating a critical mass who engaged in the "Snake" game (that is pre-installed in all Nokia handsets) craze at one time. As explained,

Participant F: ... "everybody were playing, then they'll go like ... I got 900 something points, then you'll no shio², so must go play as well."

This is also similar to the phenomenon of network gaming and multi-player gaming via the Internet. Therefore, it is likely that the downloading of games and the capability to play interactive games with other mobile device owners will be a hit if there is a critical mass involved.

4.1.3 Subjective Norms

Subjective norms are significant for three reasons. Firstly, they influence consumer adoption because most people have a need to belong, or conform to predominant behavior, which is usually brought about by the critical mass. For example, one of the reasons for the widespread adoption of Nokia handsets initially was the massive exchange of "picture" messages (using alphabets and symbols, users construct images that will only show up properly as pictures on Nokia handsets). As explained by a participant who related a similar scenario with MMS:

Student B: ... "if a lot of people are already using MMS and you still don't? ... they keep sending you MMS, and you keep cannot receive it. It's very irritating; gradually you would want to see what they actually send to me."

Secondly, as clarified by our student participants, subjective norms also provide a cue for the usefulness of the application. Conformist behavior could be due not only to the need to imitate and "belong", but also normative beliefs that "what others need should be what I need as well".

Student B: ... "if a lot of people have a need, you would also have a need."

Thirdly, subjective norms play an important communication role, as consumers seem to rely on it as a trustworthy source of information and feedback:

Student B: "Sometimes, it depends on what applications, you see. ... for mobile applications, I may wait for people to use it first..."

Interviewer: "Which one will you be more influenced by? Like the media, friends, family, or do you read up about it?"

Participant G: "Friends and media. I wouldn't go read up about such things. Can't be bothered."

Participant A: "Depends on the service."

4.1.4 Variety of Needs Met

The variety of needs the service can meet is a factor affecting attitude toward adoption. An anecdote raised by a participant led to the following discussion about this point:

Participant B: ... “No point they provide a service like pay car park, full stop... but others, like bills, fines, as well, more extensive, every other thing in your life. There’s a higher chance that you try something, and feel maybe it’s not bad, then you’ll try another, and another, then slowly pick up...”

This comment reminds us of the diffusion of stored-value cards in Singapore. The adoption of these cards only took off after the mandatory use in cars for the electronic road-pricing scheme (an automated toll-paying system for entering the business district) in Singapore. Subsequently, the use of these cards became more popular as it was later applied to many car parks, and even the grocer’s and vending machines.

The availability of more variation in the use of MDS affects people’s perceptions of its usefulness and benefits. MDS is not currently useful enough with its limited range of applications, most of which is also unknown to the ordinary mobile phone user.

4.1.5 Perceived Benefits

Two major benefits of MDS identified were functional utility and hedonic utility. Usefulness is the most easily identifiable factor influencing the adoption according to all the responses. The functional value of MDS points to two aspects: convenience and immediacy. These sentiments are shared by both focus groups.

Interviewer: “Would you be interested in shopping with your mobile phone?”

Participant B: “Yes. Why not? Sometimes, if I’m so busy at work, I don’t even have time to go and shop, so it’s very convenient...”

Participant E: “Sometimes when you are just on the streets, and you see something, and you want to check out something, you can check it out immediately... Or if you are out with your friends, and you have to decide where to go for dinner, so you can check it out immediately on the Internet to see what is good. And it’s very fast.”

Student C: ... “for certain kinds of information, you want it at that particular time, you need it ... it’s emergency that kind of thing...I need the information, there right now... even if later I have the information, it’ll be a lost cause.”

Functional utility is not the only advantage that consumers seek; hedonic “usefulness” is also important as consumers buy and consume certain products to make themselves feel good. The participants reveal keen affinity for camera-enabled phones, MMS and the

downloading of ringtones and pictures for reasons such as affection for the application and as a means of self-expression.

Student B: ...“ I like the idea you can take a picture anytime you want...”

Participant E: “...when suddenly everyone can afford a mobile phone. Then like got the same phone, so must make mine different, so download ring tones, and what have you.”

4.1.6 Existing/Present Behavior

Existing behavior serves as a basis to which the perceived benefits and risks of the new behavior is measured upon. Existing behavior can serve as a double-edged sword as it could encourage maintenance of existing behavior, or help reduce the learning curve and thereby encourage new behaviors. The participants relate this with regards to MMS:

Student C: “All I need is the basic functions. Like make and receive calls, and send and receive SMS... The optional functions are more on a case-to-case basis. Some may find that photo taking to be very useful, if they need it... But some don’t need it at all...”

Current use of SMS does not lead to a better opinion of MMS because participants do not view them in the same way. Of the fourteen participants, only about 30% had an MMS-enabled phone, and none used this capability regularly.

However, they also saw the other side of the influence of present behavior. Some are already avid players of pre-installed games on their mobile devices although these are single player games that are played only against the computer program installed in the mobile phone and are relatively simple. There are some who are also network and Internet multi-player gaming enthusiasts. Therefore, participants see these gaming behaviors similar and think that current practices will evolve to the new behavior because people are interested and the learning curve is reduced.

Student B: “People now already play games over their mobile phones. ... Especially when they are traveling, in the buses...”

Student C: “It’s an alternative source of entertainment... like last time I’ll read books, but now got my mobile phone to play with... most of those who are interested in LAN gaming... will play also, ‘cos it’s part of their hobby.

4.2. Barriers to Adoption and Use

There are many reasons for the decision not to adopt MDS, including insecurity, monetary costs, lack of human touch, a preference for alternatives and reliability.

4.2.1 Insecurity

In general, participants were insecure in three aspects: including a lack of confidence in their service providers, doubts about the reliability of the application as well as concerns about the security of mobile technology. Also, perhaps owing to the repercussions from the Internet security hazards, the security of the transaction is still a major deterrence despite people's interest in mobile transaction. These factors may pose major drawbacks especially with regard to mobile transactions.

Participants reveal a lack of trust and a generally poor impression of their service providers. This is a concern, especially with mobile transactions, because consumers may not adopt a service because of predicted difficulty in the usage as well as the lack of support in aid.

Participant E: "It's lousy... You don't hear from them, unless they (service provider) want to tell you that they have some new service, then they'll SMS you, or the next thing will be your next bill. Then you don't hear from them..."

Participant B: "...there's no way other than have complete trust in them that, that's the actual amount that you really used... I feel that there's a lack of consumer protection, they can bill anything they want..."

Interviewer: "...do you think the service providers are giving you enough help or information about MDS, or rather non-voice communications..."

Participant B: "If you are an existing subscriber, press 1. Then after 10, 15 minutes later, maybe you get some voice..."

Both groups of participants are also skeptical about the performance of mobile service applications as there is still little known about them. This is especially a concern when conducting mobile transactions because people will have to face the issue of accountability if the transaction goes awry. This is especially so with the student participants, who prefer cheaper and "just as convenient" alternatives:

Student A: "... I would rather call someone to talk to the person and make a reservation. ... Maybe I'm not good in that, that's why I don't use it."

Student E: "Maybe cock-up or something.... Then don't know who to blame."

The interest in mobile transaction is more prominent among young working adults who are possibly more time-poor. However, their attitudes toward adoption are also less positive, reflecting skepticism about MDS performance and the security of the channel.

Participant F: "... I think it's more feasible to carry around the notebook and the phone separately... You'll always fall back on something that you are comfortable with, like the PowerPoint in my laptop. And to use the phone with the PowerPoint presentation inside, I think I would still be a little afraid whether something will go wrong..."

Interviewer: "But if you are already so twenty-four by seven³ on your phone, you don't have to bring your money out, don't have to bring your cards out. Everywhere you go, just carry your handphone. Is the idea not appealing?"

Participant F: "There should at least be some kind of security code or password that you have to key in, so that at least it wouldn't be a problem if you get robbed..."

Interviewer: "Would you be interested in shopping with your mobile phone?"

Participant A: "Depends on the security."

4.2.2 Money Issues

A common characteristic of both groups is their unwillingness to pay for these services. The students were particularly concerned about cost possibly because of their limited income. Participants also distinguished between the cost of getting the device and the cost of maintaining the use of the service as separate issues. Seemingly, participants are willing to spend the extra money to be able to use the application, but this does not mean that they will actually capitalize on it.

Participant E: "... for example, my phone has GPRS, but I actually don't use it... But if I'm buying a new phone at the shop and the phone with GPRS just costs \$30 more, I will still buy the phone because it's like oh, it's additional benefit although I'm not going to use it..."

4.2.3 Lack of Human Touch

Both groups expressed concern about the lack of human touch. Human touch seemed to be more important for the time-poor young adults, who were less

capable than students of finding time to interact socially.

Participant A: ... "we could be meeting our friends through your phones."

Participant C: "That's so sad..."

Participant A: ... "when the technology is so advanced, and the cost is so cheap, people rather stay at home and have conversations... that's a concern, socially."

Student D: ... "with SMS, you cannot sense the tone of the person; ... it's not professional to use SMS to communicate 'cos there's no human touch to it. So actually calling the person would be more appropriate than SMS."

4.2.4 Difficulty in Use

Another factor hindering the adoption of some services is the ease of use of the application. As explained by a participant:

Participant F: ... "I wanted to use GPRS. I was trying to get it. So I went to the web site and all but two times I keep getting "cannot open file". It's just not easy when it comes to GPRS and that sort of thing."

This is also a major hindrance with mobile gaming because consumers are accustomed to game controls on keyboards and game devices, and not comfortable with the small size of the mobile devices, their low graphic quality and short battery life.

Participant E: "Quite hard, this one is like so small, there's no room for two thumbs to be moving around"

Participant B: "Controls small."

Participant G: "Also because my battery always run out, so I have to charge it, and it might be inconvenient to charge it where I am at that time."

4.2.5 Preference for Alternatives

Participants expressed the view that Singapore is too small a country to require MDS because of the existence of alternatives "which are all faster and cheaper". This point is reiterated several times in both sessions. Also, the use of MDS is just "yet another means of doing it", and so it is not critical that consumers adopt it.

Participant F: ... "Frankly I think it's much cheaper to stay at home and use the Internet. You're out, you use the mobile phone just to call people or send SMS..."

Using the Internet at home, calling the ticket hotline or going down to the cinema, I think that's faster."

Student C: "Actually, looking in the context of Singapore, Singapore is very small... from my place to any cinema is very nearby, so using such technology is not very feasible. There's other ways of doing it."

5. Discussion

Despite the practitioners' excitement in bringing MDS to the market, consumer acceptance is still uncertain. Our research shows that consumers are generally receptive but express several major reservations, mainly insecurity, money issues, and the lack of social motivation.

Although our small sample and qualitative approach make it risky to generalize our focus group findings, future research involving both qualitative and quantitative methodology could illuminate these issues more thoroughly. Recently, we conducted a survey on six hundred undergraduates in Singapore and the preliminary results of the survey corroborate some of the focus group findings. For example, about three out of four respondents (74.9 percent) express distrust in the reliability of the service providers in the billing and 81.9 percent of respondents find the idea of using MMS favorable. Present behavior of using the existing technologies (SMS, pre-installed games and Internet multi-player gaming) also shows significant and positive correlations with intention to use MMS (.217, $p < 0.01$) and mobile gaming (preinstalled games: .401, $p < 0.01$; multi-player gaming: .167, $p < 0.01$). Nearly half of the respondents (46.6 percent) expressed concern over the loss of human touch due to MMS while the majority of them (81.3 percent) regarded the use of MMS expensive.

5.1 Contribution to Knowledge

Consistent with existing literature, our findings suggest that consumers consider a myriad of factors, such as usefulness, normative beliefs and subjective norms before making a technology adoption decision. Most of previous studies, however, have focused on the adoption of technology in organizational contexts and also only concentrated on functional utility. In contrast, our findings corroborate the view that hedonic benefits affect consumers' adoption of technology [6], and highlight the importance of the role that industry players can perform in influencing adoption.

Interestingly, information and communication technology (ICT) which is originally intended for bringing people together could also separate people apart, as indicated by some of our participants' concern about the loss of human touch. This is consistent with

the paradox of assimilation and isolation of technological products that Mick and Fournier [25] proposed, whereby technology cannot only facilitate human togetherness but also lead to human separation. In addition, social influences affect not only normative beliefs about how our significant referents want us to behave, but also perceived beliefs and pervasiveness of use.

Our focus group findings also highlight the influence of present behavior (alternatives of satisfying particular needs) on the consideration of new behaviors, consistent with the studies by Venkatesh and Davis [29] and Eastlick and Lotz [10]. For example, consumers may consider going to the cinema directly or going online instead of booking the tickets over a mobile device.

5.2 Managerial Implications

Our focus group findings suggest that participants have a negative impression of the service providers, viewing them as profit-seeking companies rather than aids to their lifestyle. Thus, service providers could attempt to improve their images by taking an active role in meeting subscriber needs. Improving the image of the service providers will also demand establishing trust among the consumers. This will further help the adoption of MDS, especially with regards to mobile transactions.

Service providers might encourage MDS adoption by first absorbing costs for early adopters and then providing sufficient assistance to the next wave of users, thus ensuring that the perceived benefits of using an application will outweigh the costs of using it. The addition of applications via co-operation with content providers would also persuade trial of MDS. It would be advantageous to persuade consumers that MDS is an extension of alternatives such as self-service transaction machines (e.g. ATM) and cashless modes of transactions (e.g. stored value cards) rather than a new technology so as to reduce consumer perceived costs, risks and learning curve. Benefits such as “anytime, anywhere” as well as security and reliability issues should also be emphasized.

In order to reap the potential profits that MDS offers, a critical mass must be achieved. Our findings indicate that there are two major communication channels that consumers use – the mass media and word-of-mouth. As shown by the participants’ recollection of and interest in advertisements illustrating the usefulness and ease of use of MMS, industry players can consider making more use of the media in demonstrating new uses and MDS applications. The other main source of information for consumers is from word-of-mouth feedback. Thus service providers can also utilize this avenue for promotion of new services as well as encouraging adoption. For example, service providers can, based on their databases, find out users who are using or prone to using new applications. By communicating to these users or providing “exclusive

personalized promotions”, service providers can encourage them to recommend such services to their friends. For example, service providers can promote the formation of mobile communities for playing interactive gaming by offering discounts on each individual’s subscription.

5.3 Future Research

Consistent with traditional scale development methods, we used the findings from the focus group to refine a questionnaire that we recently employed in a survey. We conducted this survey for testing some of the relationships portrayed in Figure 1, and are currently analyzing the survey data. Future research examining the role of industry players on consumer adoption patterns is particularly valuable as little research has been done on the role. Future research examining how consumers cope with their present concerns with regards to an existing technology will also be useful in predicting and overcoming concerns about a new technology.

To conclude, we believe that in this dynamically changing environment, it is necessary to obtain a more thorough understanding of the adoption behavior of the consumers. This will aid the design and the marketing of the applications, thereby avoiding the lame adoption of some MDS applications, such as WAP.

6. Notes

¹ Student participants are labeled as “Student”. Young working adults are labeled as “Participant”.

² Shiok: lingo used in Singapore, synonymous with kick, high or feeling of excitement and happiness.

³ Twenty by seven means twenty-four hours by seven days a week.

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Discovery and Support of Problem-Solving Knowledge in e-Business

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Abstract

Employees generally need to solve various situations of problems occurred during task-executions in e-business. Such problem-solving behaviors contain rich information helpful to provide effective knowledge support. This work proposes a mining framework to discover problem-solving knowledge by analyzing problem-solving behaviors recorded in an intranet portal log file. The discovered knowledge can provide guidance and support to assist employees handle various situations of problems.

1. Introduction

The intranet became a platform for enterprises to deliver inner services to employees. Companies adopt Internet-based electronic services (e-services) conducting business process and sharing of process information. Database and knowledge-based system are set up as corporate knowledge repositories to manage corporate knowledge. Intranet portal provides the e-service to facilitate employees getting desire process knowledge in corporate knowledge repositories.

Providing task-relevant information to support effective task-executions in business processes has recently been investigated [1, 2, 4, 11, 16]. However, discovering task-relevant knowledge, in particular problem-solving knowledge has not been addressed. Employees generally need to solve various situations of problems occurred during task-executions in e-business. This work develops a mining framework to discover employee problem-solving knowledge from intranet access log file. The discovered problem-solving knowledge can assist employees search for solutions to provide effective task executions.

2. Related work

Kaula [8] outlined the necessary strategies for problem-solving. Wooldridge and Jennings [12, 13, 14] proposed a preliminary problem-solving model of team action. Heh [7] proposed a graphic-based evaluation model of problem-solving. Nair and Ramnarayan [10] investigated the relationship between cognitive needs of individuals and their effectiveness in solving complex problems. Gregor [5] investigated the role of explanations in knowledge-based systems to solve cooperative problems. Zhuge et al. [17] presented a cognitive-based problem-solving framework consisting of a problem-solving space, a category-based representation,

and a set of problem-solving control strategies. Zhuge [16] designed an approach integrating workflow and agent concept to cooperate problem-solving process.

Synonymy and polysemy issues have created limitations in information retrieval (IR). A high level, uniform knowledge framework is needed to better enable effective solution searching. Zhuge [15] proposed an active document framework (ADF) to make knowledge documents self-representable, self-explainable and self-executable. Moreover, Liu et al. [9] proposed a semantic topic method to assist user in self-learning.

Various techniques are necessary to support the discovery of hidden knowledge in problem-solving process. Data mining is a useful tool for discovering useful information from a large amount of data. The association rule technique is a marvelous method for discovering relationships between knowledge items. Well-known mining algorithms are *Apriori* and *Apriori-like* methods [3, 6].

3. Framework overview

A mining framework to support problem-solving process is illustrated in Figure 1. This framework is designed for e-business workflow environments. When employees encounter problems, they rely on problem-solving knowledge, e.g. user guides and experiential reports. Problem-solving knowledge is stored in corporate knowledge repositories. Companies provide Intranet portal to facilitate the tracking of employees' problem-solving behaviors, e.g. relevant documents accessed during the problem solving process. The employees' access to corporate knowledge repositories is an important resource for mining problem-solving knowledge. The intranet portal log file records the relevant documents accessed by employees. Problem-solving knowledge can be discovered from the access log file. The proposed framework contains three phases, including data preprocessing, knowledge discovery and knowledge support. In the data-preprocessing phase, a formalization engine is employed to unify the representations of various kinds of knowledge document forms. A knowledge-node format is defined to uniform the knowledge representations. Moreover, an inference engine is used to identify uncertain access behavior of employees. On the basis of uniform knowledge representations, the knowledge-discovery phase employs a mining engine to discover the problem-solving knowledge. The discovered

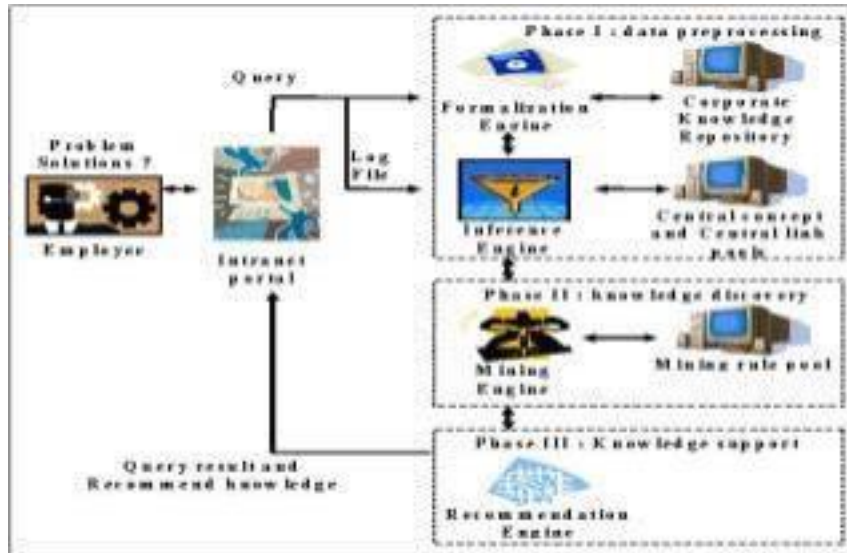


Figure 1: A mining framework to support problem-solving process

knowledge will be stored in knowledge support pools. Finally, the knowledge-support phase utilizes a recommendation engine to recommend relevant problem-solving documents to employees according to employee profiles. The recommendations assist employees solve further problems and provide effective support for task executions in e-business.

4. Proposed framework

4.1 Formalization Engine

The presentation formats of documents are varied. These can include letters, faxes, order forms, notifications, receipts, memos, etc. Although the knowledge documents are digitalized, it is hardly to search information among various types, we need a uniform format to formalize the knowledge document presentation. Knowledge document with uniform format will be the best knowledge support to solve problem occurred in e-business. In data preprocessing phase, formalization engine uses node format to provide such function.

The main function of formalization engine is to construct knowledge document profile. Semantic-based method is used to define related knowledge representation format for e-business. In order to make it easy to modularize corporate knowledge documents, we define the business knowledge document as level-wise node type:

Definition 1: *Knowledge Node (KN)*: Each corporate knowledge document is considered as a knowledge node. KN is the first level.

Definition 2: *Abstract Conceptual Node (ACN)*: Abstract conception means that expert uses a knowledge representation to abstract the concepts behind KN. Each knowledge document may contain one or many abstract conceptions. Each abstract conception is presented as an abstract conceptual node. ACN is the second level.

Definition 3: *Semantic link (SL)*: After analyzing ACNs' contents, if a semantic relation is existed, a semantic link will be constructed to connect two ACNs.

4.2 Inference Engine

The inference engine transforms the employees' sequential access behaviors recorded in the log file into KN representations, which corresponds to a KN sequence. Notably, the information of specific problem in the KN level may be sparse. To gain more information for mining process, we pay attention to the ACN level. From ACN level, a KN sequence corresponds to an ACN network. In addition to ACNs, SLs, semantic relations exist in ACN network. We define these relations as inference links.

Definition 4: *Inference link (IL)*: In sequential access behavior, KNs form a banding status. If no semantic relation exists between ACNs, an inference link may be constructed to connect them. Inference link is inferred as a candidate of human cognitive behavior.

For each problem, ACNs network is considered as a *Conceptual Knowledge Access Network (CKAN)*. Because of various situations, specific problem may own one or many CKANs. By analyzing each CKAN, we get weight and frequency of ACNs, SLs, and ILs. From knowledge document profile, we get weight of ACNs. ACNs' information used to construct each CKAN's concept profile. Links' information is used to construct each CKAN's link profile. Proposed framework uses two pool mechanisms to store profile information. *Central concept pool (CCP)* is used to store all CKAN's concept profiles of specific problem. Higher weight or frequent ACN is considered as central concept. The filtering criterion is based on threshold setting. *Central link pool (CLP)* is used to store all CKAN's link profiles of specific problem. Higher weight or frequent link is considered as central link. The filtering criterion is also based on threshold setting.

Inference engine carries out inferring process during *CKAN*'s concept and link profile construction. Working steps of process are illustrated as the following:

- (1) Read employee access behavior in intranet portal's log file.
- (2) Identify each knowledge document in access sequential patterns and search for its profile in knowledge repository.
- (3) Identify *KNs* and *ACNs* to construct *CKAN* according to knowledge document profiles.
- (4) Construct connecting links and identify link types of each pair of *ACNs*.
- (5) Record weight and frequency information of each *ACN*, *SL*, and *IL* in *CKAN*'s concept profile and link profile.

4.3 Mining engine

Data preprocessing phase provides information support for problem-solving process in e-business. In knowledge discovery phase, a mining engine is employed to discover the problem-solving knowledge. A specific problem may have more than one *CKAN* concept profile. We consider each *CKAN* concept profile as a transaction of specific problem. Concepts in *CKAN* concept profiles are considered as item in transaction. Mining engine uses mini-conf and mini-support as the thresholds of executing *Apriori* algorithm. A knowledge support pool (*KSP*) is used to store association rules of specific e-business problem. Discovered rules are considered as a specific problem's solving knowledge. The steps of mining process are illustrated as follows:

- (1) Select all *CKANs*' concept profiles of specific problem in *CCP*.
- (2) Consider each specific problem's *CKAN* concept profile as a transaction and central conceptual nodes as the knowledge items of the transaction.
- (3) Use *Apriori* algorithm to discover association rule.
- (4) Mining results stored in *KSP* are specific problem's support knowledge.

4.4 Recommendation Engine

In e-business, knowledge support plays a key role to provide effective problem-solving process. In the knowledge-support phase, a recommendation engine is designed to suggest key steps and documents for problem-solving process. A *Guiding Problem-Solving Process* (*GPSP*) is supported to assist the problem-solving process. Association among central concept nodes is used to predict empirical behavior in problem-solving process. *SL* and *IL* in specific *CKAN*'s link profile will be used to connect relevant central concept nodes to construct *GPSP*. *GPSP* shows employee the empirical problem-solving steps and key knowledge documents. Two modules are designed to provide recommendations.

Identification module

ò Problem identification function

- (1) Accumulate and gather statistics of nodes occurring frequency in all *CKANs*' concept profiles of specific problem in e-business.
- (2) Use threshold methods to filter *ACNs*. Nodes with weight or frequency higher than some thresholds are considered as central concepts of specific problem solution. Central concepts will be constructed in specific problem description stored in *CCP*.

ò Problem feature matching function

- (1) Real time to catch employee access behavior in intranet portal.
- (2) Accumulate and gather statistics of *ACNs* occurring frequency.
- (3) Identify central concepts of current problem and use clustering method to search for matching problem descriptions in *CCP*.
- (4) According to match process, it classifies current problem into specific problem or produce new problem identification.

Selection module

- (1) Get the central concept nodes and mining profile of specific problem description stored in *CCP*.
- (2) Get the mining profile of specific problem stored in *KSP*.
- (3) Use mining profile of specific problem to identify the relations between central concept nodes.
- (4) According to central concept nodes and their relations, select higher weight and frequent *SLs* and *ILs* in specific *CKAN*'s link profile to construct *GPSP* for knowledge recommendation.

5. Conclusions

Problem-solving knowledge plays a key role in supporting effective e-business services. In problem-solving process, employee access behavior contains rich knowledge. This study enforces practical knowledge discovery in problem-solving process. Proposed mining framework discovers hidden knowledge of employee access behavior. It divides knowledge discovery process into three phases. In data-preprocessing phase, a well-defined format of knowledge representation is defined to support mining and information search. In knowledge-discovery phase, mining mechanism discovers context-aware problem-solving knowledge of e-business. Knowledge-support phase provides employees guidance and documents relevant to problem-solving. The guiding process shows employee the experiential problem-solving steps and important knowledge documents.

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(5) Case Study in e-Business

Case Study – Global Business Communications, Mong Reththy, Ltd., Cambodia

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Abstract

Mong Reththy is an agribusiness industrial group of companies headquartered in Phnom Penh, Cambodia with total revenue of approximately US\$48 million from 9 divisions. The purpose of the project is to describe background of this company and the Camerica consulting group working with them. Further, to illustrate the index of the Mong Reththy website and examine the English language narrative used. The purposes of the website both locally and globally are examined and sample narrative for improvement is presented.

Introduction and Background

Cambodia struggles to rebuild itself after 30 years of civil strife and warfare, including the genocidal Khmer Rouge period and the isolation and neglect by the international community. Life expectancy is only in the mid – 50s. Infant mortality stands at 95 per 1,000 childbirths. 85% of Cambodians live in rural areas where life is harsh and access to basic services is difficult. They depend largely on agriculture for their livelihoods. The agriculture sector accounts for 32% of the total economy. For the most part, agricultural products are exported as raw materials with limited value added. (USAID and Cambodia: Retrieved on March 1, 2002 at http://www.usaid.gov/regions/ane/newpages/one_pagers/cambodia01a.htm)

Most value added manufacturing of these raw materials takes place after export to Malaysia, Singapore and Thailand. Mong Reththy is vitally interested in the feasibility of manufacturing facilities in Cambodia in order to export more valuable agricultural products at substantially higher prices. In effect, managing more of the supply chain before exports leaves Cambodia, increasing overall revenues and strengthening the young developing Cambodian economy. Mong Reththy manages logistics of the supply chains of four specific agricultural commodity products: palm oil, tapioca, rubber and grapes.

CAMERICA Consulting Group, 848 West Cesar E.

Chavez Ave., 2nd Floor, Los Angeles, CA 90012-2131, U.S.A. is a non-profit association of research consultants specializing in providing services to Cambodian agricultural and industrial raw materials producers. Mr. Phillip T. Thong, C.P.A. is the principal of CAMERICA. Mr. Thong is a successful Cambodian American partner in Thong and Yu C.P.A. firm, and leader in the Cambodian American community of southern California. It is his goal to make a significant contribution to his community both in Los Angeles and his Cambodian motherland.

Camerica -- on behalf of His Excellency Mr. Chan Sarun, Senior Minister and Minister of Agriculture, Forestry and Fishery, Phnom Penh, Cambodia, and the Mong Reththy Group, 130 Vithei Preashy Sihanouk, Phnom Penh, Cambodia, Principal: Oknha (Royal Title) Mong Reththy to examine and research global business communications and website development.

Camerica Objectives for Contribution

1. To examine the global business of Mong Reththy Group, Ltd., Cambodia to identify international markets of four commodity products: palm oil, tapioca, rubber and grapes in Cambodia.
2. To examine alternatives for Global business communications.
3. To work with Cambodian website developers who created <http://www.mongreththy.com/> to enhance website content. Specifically, rewrite extensive awkward and incorrect English text.
4. To make a personal and professional contribution to a real SME. in a newly democratized nation struggling to be recognized by the international community.

Visits were made to agricultural plantations of Mong Reththy in Southwestern Cambodia around Kampot and Phnom Bokor Mountain. Trips to Malaysia and Singapore to investigate current Mong Reththy brokers and business partners/alliances will be necessary. Numerous interviews with local experts were conducted to fully investigate market distribution and various value added manufacturing alternatives.

Mong Reththy Group of Companies

This agro industrial group of companies is headquartered

at 152S, Preah Norodom Boulevard, Phnom Penh 12301, Cambodia and enjoys total revenue of approximately US\$48 million from 9 divisions:

1. Mong Reththy Group Company Limited
2. Mong Reththy Investment Cambodia Oil Palm Company Limited (MRICOP), an International Joint Venture Agro industrial Company, whose partners are Cambodian, and Korean, established in March 23, 1996.
3. Mong Reththy Investment and Cambodia Tapioca Flour Company Limited was established in 1999.
4. MRT-RML Livestock Corporation (Cambodia) Private, Limited was established in 2001 mainly for cattle breeding and ranching for export to Malaysia.
5. Mong Reththy Group - Tiwanon Construction Joint Venture Company Limited.
6. Mong Reththy Steel Industries Company Limited
7. Samnang Khmeng Wat Construction Company Limited was named by the then Prime Minister Samdech Hun Sen, and established in October 1997.
8. Joint venture with three government owned rubber plantations: Chou Kroc, Boeung Ket and Chamcar Andong, in new infrastructure and machinery.
9. Oknha Mong Port Co., Ltd.

They own 48 pieces of heavy equipment with 12 hauling sets which puts them in a good position to play a major role in the rebuilding of the infrastructure of Cambodia.

Need - Cambodia is a post-conflict country, having suffered a protracted period of war, social upheaval and political turmoil for more than 20 years, starting first under the Lon Nol regime and then Democratic Kampuchea. During this period of upheaval, the administration system for policy formulation and implementation was destroyed. The socio-economic infrastructure such as roads, bridges, irrigation facilities among others were damaged and left in a badly neglected state. Human capital, which could have contributed to the development of the country, was decimated by massive purges, forced labor, disease, and bombing. Cambodia has a wartime legacy of millions of landmines still buried and new victims are being claimed even today. With regards to poverty, 35.9 percent of the population lives below the national poverty line and socio-economic indicators such as literacy, infant mortality rate and others are among the worst in the region.

Since Cambodia's admission to ASEAN in April 1999, the country has been enjoying an opportunity as well as facing the challenge of regional economic integration and competition at an increasingly intense pace. (The Japan International Cooperation Agency (JICA), Retrieved October 1, 2003 at <http://www.jica.org.kh>)

Website

A website such as that for Mong Reththy Group (See index page below) serves several purposes. Primarily it serves as a window to the world. An important public relations vehicle which the company can point to as pride to illustrate to potential suppliers, customers and other stakeholders – “here we are.” This company was eager to introduce themselves to a global audience with this device. It is not intended to manage the logistics of a supply chain or for transactory purposes of any type. Perhaps some day the economic need for such sophisticated utilization of software will be merited.

Two problems seem to show most significantly in this first attempt at a website. First, the company is Cambodian with predominantly Cambodian stakeholders and as such the website should speak to this local audience. The narrative seen on the index or “front page” was conceived in the Khmer language and subsequently translated into English. This English doesn’t speak so well to the local Cambodian audience. Agreed, the audience is not a group of home Internet users, but larger companies and government agencies that are much business cooperating partners. Versions of the narrative in several languages are recommended, but not the existing narrative. The entire website needs to be rewritten in say three languages: Chinese, Japanese and English; and completely redesigned and rewritten. The desired business communications or “impact message” is completely different in each language.

The second problem focuses on the website narrative intended for the global audience. The website originates from Cambodia whose language is not known much outside home borders, therefore English was chosen as a global website language. Unfortunately the translated Cambodian thought, which indeed comes from the heart, and speaks so very beautifully to the Cambodian people – does not “read” very well in English. The beauty of the narrative in native Khmer is somewhat like poetry. When translated directly into global English these thoughts from the heart give the reader a mixed reaction of quaint, odd and confusing.

The lesson is simple and important. When building a website for a local audience, and another one for the world. What the reader sees, reads, perceives and the resulting impressions are everything. When communicating meaningful values to a local audience, present them in the most meaningful way possible. When seeking commercial impact from a global audience, communicate as the global world of business communicates, in whatever language chosen for whatever audience.

Original Text from Index Webpage

As an example, compare the original text of the front page of the current Mong Reththy website (<http://www.mongreththy.com/>) (See “print screen” picture of index page below)

Introduction

Reflecting undaunted will of Oknha Mong Reththy and those of the Cambodian people in the immediate on going negotiation of the Paris Treaty: To end h decades of civil war and elevate the plight of the people and give hope for the reunification of all factional parties.

Oknha Mong Reththy Chairman and founder of the Mong Reththy Import Export & Construction Company Limited, contributed a great deal to the ashes after the so called Cambodian Year Zero which destroy the country infrastructures, economic, morality and mentality well-being of the Cambodian people. We strongly believed that our hard working years and 3 years of on going efforts to accomplish the first of it kind Agro Industrial of Oil Palm Estate, will definitely pave the ways for Cambodian and put her one famous image back on the world map.

Oknha is the noble title has granted by His Majesty Preah Bath Norodom Sihanouk Varaman, the King of Cambodia, in 1996 for the charity works he has devoted and participate in rebuilding the country. Mong Reththy Import Export and Construction Company Limited (MRIEC) was established in 1991 as a form of family business. Today MRIEC does not merely operate as a family business but has expanded to include various associated and investment companies in the country.

Back in 1991 the company main activities were exporting of Processed Cambodian Natural Rubber to Asia Countries: Singapore, Malaysia, Hong Kong, and China etc. Apart from rubber trade, we are also importing Steel Bars, Cement, and other needed Building Materials, as well as Machinery & Heavy Equipment etc. By late 1996, Oknha Mong Reththy has inaugurated its other associated companies:

Edited Text for Index Webpage

The following edited version was presented to eliminate the English writing grammatical errors, but intended to preserve the original meaning.

Introduction

*Our mission reflects the undaunted will of **Oknha Mong Reththy**, as well as the Cambodian people: To end the decades of civil war, to elevate the plight of the Cambodian people, and to give hope for the reunification of all factional parties.*

*Oknha Mong Reththy, Chairman and founder of the **Mong Reththy Import Export & Construction Company, Limited** has contributed enormously to the reconstruction of ruin after the so-called “Cambodian Year Zero” which destroyed the country’s infrastructure, economy, morality and mentality; along with the well being of the Cambodian people. We strongly believe that our three years of hard work and diligence have resulted in the first of its kind Agro-Industrial Oil Palm Estate, which will pave the way to a proud future and reestablish Cambodia’s once famous image on the world map.*

*“Oknha” is the noble and royal title that has been granted by **His Majesty Preah Bath Norodom Sihanouk Varaman**, King of Cambodia, in 1996 to Mong Reththy for his charitable works, as well as his devotion and participation in the rebuilding of Cambodia. **Mong Reththy Import Export and Construction Company Limited (MRIEC)** was established in 1991 as a small family business. Today MRIEC has expanded into a major Cambodian agro-industrial conglomerate of associated and investment companies making a significant contribution to the Cambodian economy, and employing thousands of hard working citizens.*

*Initially, in 1991, the company’s main activities were exporting processed Cambodian Natural Rubber to Asian countries such as **Singapore, Malaysia, Hong Kong, China**, and others. Since then, importation of steel bars, cement and other critical building materials, as well as machinery and heavy equipment has been added. By late 1996, **Oknha Mong Reththy** has inaugurated the following associated companies:*

Example of Text Rewritten for Global Market

Here is an example of a complete rewrite in English for a global market. We do not propose that this is the best possible rewrite and other issues and key success factors may need to be emphasized on this index or “front page” – the opening window to this company. Obviously it was

necessary to change the tone, and meaning of the opening text.

Introduction

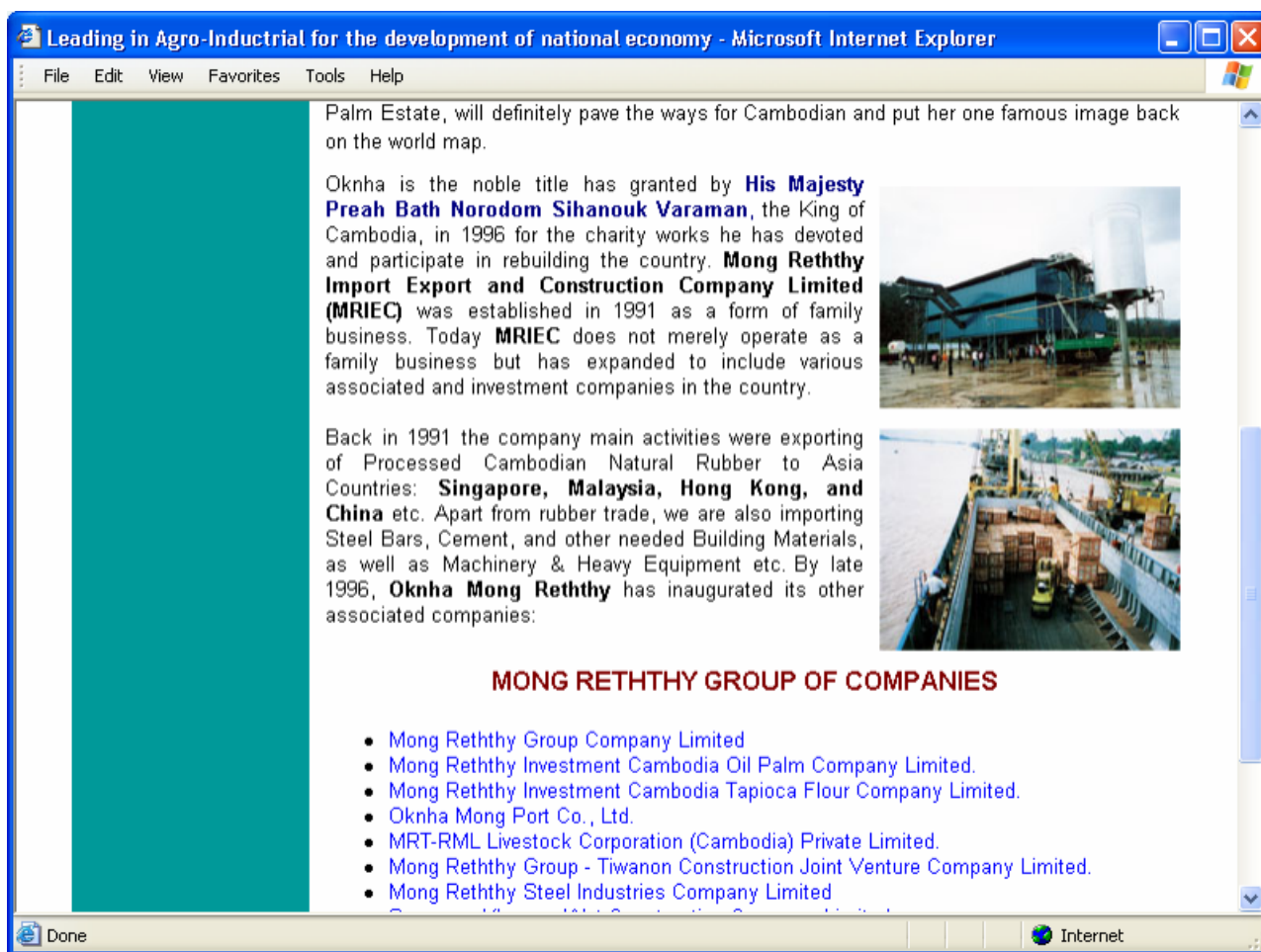
Our mission is to rebuild the infrastructure of Cambodia. We are building the finest roads, bridges, schools, temples and infrastructure systems with a traditional Khmer dedication to quality and excellence. We are dedicated to a new and prosperous Cambodia. We are a growing major player in agribusiness and construction in Southeast Asia and a loyal partner to our neighbors. Cambodia is back in business and ready to show the world her best stuff and Mong Reththy is leading the parade of key competitive strengths.

We are Mong Reththy Group -- a company big enough to rebuild Cambodia. A company with a reputation as solid as the Great Angkor Wat and a vision for the future as vast as the globe itself. We remain truly dedicated to the progress of all ASEAN economies.

We are nine solid divisions ready to provide the global market with Tapioca, Palm Oil, Industrial construction and a host of other resource based products and services.

Please contact us and let us provide a demonstration of what we can do for your company or your project. We are the project experts rebuilding Cambodia.






Leading in Agro-Industrial for the development of national economy - Microsoft Internet Explorer

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Information Sharing in Collaborative Marketing and Integrated Marketing Communications- Towards a Systemic View

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Abstract

By Internet age arrived, collaborative commerce has completely changed business environment and model. Collaborative Marketing (CM) has continuously growing in a seemingly unabated fashion worldwide. The enterprise competitive condition has completely changed into global competitive environment within supply chain. In addition, this study provides an appreciation of the emergence and content of Integrated Marketing Communications (IMC) that widely used by industry and commerce in the US and UK. Systems intervention is one main stream of systems thinking in England. In order to build a systemic approach of IMC, this research examines systems intervention to see what it can contribute to CM and IMC for enterprises. This study examines how CM can help IMC through identifying key customer knowledge sources, hence, marketing and advertising would be based on a single global campaign, with only minor adjustments for local markets. The aims of this paper are to explore the role of customer knowledge sources within collaborative IMC and develop a conceptual framework to further suggest better solution for IMC collaboration.

Taking beauty enterprise as an example, this research focuses on CKM (Customer Knowledge Management), CM, IMC and systems intervention to design the questionnaire for 120 companies. There were 8 available responses from 60 collaborative partners in Taiwan and 19 available responses from 60 collaborative partners in China (Return rate 22.5%). This paper identifies the difference of knowledge sources, CM, IMC

and systems intervention between Taiwan and China in a leading beauty enterprise and finds out that CM has significant effect on IMC that could be used for IMC planning in the future.

1. Introduction

Although collaboration maximizes the combined competencies of the partners to achieve each partner's strategic goals and to provide solutions to meet customers and stakeholder needs, the processes and procedures of collaboration required for success are a little less clear [12]. Actually, the processes for integrating customer knowledge sources are complicated. The best way to avoid the problem is to define a joint process and implementation plan for collaboration. Actually, it is difficult for enterprises to manage and balance value chain processes and further associate communications. However collaboration provides the functionality to access and utilize the information that is being communicated.

There are a number of specialists who have suggested models of IMC (IMC), including some who set out specific aspects towards achieving successful IMC [10]. The Caywood et al. [1] study introduced a new conceptual debate concerning integrated approaches to marketing communications. It is known that buyers and suppliers have high hopes for utilizing the Internet to streamline trading partner relationships. Recently, Corelissen and Lock [3] have examined IMC as a body of theory and hypothesized its influence upon practice. Low [7] identified factors that are significantly related to the

degree of integration of a company's marketing communications activities. Cornelissen [2] further collated the available evidence on the US and UK marketing communications practices.

Collaboration in IMC with enterprises from similar or competing product sectors may offer significant advantages. For example, collaboration with European firms has been a popular market entry route for Japanese firms. Perks [11] presented four major Euro/ Japanese cases of new product development collaboration. Michael [9] examined whether one hybrid form, the franchise chain, can coordinate elements of the marketing mix.

Lin [8] presented the IMC Model and it provides a framework to review, operationalize and evaluate the process and effectiveness of IMC. Based on this model, we further examine how CM can help IMC, hence, marketing and advertising would be based on a single global campaign, with only minor adjustments for local markets.

By emphasizing on knowledge in the global economy, the collaborative partners start to overlook major customer knowledge. Gibbert et al. [5] think that CKM can provide a significant competitive advantage for companies, but its possible stumbling blocks have to be appreciated. They identified two major stumbling blocks, first the cultural challenge (in terms of re-thinking the role of the customer and the far-reaching implications this has for the mindset of employees within the organization), and second the competency challenge (in terms of the skills and processes needed to take full advantage of participative techniques). There is an important issue existed CM to understand what kinds of customer knowledge sources they can share with each other. So, it would be interesting to find out the answer for collaborative partnerships.

This paper is not only focusing on organizational process improvement of IMC and CM, but also trying to tackle the issues in the dimensions of organizational

design, organizational culture and organizational politics. These four dimensions [4] must be considered in order to help to achieve the ideal dynamically balanced organization for IMC and CM. Schultz and Kitchen [13] do not believe IMC is a theory but believe the general idea of integration, processes, and systems thinking must prevail in the 21st century. However, in order to build an effective systemic approach and to avoid introducing other weaknesses, it is now necessary to carry out an in-depth consideration of systems intervention and make the IMC and CM model even more effective.

The aims of this paper are:

1. Develop a conceptual framework that identifies the customer knowledge sources and further finds out systems intervention for CM and IMC.
2. Identify the difference of knowledge sources, CM, IMC and systems intervention between Taiwan and China in a leading beauty enterprise.
3. Find out the key knowledge sources for CM and IMC.
4. Use systems intervention to choose suitable method for CM and IMC strategies.
5. See how CM can help IMC.

2. Theoretical Background

Although collaboration maximizes the combined competencies of the partners to achieve each partner's strategic goals and to provide solutions to meet customers and stakeholder needs, the processes and procedures of collaboration required for success are a little less clear (Rabin, 2002). The best way to avoid the problem is to define a joint process and implementation plan for collaboration. Actually, it is difficult for enterprises to manage and balance value chain processes and further associate communications. However collaboration provides the functionality to access and utilize the information that is being communicated. For example, collaboration with European firms has been a popular

market entry route for Japanese firms. Perks (2000) presented four major Euro/ Japanese cases of new product development collaboration. Michael (2002) examined whether one hybrid form, the franchise chain, can coordinate elements of the marketing mix.

IMC research had its beginnings with the Medill School of Journalism at Northwestern University (Duncan and Moriarty, 1997). American Association of Advertising Agencies (4As) (1989) defined IMC is a concept of marketing communications planning that recognizes the added value of a comprehensive plan that evaluates the strategic roles of a variety of communication disciplines- general advertising, direct response, sales promotion, and public relation- and combines these disciplines to provide clarity, consistency, and maximum communication impact [1]. The combination of marketing and public relations communications disciplines has a number of labels. In the late 1980s, advertising agencies attempted to co-opt the concept by calling it 'the new advertising' (Hume, 1991), but other labels were also suggested: 'the new PR' (Harris, 1991), 'integrated marketing' (Wilcox, Ault and Agee, 1992), 'integrated corporate communications' (name of a master's program at Duke University), or 'integrated marketing communications' (Schultz, Tannenbaum, and Lauterborn, 1993). Recently, Reid et al. (2001) have employed Duncan and Moriarty's (1997) Integrated Marketing Audit to examine key communications issues and demonstrated that a higher level of integration is associated with better brand-related performance. Schultz and Bailey (2000) have defined a new approach for the 21st century marketplace because the new electronic communication and marketing alternatives and opportunities explored the alternatives available to communications around the world. Bush and Bush (2000) have proposed that the explosive growth of the Internet has the potential to change agency-advertiser relationships and blur the functions performed by each.

This paper carries out a comparison of current IMC approaches using six aspects: awareness integration, unified image, database integration, customer-based integration, stakeholders-based integration, and evaluation integration.

Since the 1930s, there have been three competing models of management in organization theory- the traditional approaches, human relations theory, and systems theory. However, with the recognition of the deficiencies of both the traditional approaches and human relations theory, the systems theory has now grown to a position of prominence in management theory. Flood and Jackson (1991) mentioned: "Systems thinking developed, therefore, as an alternative to mechanistic thinking, and proved itself more satisfactory for explaining not only complex biological but also social phenomena." Systems thinking draws a blue print to tackle the main issues of IMC and help to build a systemic approach of IMC. Some approaches in systems thinking could be used to improve IMC program such as Total Systems Intervention (TSI), system of evaluation methodologies, triple loop learning and critical appreciation. TSI is presented by Flood and Jackson (1991), which provides direction to systems practitioners wishing to choose relate and choose between methodologies in a theoretically informed manner. TSI's principles and philosophy can enhance IMC approach to set up effective communication in organizations. Flood (1995) identified that unless all four key dimensions of organization (organizational process, organizational design, organizational culture and organizational politics) are taken into account, i.e., a whole system view is developed, then problem solving is bound to be ineffective. Thus, TSI provides principles, processes and methods for problem solving which enable effective intervention in these four dimensions of organization to bring about improvement, which should help IC problem solving.

Organizational process means 'rules about efficiency

of flows and control over flows' and aims to achieve efficiency in terms of no unnecessary waste of time or resources (Flood and Romm, 1996). Flood (1995a) recommended Quality Management and Business Process Reengineering to make the processes more efficient. Organizational design concentrates on 'rules about effectiveness of functions and their organization' and here effectiveness refers to achieving chosen tasks of functions (Flood and Romm, 1996). Flood (1995) recommended using the Viable System Model (VSM) which brings together five main management functions (operations, co-ordination, control, intelligence, and policy) and organizes them according to a carefully worked-out series of information flows. Organizational culture means 'mediation of behavior in terms of people's relationship to social rules and practices' (Flood, 1995). This is recognition that different people need different things, understand things differently and respond to things in different ways. Flood (1995) has found that debating methodologies such as Testing Polarized Viewpoints, Exploring and Choosing Designs, and Exploring and Making Decisions could help to resolve the human problems of organizational culture and organizational misunderstanding. Organizational politics means 'power and potency to influence the flow of events' (Flood, 1995a). It is important to understand who holds power, and how this power can be used to serve certain interests. Flood (1995) points out that Critically Evaluating Designs and Decisions could help managers to think about whose interests are being served in design work and decision making.

Basically, if the organizations can look at their IMC approach through these four dimensions of organizations, they satisfy TSI's philosophy. If all four key dimensions of organizations are fully taken into account, then effective IMC approach can be achieved. Gould, Lerman and Grein (1999) indicated the importance of globally integrated marketing communications and adopt three

emergent themes: 'the evolving nature of the globalization process, its contingency element and its cultural dimensions of client and agency.' Be considered seriously, issues of IMC can be tackled and communications can be effectively integrated under the four dimensions of organizations. Lin (2000, 2001) developed a new integrated communications model which uses a systemic view for assessing the applicability of IMC. Furthermore, systems thinking and the pluralist approach from the Center for Systems Studies at the University of Hull (U.K.) can enhance the IMC approaches [8].

Gibbert et al. (2002) have presented the concept of Customer Knowledge Management (CKM) that refers to the management of knowledge from customers, i.e., knowledge resident in customers. Moreover, five styles of CKM were also proposed and illustrated by way of corporate examples. Park et al. (2001) have focused on knowledge refinement that is a necessary process to obtain and maintain current knowledge in the domain of interest. Shaw et al. (2001) have presented a systematic methodology that uses data mining and knowledge management techniques to manage the marketing knowledge and support marketing decisions. Lesser et al. (2000) have identified four approaches (customer knowledge development dialogues, facilitating the capture of knowledge relevant data, demonstrating enterprise leadership commitment to customer knowledge) that can expand the availability and use of customer knowledge. Lin and Su (2003) mentioned a systemic integrated communications model which can help enterprises identify the potential issues of CRM. Tiwana [14] provided knowledge sources and categories such as markets, competitions, customers, orders, contracts, products and services, customer complaint and best practices. Basically, knowledge about these sources and categories must be integrated into a knowledge-enabled CRM strategy.

3. Research Design and Method

3.1 Research Framework

This paper aims to explore the relationship among customer knowledge sources, CM, IMC and systems intervention. The conceptual model is displayed in Figure 1. The problems of organizational process, design, culture and politics in each aspect of IMC must first be identified. These problems will be reflected to the three modes in order to get the best solution in a systemic view. Tiwana (2000) provided knowledge source and categories such as markets, competitions, customers, orders, contracts, products and services, customer complaint and best practices. The conceptual model is displayed in Figure 1.

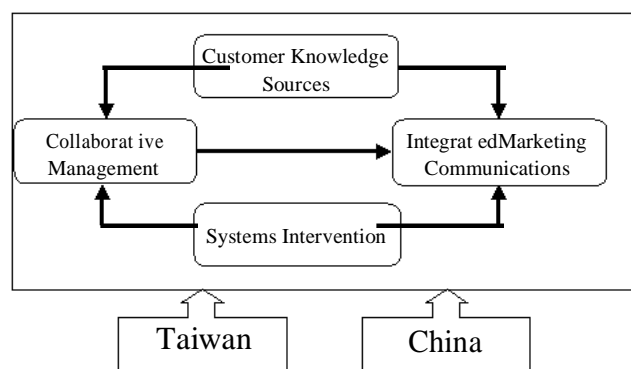


Figure 1. Research framework

3.2 Research Hypothesis

This paper aims to explore the relationship among customer knowledge sources, CM, IMC and systems intervention. Further to explore the effect of the dimensions of customer knowledge sources and systems intervention on the dimensions of CM and IMC. According to the purpose of the research and the literature surveyed, the hypothesis is identified as follows.

H₁₁: There is significant difference between Taiwan and China in the dimension of customer knowledge sources.

H₁₂: There is significant difference between Taiwan and China in the dimension of CM.

H₁₃: There is significant difference between Taiwan and China in the dimension of IMC.

H₁₄: There is significant difference between Taiwan and China in the dimension of systems intervention.

3.3 Sampling

There were 8 available responses from 60 collaborative partners in Taiwan and 19 available responses from 60 collaborative partners in China (Return rate 22.5%).

4. Research Findings and Discussion

4.1 Descriptive Statistics Analysis

As shown in Table 1, in the dimension of customer knowledge sources, the mean of market information is higher than the other factors. So it seems that market information plays the most important role in this dimension. In the dimension of CM, the mean of collaborative relationships is higher than the other factors. So it seems that collaborative relationships plays the most important role in this dimension.

As shown in Table 2, in the dimension of IMC, the mean of customer-based integration is higher than the other factors. So it seems that customer-based integration plays the most important role in this dimension. In the dimension of IMC, the mean of organizational processes is higher than the other factors. So it seems that organizational processes plays the most important role in this dimension.

Table 1. The mean of customer knowledge sources and CM

Customer Knowledge Sources		CM	
Factor	Mean	Factor	Mean
Market Information	4.443	Collaborative Relationships	4.145
Competition Information	4.128	Core Capability	4.012
Customer Information	3.898	Customer Focus	3.92
Order Information	3.66	Legal and Financial Facilitators	4.018

Product and Service Information	4.123	Business Systems	3.954
Customer Complaint Information	4.167	Common Views	3.948
Best Practice Information	4.045	Attitude	3.953

Table 2. The mean of IMC and systems intervention

IMC		Systems Intervention	
Factor	Mean	Factor	Mean
Awareness Integration	4.134	Organizational Culture	3.977
Image Integration	4.054	Organizational Politics	4.083
Database Integration	3.958	Organizational Design	4.174
Customer-based Integration	4.149	Organizational Processes	4.284
Stakeholders-based Integration	4.094		
Evaluation Integration	3.973		

4.2 Reliability Analysis

The analysis of scale reliability was performed using Item to total correlation, Cronbach's alpha coefficient and the cluster effects among variables. In the dimension of customer knowledge source, the value of Cronbach's alpha of the factor of market information, customer information, order information, product and service information, customer complaint information and best practice information are all great than 0.6. In the dimension of CM, the value of Cronbach's alpha of the core capability is less than 0.6 so we cancel this factor and the value of Cronbach's alpha of the others factors are greater than 0.75. In the dimension of IMC, the value of Cronbach's alpha of the factors of awareness integration, database integration, customer-based integration, stakeholder-based integration and evaluation

integration are greater than 0.65. In the dimension of systems intervention, the value of Cronbach's alpha of the factor of organizational culture, organizational politics, organizational design and organizational process are 0.7248, 0.6975, 0.75 and 0.7609 respectively, those values are greater than 0.6.

4.3 The difference between Taiwan and China

This research adopts t test to examine the difference between Taiwan and China regarding the dimension of customer knowledge sources, CM, IMC and systems intervention. The result of the analysis is shown as Table 3. Although there is no significant difference in both customer knowledge sources and CM dimensions, there is significant difference with the factors of awareness integration and evaluation integration in both IMC and systems intervention dimensions. So, findings provide no support for H11 and H12 and also provide partial support for H13 and H14.

Taiwan's collaborative partnerships focus on marketing information and product and service information for customer knowledge sources; collaborative relationships and legal and financial facilitators for CM; awareness integration and customer-based integration for IMC and need the solution about organizational design to get CM relationship improved. China's collaborative partnerships focus on marketing information and customer complaint information for customer knowledge sources; collaborative relationships and common views for CM; customer-based integration and stakeholders-based integration for IMC and need the solution about organizational processes to get collaborative marketing relationship improved.

Table 3. The different analysis of every dimension between Taiwan and China

Dimension		Mean Taiwan	Mean China	T-value	P-value	Significant difference
Customer Knowledge Sources	Market information	4.656	4.224	1.803	0.084	No
	Customer information	3.875	3.921	-0.192	0.85	No
	Order information	3.438	3.882	-1.578	0.127	No
	Product and service information	4.219	4.026	0.919	0.367	No
	Customer complaint information	4.188	4.145	0.19	0.851	No
	Best practice information	4.125	3.965	0.647	0.524	No
CM	Collaborative Relationships	4.4	4.053	1.696	0.102	No
	Customer Focus	3.75	3.887	-0.678	0.504	No
	Legal and Financial Facilitators	4.025	4.011	0.067	0.947	No
	Business Systems	3.917	3.991	-0.354	0.726	No
	Common views	3.875	4.021	-0.661	0.515	No
	Attitude	3.906	4	-0.4	0.693	No
IMC	Awareness Integration	4.333	3.825	3.266	0.003**	Yes
	Database Integration	4.125	3.79	1.363	0.185	No
	Customer-based Integration	4.333	3.965	1.725	0.097	No
	Stakeholders-based Integration	4.188	4	0.951	0.351	No
	Evaluation Integration	4.208	3.737	2.304	0.03*	Yes
Systems intervention	Organizational culture	4.042	3.912	0.52	0.608	No
	Organizational politics	4.044	4.123	-0.287	0.777	No
	Organizational design	4.417	3.93	2.262	0.033*	Yes
	organizational processes	4.375	4.193	0.84	0.409	No

* P<0.05; ** P<0.01; *** P<0.001

4.4 The regression analysis of the effects of customer knowledge sources and systems intervention on CM

As shown in Table 4, the dimension of customer knowledge sources has significant difference in the factors of collaborative relationships, customer focus, business systems, common views and attitude. The dimension of systems invention also has significant difference in the factors of legal & financial relationships, common views and attitude.

According to statistic outcome in the dimension of

customer knowledge sources, the factors of marketing information and product and service information directly affect collaborative relationships, the factor of customer information directly affects customer focus and the factor of order information directly affects business system, common views and attitude.

In the dimension of systems intervention, the factors of organization culture and organization design directly affect legal & financial relationships and the factor of organization process directly affects business systems, common views and attitude.

Table 4. The analysis of regression of the effects of customer knowledge and systems intervention on CM

Model	CM					
	Collaborative	Customer	Legal & financial	Business	Common	Attitude

	relationships	focus	relationships	systems	views	
Market information	0.54***					
Customer information		0.507**				
Order information				0.42**	0.356*	0.513***
Product and service information	0.423**					
Organization culture			0.449*			
Organization design			0.397*			
Organization process				0.583***	0.555**	0.504***
R ²	0.753	0.257	0.584	0.726	0.605	0.739
F value	36.572	8.667	16.868	31.718	18.391	33.944
P value	0.000***	0.007**	0.000***	0.000***	0.000***	0.000***

* P<0.05; ** P<0.01; *** P<0.001

4.5 The regression analysis of the effects of customer knowledge sources and systems intervention on IMC

As shown in Table 5, the dimension of customer knowledge sources has significant difference in the factors of database integration, customer-based integration, stakeholders-based integration and evaluation integration. Besides, the dimension of systems intervention has significant difference in the factors of awareness integration, database integration, customer-based integration and stakeholders-based integration.

In the dimension of customer knowledge sources, the factor of customer information affects database integration, the factor of order information affects customer-based integration, the factor of customer complaint information affects stakeholders-based integration and the factor of product and service information affects customer-based integration and evaluation integration.

In the dimension of systems intervention, the factor

of organization culture affects customer-based integration, the factor of organization leadership affects database integration and stakeholders-based integration, the factor of organization design affects awareness integration, database integration and stakeholders-based integration and the factor of organization process affects database integration.

4.6 The regression analysis of the effects of CM on IMC

As shown in Table 6, the dimension of CM has significant difference in the factors of customer-based integration, stakeholders-based integration and evaluation integration. In the dimension of CM, the factor of legal & financial relationship affects customer-based integration, stakeholders-based integration and evaluation integration; the factor of common views affects evaluation integration and the factor of attitude affects stakeholder-based integration.

Table 5. The analysis of regression of the effects of customer knowledge sources and systems intervention on IMC

Model	IMC				
	Awareness	Database	Customer-based	Stakeholders-based	Evaluation

	integration	integration	integration	integration	integration
Customer information		0.323**			
Order information			-0.349*		
Product and service information			0.544**		0.622**
Best practice information				0.27*	
Organization culture			0.543**		
Organization leadership		0.465***		0.484**	
Organization design	0.439*	0.979***		0.377**	
Organization process		-0.698**			
R ²	0.193	0.817	0.63	0.722	0.386
F value	5.972	24.531	13.066	19.899	15.737
P value	0.022*	0.000***	0.000***	0.000***	0.001**

* P<0.05; ** P<0.01; *** P<0.001

Table 6. The analysis of regression of the effects of CM on IMC

Model	IMC				
	Awareness integration	Database integration	Customer-based integration	Stakeholders-based integration	Evaluation integration
Collaborative relationships	0.223	0.18	0.253	0.169	0.222
Customer focus	0.302	0.081	-0.052	-0.096	-0.156
Legal & financial relationships	0.494	0.647	0.796**	0.795**	0.853**
Business systems	-0.072	0.236	-0.511	-0.325	-0.044
Common views	-0.111	-0.553	-0.184	-0.637	-1.089*
Attitudes	-0.339	0.038	0.355	0.822*	0.568
R ²	0.317	0.363	0.562	0.631	0.471
F value	1.546	1.896	4.272	5.511	2.97
P value	0.215	0.131	0.006**	0.001**	0.031*

* P<0.05; ** P<0.01; *** P<0.001

5. Conclusion

The findings of this research are as follows:

1. Although there is no significant difference in both customer knowledge sources and CM dimensions between Taiwan and China, there is significant difference with the factors of awareness integration and evaluation integration in both IMC and systems intervention dimensions.
2. Collaborative partners consider that more market information, and product and service information can build collaboration and trust relation between collaborative partners. Solving methods of organizational culture and organizational design can help to clarify with the legal and financial relation between collaborative partners. In addition, gathering order information and the solving methods of organizational process will help to build up business IT system, common view and positive attitude.
3. In IMC dimension, gathering customer information

and solving methods of organizational design, organizational politics and organizational process will help to database integration. Gathering order, product and service information and solving methods of organizational culture will help to customer integration. In addition, gathering best practice information and solving methods of organizational design and organizational politics will help to stakeholders-based integration.

4. CM has significant effect on IMC that could be used for IMC planning in the future.

Moreover, this study presented a conceptual model of Collaborative-CKM to see how CM can help IMC implementation. The result of the research could be consulted by the other industry to create their Collaborative-CKM framework and IMC implementation.

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Early Supplier Involvement in e-Product Configuration for Mass Customization

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Abstract

In terms of transforming supply chain into integrated value systems, the benefits of Early Supplier Involvement (ESI) in product development have been widely accepted. Despite past advancements in ESI, some unique issues have not been addressed for ESI in e-product configuration for mass customization. As far as variety management and online configuration are concerned, the difficulties of ESI in online mass customization manifest themselves through two main aspects: (1) Support the seamless information integration with respect to its high variety and large volume not only among internal functions but also with external suppliers; (2) Support real-time online configuration for product configuration generation and optimization based on customer requirements and supplier capabilities. Accordingly, this work proposes two potential solutions. PFA-based integrated information model is established to synchronize the PFA generic structure and supplier product information. Meanwhile, the mechanism of real-time bidding is explored to back up online configuration with the rapid RFQ requirements.

1. Introduction

e-commerce and mass customization have been foreseen as a primary style of manufacturing in the coming decade and beyond. With respect to new capabilities implied by e-commerce, customers will be able to input and interact directly with design, manufacturing and service providers. The providers will have to respond to a high variety of requirements and orders within the constraints of cost, schedule and quality. With the advent of information technology, electronic product configuration (ePC) for mass customization is being recognized as a potential dimension to enhance company profitability through a synergy of increasing customer-perceived value while reducing customization cost and improving product realization efficiency.

The implementation of ePC for mass customization mainly involves two critical issues: (1) Electronic catalogs have to be properly constructed to organize unstructured product information, achieve effective variety management, and enable reengineering companies' supply chain relationships. (2) The basic mechanism of online configuration needs to be explored through modeling product configuration process, formulating intelligent configuration systems, and developing approaches to the

rapid request-to-quotations (RFQs) processing

In terms of transforming supply chain into integrated value systems, the benefits of Early Supplier Involvement (ESI) in product development have been widely accepted. As stated by [1], ESI is advocated as a means of integrating suppliers' capabilities in the buying firm's supply chain system and operation. Partnerships are formed with suppliers to take advantage of their technological expertise in design and manufacturing. A number of empirical studies reveal both strategic and tactical benefits of ESI. Dowlatsahi [2] develops a most comprehensive ESI framework. It is an initial conceptual ESI framework and can be used by companies. Bidault et al. [3] report the results of an empirical study that explores the drivers of the adoption of ESI in the product development process. Hartley et al. [4] conduct a study that empirically tests whether management of the buyer-supplier interface affects supplier-related delays. LaBahn et al. [5] develop a contingency model of component supplier intentions. Wynstra et al. [6] propose a coherent framework of specific activities across a number of different management areas within purchasing involvement in product development. Dowst [7] outlines nine areas in which suppliers can be involved in the buyer's design process. Huang et al. [8]~[9] identify that major ESI issues include make or buy decisions and supplier selection. Research literature on ESI in online mass customization is relatively scarce. Ghiassi et al. [10] describe a software system that supports electronic business operations in mass customized markets with synchronized supply chain required.

In spite of past progress in ESI, some unique issues have not been addressed for ESI in ePC for mass customization. As far as variety management and online configuration are concerned for ePC, the difficulties of ESI in online mass customization manifest themselves through two aspects.

Firstly, mass customization is facing a variety dilemma resulting from the continuous generation of product variants to meet diverse customer needs. To achieve effective variety management, a promising strategy is to shift the practice from designing and managing individual product instances to establishing product families. Although many research efforts have been put on supply chain management issues such as improving the process efficiency and integrating manufactures' systems with suppliers', there is a remarkable lack of clarifying the underlying mechanism of such integration in mass

customization context, where product information is normally organized as product family architectures (PFA).

Furthermore, online configuration is another crucial factor to a success of ePC. Since mass customization involves understanding accurately customer needs and subsequently creating a complete description of a product variant that meets those needs, this is typically a sales order configuration process. Such a configure-to-order process assumes that a valid design is assembled from instances of a fixed set of well-defined component types (e.g., part catalogs), in which components are interconnected in a predefined way to meet a set of customer requirements and certain design constraints. ESI in online configuration is mainly embodied on supply development based on competitive bidding among suppliers. The bidding process is time consuming and often conducted offline. Thus, the traditional bidding is not applicable for real-time product configuration design with the rapid RFQ processing.

To overcome the two key hindrances of implementing ESI in ePC, this work emphasizes two potential solutions accordingly. PFA-based information integration between various business entities across a supply chain enables incorporation of ESI in online mass customization. Meanwhile, real-time bidding is proposed to accommodate the demands of online configuration.

2. Framework of ePC for mass customization

With the utmost concerns on the fundamental issues of ePC, an ePC system is characterized by two basic properties: (1) Supporting the information management and integration in terms of its high variety and large volume not only within internal functions but also with external suppliers. (2) Supporting real-time online configuration for product configuration generation and optimization based on customer requirements and supplier capabilities.

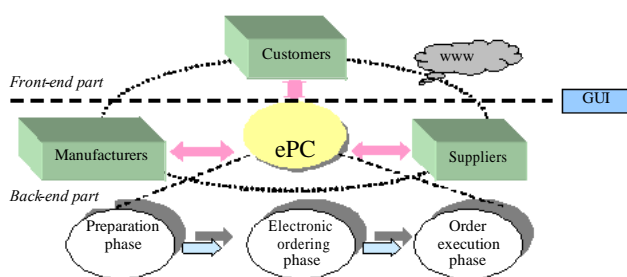


Figure 1. A simplified framework of ePC for mass customization

Electronic linkages enable better communication and coordination among distinctive entities across a supply chain and necessitate the redesign of the traditional supply chain relationships. A framework of ePC can be constructed to introduce the concept of integrated “value chains” into the online mass customization process. The whole ePC process is separated into three major phases including the preparation phase, the electronic ordering phase and the order execution phase. Once the management adopts online mass customization as its

business strategy, the general procedure will start. Figure 1 illustrates the simplified framework.

Along the overall procedure, the task of the preparation phase is the construction of product family architecture (PFA), which represents product knowledge needed in the online configuration process. It defines the generic product model and classification (assortment) of products and component parts by means of modules, variety parameters, and constraints. During the electronic ordering phase, PFA is applied to product configuration. It creates a specific product instance or variant based on the generic model. This configuration solution can be represented as a product specification, a sales order, or a part list or a BOM. In this sense, PFA-based product configuration becomes the derivation of product variants through instantiating the generic product structure according to customer-specified variety parameters [11]. The order execution phase encompasses a number of sub-activities such as order entry, production scheduling, material planning, capacity planning, shop floor control, and so on. Research and applications in this area have been under their relatively strong status.

3. ESI in ePC for mass customization

Online mass customization implies an advantage over traditional supply chain intermediaries, that is, the direct interaction among customers, manufacturers and suppliers for every single transaction, which involves coordination about the customer-specific product design. The costs rising from customization consist largely of information costs resulting from the transfer of individual configurations to manufacturing, the increased complexity in production planning and control, the coordination of external suppliers involved in individual assembly, and individual distributions of customer-specific products. Electronic linkages enable companies to reengineer supply chain relationships fundamentally in reducing transaction costs through electronic handling of orders, invoices, and payments. These will facilitate reduced inventory requirements and vendor managed inventory programs. In particular, online product configuration results in an increasing number of supplier-customer relationships and an increasing use of supplier parts. Design-stage sourcing, if accomplished properly, is particularly effective at the downstream assembly-to-order stage of order fulfillment. Therefore, the involvement of suppliers in online product configuration becomes an important issue for web-based sales support. Furthermore, suppliers should be involved earlier than they must be actually involved. During online configuration, decisions regarding supplier parts, such as make or buy decisions, bid preparation, and supplier selection, must be determined with real-time interactions with customers, marketing personnel, and designers. Traditionally, however, suppliers are often involved offline after design is over.

3.1 PFA-based integrated information model

As the front-end of the company’s interactive interface

to online customers, electronic catalogs work as a virtual gateway by providing customers with an immediate access for obtaining product information, ordering goods, making payment, providing feedback and participating in other corporate activities. Good electronic catalogs should be built upon a thorough understanding of the coherence of product information. This research extends our previous work on the product family architecture (PFA) for mass customization [11] [12]. PFA is the conceptual structure and overall logical organization of generating a family of products, which provide a generic umbrella to capture and utilize commonality, within which each new product is instantiated and extended so as to anchor future designs to a common product line structure. The rationale of such a PFA lies in not only unburdening the knowledge base from keeping variant forms of the same solution, but also with modeling the design process of a class of products that can widely variegate designs based on individual customization requirements within a coherent framework. For each view of PFA, such as functional features (FFs), technical parameters (TPs) and components / assemblies (CAs), a generic structure can be established to understand variety and its impact on product differentiation [13]. There are basically three aspects underlying a genetic variety structure (GVS), which are product structure, variety parameters and configuration constraints.

(1) Product structure: All product variants of a family share a common structure. It can be described as a hierarchy comprising parts (P_i) at different levels of abstraction, where $\{P_i\}$ can be either abstract or physical items. Such a breakdown structure (AND tree) of $\{P_i\}$ reveals the topology for end-product configuration.

(2) Variety parameters: Usually, there is a set of attributes (characteristics variables), A_i , associated with each P_i . Among them, some variables are relevant to

variety and thus are defined as variety parameters, $\{V_{ij}\} \subset A_i$. Like attribute variables, parameters can be inherited by child node(s) from a parent node. The instances, $\{P_{ijk}\}$, of a particular P_i in relation to a certain V_{ij} embody the difference among product variants.

(3) Configuration constraints: Configuration constraints manifest themselves through restrictions on the combinations variety parameter values, $\{P_{ijk}\}$. For the player example in Figure 2, there is a color compatible constraint among $\{P_{33k}\}$ and $\{P_{51k}\}$. The instantiation of a part, P_i is achieved by specifying one and only one value for each variety parameter related to P_i that is,

$$P_i \xrightarrow{\{V_{ij} \rightarrow V_{ij}^*\}} \{P_{ijk}^*\}, \forall k \in [1, N].$$

This can be expressed as a XOR (i.e., exclusive OR) relationship in Figure 2, meaning only one of $\{P_{ijk}\}$ can be selected for a product variant. For example,

$$\begin{aligned} V_{31} &\rightarrow V_{31}^* \\ V_{32} &\rightarrow V_{32}^* \\ V_{33} &\rightarrow V_{33}^* \\ P_3 &\xrightarrow{V_{34} \rightarrow V_{34}^*} \{P_{31k}^*, P_{32k}^*, P_{33k}^*, P_{34k}^*\}, \forall k \in [1, N] \end{aligned}$$

As far as variant handling is concerned, the rationale for the generic variety structure lies in the recognition of the origin and subsequent propagation of variety. Three levels of variations have been indicated, i.e., at the structure, variety parameter and instance levels. Different variation levels have different variety implications. Accordingly, a generic representation can be introduced to represent variety with minimum data redundancy. There are two basic concepts as described below.

(1) Generic product: A generic product represents a set

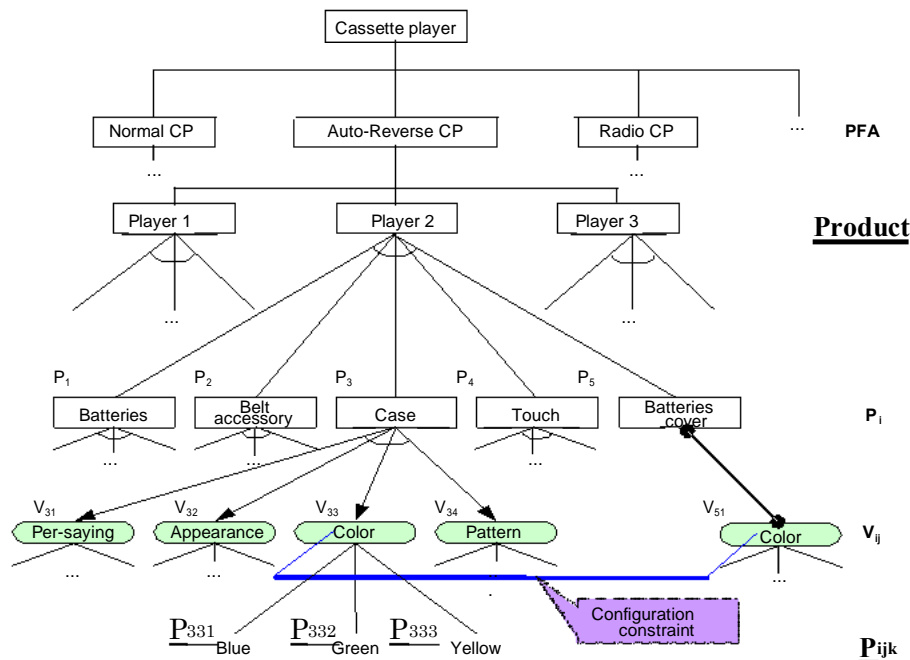


Figure 2 Generic variety representation for CP products

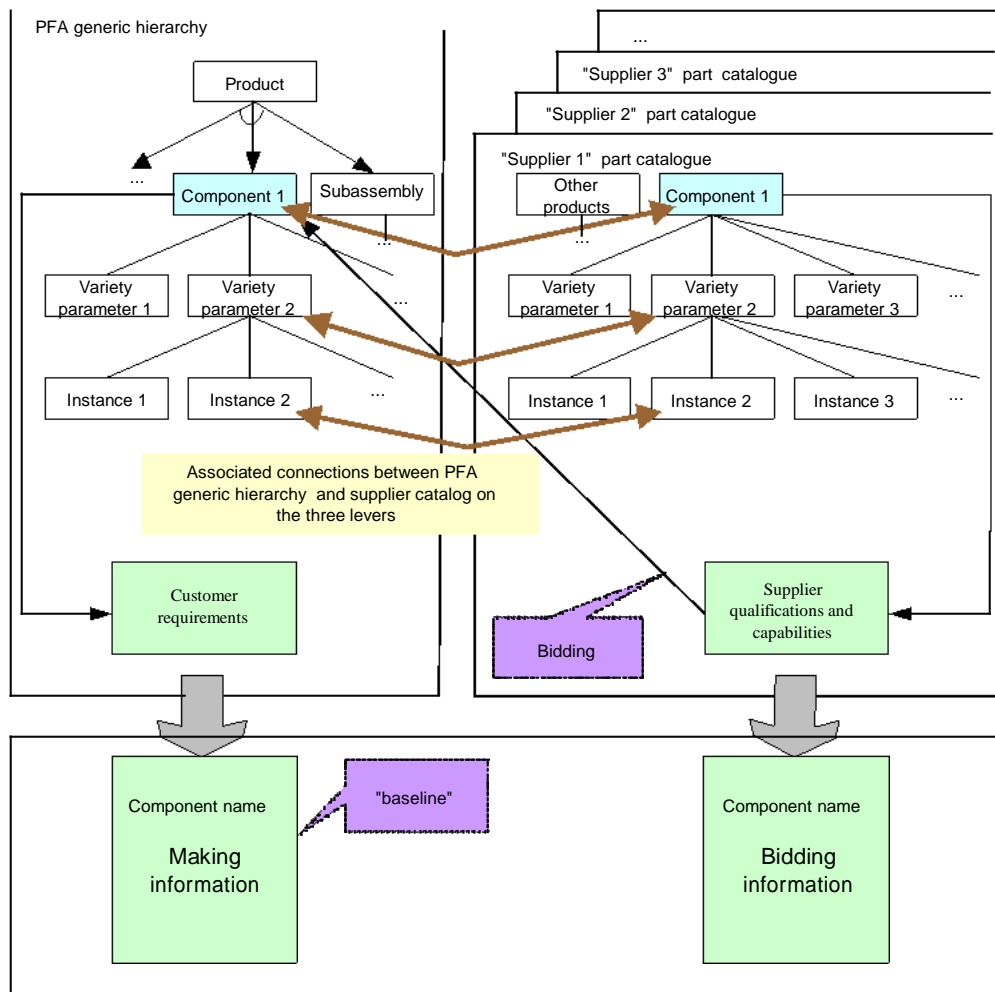


Figure 3. Integrated information model for ESI in online configuration under the umbrella of PFA

of similar products (called variants) of the same type (namely a family). A product may refer to an end product, a subassembly, an intermediate part, or a component part. For the player example in Figure 2, a blue case (P_{331}^*), a green case (P_{332}^*) and a yellow case (P_{333}^*) are three individual variants, whilst a generic product, $P_3|v_{33}$, represents such a set of variants (a family of player cases), that is, $P_3|v_{33} \rightarrow \{P_{331}^*, P_{332}^*, P_{333}^*\}$. Nonetheless, these variants are similar in that they share a common structure (Figure 2) in configuring a player.

(2) Indirect identification: Instead of using part numbers (referred to as direct identification), the identification of individual variants from a generic product (within a family) is based on variety parameters and their instances (a list of parameter values). Such identification is called indirect identification. In the above example, a variety parameter, color (v_{33}), and its value list, {"blue", "green", "yellow"}, can be used for an indirect identification of a particular variant, e.g., $P_{331}^* \sim P_3|v_{33} = \text{"blue"}$. On the other hand, the identification of product family (generic product) "player case" is described as P_3 .

The electronic catalog works not only as the front-end of the company's interactive interface to on-line customers, but also integrates the back-end product operation capability of manufacturers and suppliers. The online sales order configuration coupled with supply chain planning is an important strategy in order to synchronize design and production planning functions by considering materials and capacity availability associated with suggested configurations.

Figure 3 illustrates how to incorporate ESI into online mass customization under the umbrella of PFA. Suppliers to certain component parts can be organized in a similar way to the GVS, in which attributes of the suppliers can be retrieved and evaluated according to their relevance to and satisfaction of those variety parameters required by certain component parts in a particular configuration. In this sense, variety parameters play an important role to link suppliers to the PFA.

Such issues as "Make" or "Buy" decisions and supplier selection can be dealt with according to the justification of the values of relevant variety parameters between a specific supplier and a particular instantiation of the PFA. Figure 3 shows the elaboration of the supplier product model and its information exchanges with the PFA, through which PFA information and supplier part

information can be synchronized.

3.2 Real-time bidding

ESI in online mass customization differentiates itself from traditional ESI in product development through real-time bidding. Traditionally, the process of inviting and submitting bids is somehow time-consuming and often conducted off-line. With online mass customization performed, customers highly desire real-time online configuration, which aims at producing rapidly product configuration design with estimated price and delivery time subject to customer requirements and engineering or physical constraints. As such, it is really imperative to redesign the way in which a bidding process is incorporated in online configuration under mass customization environments. Real-time interactions between various entities are required as illustrated in Figure 4.

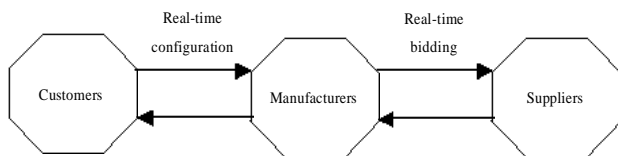


Figure 4. Real-time interactions

3.2.1 Static real-time bidding

Figure 5 shows an overview of the static real-time bidding process. A core of implementing static real-time bidding is to set up a centralized database for integration and management of supplier bidding information. The whole process starts with capturing customer functional requirements and ends at order entry. It is divided into three main stages including bidding preparation, bidding implementation as well as configuration generation and optimization.

In the bidding preparation stage, customer needs are captured as a set of functional requirements to certain components parts taking advantage of the electronic catalogs of ePC systems. As the electronic catalogs are organized based on PFA, customer requirements are actually reflected onto corresponding variety parameter instances within the generic structure of PFA. Subsequently the particular instantiation of the PFA is linked to product information systems of both manufacturers and suppliers, which are constructed in a similar way to the GVS of PFA. As a result, attributes of manufacturers and suppliers can be retrieved and evaluated according to their relevance to and satisfaction of those variety parameters in terms of customer functional requirements. In this sense, variety parameters work as a bridge to connect customers, manufacturers and suppliers together under the umbrella of PFA. While the mapping relationships among the triple entities are straightforward by using the PFA generic structure, it is critical to establish such linkages so as to enable downstream tasks such as “Make” or “Buy” decision and best supplier selection.

In respect of static real-time bidding, supplier bidding information must have already existed, that is, a number of potential suppliers are selected to put into an initial database based on last experience. In this case, ePC invites suppliers to provide the entire PFA-based product information instead of inviting bids for individual component parts. The bidding information is constantly updated in terms of suppliers’ current capabilities. Towards this end, it is essential to integrate the centralized supplier database into their MRP or ERP systems. Moreover, the suppliers in the database may keep changing. New suppliers are added with new partnerships built whereas unqualified suppliers are deleted.

Based on customer requirements, supplier bidding content is primarily comprised by two parts, supplier

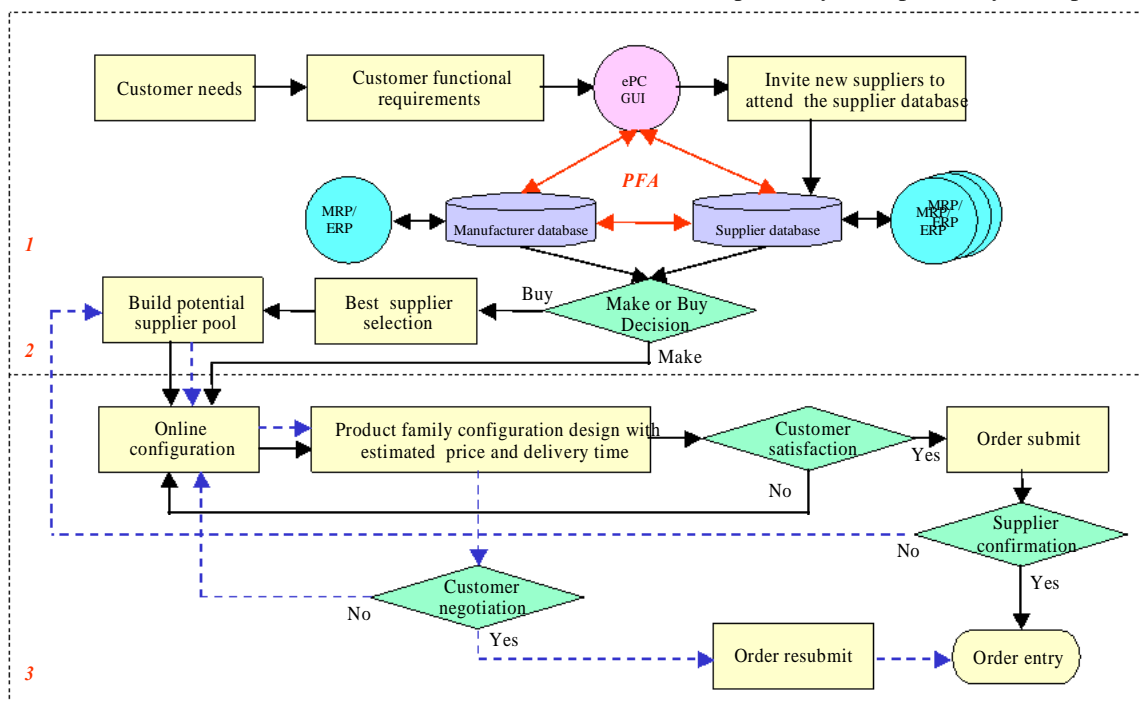


Figure 5. Static real-time bidding

qualification information and supplier production capability. Supplier qualification information is related to a set of fundamental non-technical requirements such as financial status, quality management systems and after sales customer service. On the other hand, supplier production capability is mainly concerned with technical requirements consisting of PFA-based part catalogs as well as component price and delivery time.

According to supplier bidding information, “Make” or “Buy” decision and best supplier selection can be carried out to achieve real-time bidding.

“Make” or “Buy” decision making is embedded in the

ePC system. Manufacturers who are capable of providing customers with the expected functional features first publish their “Making” information of specific component parts as a baseline for all suitable suppliers who are automatically authorized to participate in the bidding process. Through comparing with supplier bidding information, ePC can draw conclusions whether or not “Buy” has advantages over “Make”. Outsourcing only occurs when supplier bidding information surpasses the baseline. A Make/Buy index (MBI) is introduced to express the outcomes of comparisons between the suppliers and the baseline. Initially, MBI is 0 for both

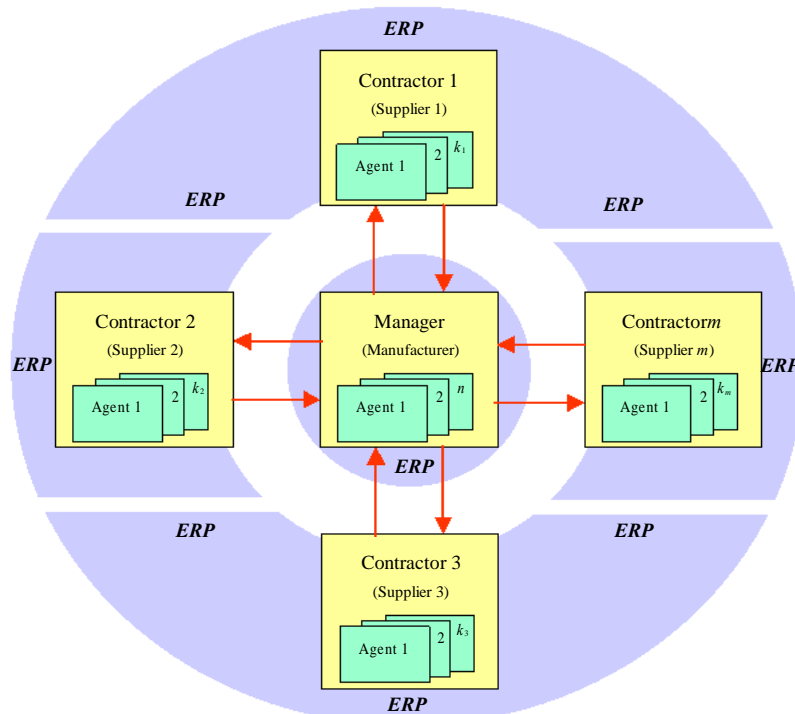


Figure 6. A multi-agent system supporting dynamic real-time bidding

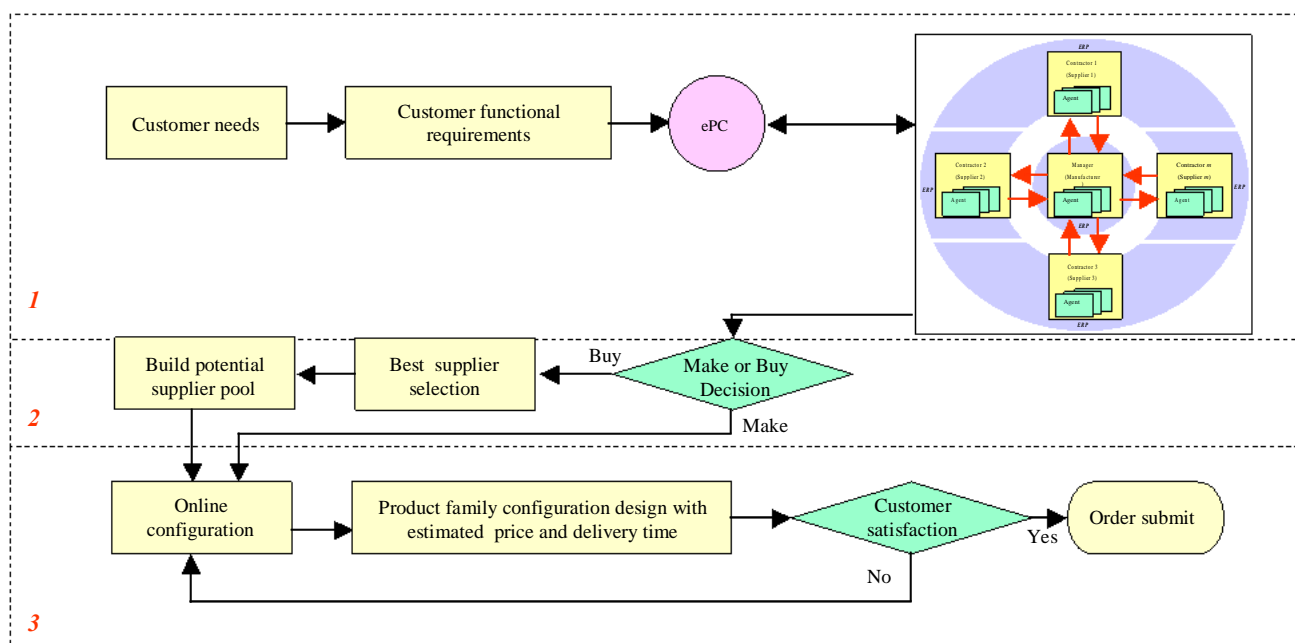


Figure 7. Dynamic real-time bidding

Qualified suppliers with MBI equal to 1 are under further consideration for best supplier selection. Supplier selection is a multi-criteria decision making problem, which contains both qualitative and quantitative factors. In order to select the best suppliers, it is necessary to make a tradeoff between the tangible and intangible criteria, some of which may be in conflict with each other. Besides the Make/Buy index (MBI), other indices can be introduced to measure the extent to which supplier capabilities match customer requirements.

It is notable that a customer-satisfied configuration design needs to obtain the confirmation from the relative suppliers when taking into account possible variations of supplier capabilities. In other words, the selected suppliers have to make sure their bidding information once more in present scenario. Next, the contracts can be awarded to them. If the suppliers cannot offer overall production capabilities as promised in bidding information, they are referred to as unqualified suppliers, and a reconfiguration is done without the consideration of the unqualified suppliers in the potential supplier pool. The results of reconfiguration are then negotiated with customers.

3.3 Configuration generation and optimization

With product design practice shifted from designing an individual product to designing a product family for mass customization, product configuration design is also referred to as product family configuration design, which always contains two fundamental tasks, generation of a family of configuration design alternatives and evaluation for the optimal one. In response to them, an intelligent system is desired to achieve the following three targets simultaneously for product family configuration design: (1) Automatically produce a family of feasible configuration design alternatives according to all the requirements and constraints. (2) Subsequently select the optimal configuration design from the family in terms of multiple rational design objectives. (3) Reusable and robust to varying configuration spaces in various customization cases.

Product configuration design and optimization start with creating a PFA generic variety structure (GVS) representation. After that, customers propose functional requirements according to customizable features represented in the GVS. A configuration space is then derived from the synthesized information provided by a set of predefined modules and the customers' requirements. All configuration alternatives can be generated from the configuration space. After formulating a mathematical model with respect to the configuration space, an optimization algorithm is employed to produce the optimal configuration alternatives. A class diagram describes the underlying mechanism of product configuration design and

optimization in Figure 8.

Customer value comes from a balance of quality, cost, and delivery time. Cost, quality, and time are three commonly used parameters in expressing customer value. To assist customers in dealing with customization options, customer-perceived quality is differentiated from engineering quality, which is not what customers really care about. In this case, utility is taken advantage of to measure customer-perceived quality. As such, Utility of quality, customization cost and delivery time are proposed as three critical performance criteria for product family configuration design optimization. Solutions resulting from such multiobjective optimization are expected to comprehensively express customer value and desirability. In addition of consideration from customer perspectives, selection for the "best" configuration design may involve more optimization objectives from the perspectives of manufacturers, suppliers, distributors, retailers and so on. In essence, it reveals the importance of product family configuration design carried out under the umbrella of the whole supply chain. For instance, from the manufacturer or supplier perspective, customizability is recognized as a potential index to fully measure the capability of design and manufacturing in terms of the nature of product family design. This direction is under an active exploration.

4. Implementation consideration

A computer-integrated system is necessary to develop the ePC for mass customization with static real-time bidding. Figure 9 shows an example of a system architecture. Customization by customers is enabled

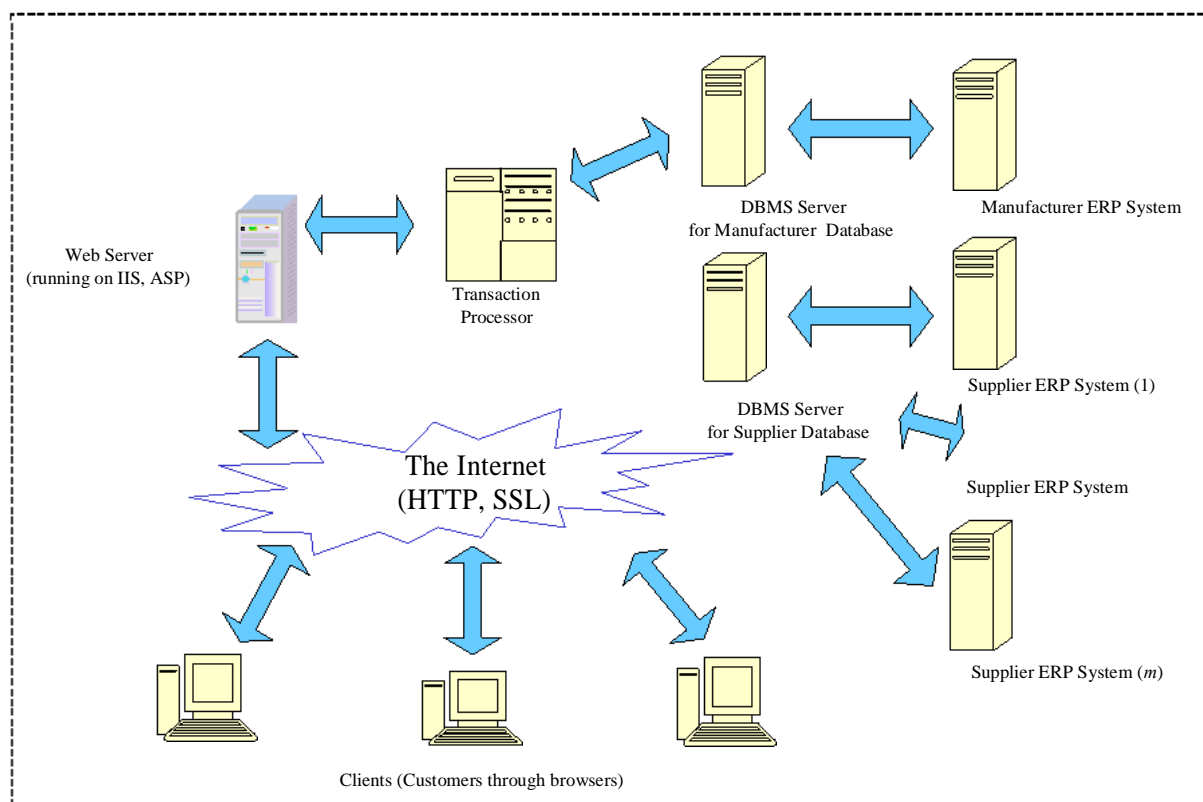


Figure 9. System architecture

through any Internet browsers. All information flow from the Internet is handled by the web server, in this case, running on an Internet Information Server (IIS) and using Active Server Pages (ASP) technology. The transaction processor acts as a connection module to process customers' data, real-time bidding and online configuration. Part of data that the transaction processor handles is retrieved from and updated into the database management system (DBMS) servers. Different DBMS servers could be assigned to deal with different tasks.

Two DBMS servers work as the manufacturer database and the supplier database respectively. Moreover, they are integrated with the ERP systems of both manufacturers and suppliers.

5. Conclusions

This research tried to investigate fundamental issues on ESI in online mass customization. PFA-based integrated information model is established across a supply chain to achieve effective variety management. Furthermore, the underlying mechanism of real-time bidding is explored to support online configuration. Two categories of methodologies are proposed as static and dynamic real-time bidding. A system architecture has been demonstrated for the ePC system with static real-time bidding.

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Development of eBusiness Strategies For Competitive Advantage

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Abstract

The current business environment is very competitive and complex that organisations need to understand new possibilities and opportunities in order to survive, sustain and grow. This requires creation of strategic partnerships based on new eBusiness models. To implement these models organisations need to IT enable its business process by undergoing an eTransformation process. We conducted a study using Porter's five competitive forces and new business models in order to give a new meaning to eBusiness strategies. This study also describes the decision making process in arriving at the business strategies and appropriate eBusiness models and the competitive advantage it gives to the organisations

Keywords: eBusiness Strategy, 7E's in eTransformation, Porters Forces, eBusiness Models, Competitive Advantage

1. Introduction

The digital revolution is changing the way buying and selling is being done creating new business cultures, new business strategies and new business models. There are many force working on organisations forcing them to revolutionise the way they do business. These forces effect the organisation so much that a need is created for business organisations to transform in order to Survive, Sustain or Grow [6]. There are five competitive forces described by Porter that effect organisations and impact on their position in the market. They are the threat of new entrants, rivalry among existing firms, threat of substitutes, bargaining power of suppliers and bargaining power of buyers [10].

In addition to the forces affecting the competitiveness of the organisation, ETransformation also has had a major impact on the way business is being done in the world. Many businesses such as Amazon.com, ebay.com and DELL have completely changed the way business is being done introducing new strategies and new business models to gain competitive advantage.

This study looks at Porters five competitive forces and discusses what strategies should be adopted to minimise the negative impact of the forces and to capitalise on the forces that can be used for the business's advantage. It also looks at eBusiness models and proposes the most effective models for different combination of forces.

2. Theoretical Background

2.1 Michael Porter's Five Competitive Forces

Micheal Porter has identified five competitive forces that determine the attractiveness of a market [10]. They are described in Figure 1.

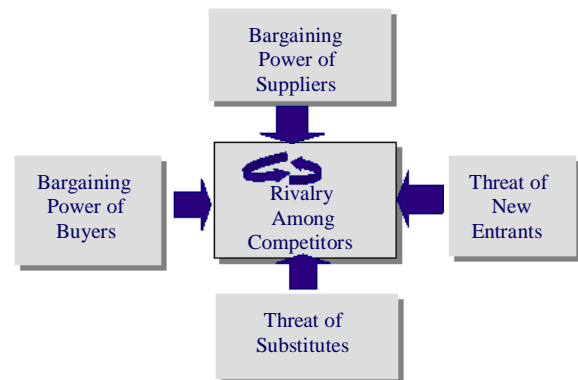


Figure 1: Micheal Porter's Five Forces [10]

The competitive forces are as follows:

- (i) Threat of New Entrants: This deals with the attractiveness of the industry sector and the height of it's entry and exit barriers [14].
- (ii) Rivalry among existing Firms: This discusses the strength and aggressiveness of the competitors in the industry sector. An industry is considered to be unattractive if there are many aggressive competitors thereby resulting in price wars, advertising battles, new and competitive product introductions, etc.
- (iii) Threat of Substitutes: Some products/services have substitute products eating in to the market share which is very difficult to manage. Substitutes generally place a limit on prices and profits, making the industry unattractive and unprofitable to work in.
- (iv) Bargaining Power of Suppliers: Suppliers can impact the price of products and limit the quantities as well if they are few in the market and if they are concentrated or organised.
- (v) Bargaining Power of Buyers: Buyers become powerful when the switching costs are low, when products are undifferentiated and when they are price sensitive. The customers are very powerful in the online economy as there are so much of information about companies for comparisons and switching costs being low.

The study proposes business strategies and eBusiness models by looking at which force is high and which force is low at a given time.

2.2 eBusiness Models:

The industry sectors are changing the way they do business by using many different collaborations with customers (B2C), service providers (B2B), financial organizations (ePayments), government (B2G), and even competitors (B2B). There are many eBusiness Models that organizations can use effectively to get benefits such as group marketing, group ordering, product bundling, direct-to-consumer access, etc. As mentioned by Rappa [11] and Burn [4] Internet commerce has given rise to new kinds of business models.

The models described by Rappa and Burn have been categorized in to a few main eBusiness models with a fare amount of differences and advantages. Few models have been added by the authors to complete the existing and new eBusiness Models. It is important to evaluate which model gives the optimum advantage for the business being considered. Some of the emerging and existing eBusiness Models are described below.

- The linear Model (Traditional)

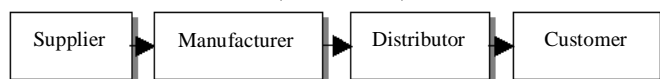


Figure 2: The Linear Model

- The Digital Value Hub (eEconomy)

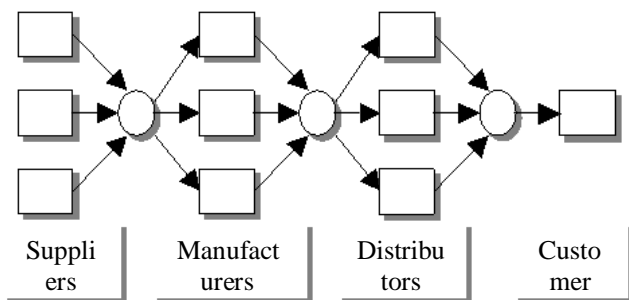


Figure 3: The Digital Value Hub

- Direct-to-Customer eBusiness Model



Figure 4: Direct-to-customer Model

The approach adopted by DELL increased their sales from \$7M per day in 1997 to \$40M per day in 2000 [14]. This model which bypasses certain nodes in the supply chain gives the manufacturer the competitive advantages to sell at a lower price reducing intermediaries, faster delivery of goods, build according to customised orders, earlier receipt of payments, speeds up new product

release cycles, uses customer data to provide value added service and helps proactive decision making [14].

- Supply chain eBusiness Model (Horizontal Marketplace):

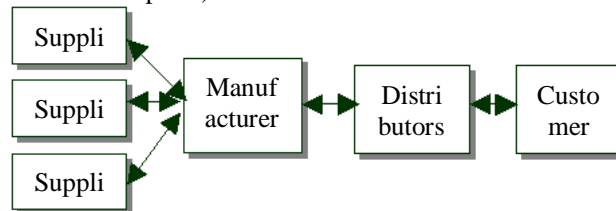


Figure 5: Supply chain eBusiness Model

This model creates a virtual value chain and an information flows across the supply chain. All parties have a strong electronic link among backend systems. This enables very effective order processing, product tracking and fast resolution of SCM issues.

- Full service provider eBusiness Model (Vertical Marketplace):

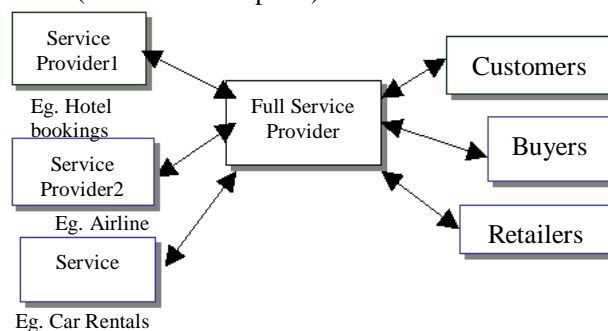


Figure6: Full service provider eBusiness Model

This is a very effective portal where the manufacturer sells their own products or services bundled with third party products or services. This offers a wider range of products/services to the customer at a reasonable or lower price as the products are bundled and therefore, concessions can be introduced. This is a very effective strategy to achieve economies of scale in delivery/distribution, channel usage and promotion which takes care of the threat of new entrants to the market.

- eAuctioneer eBusiness Model:

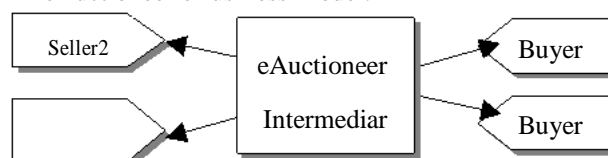


Figure 7: eAuctioneer eBusiness Model

The eAuctioneer model is very successfully used by eBay. Here the intermediary does not take responsibility

for the sale or the payment and the eAuctioneer owns the valuable customer relationship and data but not the transaction.

- Revenue sharing eBusiness Model

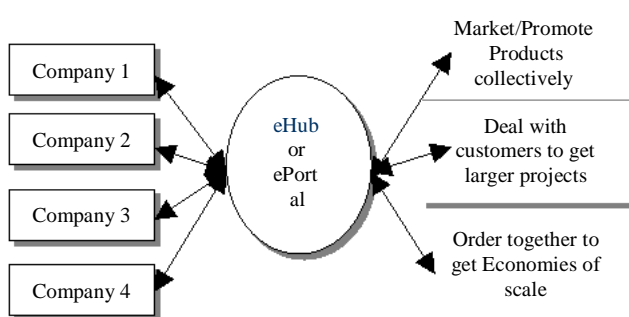


Figure 8: Revenue sharing eBusiness Model

This model uses the synergy of a collection of SMEs to get the competitive advantage. The eHub or the ePortal is the front-end for a collection of SMEs in the same industry using the portal to either market/promote each other's products collectively, pose as a larger company with a wider product range/capacity to get larger projects or use bulk ordering with suppliers to get economies of scale. Either way, the collective synergy is a much greater strength for the SMEs involved than trying to market or buy separately.

3. The Environmental Analysis and the Development of eBusiness Strategies

The study describes the business strategies adopted and eBusiness models that can be used after analyzing the business environment of an organization. This is used in linking environmental analysis to eBusiness Goals/Strategy development in the strategic eTransformation Model: Seven E's in eTransformation [2]. The 7E Model is developed by the researchers at the University of Western Sydney, Australia and currently, it is successfully being used to eTransform SMEs in the manufacturing sector in Western Sydney Region [3]. The Model is described in Appendix 1. The first two stages of the model deal with analyzing the strategic position of the company in the competitive environment it works in order to develop business strategies, eBusiness models and strategic alliances for the benefit of the company.

4. The Market Forces, Development of Strategies and eBusiness Models

As expressed earlier, Porter explains why strategies need to be developed according to the market forces working on a company in a given industry. As Porter explains, strategic positioning is "performing different activities from rivals or performing similar activities in different ways"[9], where competition is minimized by the adoption of proper differentiation strategies. The following section will explain how business strategies

and the appropriate eBusiness models should be linked to a company to get the competitive advantage depending on what forces work on that company. There are other factors such as the market economics (monopoly, oligopoly, perfect competition), company strengths/weaknesses and external opportunities/threats that will effect the final decision to adopt a particular strategy and a specific eBusiness model for the company.

According to Porter [10] the five forces working on a company at a given time are (i) Threat of New Entrants, (ii) Rivalry among competitors, (iii) Threat of Substitutes, (iv) Bargaining Power of Suppliers and (v) Bargaining Power of Buyers. When the forces are high, the strategy is mainly to position the company in the least vulnerable position or in other words, in a position where the company is least effected by the competitive forces. When a certain force is high, the business strategy should be to either minimize the force or diversify in to an area that will have a minimal effect from that force. When a force is low, the strategy should be to capitalize on the force or to use it to get more competitive advantage.

4.1 Threat of New Entrants

The best way to achieve the competitive advantage when there is a major threat from new entrants is to either differentiate or to strengthen the barriers of entry. This could be done by either adding value to the product/service by product differentiation strategy or product bundling. Another strategy would be to form strategic partnerships or alliances to strengthen the company's position in the market. Customer Relationship Management (CRM) [1] or in other words, providing a better, convenient, less costly customized service to the customer is also another strategy. Cost leadership is also an effective strategy where the company is in a position to reduce the price of the product/service to an extent that newcomers cannot even come close to the pricing structure.

The most suitable business models would be

- The Full-Service-Provider Model for value added service providing or product bundling where the new comers find it difficult to compete with
- Direct-to-Customer Model for Customer Relationship Management (CRM) [1] strengthening the B2B partnerships with suppliers to give the customer a customised product according to customer requirements
- EPortal Model where existitng competitors get together for joint marketing, bulk buying of raw materials to get the competitive advantage through economies of scale and use the synergy to increase the product line making it difficult for new entrants to survice in the market
- Digital Value Hub Model to have strong B2B strategic partnerships with existing nodes in the supply chain such as suppliers, manufacturers, dealers and customers.

These strategies and eBusiness Models make sure that there are major barriers for the new entrants making their entry full of obstacles there by getting the advantage to the company.

4.2 Rivalry Among Existing Firms

When there is a very high (perfect) competition in the industry, customers are given a wide choice of companies to select the service/product from. With the Internet, the customers can compare prices/products/services, company's profiles, other products/services offered, after sales services, etc. very easily and conveniently. The main strategy would be to differentiate, integrate, promote, manage customer relationships and have strategic partnerships.

Value addition or Product differentiation will move the product from a very competitive market to a market segment which would not be that competitive. Product bundling will provide a total solution to the customer which many competitors would not be able to provide. This is practiced a great deal in the tourist industry where they deal with ticketing, hotel bookings, car rentals, etc.

With internet technologies, it is very easy to link up with partners to form strategic alliances. Organisations can link up horizontally with the supply chain to provide a value added better service to the customer increasing CRM. Target marketing or niche marketing are effective marketing strategies which will make a major difference in creating awareness of the company and its products/services.

Another effective strategy would be the price discrimination strategy as proposed by Shin [13]. There are many Internet shopping agents such as pricescan.com and mySimon.com [8] offering price comparisons and a lot of other information to customers to compare products/features and prices. Companies can change different prices for different market segments or different combinations of product/service offerings for different prices. Discounted pricing can also be offered depending on quantities as well. This makes it difficult for customers to compare prices of alternate products offerings [13].

The most suitable eBusiness Models would be

- Direct-to-Customer Model for better CRM and to provide a quicker convenient service to any customer anywhere in the world
- The Full-Service-Provider Model to provide the supporting services using the concept 'product bundling'
- EPortal Model for a few competitors to get together for joint marketing, bulk ordering (to get economies of scale) and taking large orders using the revenue-sharing concept.

- Supply Chain Model to provide a better service to the customer including order tracking, customised products/services, etc.
- eAuction Model to market the products in a new C2C market place attracting new customers from a different market segment.

4.3 Threat of Substitutes

This threat is often ignored or neglected till it becomes too big a threat to handle. The plastic bag manufacturers face the substitute force coming from the paper bag manufacturers and promoters such as the environmental groups. The best strategies for such a situation would be product diversification, market diversification, product bundling, effective pricing strategies or strategic alliances.

Diversifying in to a new product or market is a permanent solution of avoiding the pressure of dealing effectively with substitute products/services, but, is not always possible. Strategic alliances and product bundling can add value to the basic product/service taking it away from direct competition from substitutes. One good example would be how soft drink producers link up with major food chains such as McDonalds, Hungry Jacks and KFC to beat the competition coming from ready-to-drink fresh juice producers and dairy drink producers. In certain markets, with price-sensitive customers, cost effective pricing strategies would negate the force coming from substitute products.

The most suitable eBusiness Models would be

- The Full-Service-Provider Model mainly for Product bundling and Strategic Alliances. This can also be used effectively for discounted or low pricing strategies.
- The ePortal Model can also be used for many competitors to get together and act as a Market Force using the synergy mainly to market or promote the products/services.

4.4 Bargaining Power of Suppliers

In an industry where there are limited or powerful suppliers of raw materials, a company can face major problems not being able to produce the products on time or to the expected quality and quantity. The suppliers can also monopolise on the prices for raw material thereby affecting the pricing strategies of the manufacturer. The best strategies for such situations are backward integration, Supply Chain Management (SCM), strategic alliances and bulk ordering strategies.

Backward integration will allow a company to become a component manufacturer or a raw material dealer reducing or eliminating the barrier of dealing with the bargaining power of suppliers. Supply Chain Management will definitely improve the relationships with the nodes of the value chain where the raw material ordering, manufacturing, buying from suppliers and

tracking rawmaterial orders will result in lowering the bargaining power of the suppliers. Electronic links will help the transfer of valuable information w.r.t. raw material which will ease the situation. Bulk ordering is also a good strategy where few companies who are in need of the same material get the pricing advantage by ordering in larger quantities (getting economies of scale).

The proposed eBusiness Models for such a situation would be

- The Supply-Chain Model which will increase the relationships with the companies in the manufacturing process tremendously. It can also deal with backward integration effectively.
- The ePortal Model which could be used to get the advantage in bulk ordering which could lower the cost of raw material and the dependence on the suppliers.

4.5 Bargaining Power of Buyers

One of the most important dynamics driving the expansion of the global online environment is the shift or power in the business relationship from seller to buyer [7]. As predicted by Alwin Toffer in 1990s, the buyer is becoming more and more powerful making the seller's job more and more difficult to survive in the competitive business world. In some instances, the buyers or customers are getting together in ordering in bulk to get products for the minimum prices. With the Internet, the services offered have impacted the buyer more than ever demanding convenience, 24/7 service, best bargains, best discounts, services with no geographical boundaries and more than ever, excellent Customer Relationship Management (CRM).

The best strategies proposed are Product differentiation (with value addition), Customer Relationship Management (CRM), Marketing Strategies, Pricing Strategies, Expanding Product lines, etc.

Product differentiation is improving the product and adding value to it to be different from the competitors. Porter's differentiation strategy [9] is very effective in such instances. CRM will let the company focus on high value customers [1] and have a customised approach rather than a mass-production approach. This will create brand loyalty and trust among customers.

Online and offline marketing strategies [7] and Customer Relationship Marketing [8] are another important ways of promoting the company and products to reach the customers. There can be so many other mechanisms that can be used such as product based marketing, customer based marketing, segmented and behaviour oriented marketing [12]

Traditionally, the price of a product/service depends on quality, features, quantity, type of customer, etc. On the Internet, there are many more strategies used and one such technique is customised negotiated pricing, used by

priceline.com. Here, the customer sets the price and allows the sellers to bid and the lowest bidder gets the sale [7]. Another pricing strategy would be to camouflage the real price by bundling or unbundling the product/service related components or features thereby making it difficult for customers to compare the pricing with similar products/services. eAuctions such as eBay.com and reverse auctions are also ways of reaching the cyber customers in the e-marketplace. [12]. Expanding the product line can also give the customer a wider variety and choice creating a customised approach to selling products/services.

The most suitable eBusiness models for that category are described below.

- Direct-to-Customer Model has many advantages such as good CRM, understanding the customer better, customised product/service offering, being able to sell at a lower price, rapid offering of the latest or the newest products/services, etc.
- The Full-Service-Provider Model offering a bundled product making it convenient for the customer to get all the services needed from one company.
- EPortal Model where many competitors getting together in order to cater to large orders or to increase the collective product line to show that the company is larger than in reality.
- EAuctions Models that can be used to market, advertise and sell products with different client market segments dealing with brand loyal and other customers effectively.

Depending on which force is working on the company, the strategies are developed and the suitable eBusiness models are being used. Table 1 describes the summary of all the strategies described in this section.

Porter's Force	Business Strategies for Competitive Advantage	Suitable eBusiness Models
Threat of New Entrants	Product Differentiation / Product Bundling / Customer Relationship Mgt (CRM)/Strategic Alliances / Cost Leadership	Direct-to-Customer Full Service Provider EPortal Digital Value Hub
Rivalry among existing Firms	Product (Value-added) Differentiation / Strategic Alliances /Product Bundling / Horizontal integration / Marketing / Price discrimination strategies/ Pricing Strategies / Targeting Niche markets/ Customer Relationship Management (CRM)/Expand Product Line	eAuction Model Full Service Provider EPortal Supply Chain Model Direct-to-customer Model
Threat of Substitutes	Product diversification / Market diversification / Product bundling / Strategic Alliances / Pricing Strategies	Full Service Provider ePortal / eRegion

Bargaining Power of Suppliers	Product differentiation / Backward Integration / Supply Chain Management (SCM) / Strategic Alliances / ePortal for bulk ordering	Supply Chain Model EPortal / eRegion
Bargaining Power of Buyers	Product (Value Added) Differentiation / Forward Integration / Marketing / Product bundling / Product Development / Strategic Alliances / Customer Relationship Management (CRM) / Cost Leadership / Pricing Strategies / Expand Product line	Direct-to-customer Full-Service-Provider EPortal eAuctioneer

Table 1 : Development of Business Strategies/eBusiness Models using Porter's forces

The effectiveness of the appropriate strategies and eBusiness models described above can only be measured by actually applying them to businesses and measuring its success. The researches at University of Western Sydney is applying these strategies to the businesses [5] in the industrial sector validating and refining the models, methodologies and strategies through a process of Action Research.

5. Conclusion

eTransformation is actually a business transformation to get the competitive advantage. The Internet makes it so easy to link up with strategic partners, but, the proper business strategies and business models should be adopted looking at the environmental forces and competitive forces working on the company. The mix of using a strategic eTransformation model along with a strong environmental analysis using some of the best models available such as the Porters Five forces model and the SWOT analysis and linking up with emerging eBusiness models definitely give the competitive advantage to any company working in any industry sector.

Appendix 1

The Seven E's in eTransformation – A Strategic eTransformation Model

The Seven E Model [2] was developed by the researches in the University of Western Sydney after carefully analysing the existing eTransformation methodologies and Models. This Seven E model is being currently used to eTransform SMEs in the Western Sydney region [3].

This model consists of seven very important aspects of eTransformation (Figure A). Each stage is important in its own right and as a part of the whole process. The seven steps, out of which six steps could be achieved one after the other are linked to the seventh step 'Evolution', which deals with the crucial issues related to change management. After each stage, the organization can go

through the changes to the evolution stage and through that, go to the next stage, after the required evolutionary change management issues are done.

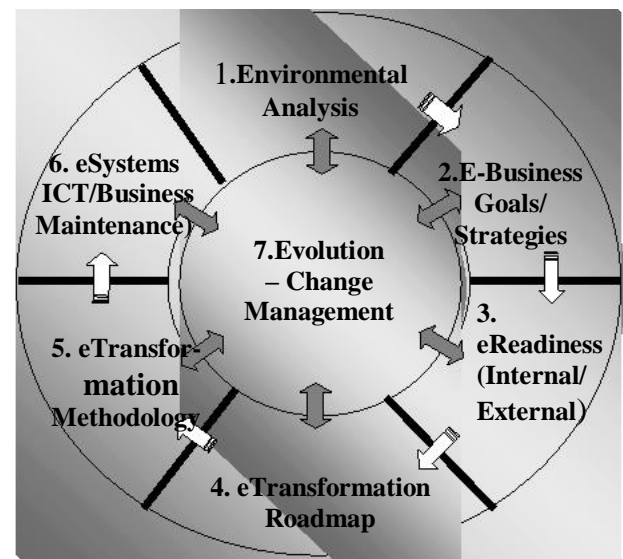


Figure A : The Seven E's in eTransformation (Arunatileka, 2003a).

The significance of each stage of the 7E model (Table A)

Stage	Significance	Methodology used
1. Environmental Analysis	To understand the Global IT and Business Trends and the Sector's Strategic Situation	Understanding of Global Trends in Business and IT SWOT Analysis Industry Analysis (Porter's Forces)
2. eBusiness goals and Strategies	Develop eBusiness goals and strategies to gain competitive advantage	Develop eBusiness, Strategies & Adopt eBusiness Models
3. eReadiness	E-Readiness of the industry and the enterprise under consideration	Questionnaires to measure eReadiness of the Internal and External entities
4. eTransformation Roadmap	To develop a specific path to proceed for the organisation	eTransformation Roadmap and the Convergence Model
5. eTrans. Methodology	eTransform the organization in an incremental way	The Evolutionary eTransformation methodology
6. E-Systems	Provide support and maintenance of the implemented systems	Develop IT Policies, Security, Support, Maintenance mechanisms
7. Evolution - Change Mngmnt.	Management of the proposed changes in an evolutionary manner	McKensy's 7S Model for Organisational Change

The significance of each stage of the 7E model and the methodologies used (Table A).

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The Study of Maximizing Customer Equity by Segmentation: A Modified K-Means Approach

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Abstract

As segmentation has been one of the central marketing tasks for decades and customer profitability valuation has seen wide study during the past few years, surprisingly, up to this date, there is a gap in marketing research that await a bridge to link up of these two important and closely related dimensions. In this paper, we introduce a decision support system with the goal of maximizing customer equity by segmentation. The decision support system introduced here is unique in that it accommodates the essence of customer profitability valuation into a segmentation scheme in a sensible and flexible manner, that it suggests the number of segments to be determined by the goal of profit maximization instead of some arbitrary numerical criterion, and that central to its technical core the outlier problem which is pervasive in cluster analysis has been addressed by a modified K-Means algorithm so that clustering can reflect the pattern of the majority of ordinary observations in a data set instead of being influenced by a handful of outliers. It followed by a number of test datasets from a public data source and a conclusion remark was made at the end.

1. Introduction

Central to the current Customer Relationship Management (CRM) thinking is the idea that a firm's customer base is the key to the business' profitability. Just as Blattberg and Deighton [1] put it, the essence of CRM emphasizes that "growing a business can be framed as a matter of getting customers and keeping them so as to grow the value of the customer base to its fullest potential". In this light, there are two stepping stones to successful CRM implementation: customer profitability valuation and customer segmentation.

What underlines the importance of customer profitability valuation is the recent emphasis on the concept of customer equity which, for a firm, can be defined as the total of the discounted lifetime values of its customer base [13]. At the individual level, therefore, an

array of studies has aligned "lifetime value" with the revenue and cost associated with a customer over time [2], [6], [8], [12]. The essential assumption implied in this type of models is that managers can predict, at least with tolerable errors, *both* a customer's expected contribution to a firm's revenue over time *and* the costs that will incur for the acquisition, maintenance, and retention of this customer, again, over time. As a manager is likely to point out, this assumption may not be realistic for marketing decisions (in which costs are usually determined by marketing mix strategy and strategy in turn follows segment definition) in any marketplace that sees competition and undergoes structural change, which most industries do nowadays. That is, except for the role to play in long range planning, current customer profitability valuation models neither fit in nor provide practical guidance for manager's actual decision making.

The other stepping stone to CRM is customer segmentation. Having seen limelight in marketing for at least half a century, segmentation mainly "involves viewing a heterogeneous market as a number of smaller homogeneous markets, in response to differing preferences, attributable to the desires of consumers for more precise satisfaction of their varying wants" [16]. Technically, segmentation issues that usually puzzle researchers and practitioners include the "optimal" number of segments and the bias of segmentation caused by outliers in a dataset. Yet more importantly, though various models have been proposed for segmentation in the marketing research literature (for a comprehensive review, see Wedel and Kamakura [17]), the relationships between most established quantitative segmentation models and marketing decision making, as implied managerial relevance in which should be the *raison d'être* of developing a model, are mostly neglected.

Meanwhile, to follow the CRM principles, a profit-maximizing firm will seek to maximize the profit to which its customer base can contribute. In terms of implementation, customer segmentation is likely to play a central role. Surprisingly, however, except for a few superficial discussions on the importance of market segmentation on customer profitability [11], [12] to the

best of our knowledge, there seems to be a vacuum in marketing research that clarifies the relationship between customer profitability and segmentation, not to say attempts that formally links up these two important issues in a model.

This paper, therefore, aims to present a managerially relevant and easy-to-implement model in the form of a decision support system (DSS), to which we give the name of MCES (Maximizing Customer Equity by Segmentation), that addresses the several issues mentioned above. In the following sections, we will first discuss the relationship between customer profitability and segmentation, and then propose a segmentation decision framework for the maximization of customer profit—the backbone of our proposed DSS. Next, on the more technical front, we will introduce a modified K-means cluster algorithm that serves as the quantitative core of the DSS. Finally, we will discuss the implication of such a DSS as well as directions for future research.

2. Assumptions of MCES

Current customer profit valuation techniques are developed upon the assumption that managers can reasonably predict the revenue a customer will contribute to the firm *as well as* the costs necessary for generating them. What is implied in models thus developed [2], [6] [8] then is that the revenue side and the cost side can be determined *simultaneously*. Arguably, though sound in terms of strategic thinking, of accounting, and perhaps of financial performance projection, current customer profitability valuation models thus developed seem distant from managers' daily marketing decision making. It needs not be so. The value of customer valuation and its accompanying CRM implications, we propose here, can be fully unleashed so that it can fit neatly in marketing decision making process if a more realistic view of customer profitability is taken. The key to managerial relevance for customer valuation in the context of marketing decision making, however, is the important but long neglected link (in terms of implementation) between segmentation and customer valuation. Just like Wedel and Kamakura [17] mentioned, traditionally, segmentation models put emphasis on goodness of fit and neglect the importance of relating marketing research with marketing strategy within a single model. The proposed MCES model in the form of a DSS, that will be introduced below, is a formal attempt to develop a managerially relevant framework which aims to combine inference and profit maximization and in which, in the words of Wedel and Kamakura ([17], p.340), "decisions on the proper number of segments would be based on managerial criteria (expected profits)

rather than goodness of fit; inferences would be made directly in terms of the optimal marketing effort rather than mere descriptions of the segments."

The first task in actually bridging customer profitability and segmentation, given the essence of customer valuation and that profit is the difference between revenue generated and costs incurred, then, is to make more realistic assumptions than what current customer valuation models assume. In this light, the tenet of the decision support system proposed here is that for a manager with bounded rationality, certain experiences with the customer base to be managed, and perhaps some familiarity with established probabilistic models (not a necessary condition, though), the revenue a customer can generate in a reasonable period of time can be roughly predicted *a priori*, whereas the cost side can only be managerially estimated *after* marketing decision relating to segmentation is made. In the marketing research literature, the array of well-established models based on NBD has demonstrated that even without marketing mix information in the form of covariate, an NBD-based model performs well in a wide range of applications for the description of customer's repeat behaviors, which in our context can be directly translated into revenue generated by a customer base [10], [14]. A single customer's future contribution to a firm's revenue, then, can be easily derived by, say, empirical Bayesian method. For a nonstationary customer base, inferences can also be made by modified models with a nested NBD core [15]. Even without resorting to these formal probabilistic models, current practice has various heuristics for the prediction of customers' revenue generation potentials built in a wide range of CRM systems. Therefore, it can be reasonably expected that for a single customer, a firm can get a rough but useful estimate as to his/her future contribution to revenue stream, which can serve at least as a baseline in our model. On the other hand, the cost side in the profit equation is more subtle. In fact, in the segmentation context, it is only after the segments and the respective marketing strategy set are defined that the cost to maintain a specific customer can be reasonably calculated. Therefore, in our MCES DSS, we assume that:

1. Each customer's expected contribution to a firm's revenue, given the context, can be roughly calculated by certain heuristic or a formal probabilistic model.
2. Managers cannot figure out the cost to maintain any segment *a priori* (i.e., before a segment is defined), but are able to do it given the defined segments.
- 3.

3. MCES as a Decision Support System

Given the above-mentioned assumptions, here we propose a model to maximize customer equity by segmentation (MCES) in the form of a decision support system. Suppose that each customer's expected contribution to the firm's revenue stream in a period of time is given (either calculated by certain heuristic or estimated by a probabilistic model), the decision framework, which combines managerial judgment and a modified clustering method, can be summarized in the following steps:

1. Managerially define a desirable range of number of segments $[S_i, S]$, $S, S_i \in \mathbb{N}$ and $S_i < S$
2. Setting $m = S_i$
3. Assigning observations into m segments by modified K-means (to be introduced in the next section)
4. For $j=1$ to m , (managerially) judge the cost to maintain each segment thus derived, C_j . Meanwhile, calculate the sum of expected revenue to be generated by the segment members, R_j . Then calculate expected profit (loss) from each segment, $P_j = R_j - C_j$.
5. Summing up expected profits (losses) across the m segments, get gross expected profit E_m , $E_m = \sum_{j=1}^m P_j$.
6. If $m < S$ then $m = m + 1$ and go to step 3; otherwise go to step 8
7. Compare the E_m , $m = S_i, \dots, S$, choose the solution among the $S - S_i + 1$ choices which maximizes E_m .
8. End

For a fictitious example, let's assume that the expected contributions to revenue in the coming year of a small bank's 500,000 customers (by whatever heuristic/model on which its CRM system may rely) are given. The manager, upon making the annual strategic marketing plan, applies MCES for customer segmentation. Taking the resources available and past experiences into consideration, she first decides that the number of segments with managerial meaning as well as operational efficiency/effectiveness should fall between 2 and 5. Therefore, MCES guides her through scenarios with 2, 3, 4 and 5 segments, respectively. For each scenario, once the segments are objectively defined (to be elaborated in the next section), the manager judges the appropriate cost for the maintenance of each segment depending on segment characteristics that can be easily summarized in the form of descriptive statistics (e.g., segmental means). The system then calculates the expected profit of each segment. The total expected profit

for the scenario is then derived by summing over the segments. Having done this for the four scenarios with different number of segments, the system list all the scenarios' expected profit in descending order. The "best" segmentation scheme is now obvious.

Simple as it seems, though, this proposed MCES framework has several features that positively distinguish it from established segmentation schemes:

1. It accommodates the essence of customer profitability valuation into a segmentation scheme in a sensible and flexible manner.
2. Unlike most segmentation approaches that make the defined segments *independent* of strategic considerations, MCES allows for, actually depends on, managerial judgment as an important input in finding the "best" definition of segments. In this way, a segment is no longer the end *per se* (as most segmentation models imply), but the means used by managers for the attainment of managerially desirable goal—which is what segmentation is managerially meant for.
3. The application of MCES addresses the issue that usually puzzles modelers as well as managers, namely: how many segments is the *most appropriate*? As Milligan and Cooper [9] concluded from their empirical comparisons among 30 stopping rules for the determination of number of clusters in cluster analysis, lacking a universal theoretical criterion and susceptible to data dependency in empirical settings, it is almost impossible for any numerical rule to claim as the "most appropriate" for the number of segments. Under MCES, however, the thorny problem of number of segments is solved, no longer by an arbitrary rule, but by the interplay of cluster analysis and managerial judgment (it should be highlighted here that it is not the number of segments a priori, but the costs associated with segments post-hoc to be judged by managers).

4. Modified K-Means as the Technical Core of MCES

Given a set of relevant individual level customer information, be it behavioral and/or demographic, cluster analysis is the dominant approach to segmenting a customer base. Among various cluster analysis methods, K-means is the most popular one. As Green et al. [5] and Huang [7] indicated, K-means is capable of handling large database that the business uses for their marketing efforts. Therefore, we have K-means as the technical core of the above-proposed MCES (Step 3). However, K-Means is highly susceptible to out-of-proportion

influences of outliers [4]. Therefore, here we propose a modified K-Means algorithm by temporarily skipping outliers in the step of cluster formation. To implement this approach, the mean and standard deviation of the whole data set is first calculated. Data points whose distance to this mean going over some multiple z of the standard deviation are then temporarily skipped. Once the cluster analysis of the remaining, “ordinary”, data points is done, the extreme-value points are then ascribed to the nearest group according to the distances calculated between the extreme-value point and group means.

Algorithm

Program Initiated

Step 1. Calculate the mean and standard deviation of the data set. Skip the points whose distance to this mean is beyond z standard deviation.

Step 2. Randomly generate seeds for non-extreme-value points.

Step 3. Following traditional K-Means, start grouping.

Step 4. Check the grouping by MSE. For example, in Figure , calculate the MSE from point C to group A and the MSE from point C to group B, respectively. If $MSE(C, \text{group B}) < MSE(C, \text{group A})$, then accept that C belongs to B. Otherwise, regroup point C into group A.

Step 5 After all non-extreme-valued points are segmented, assign extreme-valued points into groups whose group means are nearest to these points.

End of program

The Network Data Examples

We use four data sets that have been previously analyzed and published that are available in the public domain for an empirical test of this modified K-means. According to the requirement stated above, we first set the criterion of extreme value, z , equal 2. That is, those data points that are more than 2 standard deviations away from the data mean are treated as outliers. The model results, both from traditional K-Means and from the modified K-means are compared in Table 1.

Judging by Table 1, the modified K-means we propose here leads to more appropriate segmentation in terms of segment membership identification. The within-group SE criterion also indicates that our model outperforms the traditional one in most cases. The exception, however, has some interesting implication. An intuitive explanation of the exception is that by traditional K-Means, outliers are accounted for in the grouping process simultaneously with other points. Our two-stage modified K-means, instead, defines group boundaries solely on non-outlier points. As Figures 1

illustrated, in cases where outliers are really “extreme”, traditional K-means are likely to be heavily biased by these extreme points. In that case, traditional K-Means may lead to better SE comparing with our method. However, managerially, the segmentation which is less susceptible to the influences of extreme-valued points are more relevant if the majority of “normal” data points are of central concern in a segmentation scheme.

5. An application of on line customer behavior survey

Since the MCES decision framework has not been introduced into practice, to demonstrate how it will actually work, here for mainly pedagogic purpose we simulate a project to exposit how managerial judgment would be fused with a decision support system under MCES. This simulated project aims to segment a bank’s potential customers for the purpose of launching the bank’s online transaction platform. That is, given a base of prospects, we, playing the role of the bank’s marketing manager, would like to segment potential customers by their online behaviors so that various marketing mixes can be offered to different segments for the purpose of maximizing the transaction platform’s expected profit. The data comes from the online survey from GUV’s WWW user Survey Team. It includes 103 items and result in 9147 observations.

As the data consists of prospects instead of customers, expected size of customer base as well as expected contribution to online transaction revenue by future customers can only be predicted by heuristics concerning penetration, pattern of transaction amount and frequency, rate of retention, and so on. Therefore, in this simulation, the manager is able to assign an expected value to each observation with the aid of a heuristic based purely on demographic profile. Before the implementation of cluster analysis, the manager looks at the discriminating power of the 103 items in the survey by using a heuristic criterion of max-min difference. That is, for each attribute (item), the manager calculates the difference between the biggest and the smallest value among the 9147 observations. Only attributes whose max-min differences are larger than 0.2 are then included for the following cluster analysis. 21 attributes are therefore retained for analysis.

Initiating MCES, the manager first sets up the range of number of segments between 2 and 5. Here we only illustrate how the system works for the situation when it comes to the scenario of 4 segments. In this case, the technical core of MCES, the modified K-Means ascribed the 9147 data points into 4 segments. The result is summarized, in the form of descriptive statistics, which

is presented to the manager for human input. The system then sums up expected contribution to revenue of each segment member to derive expected contribution to revenue by each segment.

Apparently, segments 1 and 3 are heavy Internet users. Between them, segment 1 users reflect a relative functional orientation that uses Internet mainly for information search, while segment 3 users in comparison reflect a relative leisure orientation that uses Internet mainly as the substitute for entertainment and interpersonal communications. On the other hand, segments 2 and 4 consist of light users. In terms of orientation, segment 4 is similar to segment 1, whereas segment 2 is close to segment 3.

Given the analysis (table 2), the four segments found are different in orientations and/or degree of usage. The manager therefore initiates a set of strategies for the four segments found.

1. Hard-core penetration

For segment 1, the heavy and functionally-oriented Internet users, direct benefits of online transaction with the bank should be intensely communicated through multiple online communication channels to reach rapid penetration.

2. Soft-core penetration

For the heavy and leisure-oriented Internet users of segment 3, another set of online marketing communication mixes should be initiated based on a tune with hedonic appeal. Rapid penetration is also the goal.

3. Functional communications

To segment 4, the light and functionally-oriented Internet users, well-designed and user-friendly online transaction platform should be explained via both online and offline channels. The short-term goal is not necessarily to attract these customers to directly apply for the service, but instead on lowering their psychological barrier to the Internet environment and on developing the trust of the bank's system from these customers.

4. Leisure communications

A soft-soft communication plan should be initiated for segment 2 which consists of light and leisure-oriented customers. Hedonic appeals should be stressed in design, and the goal is to attract these customers by, for example, word of mouth, in a longer run.

Given the strategic outline and the information of expected segment contribution to revenue, the manager then allocates resources for the management of these four segments. The cost associated with each segment can then be estimated. Therefore, expected profit in the four-segment scenario can be derived. Repeating the same procedure over the scenarios of 2, 3, 4, 5 segments, respectively, the segmentation scheme that maximize the expected profit of the online transaction platform is then

decided. The beauty of MCES is that upon the final definition of segments, the manager has already considered feasible alternatives and objectively chosen the best option among them. Meanwhile, once the segments are defined, the manager already has a set of strategic map as well as profitability projections.

6. Conclusions

As segmentation has been one of the central marketing tasks for decades and customer profitability valuation has seen wide study during the past few years, surprisingly, up to this date, there is a gap in marketing research that await a bridge to link up of these two important and closely related dimensions. By the introduction of a decision support system (MCES) with the goal of maximizing customer equity by segmentation, this paper attempts to fill the gap. We take the view that for a segmentation scheme to be managerially relevant, segments should not be the end of a one-shot model which is independent or antecedent of strategic decision making. Instead, managers should be provided with a set of possible segment alternatives as the means for them to initiate relevant strategies so that profit maximization, or customer equity maximization if one likes, can be objectively approached through the interplay of numerical classification rules and managerial judgment. The MCES decision support system introduced here is unique in that it accommodates the essence of customer profitability valuation into a segmentation scheme in a sensible and flexible manner, that it suggests the number of segments to be determined by the goal of profit maximization instead of some arbitrary numerical criterion, and that central to its technical core the outlier problem which is pervasive in cluster analysis has been addressed by a modified K-Means algorithm so that clustering can reflect the pattern of the majority of ordinary observations in a data set instead of being influenced by a handful of outliers. More managerially relevant segmentation, therefore, is expected from the adoption of this decision support system. We also resort to fictitious case as well as real-world data to exposit and demonstrate, at least partially, the performance of the proposed framework. In a word, the system reflects our argument that it should be managers, rather than numerical methods, that should have a final say on the definition of customer segments.

Common sense MCES may seem if one buys in the popular CRM rhetoric. However, to the best of our knowledge, segmentation techniques, no matter how complicated and/or refined they are, have never been fused into the customer profitability valuation framework which we think to be of ultimate importance if a firm

really aspires to leverage its expensive CRM system. And to actually achieve this goal, managerial judgment should play no lesser role than complicated numerical rules in segmentation tasks. Admittedly, being a pioneering research that attempts to fuse two important CRM dimensions together, this paper puts more emphasis on the principle side rather than details. Given the foundation we lay here, a few important aspects should be attacked in the future. For example, quoting various references, this paper takes each customer's expected contribution as exogenously given. One direction of future research is to handle this aspect within the system. Meanwhile, though a series of research based on probability models has shown that marketing covariates are not necessarily crucial for the prediction of customer's repeat behavior, a further refined MCES may allow for expected customer contributions to be changed given a set of marketing mix for a specific segmentation definition. Meanwhile, for some reasons that cannot be expected a priori, there may be cases that a firm decides to discard certain segment(s). It is therefore of interest for future research to take this possibility into account.

To sum up, guided by the principle of profit maximization, this study adds to managers' decision making toolbox an objective and easy-to-implement framework for segmentation. Also, upon segmenting a customer database, the modified cluster algorithm proposed in this study will serve to lessen biases caused by outliers in a database as is frequent in segmentation practice. We believe that a decision support system thus developed will improve a business' efficiency and effectiveness in segmentation so that the potential of its CRM system can be tapped.

7. References

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Table 1 Summary of cluster analysis results

		Glass	Iris Plants	Letter Image	Lung Cancer	Wine
No. of Data		214	150	20000	32	178
No. of Attribute		9	4	16	56	13
Extreme Value (Yes/No) – 2σ		Yes (No.106、 107、 108、 111、 112、 113、 132、 164、 172、 173、 185)	No	Yes (No.10、 553、 9518、 11843、 14741、 15334、 16750、 17599、 18469)	No	Yes (No.4、 6、 11、 15、 19、 32)
No. of Cluser		2	3	26	3	3
<i>MSE</i> (Inter-Cluster)		27.01899	14.16062	53.32213	47.37889	304578.9
<i>MSE</i> (Intra-Cluster)		6.729922	0.527575	33.67757	16.82197	15482.57
Intra- <i>SE</i>	Modified K-Means	859.4714	78.85563	633859.7	551.2781	2461905
	K-Means	821.3103	78.87183	617196.2	567.6376	2634232

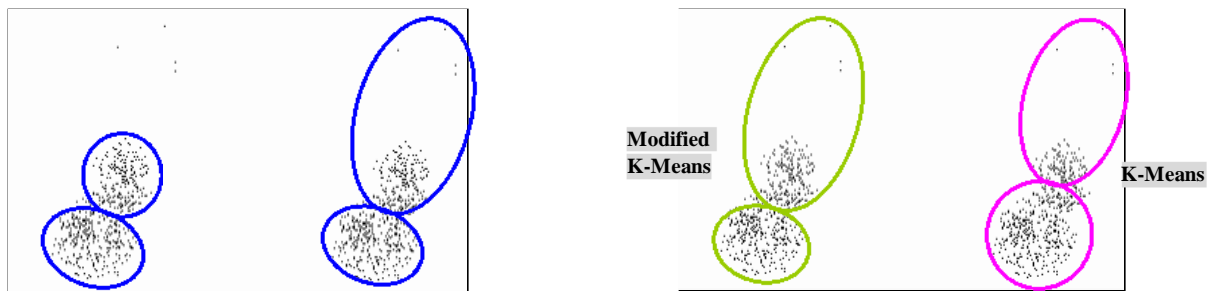


Figure 1 The comparison of dealing extreme value points by K-Means and modified K-Means

Table 2 The four segments found

		Orientation	
		Functional	Leisure
Usage	Heavy	Seg. 1	Seg. 3
	Light	Seg. 4	Seg. 2

Barriers to Uptake of Wireless Healthcare Applications – A Review

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ABSTRACT

Wireless technology is growing and a number of vendors are providing solutions in the area of healthcare. These solutions include electronic prescriptions using handheld devices, data capturing at point of entry using wireless devices, communication of patient information and accessing patient databases using handheld devices. While these new systems appear to be providing solutions to some of the problems encountered by the healthcare industries, there are a number of barriers associated with the wireless technology itself, prohibiting the uptake of this technology in healthcare settings. This paper provides a review of such barriers.

INTRODUCTION

Recent advances in wireless and mobile technology have enabled healthcare industries to provide more responsive service to their customers. Wireless applications that are emerging in the market address some of the problems of the healthcare industries such as data management. This development has prompted renewed interest in technological issues associated with healthcare industry and how the emergence of wireless technology can be applied to the healthcare settings. Current research and development in the area of healthcare includes prescriptions, pharmacy and billing applications. According to a report released in the Wireless News in 2003, it appears that the hospital systems are the fastest growing market for wireless technology. According to [1], wireless technology sector is expected to become a \$2 billion industry within five years. According to GE Medical, the number of clinicians using wireless tools will increase from 1 in 100 today to 1 in five by 2004. Therefore, hospitals are investing money into wireless technology that will augment the management of hospital operation.

However, there is still doubt as to whether wireless mobile technology would provide anticipated benefits as the introduction of such technology in hospital environment is still in its infant stages. A number of barriers associated with the performance of wireless technology are yet to be answered in the literature as the applicability of wireless technology to healthcare is just emerging [2]. The objective of this paper is to identify some barriers to wireless technology in a healthcare setting.

WIRELESS MOBILE TECHNOLOGY

Wireless technology includes the concept of mobile computing, which consists of portable devices that can connect to traditional networks without the utilisation of cables [3]. In a wireless network, computers in an office are linked to one another. These computers communicate using radio signals. The network itself is built around an access point and this point may have a wired connection to another network. This access point can receive data and transmit the same to wireless adapters found in the base computers [4]. In healthcare settings, this technology can be used to access data about a patient, to enter certain predefined terms in order to process billing details or to capture patient data at the point of entry.

The need for wireless technology in healthcare is justified by many studies. For example, [5] provides initial thoughts of applicability of wireless technology in addressing the financial crisis encountered in many healthcare systems. [6] elaborates how wireless technology can be utilised to address the increasingly complex information challenges currently encountered by healthcare information systems. [4] mentions the role of wireless technology and hence the mobility of data using wireless devices in order to comply with the rigorous regulatory framework. [7]'s study provides insights into how wireless technology could be used to reduce medication errors and to generate affordable healthcare applications that allow for

greater mobility and ease of use in entering, sending and retrieving data. Similar views can be found in [8].

While these studies provide justification to the use of wireless technology in healthcare settings, [1] raise warnings as to the infancy stages of the devices in the area of wireless technology that are used for data management. [9] warns of the slower speed of wireless devices compared with the desktop computers. [10] points out the high costs to initially set up these wireless networks and their impact on the financial resources of already struggling healthcare industry. [11] is concerned with the lack of real time connectivity due to the mobility of the wireless devices and their adverse influence at critical times. [12] discusses the limited size of screens found on many mobile devices such as PDAs and argues on their lack of suitability in displaying critical data – especially in medical imaging. [13] provides a discussion on the hard-to-see display screens of current mobile devices and the potential difficulty that these screens can introduce for medical professionals. [14] points out the adverse effects of wireless devices on healthcare industry in terms of the need for high quality graphic displays in specific healthcare settings such as operating theatres. While there is general agreement that wireless technology would provide solutions to some of the problems encountered by healthcare industries, it appears that there are some barriers to the uptake of this technology in the healthcare industry.

Further literature review indicated that it is possible to construct a taxonomy for these barriers. We have grouped these barriers into hardware barriers, software barriers, protocol barriers, cost barriers, logistics barriers, interfaces barriers, wireless coverage barriers, security issues, patient care specific to healthcare settings, efficiency of wireless systems, performance barriers and perhaps workforce issues. Some of these are reviewed in the following sections.

HARDWARE BARRIERS

The hardware barriers of wireless technology applicable to healthcare include the demand for more processing power, potential interference to other existing medical devices, range issues, problems associated with bandwidth and energy consumption by current devices [15-17]. Current healthcare applications process a lot of data and hence the information storage at main memory level is crucial for this processing. Due to their sizes, mobile devices have limited memory power (compared with desktop computers) and this appears to be a barrier in implementing major applications with voluminous data on mobile devices. The size of

the devices also place some constraint on the Central Processing Unit (CPU). Increasing the power of the CPU adversely affects battery life. Battery life is very important for mobility. Due to the limited power possessed by batteries in mobile devices, frequent charging becomes necessary. This introduces usage limitations. When the hardware is not robust enough, various user settings may be erased by weaker battery and the device may need to be reset. This is a source of major concern and seen as a barrier as this restricts long period of mobility without charging.

The hardware devices also cause problems with other existing medical devices by interfering with them. For instance, mobile telephones are not allowed in a number of hospital environments. These interference problems appear to be limiting the usage of certain mobile devices and is considered a barrier. Due to their nature, current mobile devices used for data processing can communicate only up to certain physical distances and this physical range appears to be a major barrier in hospital environments as these environments, can for some very large hospitals, span over a few square kilometers. As the devices move away from their wireless nodes, the communication signal strength becomes weaker and this may introduce unforeseen problems in terms of data management and communication. This is seen as a hardware barrier and healthcare industries are wary of this problem.

Current research in the area of hardware for wireless technology includes the combination of electronic and mechanical components to reduce interference, improved processing power, long battery life, devices going to 'sleep' mode automatically when they are not in use in order to conserve battery life and higher bandwidth [16]. While the comparative analysis of wired and wireless costs has been extensively covered by [16], it is only within the last five years that wireless hardware has become cost effective and hence a cheaper alternative to wired systems. [18] highlights that 'many healthcare providers are extremely adverse to risks associated with adoption of new information technologies' (p.80). In essence, the hardware barriers include the slower information-transfer speeds due to device restrictions, lack of real time connectivity due to device compatibility, small, hard to see display screens due to size restrictions and limited graphic capabilities due to processing power restrictions.

SOFTWARE BARRIERS

A major barrier in terms of software products for the healthcare industry appears to be the incompatibility of off-the-shelf products with specific environments. An area of common

agreement found in the literature is that hospital systems are custom applications that may seldom be applied to other hospitals [19, 20]. Research into this problem includes the design of generic wireless hospital toolsets that can be applied and customised to any hospital [21] and the abstraction of network connection components within the software that will allow for adaptation to either wireless or wired environments [22]. Further, due to lack of technical expertise and costs associated with software training, the healthcare industry is not in a position to attempt new wireless applications. This appears to be a major barrier in the area of wireless software solutions.

In terms of software, research into wireless mobile software is currently scattered in terms of issues ranging from use of web technology [23] to computing language and protocol support [24]. There is also a significant rivalry between proprietary languages for dominance over the wireless market [25]. [26] question the capability of wireless applications in the area of data management. One specific problem raised was the problems encountered due to the mobility offered by wireless. This mobility has created software technical issues of resolving a user based on the location details due to mobility. [26] also question the software issues associated with security and privacy as users move from one service provider to another. The security issues have been highlighted as major barriers in the uptake of mobile devices by many researchers.

PROTOCOLS BARRIERS

The emergence of wireless technology at the user level is attributed to the publicity of the Bluetooth protocol. About 5 years ago, this protocol was publicised by vendors such as IBM and Microsoft. However, since then other protocols such as those by the IEEE have emerged in the market. Current trend appears to be a move towards the use of non-proprietary protocols such as the IEEE 802.11 series [24, 27, 28]. Due to the variety of protocols available, organisations find it difficult to choose a protocol suit that would meet the needs of all the organisations' applications. This has resulted in confusion. This appears to be a barrier.

[29] points out that there is a lack of benchmarking statistics in the area of performance of protocols. While there have been implementations of wireless mobile technology within the health care system, much of the research conducted into wireless implementations have been descriptive in nature and describes the advantages of using the wireless system using single qualitative opinions [30-32]. Therefore, it appears that there is an overall lack of quantitative data collection to prove the claimed wireless advantages. This has resulted in lack of

confidence in using such a technology in a healthcare setting. This is seen as a barrier.

While the hardware devices are useful in the total picture of wireless technology, they need to communicate and a set of agreed upon rules for communication is used to ensure uniformity and device neutrality. These set of rules are called protocols. An area of controversy within the literature and the IT industry is the support for wireless protocols [29] as multiple vendors provide multiple protocols. For instance, to communicate using wireless technology different sets of protocols are available such as Bluetooth and IEEE. On one hand the hardware manufacturers are imbedding support for as many wireless protocols as possible, allowing for integration of new and existing wireless systems in order to maintain healthcare applications developed so far. On the other hand, support for multiple non-standard wireless protocols increases hardware prices and encourages non-compliance with standards. This is seen as a barrier to the uptake of wireless technology in healthcare industries.

COST BARRIER

There are competing views within the literature as to whether wireless systems are worth the cost of development and implementation [33, 34]. Few studies have expressed concerns regarding the viability of wireless technology because of the unjustified benefits. It appears that these feelings stem from the fact that most studies have looked into the cost advantages of new wireless systems with existing systems from a technical point of view and compared the technical cost factors alone. However, studies that have investigated a number of other intangible factors indicate that wireless implementation may provide enormous benefits such as quality of healthcare services to wider community. What appears to be a major barrier is the cost of installation of the new system when a working wired system is already available and the lack of immediate return on the investment.

For the majority of research into wireless implementations, wireless technology is portrayed as the next revolution in hospital care [28, 35, 36]. "Wireless" would seem to indicate that there is no need for wires, but wireless systems need to connect to the main wired infrastructure at some point. This has been indicated in our opening paragraphs. The age of the available physical infrastructure may become a barrier when buildings classified under the 'historical structures' are considered for wireless implementation, as any work on the infrastructure needs permission from relevant authorities. Therefore, cost issues become a concern to organisations because the existing physical infrastructure needs to be maintained as it is or needs

to be upgraded to accommodate various wireless access points.

Return on investment is what businesses are aiming for when investing in a system. This area has also been covered extensively within the literature, and most seem to highlight the reduced occurrence and therefore cost of recovery from medical inaccuracies [36, 37]. Studies have explored the issues of savings from billing errors and any associated legal costs [36, 37]. Cost appears to be a major barrier to the wireless uptake in healthcare.

USER INTERFACE

User interfaces are identified as a crucial link between wireless devices and end users and the issue of user interfaces is emerging in the literature due to the significance associated with the cognitive ability of users in understanding various interaction techniques using these interfaces. While user interface design is an established research area for wired systems, research in the area of interfaces associated with wireless technology is improving in the recent years. Surprisingly, hospital wireless information systems research is not at the forefront of mobile interface design despite the fact there are many wireless healthcare devices already available in the market place such as blood pressure monitors [38, 39]. One reason may be due to the special conditions under which the wireless systems are being utilised in healthcare and the sensitivity of these devices and the information packets passed through these devices. An emerging area of interest is voice recognition for medical command transcription as this may avoid transcription errors and delay in transcribing manual records from source to a computer based records [38]. While traditional computing has evolved in the past three years with various software applications to recognise voice samples, the wireless technology is still struggling due to the hardware limitations of the wireless devices. Further, due to the sensitivity of the patient information, there is some form of reluctance by physicians to adopt this concept. This appears to be a major barrier for the uptake of wireless technology in healthcare. While the voice recognition will mimic data entry operations, a problem that is being investigated is the elimination of background voices and unauthorised command entries so as to arrive at accurate translation of voice commands into data fields. It is hoped that research into speaker recognition will help to eliminate commands from unauthorised personnel and background voices, by authenticating the users voice, and determining the users authority [38]. It is widely accepted that the choice of mobile devices is an important consideration for wireless implementation and this choice is dictated by the ease of use provided by the interface. This appears to be a barrier because

healthcare industry is reluctant to commit on a type of device due to the infant stages of development in this area [36, 40].

COVERAGE

Coverage is not only a technical wireless issue, but also an issue within the hospital setting. By nature, mobile devices may be used to roam around and it is important that connection to the network is retained so that collected data is not lost and information is accessible when and where it is needed. Previous studies provide details of wireless coverage in healthcare settings [36, 41].

Of particular interest to a healthcare setting is the range of the Wireless Local Area Network (WLAN) because of the scale and dispersion of physical buildings [27, 42]. This has lead to research into how range can be maximised through optimising bandwidth and signal strength in a healthcare setting [43]. [44] suggests that wireless range should be limited for security reasons because by having a wider range for wireless devices, the geographical area for network hacking is increased, making these attempts more difficult to monitor and prohibit. It appears that Baylor's theory is purely hypothetical and there is no concrete evidence available to support such a theory. Further, current wireless devices are capable of handling Wireless Encryption Protocols (WEP) and the adverse effect arising out of hacking can be minimised. While studies have compared the wireless range available for various wireless technologies, there appears to be no conclusive agreement as to the security issues associated with the wireless coverage [45]. Issues associated with wireless range appear to a major barrier in the uptake of wireless technology in healthcare settings.

The issues of unexpected problems in connection due to coverage have been studied in prior research [41]. These connection losses are not only inconvenient, but may also risk data access to ensure patient well being by not having important patient data available when it is required for the administration of medication. Prior studies attribute these problems to network range, lead walls and wireless interference [27]. Furthermore, it appears that fundamental problems in coverage may result in denial of service when patient information is most needed. In certain cases, denial of service can result in legal prosecution and healthcare industries are aware of this issue. This has resulted in a barrier adversely influencing the uptake of wireless technology in healthcare settings.

In the past two years, research studies focus particularly on the load-testing of WLAN's [46] and whether implementations are capable of handling the

wireless needs of the hospital environment. Prior studies into interference have covered aspects of technical issues and is of particular concern to hospitals due to the importance of medical data integrity [47] and disruption of sensitive medical equipment, which could put patient's lives at risk. Due to the importance of medical data for health, billing and medical reasons, data integrity needs to be ensured. Interference from walls [45], other RF equipment and coverage holes may diminish or corrupt data integrity leading to losses in patient health data, billing revenue, and legal recovery costs [41]. These are potential barriers to the uptake of wireless technology in healthcare settings.

In terms of radio interference, there exist two dominant competing views within wireless hospital literature; one suggests that interference with medical equipment is non-existent [47], and the other portrays interference as life threatening [36, 48, 49]. According to the first group of literature "Wi-Fi-enabled handhelds or laptops generate about 5 percent of the radiofrequency power that cellular or PCS phones emit". Medical treatment and diagnostic equipment manufacturers have even gone as far as embedding wireless systems into their equipment [47]. However studies have investigated the issues of interference with sensitive equipment and have deployed measures such as frequency modulation to attempt to remove this interference. Interference has been noted ranging from pace maker disruption which, are possibly life threatening to wheel chair malfunctions [50]. These equipment malfunctions have been put down to the lack of medical device immunity to Radiofrequencies (RF) and the increased number of RF emitting devices such as mobile phones and mobile computers. Standards for medical equipment immunity were established in 1993, and these standards must be tightened to allow for increased number and power of RF and their close proximity to sensitive equipment. These conflicting outcomes from prior studies demonstrate that there exists competing views on the issues of interference in the hospital setting, ranging from total acceptance to the banning of wireless technology neither of which seems appropriate [51], resulting in perceived barriers.

SECURITY

Security appears to be a major barrier to the uptake of wireless technology in many areas, including healthcare. The management of security issues in a hospital is an established area, but is challenged through the introduction of wireless technology. Research has been undertaken to specifically lay down foundations for wireless security management [44]. The main concerns for security management within a hospital setting are confidentiality of billing and medical information

[19, 41, 51] and privacy of patient information [19, 41]. Of particular concern to the protection of private and confidential information is the monitoring of network accesses [43] and the tracking of mobile devices [47].

Security threats in wireless environment can range from passively eavesdropping into others' message to actively stealing user's data [52]. In a radio frequency operated mobile commerce, it is possible to listen to one's communication with minimum difficulty. This has an impact on healthcare because of the concern about data and voice messages from unauthorised access. On the other end of the problem is the inherent security risk involved in transferring information over the networks. This problem consists of two components: *identification integrity*, and *message integrity*. The identification integrity refers to the signature elements found in the messages in order to establish where the message is originating. The message integrity refers to details to establish that the message is received as sent and no third party has attempted to open, modify or alter the contents. According to [53], these two items appear to cause a lot of concern to both sender and receiver. While the sender risks theft or misuse of their personnel information such as account and bank details, the receiver (a healthcare provider) risks repudiation of the transaction and resultant non-payment.

In addition to the above two, additional security concerns in wireless technology arise due to the new development in technology itself [53]. The mobile technology is envisaged in such a way that the services offered will eventually warrant payment for the type of services offered. This is already emerging in the domain of mobile telephones. For instance, when mobile telephone users access other network carriers, a special charge is levied on the users. Therefore, it is safe to assume that there will not be any "free services" in the future. The technology is developing in such a way that the payment for such services will be through some form of "smart cards". The details stored in the smart cards need to be transmitted via the networks for validation and verification in order to determine service levels. If these networks are not fully secure, there are possibilities for security breaches to happen.

One major security breach that can happen in wireless networks is when the user details are transformed from one mobile network to another [54]. When this transformation occurs, any encrypted data needs to be decrypted for transparency. In wireless technology, when mobile devices make requests to web pages of a network server, a four-stage process is followed. First, the requests arise from the originating Wireless

Transport Security Layer (WTSL) protocol. Second, the requests are translated at the originating Wireless Application Protocol (WAP) gateway. Third, they are sent to the standard Session Security Layer (SSL) protocol of the destination network. Fourth, the translated information reaches the Hyper Text Transfer Protocol (HTTP) modules in the new network in order for the requests to be processed. In the process of translating one protocol to another, the data is decrypted and then re-encrypted. This process is commonly known as the "WAP Gap". If an attacker is able to have access to the mobile network at this point, then simply capturing the data when it is decrypted can compromise the security of the session.

Data in the Mobile environment is secured using encryption technology. According to [55], it has already been proven that the technology is vulnerable to attacks. Hackers have broken some of the existing algorithms for encryption. So, there is nothing like a complete security. Further, there is no international regulatory framework available to fix certain security related problems. For example, in the current climate, no individual organisation or government can guarantee security to consumers. When the security breach appears in an international transaction, no one country will be able to assume responsibility to prosecute the vandals. While these problems have been recognised and solutions are being proposed, organisations tend to lose consumer confidence. This will potentially impact organisation's revenue.

Trust is central to any commercial transaction and more so in the case of healthcare [56]. Trust is normally generated through relationships between transacting parties, familiarity with procedures, or redress mechanisms. In the case of healthcare, the need for creating the trust in the consumer assumes extreme importance because of its virtual nature. It hinges on assuring consumers and associated businesses that their use of network services is secure and reliable, that their transactions are safe, that they will be able to verify important information about transactions and transacting parties such as origin, receipt and integrity of information, and identification of parties dealt with. Therefore the challenge is not to make mobile Commerce fool proof but to make the system reliable enough so that the value greatly exceeds the risk.

Any new development in technology in today's consumer minds creates both curiosity as well as reluctance. The informality and lack of overall control creates the perception that the Internet is inherently insecure [57]. This inherent perception can trigger business risks and technological risks [10]. Business risks involve products and services, inadequate legal provisions,

reliability of trading partners, behaviour of staff and demise of Internet service provider. Technological risks involve hacker attacks, computer viruses, data interception and misrepresentation all arise. To achieve satisfactory levels of trust, organisations have to think about managing both business and technological risks. Currently healthcare relies mostly on knowledge-based trust that is useful for Business-to-Business commerce [56]. However, there is a big surge in the identification-based trust to satisfy consumer concerns about their transaction details. In addition, current architectures for mobile communications do not provide full security measures in terms of transaction integrity. Some of the models envisaged for mobile communication are based on smart cards oriented approach and hence the issue of transaction security needs greater examination in healthcare.

WORKFORCE ISSUES

The impact of changing work practices due to the advancement of the information technology is a major concern in many organisations, including healthcare organisations. The changing work practices include an increased reliance on computing technology and a move towards a more flexible workforce [58]. While the increased reliance on computing leads to technical errors that may go unnoticed by healthcare operators at the time of capturing patient data, the move towards a more flexible workforce may introduce health related issues. While these two major issues are only concerns at the moment, they may become a major barrier for the uptake of the mobile devices in the healthcare because only a selected few people may be offered training due to cost implications. According to [58], the huge expansion of the use of IT would further result in information overload, causing increases in working time, leading to problems in scheduling the available workforce and work coordination. In the healthcare industry, when these problems are applied to the existing workforce, it would result in a shortage of manpower with the right levels of training. This will adversely impact the healthcare industry resulting in some form of barrier.

CONCLUSION

This paper provided some barriers to the uptake of wireless technology in a healthcare domain. While these barriers appear to be dominating the industry in the current time, a number of solutions are also emerging to address these barriers. In recent months healthcare solutions started appearing using handheld devices and these solutions appear to provide promising signs.

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eTransactions in the Australian Supply Chain Setting

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Abstract

Many sectors of the Australian economy have, in recent years, undertaken an analysis of their supply chain structures. Each sector has determined the underlying technologies to be recommended for use on the basis of past practice in that sector and, in some cases, international practice in the sector. In this article, the authors examine the current role of e-transactions within the context of Australian supply chains.

Our analysis indicates that there is a bifurcation of technical choices along the demarcations of XML and EDI business solutions. For instance, while Mining and Finance have gone the XML route, Wholesale and Retail Trade, along with Transport and Storage have chosen EDI. Moreover, the Health sector appears to be leaning towards keeping both options open to its organizations.

We argue that two factors will need to be considered which will be affected greatly by this parting of the ways on the technology issue. One is the concept of 'design for supply chain' which involves demand generation through joint development of new products and the flow of material across different supply chain entities. The second is the impact of the growth of global trade within international economic blocs.

A natural conclusion is that Australian industry must support a merging of EDI and XML standards.

1. Supply Chains – The Background

Many sectors of the Australian economy have, in recent years, taken on an analysis of their supply chain structures. Although this analysis has taken various forms, a common approach has been for several large organizations, stake-holders in the sector, to band together to fund and support study and development.

Reasons for initiating such projects vary. Faced with cut-backs and down-sizing, some companies have focused on core competencies and attempt to achieve competitive advantage by leveraging their suppliers' capabilities and technologies. Exploitation of these capabilities is expected to result in 'improvements in product quality, quicker integration of technological

breakthroughs, and shorter new product development lead times' [16], thus also providing a competitive edge over competitors.

There is also an expectation of lower transaction costs to the organizations involved as a result of improved trading processes [12]. This is particularly true where businesses at the lower end of the supply chain are not currently trading electronically, but might be encouraged to do so in order to achieve lower costs. However, there are many challenges to integrating businesses' electronic systems through a supply chain, and advice on how to go about it is difficult to come by. A recent study [8] indicates that SMEs greatly underestimate the critical success factors.

Kannan and Tan [9] state that '...no evidence exists on the impact of supplier management on a buying firm's business performance.' In their study, they 'examine relationships between the perceived importance of supplier selection and assessment criteria for items being used in production, and business performance.' Included in the study are several 'hard' criteria such as price and quality, as well as a number of 'soft' criteria such as management compatibility, integrity and buyer-supplier fit. The one supplier assessment factor to correlate positively with all performance measures was also considered to be least important by the group of respondents – all large U.S. firms. This factor was *information sharing*. The authors conclude that 'the results suggest the need for further study of buyer-supplier communication processes. They also suggest a need to develop metrics that allow the effectiveness of buyer-supplier relationships to be assessed.'

In this paper, we consider and compare the approaches to the information sharing mechanisms, integral to the conduct of business within the supply chain, which have been recommended in a number of Australian economic sector projects. The recommendations appear to be essentially one of two choices, resulting in an apparent divergence in solutions adopted by inter-industry sectors.

For this analysis, we have chosen only those sectors in which supply chain management has been undertaken in an attempt to involve the entire sector. Thus, nine out of the seventeen designations of the Australian Bureau of Statistics ANZSIC listing are included here:

- B. Mining
- C. Manufacturing
- E. Construction
- F. Wholesale Trade
- G. Retail Trade
- I. Transport and Storage
- J. Communication Services
- K. Finance and Insurance
- O. Health and Community Services

We discuss the various supply chain management projects undertaken within the last five years or so, particularly in Australia, and provide a description of the information sharing mechanisms chosen. We then consider the implications of these decisions in terms of cross-sector compatibility.

2. The Projects

In this section, we consider supply chain management projects in recent years for nine of the Australian economic sectors and, in particular, focus on eTransaction recommendations arising from those projects.

2.1 Mining

Quadrem was conceived in mid-2000 by 14 of the world's largest mining, minerals and metals companies. Quadrem is a global, internet-based electronic marketplace designed to revolutionize the procurement process in the industry. The marketplace functions are expected to permit participating buyers and suppliers to capture cost reductions and new efficiencies throughout the procurement process. All mining, metals, minerals and mineral processing companies and all suppliers are encouraged to participate. The goals of Quadrem (<http://www.quadrem.com>) as stated on their website are:

- Generate sustainable value for all participants through streamlined transaction and business processes,
- Drive the application of standards in documentation and business processes, and
- Provide many-to-many connectivity for mining buyers and suppliers.

The main areas of focus for Quadrem are on eCatalogues and document exchange.

Quadrem recently signed an agreement with Elemica, the technology infrastructure provider to the chemical industry to create a hub-to-hub connection. Accomplishments and aims of Elemica (<http://www.elemica.com>) are:

- Develop a set of industry-specific transactions.
- Format their transactions using XML.

Quadrem offers a package based on two XML-based standards which, they state, 'provides the infrastructure

that supports the automation of transactions between buyers and sellers and assists with the full integration of these processes into their own systems'. We can say, then, that Quadrem have 2 goals:

- Standardize on XML
- Offer interoperability

These items, taken together, indicate that Quadrem understand the value of adhering to standards, and yet they realize they cannot unilaterally impose a software technology on their customers. Since they are constrained by the investment their potential customers have in packages such as SAP, they aim to provide an interface to such packages.

2.2 Manufacturing

Here, we discuss only two areas, automotive and semiconductor, both of which fall under the 'Manufacturing' heading.

While automotive suppliers vary in their adoption of e-business procedures as a supply chain tool, a recent survey by The Center for Automotive Research [4] indicates that 47% expect it to be a requirement for doing business with the automotive industry within two to three years. Additionally, the survey showed that a majority (81%) of suppliers anticipate a consolidation of the automotive supply chain in the near future, and that, in consequence, customers will reduce their supply chain base all the way along the chain.

The authors of the White Paper on Manufacturing Event Management [2] point out that for automotive suppliers 'the ability to sustain competitive advantage lies in the agility to profitably respond to customers requests'. The White Paper also notes that a move in the industry to 'built-to-order' puts even greater pressure on suppliers to have short lead times, resulting often in high inventory costs.

Tight supply chain structures over many years in the automotive industry have been more conducive to supply chain management strategies than in other sectors, and as a result, a number of off-the-shelf management systems are available. Some of these are PowerB2O, Lean Manufacturing and Supply Chain Execution.

We now turn to the semiconductor section of manufacturing. In many ways, this is similar to the automotive industry because of global coverage and competition alongside a narrow supply chain structure. In 2001, although semiconductor industry capital expenditures fell by more than 35%, companies increased their supply chain management tools budget by 12% [19]. Reasons for the push in this direction include over-inventory and mismanaged inventory situations as well as corporate consolidation. Comparable to 'built-to-order' requirements in the automotive industry are requirements for the handling of 'exceptional' situations for

semiconductor design. Thus software designed for this kind of problem, such as PowerB2O, is popular.

The Semiconductor Research Corporation, which was established in 1982 by the Semiconductor Industry Association, is an international consortium of companies and universities, and as one of its four goals, cites: 'networking among peers up and down the supply chain'. This organization, therefore, ensures that supply chain management issues in the semiconductor industry are acknowledged and addressed.

2.3 Construction

A report of the Australian Construction Industry Forum [15] indicated that 30% of a construction project's total cost is the result of poor information management. Much of the problem is blamed on the failure of hardware and software solutions to meet operational requirements that include mobility of the workforce, diverse working conditions and lack of a fixed infrastructure.

In January 2000, the Construction Industry Advisory Group BSITE (<http://www.bsite.com.au>) was formed. This was an amalgamation of twenty industry leaders from throughout the industry supply chain in both Australia and New Zealand.

BSITE uses technology already prevalent on construction sites, such as mobile phones and fax machines, to perform core functions including job scheduling, time sheeting, activity logging and reporting, contract management, project workflow and document revision.

Thus, rather than being specifically a supply chain management consortium, BSITE focuses on workforce management and project collaboration. They have adopted various global standards for communication between the user and BSITE's software, and have simultaneously used this arrangement to shield the customer completely from the implementation of that software.

Aconex is another Australian business with international customers which targets the same market as BSITE. Their web site (<http://www.aconex.com.au>) says Aconex 'delivers project collaboration software to the global construction and property management industry'. Aconex offer applications which are 'secure, based on 128-bit SSL encryption, and are accessed through standard Internet browsers from anywhere in the world.'

Aconex, then, have taken a different view of the concept of standardization than have BSITE. Rather than target mobile phones, Aconex target customers using standard PCs and provide a single mechanism to access their software.

2.4 Wholesale Trade

The wholesale and retail trade industries must deal with thousands of items, which are bought and sold in numerous locations. The most pressing issue for these industries has been to systematically number products, services, assets and locations, which is precisely what a barcode system is designed to achieve.

The most prevalent bar coding system in Australia is the international EAN system.

EAN has recently joined forces with the Uniform Code Council (UCC) which takes a global leadership role in establishing and promoting multi-industry standards for product identification and related electronic communication with the goal of enhancing supply chain management. The UCC was established in the early 1970's and currently has over 200,000 members worldwide spanning a number of industry sectors including Agriculture, Manufacturing, Utilities, Wholesale and Retail Trade, Communication Services, Property Services, Government, Health and Recreation.

The meat and wool industries form significant components of the wholesale trade industry. Both of these sectors have implemented EAN bar code technology and have developed guidelines for the use of bar codes. For the wool industry, this was completed in 1999 with a committee including both Australian and European wool wholesalers along with CSIRO and EAN [5]. The meat industry's final guidelines were developed jointly between the Australian Meat Industry and EAN and were released in January 2002 [6].

Despite the huge and disparate nature of the wholesale and retail trade industries, much standardization has been achieved by adopting the EAN•UCC numbering and bar coding system (<http://www.ean.com.au>). EAN sees XML as an alternative to UN/EDIFACT in that either one could be adopted as the EDI syntax of choice. Indeed, they understand that it may be necessary for an organization wishing to adopt such a standard to use both in order to achieve interoperability.

2.5 Retail Trade

The grocery segment of the retail industry has implemented an electronic tracking system which is more progressive than those used elsewhere.

The Food Marketing Institute is a U.S. based, but international, professionally staffed organization with close to 2,500 member companies around the world. Although not designed to be a marketplace for the industry, the Food Marketing Institute supports networking between its members and provides relevant, up-to-date information for those working in the sector.

The introduction of ECR (<http://www.ecraustralasia.org.au/index.htm>) in Australia and New Zealand through Efficient Consumer Response Australasia reflects a commitment to take costs out of the grocery supply chain and better satisfy consumer demands through the adoption of world's best practices. Launched in November 1999, ECR Australasia is an informally constituted joint industry body that is supported by the Boards of the Australian Food and Grocery Council (AFGC), Australian Retailers Association, National Association of Retail Grocers of Australia, New Zealand Grocery Marketers' Association, New Zealand Retail Merchants Association and Foodstuffs (NZ) Ltd. The secretariat is located within the AFGC and not as a separate legal entity as in many European countries. Member companies of all supporting organisations are eligible to participate in, provide input to, and access the outputs of ECR Australasia.

ECR Australasia was created with the objectives of:

- delivering benefits to grocery industry trading partners by working together to better meet consumer needs and add consumer value through the establishment of standard industry practices and the development of successful business approaches;
- educating industry participants about the benefits of ECR, through pilots, case studies, seminars and reports; and
- liaising with other industries and organisations, both in Australia and overseas, to ensure common solutions to common problems.

The Uniform Code Council (UCC) is planning some technical innovations specifically for the Retail industry. These include an extension to barcodes called Reduced Space Symbolologies (RSS), expressly for perishables such as produce and meat.

UCC is also promoting Radio Frequency Identification (RFID) tags as a new technology for product labelling. However, RFID is also being promoted as leading to another, albeit unusual, type of interoperability – the fusion of 'physical product flows with the corresponding information flows' (http://www.fmi.org/technology/FMI_it_rfid.pdf). What is new here is the application of RF tag technology to retail products.

Another organization advocating standards for the retail industry is Voluntary Interindustry Commerce Standards (VICS) (<http://www.vics.org>). Their focus is the VICS Standard Bill of Lading (BOL) and 2003 is the target year for the mandatory adoption of the 17-digit VICS BOL number. An interesting point is that they say bar code printing of this BOL number is optional but, if printed, must be done using EAN•UCC-128 symbology.

We note that EAN•UCC appears under various industry sectors in this paper, and so is clearly a standard which can claim to be 'cross-sector'. This can also be

interpreted as meaning that retail trade is not trying to develop standards in isolation to other components of a complex, technology-based society.

2.6 Transport and Storage

In a presentation to the Working Party for the Information Economy Group of the OECD, Malone [11] states that 'The transport industry provides the logistical operations for Australian business through the movement of goods in the supply chain and to market. These key horizontal linkages mean that transport makes a significant contribution to the Gross Domestic Product...Transport activities underpin the effectiveness of hundreds of thousands of small businesses in Australia

- it is a sector that cannot be disintermediated in the supply chain for goods;
- it accounts for a high proportion of transaction costs; and
- its adoption of e-commerce is likely to drive e-commerce uptake in the many sectors it services...with consequent benefits for those services.'

The Australian government has therefore undertaken, in partnership with industry, to facilitate and support e-commerce uptake specifically in the transport and logistics sector. The government-sponsored 'Trucks Online' project was completed in 1998 and proposed an EDI solution.

Tradegate-ECA is a not-for-profit, non-government, Australian user organisation, headquartered in Sydney, Australia. Its role is to facilitate the use of electronic commerce techniques for the exchange of information between customers and their suppliers, with a focus on exporting and importing. It does this by bringing together many different types of organisations involved in several supply chains so that a common agreed strategy can be developed and implemented using the relevant international standards. Thus, in many ways, it is a cross sector approach to trading.

The Tradegate 'community' has 850 members across Australia, including air and shipping lines, freight forwarders, railway operators, customs brokers, trucking companies, importers and exporters, banks and insurance companies.

Tradegate's Domestic Transport Project, DOMEDI, has implemented the following:

- Adopt the global EAN•UCC numbering and bar coding system
- Standardize message types rather than (product-specific) messages
- Standardize at federal government level
- Encourage industry-wide adoption, i.e. interoperability between companies

- Incorporate overseas work, i.e. encourage interoperability between countries.

These days, transport is more often referred to as Logistics Chain Management since it is viewed as being an integral part of Supply Chain Management.

An Australian company specializing in software for this field is Logistics Systems International (<http://www.lsi.net.au>) which targets interoperability between the sending, transport and receiving systems using standard barcode technology for tracking purposes.

2.7 Communication Services

Despite the fact that the telecommunications industry is the provider of the means of electronic invoicing to all other industries, it itself is so highly competitive that it has not reached the point at which a group of major players in the industry has seen the imperative to form a consortium.

A large number of organizations (Deloitte Touche and Tohmatsu, Canopy International) provide professional services such as supply chain assessment, strategic and financial consulting specifically targeting the telecommunications industry.

In Australia, SETEL – Small Enterprise Telecommunications Centre Limited – has sought to replicate the Business Council of Australia e-Commerce Roundtable in pulling SMEs in the industry into a forum to ensure that:

- Carriers and providers give out accurate and timely information about products and services, and that
- Small businesses take steps to inform themselves about products and services as part of responsible business decision making.

SETEL was established in 1992 to service the research, policy and information needs of the small business members of the Telstra Small Enterprise Policy Panel, plus the wider small business community, and to provide research material from the Small Business sector perspective. SETEL [17] has an important document available for people who want a gentle introduction to reasons for the adoption of eCommerce, and which discusses the influence this adoption will have on a business's supply chain.

2.8 Finance and Insurance

In the banking industry, the SWIFT consortium has been around since 1977. SWIFT (<http://www.swift.com>) is an industry-owned, international cooperative (under Belgian law) supplying secure messaging services and interface software to 7,000 financial institutions in 200 countries, and it employs about 1,500 people. SWIFT provides messaging services to banks, broker/dealers and investment managers, as well as to market infrastructures

in payments, treasury, securities and trade. These services are designed to help customers reduce costs, improve automation and manage risk. The guiding principles of SWIFT are: to offer the financial services industry a common platform of advanced technology and access to shared solutions through which each member can build its competitive edge. The solutions developed are based on XML.

In order to join SWIFT a minimum level of infrastructure must be in place, and so small business is to a large extent excluded from membership. In early 2002, SWIFT migrated from X.25 connectivity to IP connectivity and has established SWIFTNet and SWIFTNet FIN to assist with the move.

Considering that 'SWIFT is the industry-owned cooperative supplying secure messaging services and interface software to 7,000 financial institutions in 198 countries', this indicates that:

- the financial sector is capable of being intensely focused
- intercontinental interoperability can be achieved
- in this, admittedly unique, sector, convergence on a single standard is possible.

SWIFT standards are based on, but not limited to, ISO 15022, XML and XML schemas.

In the Australian health insurance area, SuperEC (<http://www.superec.org>) got off the ground in 2000. It has three levels of membership with over two dozen members. The governing council is comprised of four key bodies: the Association of Superannuation Funds of Australia Limited, the Australian Taxation Office, the Investment and Financial Services Association, and the Association of Payroll Specialists. An early policy decision for SuperEC was to ensure that the standards would be written in a manner that is neutral to the technical transport mechanism. Another decision was to choose technologies that would allow participation at a low cost. Technically, the standards are a set of XML message packets that may be sent as attached, encrypted email. This set of technologies is available on all platforms and at a relatively low cost of implementation. SuperEC has also developed messaging standards for the industry. SuperEC itself is based on ebXML [3].

A recent move in this sector has been to a business reporting standard with the introduction of XBRL (See <http://docs.hr-xml.org/20010419/XBRL-ExecSummaryGeneral%20Ledger.pdf> for a summary provided by XBRL.org). This is an open specification standard for software, developed by almost 200 companies, professional organizations and governments world-wide, which is designed to capture, analyze and reuse business information. It is based on XML and is compatible with ebXML.

2.9 Health

An innovative e-commerce project begun in the late nineties in Australia was PeCC, originally 'Pharmaceutical Electronic Commerce and Communication', but later changed to 'Project for Electronic Commerce and Communication'. Quoting from [18], 'PeCC's vision was to link the pharmaceutical supply chain end-to-end, starting with manufacturers and ending with the consumption point – the hospital patient...The vision included a common numbering system and integrated information systems throughout health so that products could be ordered, coded, tracked, delivered, stored, dispensed with barcode-swiping all the way. EDI was successfully implemented for orders and confirmations for manufacturers and distributors, with supply chain reform pilots in some hospitals.' But because of confusion over EDI protocol standards, 'there is a general movement towards a common standard called X12. This, in turn, is part of an international movement towards UN/EDIFACT' [13].

Since UN/EDIFACT is becoming so widespread, it is clear that this drive for interoperability within the health sector should automatically lead to interoperability with players in other industry sectors.

The National Supply Chain Reform Task Force (NSCRTF) was established in 2000 to identify key areas for joint work between governments, the hospital sector and product suppliers to facilitate the adoption of an e-enabled supply chain in hospitals. Their report, (NSCRTF 2003) indicated that there were many weaknesses in the sector. In January 2002, the Australian Health Ministers' Advisory Committee endorsed the NSCRTF national plan covering five key areas. The list of tools identified as needing consideration for use in the industry are: EDI, XML, EAN barcoding, e-marketplaces and e-catalogues, web services, e-mail and fax.

It is unfortunate that, in 1983, the health industry in North America established a barcoding system through its Health Industry Business Communications Council (HIBCC; <http://www.hibcc.org/barcode.htm>) which is formatted differently from the EAN codes. The global health industry tends to have adopted the North American style coding.

A number of related health industry projects have sprung up in Australia over the last few years. One such is the ICTeHealth Project, which includes the PeCC and NSCRTF perspectives, and focuses on determining the data interoperability problems in New South Wales hospitals. This project began in 2002 and is concerned with investigating the flow of information in four key areas of clinical process within a hospital setting – pathology, pharmacy, purchasing and radiology.

At the international level, two projects stand out:

Global Health Exchange (<http://www.ghx.com>) was founded in 2000 by five leading health care suppliers: J&J, GE Medical, Baxter, Abbot Labs and Medtronic. It provides supply chain solutions to bring together hospitals, manufacturers and wholesalers. They have developed a range of product components which connect in various ways to GHX's own AllSource system. For instance, hospital staff can use a web browser to connect to AllSource, or GHX and their partners can provide customized code which links a hospital's existing ERP system to AllSource. AllSource corresponds exactly to HIBCC's Universal Product Number Repository, which means a single converter between the two would serve all users of both systems.

HL7 promotes a set of American National Standards Institute (ANSI)-approved standards, covering clinical documents and the sharing of medical knowledge, as well as administrative documents covering intellectual property, ethics, and so on. The clinical-type documents are XML-based, so as to be both human- and machine-readable, and to be deliverable to devices such as web browsers and mobile phones.

Their Reference Information Model (RIM) is actually expressed in the Unified Modeling Language (UML). RIM is not a product-based approach, but a clinical-activity-based approach, and hence differs significantly from previously mentioned systems.

3. The Cross-Sector Issues

We have seen above that Australian industry sectors have generally taken one of two paths when instituting technical solutions to their cross sector business: a choice between XML and EDI.

The question remains: for those companies who must work cross-sector, and for those who do business on the global scene, how large is the barrier imposed by the use of two separate and very different schemas?

Handfield and Nichols [7] point out that 'Supply chain members will increasingly need to improve coordination not only in the area of demand replenishment, but also in the area of demand generation through joint development of new products. ...An equally important benefit of this collaboration is the increased standardization and simplification of product designs that can lead to a "design for supply chain" approach.... Design for supply chain extends the concept of "design for manufacturability", which refers to the process of simplifying product designs to allow easier manufacture and assembly, to the broader scope of the entire flow of material across different supply chain entities.'

Thus, these authors imply that in order for supply chain management effectiveness to move to 'the next level', the technical ability to work seamlessly across sectors must be in place.

On another level, they note that global trade “is increasingly taking place within blocs, such as the European union, the North American Free Trade Area, and other regional groups. ...the bulk of international trade takes place in materials and intermediate components. Global corporations will ship semi-manufactured products between their own facilities or from suppliers to assembly plants and distribution centers. The trend toward global supply chains has been fueled by needs for centralized research and development, the development of homogeneous markets and global products and global market segments for many products, the need for economies of scale in specific industries, wage differentials between advanced countries and other less developed countries, and political efforts to maintain low tariff barriers.”

They raise a number of important questions about global supply chains and their management, arguing that the crossing of international boundaries must necessarily impact business strategies. One of the specific questions not posed is the issue of technology, and whether it will be *possible* to integrate different business technologies across global supply chains.

It is clear to the present authors that the technology may well be one of the most significant barriers to the development of any economy past national boundaries. The problem of interoperability has already been recognized by several major players. Microsoft, as part of a ‘module map’ for reshaping business software [1], has plans to develop software for small to medium-sized businesses which is ‘fully interoperable and interconnectable’. One of the biggest problems faced by companies who have invested large amounts in expensive software is to get it all to work together. While this sounds as if Microsoft has solved the XML versus EDI problem, this is not the case. Microsoft is using XML to enable web services via their .NET system. Sun and IBM have taken up similar strategies, Sun One and WebSphere, both based on XML.

The UCC was, from its inception, a proponent of EDI and in 1996, at the urging of a number of commercial and industrial sectors, conducted a study to determine the feasibility of merging several different existing implementation guidelines into one. The positive feedback from this feasibility study resulted in the development of an Industrial/Commercial purchase order based on the United States EDI ASC X12 national standard, and in November 1997, the UCC became the management and administrative body for I/C EDI.

The priorities of early EDI standardization were in the areas of customs, commerce and transport. Europe and the United States developed EDI solutions independently. The European version, EDIFACT, included accounting functionality while ASC X12 did not. In contrast, the aims of XML were to be non-proprietary and self-

describing, and flexibility rather than standardization was a main goal.

With the strong push in the business world to the use of XML, the link between EDI and UCC is founded on a set of Business Messaging Standards based on XML, and this is consistent with the move to interoperability of EDI and XML via xCBL and XRBL. The EDI standards committee X12 along with UN/EDIFACT are now working on Next Generation EDI based on XML, which appears to focus only on internal financial and managerial reporting.

4. Conclusions and Recommendations

In choosing technical standards to support supply chain management, a number of Australian industry sectors have chosen to go with XML based standards while others have gone with EDI. While recent developments have seen a significant improvement in interoperability between these two standards, the cost of the interface remains high.

In order for Australian commerce to remain competitive in a global environment, where increased standardization and simplification of product design are expected, the technical ability to work seamlessly across sectors and national boundaries is an imperative.

In addition, the move to trading within and between geographic and political ‘blocs’, resulting in global supply chains, must inevitably lead to an integration of business technologies across large sectors.

To enable Australian business to stay abreast of these global moves, the authors therefore propose the development of a universally and freely available translation scheme between the most recent XML and EDI syntax versions organized by the Uniform Code Council in conjunction with those sectors which would benefit immediately: Wholesale and Retail Trade, Transport and Storage, and Health. Such a translation scheme would be an inexpensive solution to the interoperability problem and, based on experience of the authors [10] could be achieved within two to three years.

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An Empirical Study on the Business Models of Import & Export

Companies in China

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Abstract

This paper first compares the definitions for business model in e-commerce given by scholars from all over the world, and then discusses types of business models in the application of e-commerce for China's import and export companies, and points out that three unique types of business models are adopted now in the practice of e-commerce for China's import and export companies. Also, this paper analyses the current state and business models of the largest import and export companies in Jiangsu Province, China as example case, and forwards some suggestions on how to improve the performance of e-commerce of those companies by selecting a suitable business model.

1. Definitions of Business Model in Electronic Commerce

1. 1 Definitions

Different scholars and researchers define *Business Model* in different ways. The most common definitions are as follows:

Rappa (2002) thinks that a business model is the method of doing business by which a company can sustain itself -- that is, generate revenue. The business model spells-out how a company makes money by specifying where it is positioned in the value chain. Rappa also thinks that Internet commerce will give rise to new kinds of business models, for example, the Web

has popularized the auction model and broadened its applicability to a wide array of goods and services [3].

Timmers (1998) gave the definitions of business model as follows:

- z An architecture for the product, service and information flows, including a description of various business actors and their roles; and
- z A description of the potential benefits for the various business actors; and
- z A description of the sources of revenues.

Also, Timmers (1998) listed 11 business models currently in use or being implemented, and they are: (1) E-shop; (2) E-procurement; (3) E-auction; (4) E-mail; (5) Third-party marketplace; (6) Virtual communities; (7) Value-chain service provider; (8) Value-chain integrators; (9) Collaboration platforms; (10) Information brokerage, trust ; (11) other services[4].

Weijun Zhong (2003) defines business model from the perspective of value creation pattern, and his definition can be seen clearly from table 1.

Table 1 Business model defined from the perspective of value creation pattern

Bus iness Model	Buil der of the Web	Users of the Web	Value Creation Patterns
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Inc ome-dr iven	Pure e-comm erce dealers	Visitor s of the Web	Acquirin g income directly
Cos t-drive n	Trad itional business dealers	Traditi onal business dealers	Lowerin g cost
Ser vice-dr iven	Thir d-party (brokers)	Traditi onal business dealers or those who need services in traditional business	Acquirin g fees for providing services
Sca les-driv en	Busi nesses seeking growth	Busine sses seeking growth	Enhanci ng the power of the businesses and Expanding market share
Str ategy-d riven	Busi nesses with great insights	Busine sses with great insights	Enhanci ng Competitive advantages

1.2 Comments on the Above Definitions

Although business models are perhaps the most discussed topic, however, they are the least understood aspect of the internet. So we still have no definition for it that can be accepted by everyone. It depends on a lot of factors including what goods or services a company deals with and which line the company is in. Especially when we discuss a specific line or industry, we can find that a certain industry might develop its own way of doing business and thus develops its unique business model, and the import and export companies in China are no exception [1].

2. Types of Business Model in the Application of E-Commerce for China's Import & Export Companies

2.1 The Importance of E-commerce for Import and Export Companies in China

With the reformation in the area of import and export business in China, more and more production companies got the license of dealing with import and export operations by themselves which made the professional import and export companies face even tougher competitive environment. Gone are the days when state-owned professional import and export companies dominate and enjoy the benefits of monopoly. One way of reducing such competition is to improve their efficiency by using internet and implementing e-commerce [2].

Internet can affect the professional import and export companies in the following three ways:

- z Reducing the barriers to import and export business, or in other words lessen the importance of the roles that those professional import and export companies play.
- z Changing the way of doing business for those import and export companies in China, especially when EDI (Electronic Digital Interchange) has become more and more popular in China. Those companies who can integrate resources from both suppliers and buyers may have more opportunities of doing well in the future.
- z Urging the reformations of the trade-related government departments. As we know, e-commerce can not be realized without the basic infrastructure including laws, tax policies, telecommunication constructions and etc. So government departs including customs, taxation bureaus and Ministry of Commerce have done a lot to facilitate the implementation of

e-commerce for import and export companies.

2.2 The Three Main Types of Business Models in the Practice of E-commerce for China's Import and Export Companies

The Chinese import and export companies created their own models in the process of exploiting e-commerce chances. We should not rigidly copy the above-mentioned business models for import and export companies since those business models might be only effective for certain companies in certain industries. The author summarizes three main types of business models as follows:

E-government mode. Like TradeNet in Singapore, the Ministry of Commerce of China has made great efforts in establishing a system which can integrate the whole process of doing business by using internet. One of the achievements of the Ministry of Commerce of China is that it created an identical series of standards that can be used among government departments, import and export companies, banks, transportation companies and so on. Another achievement is that the Ministry of Commerce of China also established the Online Trade Fairs on its own website (www.ec.com.cn/) which enable hundreds of thousands of dealers from both at home and abroad "meet" on internet and thus create potential opportunities for them[5].

Self-established websites. Most of the Chinese import and export companies built their own websites. But up to now those websites can only be used as Yellow Pages, which can only release company information, and most of the websites do not update frequently. This has limited the use of the websites, and those websites can not really be used to fulfill transactions. Another shortcoming of the so-called self-established websites is that it's quite expensive to build and maintain them, and the import and export companies lack professional technicians in computers who can

guarantee the everyday operation of the websites[6].

Third-party marketplace. Due to the expensive maintenance fees and the fact that most of the self-established websites are not well-known by their target audience, most of the companies are members of at least one third-party website. Among the third-party websites the most famous one is Alibaba.com. We can see the popularity of this website by some statistics (see table 2).

Table 2 Some statistics about www.alibaba.com

Item	Statistics	
	Chinese Website www.China. Alibaba.com	International Website www.ali baba.com
number of members	1.5 Million	0.6 Million
new members per day	3000	1000
web pages visited per day	5 Million	1 Million
web pages visited per month	150 Million	3.5 Million
pieces of information for demand and supply per day	11, 000	4, 000

data base for business information	0.9 Million	0.6 Million
enquiries every month	2 Million	1 Million

Source: <http://www.zjol.com.cn>, June 19, 2003

2.3 Some Characteristics of the Business Models of the Import and Export Companies in China

z government departments play a very important role in pushing the development of e-commerce in foreign trade area in China.

z most of the import and export companies use more than one mode of business model in their e-commerce practice.

z Due to the complexity of foreign trade process, the mode of business model for import and export companies should consider more factors and involve more participants including government, banks, telecommunication companies, transportation companies and etc.

3. Case Study—Current State and Business Models of the Largest Import & Export Companies in Jiangsu Province, China

Jiangsu province is a developed province located in east China, and according to the most recent statistics from January through July 2003, the amount of export of Jiangsu province reaches \$29.62 billion, which is 13% of the total export of the whole country. In the meantime, the import and export companies strive to start and implement their e-commerce in doing business with foreign companies. We can have a glance at the current state of those companies in Jiangsu Province, also we can judge the business models

that they adopt from a recent survey made by the author of this paper among the largest import and export companies concerning their e-commerce.

3.1 The Largest Import and Export Companies in China Are Still at the Early Stage of E-commerce.

According to the above-mentioned survey, the largest import and export companies in Jiangsu Province are still at the very early stage of e-commerce. For example, only 10% of the companies established websites where their

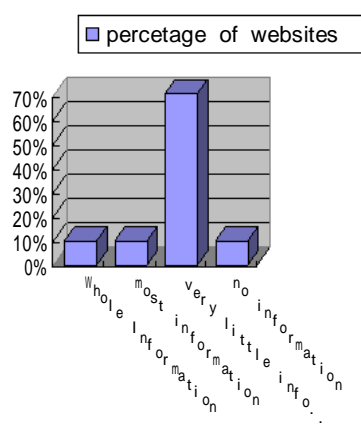


Figure 1 How much information the websites can provide

customers can get information of the whole products, another 10% of the websites provide most of the products' information, but 70% of the websites can only provide their customers with very little information about their products, and 10% of the websites provide no information about their products (see Figure 1).

3.2 The Challenges That the Import and Export Companies in China Are Facing.

According to the survey, the largest import and export companies meet with the following difficulties or problems (see table 3). From Table 3 we can see that the 3 biggest problems for those companies in doing e-commerce are lack of credit (55%), lack of cooperation from their

upstream and downstream business partners (45%) and lack of safety or online settlement means (40%).

Table 3 Problems that import and export companies are facing in doing e-commerce

Type of problem	Percentage of the companies that have the problem (%)
No enough technicians to maintain websites	25
Weak information system	35
Lack of laws	35
Lack of Credit	55
Lack of safety	40
Lack of popularity	25
Logistic problem	10
The upstream and downstream partners' cooperation	45
Online settlement problem	40

3.3 Some Tips on How the Import and Export Companies in China Improve Their Performance in the Process of Implementing E-commerce.

(1) The government at all levels should make laws to guarantee the implementation of e-commerce.

(2) The import and export companies should know that e-commerce is a trend in the future and an efficient way of enhancing their competitiveness in doing business.

(3) E-commerce is a gradual process in which every participant can only progress little by little, and the performance of e-commerce can only be seen in a relatively long time.

(4) The companies should attach great

importance in online marketing skills which are quite different from the offline ones.

4. Conclusions

(1) Business model is a different conception for different industries dealing with different products or services, therefore we have different definitions for it from scholars and researchers all over the world.

(2) Business models of e-commerce for China's import and export companies are unique because of the unique circumstances of China in its laws, credit conditions, information system, logistic system and other basic infrastructure.

(3) Although e-commerce for China's import and export companies is still in its inception period, progress has been made and the difficulties will be overcome since more and more parties now get involved to try to create a suitable and efficient business model to improve the performance of e-commerce for those import and export companies in China.

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On the impact of electronic commerce on logistics operations

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Abstract

This paper formulates and analyzes a model to integrate inventory management and promotion decisions in a multi-product environment. The model assumes that actual demands for the items depend on both item availability and the level of promotion used for the item. A notable feature of the model is that customer demand is partially backordered, where the fraction of demand backordered depends on how long a customer has to wait for delivery. The firm is assumed to have a limited promotion budget. The effect of a promotion is modeled through an increase in the demand rate of the item being promoted. We formulate a general, non-stationary, finite horizon version of the problem. However this problem is very difficult to solve optimally. In order to develop insights into the nature of the solution we formulate a stationary version of the general problem with the additional restriction that only one item can be promoted at a time. An efficient solution approach is developed for this stationary version, and limited numerical results are provided. These numerical results indicate that a coordinated approach to promotions and logistics decisions can lead to significantly higher profit for the firm.

1. Introduction

The emergence of internet based communication channels has enabled new levels of coordination in global manufacturing and logistics. Initiatives such as Collaborative Planning and Forecasting, electronic marketplaces, B2B and retailing over the web allow companies to develop new methods for designing and managing logistics systems. From the operations researcher's perspective, the challenge is in developing models that incorporate the additional data that is available in these environments and in using the data to implement more efficient and effective logistics policies. Since so much more data on customer behavior can be collected, we expect that these models will encompass more and more sophisticated modeling of customer behavior. This will allow a closer integration of marketing decisions with basic logistics decisions such as inventory management.

The goal of this paper is to develop a model to illustrate how marketing and operations decision-making can be integrated. The model we develop assumes that demand for items depends on both item availability and the level of promotion used for the item. We also assume that there is a limit on the amount of promotional activities

that the firm can engage in (this may reflect a limited promotion budget, a limit on the ability of consumers to absorb the promotional message, or a limit on the capacity – space on a web site – of the delivery vehicle for the promotional message). By choosing the promotions carefully and integrating the promotion schedule with inventory management the firm should be able to increase profits compared to a situation where inventory management and promotions are independently managed.

An important aspect of Internet retailing operations is the planning and coordination of advertising and promotions. Critical pages on a web site display featured items and certainly have an effect on the sales for these items. This behavior is similar to point-of-purchase displays in physical retailing, but is much more powerful since it can encompass any items that the retailer sells, not just those that satisfy certain size and selling price constraints.

Building upon the ability of e-commerce to capture more details of a customer's shopping behavior we present a scheme to coordinate customers purchase behavior with promotions and inventory stocking decisions. Our model shows how to coordinate the scarce resource of featured item advertising with inventory decisions in order to maximize the revenue from the assortment of items the retailer sells and to minimize the inventory costs.

Our model can be viewed as a generalization of the classical Economic Order Quantity model [10], and the related literature is vast, see e.g. [9] [23].

There is a small but growing literature that considers the impact of customer behavior on operations decisions. One strand of this body of work focuses on substitution behavior (see [1] [2] [7] [15] [21]).

Another strand focuses on promotion decisions. Cheng and Sethi [5] consider a periodic review model coupled with promotion decisions. Huchzermeier et al. [11] study the effect of consumer decisions when faced with promotions on the supply chain. Iyer and Jianming [12] show that information sharing is important in the context of retail promotions. In contrast to these papers we consider a continuous review model, explicitly consider stockouts as a cost reducing tactics, and consider multiple items in the context of limited promotions, as is the case for featuring items on web pages.

In our model we assume that actual demand depends on whether the item is in stock or not (in which case the demand rate further depends on the amount of time that will elapse until backorders can be filled). Some models where only a fraction of the demand is backordered when

a stockout occurs are examined in [16] [17] [20] [22].

Backorders have been the subject of extensive research in the context of stochastic models. An order point order quantity model with a mixture of backorders and lost sales is investigated in [19]. Lost sales will occur when backorders exceed a certain threshold level. General backorder costs in stochastic inventory models are discussed in [4], and in [3] backorder costs have fixed and proportional components.

Another approach to modeling the effect of stock-outs can be found in [18], where it is assumed that the demand rate is influenced by backorders. The approach of modeling backorders as dependent on the time until they can be filled was used by us in a somewhat different context in [8].

There is also extensive research on perishable inventories, when the stock at hand may decay, or become obsolete. One representative paper [14] integrates the stocking decision with backordering. While we do not have perishable inventories, we have “perishable” backorders, in the sense that backorders grow less than proportionately with the elapsed stockout time.

Finally, [13] uses an exponential pent-up demand function in the context of stochastic lead times. The focus is on algorithms to obtain the optimal stockout period without deriving any structural results. In this paper we model customer response to backorders through a general function, which allows various reaction curves to be fitted using available customer data. For details see [8].

The paper is structured as follows. In the next section we develop a general model for integrated promotion and inventory management over a finite time horizon. This model will be seen to be too complicated to solve optimally, hence we develop a simpler average cost version of the model in section 3. In section 4 we show how the single item average cost version of the model can be solved optimally, and in section 5 we will extend the analysis to the multiple item problem. Section 6 will discuss several numerical examples while in section 7 we give conclusions and ideas for further work in this area.

2. The Finite Horizon Model

We introduce the following notation.

N = the number of items in the assortment, indexed by i ,

T = length of the planning horizon,

D_i^H = demand rate for product i when it is being promoted,

D_i^L = demand rate for product i when it is not being promoted,

p_i = net margin (excluding inventory holding cost, fixed costs and promotions costs) per unit sold for item i ,

h_i = inventory holding cost (per unit per time period) for item i ,

F_i = fixed ordering cost for item i ,

$k_i(u)$ = fraction of demand that can be backordered

when item i is out of stock if the backorder will be filled in u time units, assumed to be non-increasing in u ,

c_i = cost per time unit of running the promotion for item i ,

w_i = promotional “weight” for item i , measures how much promotional capacity is consumed by fixed ordering cost for item i when it is being promoted,

W = total promotional capacity available (cannot be exceeded at any point in time),

$X_i(t) = 1$ if item i is being promoted at time t , 0 otherwise,

K_i = total number of replenishment orders placed during the planning horizon for item i ,

Q_i^k = order quantity for item i at the time that the k -th order is placed for item i ,

T_i^k = time that the k -th order is placed for item i ,

$S_i(t)$ = physical inventory for item i at time t ,

$\Theta_i(t)$ = amount of time (measured from time t) until the next delivery is received for item i ,

$\hat{D}_i(t)$ = effective demand rate at time t for item i .

We assume that the demand for each item is deterministic. While there is physical inventory for item i , the demand rate is D_i^H while the item is being promoted, and D_i^L while it is not being promoted. If there is no physical inventory for item i , and it is u time units before the next delivery, the effective demand rate is $D_i^H k_i(u)$ while the item is being promoted and $D_i^L k_i(u)$ while it is not being promoted. Hence promotion affects the base demand rate, while physical inventory and the time until the next delivery affect the fraction of the base demand rate that is converted into sales. With these assumptions, the sales rate for item i at time t is equal to

$$\hat{D}_i(t) = (D_i^L + (D_i^H - D_i^L)X_i(t)) \times (I_{\{S_i(t) > 0\}} + k_i(\Theta_i(t))I_{\{S_i(t) \leq 0\}}). \quad (1)$$

The company will thus try to maximize

$$\sum_{i=1}^N \left[\int_0^T p_i \hat{D}_i(t) - c_i X_i(t) - h_i S_i(t) dt - K_i F_i \right] \quad (2)$$

subject to the following constraints.

Don't exceed the promotional capacity:

$$\sum_{i=1}^N w_i X_i(t) \leq W, \quad 0 \leq t \leq T. \quad (3)$$

Definition of sales:

$$\hat{D}_i(t) = (D_i^L + (D_i^H - D_i^L)X_i(t)) \times (I_{\{S_i(t) > 0\}} + k_i(\Theta_i(t))I_{\{S_i(t) \leq 0\}}), \quad (4)$$

$$0 \leq t \leq T, i = 1, \dots, N.$$

Physical inventory balance constraints:

$$S_i(u) = \left[S_i(0) + \sum_{k: T_i^k \leq u} Q_i^k - \int_0^u \hat{D}_i(t) dt \right], \quad (5)$$

$$i = 1, \dots, N; 0 < u \leq T$$

Order must clear the backlog:

$$\sum_{i=1}^k Q_i^s \geq \int_{t=0}^{T_i^k} \hat{D}_i(t) dt, \quad k=1, \dots, K_i; i=1, \dots, N. \quad (6)$$

Order sequencing:

$$T_i^k < T_i^{k+1}, \quad k=1, \dots, K_i-1; i=1, \dots, N. \quad (7)$$

Definition of θ_i :

$$\theta_i(t) = T_i^k - t, \quad T_i^{k-1} < t \leq T_i^k; k=1, \dots, K_i; i=1, \dots, N. \quad (8)$$

$X_i(t)$ is binary:

$$X_i(t) \in \{0,1\}, \quad 0 \leq t \leq T_i^k, i=1, \dots, N. \quad (9)$$

Clearly this problem is NP-Complete and would be extremely difficult to solve in the general case. Instead of attempting this (or developing heuristics for it) we instead formulate a simplified version in the next section.

3. A Simplified Model

In this section we will simplify the general problem formulated in the previous section in several ways. First, we will assume that only one item can be promoted at a time. This corresponds to assuming that $w_i = 1$ for all items and that $W = 1$. The second simplification is achieved by formulating an average profit version of the model, by assuming that all items are on the same replenishment cycle, and by requiring that an item can be promoted only once per cycle. Hence in this problem we have the following decision variables (in addition to the notation introduced earlier):

T = the common cycle length for all items,

φ_i = the amount of time that item i is promoted during the cycle, and

Q_i = the order quantity for item i .

Finally, we define

$\Pi_i(\varphi_i, T)$ = maximum profit that can be achieved for item i in a cycle of length T when a single promotion of length φ_i is used and a single replenishment order is placed for item i .

We assume that a stationary policy is followed (clearly this is optimal in the simplified model), and since every item can be promoted only once per cycle, a feasible promotion schedule exists as long as total promotion time during a cycle does not exceed the length of the cycle. Hence the problem we want to solve can be formulated thus:

$$\Pi^* = \left\{ \begin{array}{l} \max \quad \frac{1}{T} \sum_{i=1}^N \Pi_i(\varphi_i, T) \\ \text{s.t.} \quad \sum_{i=1}^N \varphi_i \leq T \\ \varphi_i \geq 0, \quad i=1, \dots, N \end{array} \right\}. \quad (10)$$

In the next section we will show how $\Pi_i(\varphi_i, T)$ can be found efficiently for a given φ_i and T .

4. Solving the Single Item Sub-problem

In this section we will formulate the single item sub-problem, derive properties of the objective function, and give an efficient algorithm to solve it. Since we will

only consider one item here, we simplify the notation somewhat by dropping the subscript i in this section.

We will define a cycle to run from the moment the item runs out of stock (at time 0) until the item runs out of stock again (time T). Let x = the time at which the replenishment order arrives. During the cycle we can distinguish two distinct periods: when $0 \leq t < x$, backlog accumulates at a rate of $k(x-t)$ times the demand rate (which depends on whether a promotion is in effect). When $x \leq t < T$, sales occur directly from stock. (Note that in an extreme case it is possible that $x = 0$, i.e., the item is never stocked, the company takes orders and fills those orders when a replenishment order arrives.) The first issue to decide is when the promotion (which is assumed to have a length $\varphi < T$) should be scheduled.

Proposition 1. Let x (= the time during a cycle that the inventory runs out) be given. Let y = the start time of the promotion that maximizes the per cycle profit. Then

$$y \leq x \leq y + \varphi \leq T \quad (11)$$

Proof. It is tedious but not difficult to show that all the other cases are dominated by one that satisfies equation (11).

Next, define $z = x - y$. Then (11) is equivalent to

$$\max(0, \varphi + x - T) \leq z \leq \varphi \quad (12)$$

For given stockout time x and promotion start time y satisfying (11), the total units sold per cycle is given by

$$Q(x, z) = [T - K(x)] D - \int_0^{\varphi} K(x-t) D - z D \quad (13)$$

where

$$K(x) = x - \int_0^x k(t) dt \quad (14)$$

and total inventory (in units of product \times time units) is

$$H(x, z) = \frac{1}{2} (T - x)^2 D + \frac{1}{2} (\varphi - z)^2 D - z D \quad (15)$$

Note that K is convex, and hence $Q(x, z)$ is jointly concave in x and z . Since $H(x, z)$ is jointly convex in x and z it follows that $\Pi(x, z) = pQ(x, z) - hH(x, z) - F$ is jointly concave.

Proposition 2. The policy (\hat{x}, \hat{z}) that maximizes the profit per cycle for a given promotion length φ and cycle length T can be characterized as follows. If $hT \leq p(1 - k(0))$ then $\hat{x} = 0$, otherwise \hat{x} solves the equation

$$k(x) - \frac{h}{p} x - \left(1 - \frac{hT}{p}\right) = 0. \quad (16)$$

If $h\varphi \leq p(1 - k(0))$ then $\hat{z} = 0$, otherwise \hat{z} solves the equation

$$k(z) - \frac{h}{p} z - \left(1 - \frac{h\varphi}{p}\right) = 0. \quad (17)$$

Proof: Note that

$$\frac{\partial \Pi(x, z)}{\partial x} = [h(T - x) - p(1 - k(x))] D^L, \quad (18)$$

$$\frac{\partial \Pi(x, z)}{\partial z} = [h(\varphi - z) - p(1 - k(z))] (D^H - D^L). \quad (19)$$

Hence the first order conditions are equivalent to (16) and

(17). However, these don't give the solution if any of the constraints in (12) is violated. It is easy to show that the left hand sides of (16) and (17) are decreasing in x and z . If we substitute $z = \varphi$ in the LHS of (17) we obtain a non-positive number, and hence $\hat{z} \leq \varphi$. If we substitute $z = 0$ in the LHS of (17), we obtain a positive number as long as $h\varphi > p(1 - k(0))$, and hence in that case \hat{z} satisfies equation (17).

Substituting $x = T + \hat{z} - \varphi$ into equation (16) yields a non-positive number since the second term cannot exceed $k(\hat{z}) - 1$ by equation (17). Hence $x \leq T + \hat{z} - \varphi$. Finally, substituting in $x = 0$ into (16) concludes the proof.

To conclude this section, we prove the following proposition.

Proposition 3. Assume $\lim_{x \rightarrow \infty} \frac{1}{x} \int_0^x k(t)dt = 0$, then

- (i) $\lim_{T \rightarrow \infty} \frac{1}{T} \max \{ \Pi(x, z) \} = 0$
- (ii) $\lim_{T \downarrow 0} \frac{1}{T} \max \{ \Pi(x, z) \} = -\infty$

Proof: To prove (i), first note that $Q(\hat{x}, \hat{z})/T$ is bounded from above by D^H as $T \rightarrow \infty$, while $H(\hat{x}, \hat{z})/T$ approaches ∞ as long as $(T - \hat{x})^2/T \rightarrow \infty$. So assume $(T - \hat{x})^2/T \leq U$ for all T . Then \hat{x} grows about as fast as T , and the assumption insures that $Q(\hat{x}, \hat{z})/T \rightarrow 0$ as $T \rightarrow \infty$. To prove (ii), note that $\Pi(\hat{x}, \hat{z}) \rightarrow -F$ as $T \rightarrow 0$.

5. Solving the Multi Item Problem

In this section we give an efficient algorithm to solve the multi-item problem (10) formulated in section 3. First of all, using the derivation in the previous section it is not hard to show that note that $\Pi_i(\varphi_i, T)$ is jointly concave in φ_i and T . Hence the objective function in (10) is quasi-concave. To solve (10) we adopt the following approach. Define

$$G(T) = \left[\begin{array}{l} \max \sum_{i=1}^N \Pi_i(\varphi_i, T) \\ \text{s.t.} \sum_{i=1}^N \varphi_i \leq T \\ \varphi_i \geq 0 \ (i = 1, \dots, N) \end{array} \right], \quad (20)$$

$$f_i(u; S, D) = \left(p_i(S - K(u)) - \frac{1}{2} h_i (S - u)^2 \right) D, \quad (21)$$

$$g_i(S; \lambda, D) = \max \{ f_i(u; S, D) - \lambda S : u \geq 0 \}, \quad (22)$$

then

$$\Pi_i(\varphi, T) = g_i(T; 0, D_i^L) + g_i(\varphi; 0, D_i^H - D_i^L) - F_i, \quad (23)$$

and the Lagrangian of (20) can be written as follows.

$$G(T) = \sum_{i=1}^N g_i(T; 0, D_i^L) - \sum_{i=1}^N F_i + \min_{\lambda \geq 0} \left\{ \lambda T + \sum_{i=1}^N \max_{\varphi_i \geq 0} g_i(\varphi_i, \lambda, D_i^H - D_i^L) \right\} \quad (24)$$

Note that we can write the inner maximizations in (24) as follows:

$$\max_{\varphi_i \geq 0, z_i \geq 0} \left\{ \left[p_i(\varphi_i - K(z_i)) - \frac{1}{2} h_i (\varphi_i - z_i)^2 \right] (D_i^H - D_i^L) - \lambda \varphi_i \right\}, \quad (25)$$

and that the objective function in (25) is jointly concave. Using the first order conditions and (17), one readily shows that the optimal solution to (25) is given by

$$\begin{aligned} \hat{z}_i(\lambda) &= 0, \hat{\varphi}_i(\lambda) = 0 & \text{if } \lambda r_i \geq 1 \\ \hat{z}_i(\lambda) &= k_i^{-1}(\lambda r_i) \\ \hat{\varphi}_i(\lambda) &= \hat{z}_i(\lambda) + \frac{p_i}{h_i}(1 - \lambda r_i) & \text{otherwise} \end{aligned} \quad (26)$$

where $r_i = 1/(p_i(D_i^H - D_i^L))$. Hence these sub-problems are particularly easy to solve. The second major term in (24) is therefore a standard Lagrangian optimization problem that is quite easy to solve numerically. Similarly, note that finding $g_i(T; 0, D_i^L)$ merely requires solving (16).

Therefore $G(T)$ can be readily found for any T . So we are finally ready to give the approach to solving the problem

$$\max \{ G(T)/T : T > 0 \} \quad (27)$$

which of course is merely a different way of stating (10). Define $B(T; \alpha) = G(T) - \alpha T$. It is not hard to show the following

Proposition 4.

- (i) If $B(T; \alpha) > 0$ for some $\alpha \geq 0$ and $T > 0$ then $\Pi^* > \alpha$.
- (ii) If $\max \{ B(T; \alpha) : T \geq 0 \} \leq 0$ then $\Pi^* \leq \alpha$.
- (c) $B(T; \alpha)$ is concave in T .

Using this one can easily devise efficient algorithms to solve equation (10). The details will be left to the reader. For other examples of this approach see [6] [8].

6. Numerical results

In this section we will provide the results from a modest numerical study. In the study we assume that $k_i(u) = e^{-u_i}$ throughout. Example 1 has $N = 4$ identical products with parameters as follows:

$$D_i^H = 20, D_i^L = 14, p_i = 3, h_i = 0.2, F_i = 10, \mu_i = 1 \quad (28)$$

For this case the optimal solution is

$$\begin{aligned} x_i &= 0.1862, z_i = 0.0436, \varphi_i = 0.6837, \\ T &= 2.735, \Pi_i = 39.17, \Pi = 156.69. \end{aligned} \quad (29)$$

First of all, it is interesting to see what happens when marketing and operations don't coordinate on setting the cycle length T . Figure 1 shows the total profit that is achieved when marketing arbitrarily chooses the cycle length and the inventory policy used is optimal given the cycle length.

The figure clearly shows a substantial penalty in terms of lost profit when the promotion cycle is too short, and a much less severe penalty when the promotion cycle is longer than optimal. Part of the steep decline in profits with a short cycle may be due to the model assumption that inventory cycles and promotion cycles must coincide.

When promotion cycles become very short, one replenishment order might be placed to cover two or more promotion cycles. We don't consider this possibility here.

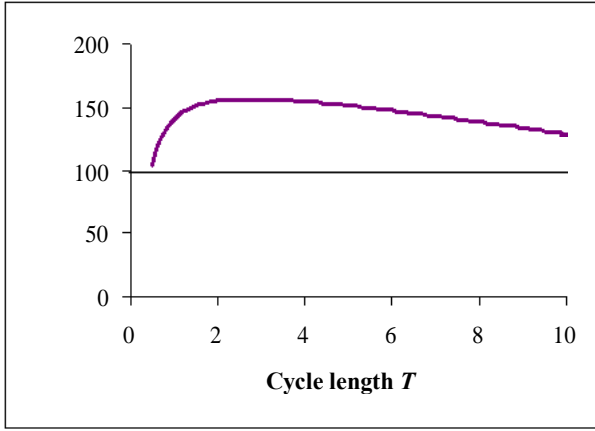


Figure 1: Maximum total profit given the cycle length T for Example 1.

Next, we consider the impact of the customers' willingness to wait for an out of stock item. This is captured in the model through the parameter μ of the function $k(u)$. The larger μ , the less willing customers are to wait. In the base case when $\mu = 1$, the fraction of customers that is willing to wait one time unit is equal to $\exp(-1) = 0.368$. In Figure 2 we show base case profit as a function of T for $\mu = 0.1$, $\mu = 0.5$ and $\mu = 2.0$, with other parameters as in (28).

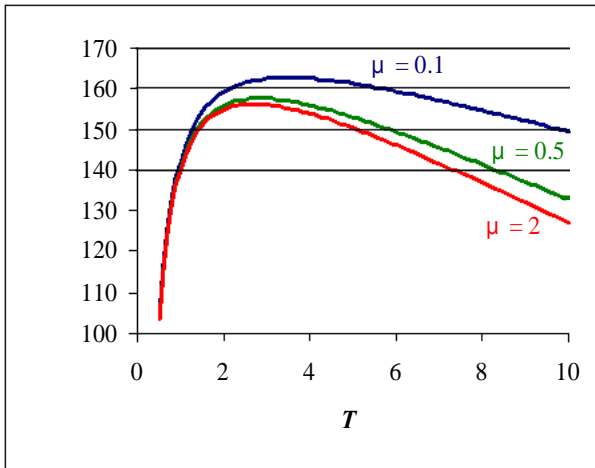


Figure 2. Impact of promotion cycle length T for varying customer willingness to wait for Example 1.

This shows that the profit is less sensitive to long promotion period lengths when customers are less sensitive to stockouts. For short promotion periods there is virtually no difference, which is accounted for by the fact that stockout durations are very short when the order cycle is short and hence fewer lost sales occur.

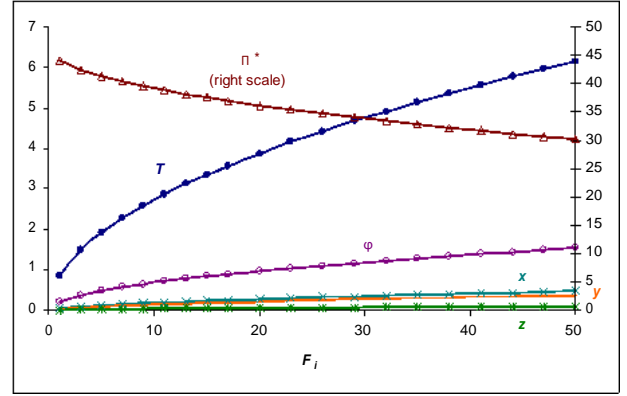


Figure 3: Optimal policy and profit as functions of fixed cost F_i for Example 1.

Next, we consider the impact of the fixed cost on the optimal policy and its cost, see Figure 3. This figure uses the base case parameters but varies the fixed cost F from 1 to 50. As expected, the optimal cycle length T increases as the fixed cost increases, and the optimal profit Π^* decreases. Since there are 4 products with identical parameters in this example, the optimal policies are identical as well. The promotion length φ is always equal to 25% of the cycle length T and the parameters x , y and z show little change when expressed as a proportion of the cycle length.

Finally, we will consider an asymmetrical example. The parameters for Example 2 are:

$$\begin{aligned} D_1^H &= 22, D_2^H = D_3^H = D_4^H = 20, \\ D_1^L &= 14, p_i = 3, h_i = 2, \mu_i = 1 \end{aligned} \quad (30)$$

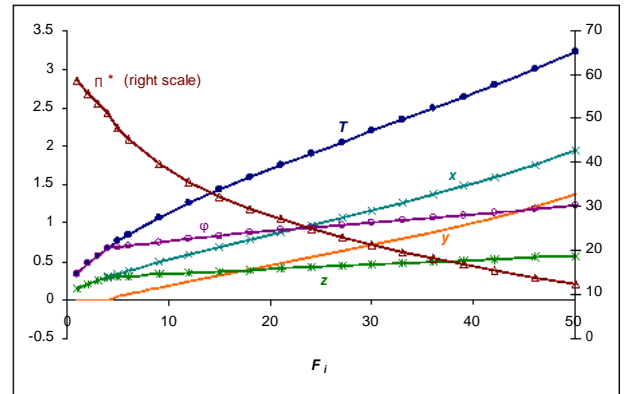


Figure 4. Optimal policy and profit for item 1 as functions of F_i for Example 2.

The optimal policies for item 1 are shown in Figure 4. In this example we see that when F_i is small (less than about 4), $y_i = 0$, $\varphi = T$ and $x_i = z_i$, i.e., item 1 is always being promoted, even though the item is not always in stock. The duration of the stockout is short enough however to prevent serious loss sales. As the fixed cost F_i increases, increasing inventory holding costs make it more advantageous to incur more stockouts for item 1 and therefore it becomes less attractive to do promotion on item 1, which allows promotions to be scheduled for the other items as well. Note that the optimal profit for item 1 is not a convex function of F_i at the point where

promotions for the other items become attractive. The optimal policies and profits for items 2, 3 and 4 are depicted in Figure 5.

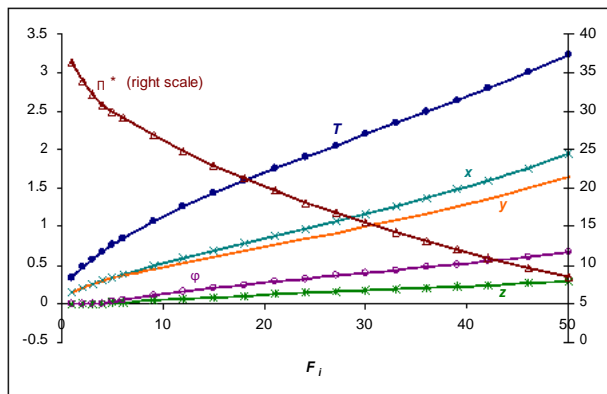


Figure 5. Optimal policy and profit as functions of F_i for items 2, 3 and 4 in Example 2.

Items 2, 3 and 4 are not scheduled for promotion until the fixed cost F_i exceeds about 4, and these items consume more and more of the total promotion budget as the fixed cost increases (at $F_i = 50$, about 40% of a cycle is used to promote item 1, and about 20% is used for each of the other three items). Note that the optimal policies in this example are neither convex nor concave functions of F_i .

7. Discussion

It is not hard to come up with interesting generalizations of our model. In the first place, the reaction of customers to promotions is very simple in our model. An obvious modification would be to make the sales rate during promotions a function of how long the promotion has been going on, similar to the backlogging rate being dependent on how long the customer has to wait until the item will be delivered. A second modification could be to allow several promotions to go on simultaneously, possibly accompanied by a segmentation of customer market. Both these modifications would make the model more realistic, but estimating the necessary parameters would become more difficult. We have demonstrated that it is quite possible to combine logistics aspects and marketing aspects in a comprehensive model. The advantage of this is obvious: as companies acquire better and more comprehensive information systems, much more details about customer preferences and behavior become available, and companies can use this information to improve both the service to their customers and their own bottom line.

The models in this paper are just the beginning, however. An operational model takes into account the specific information available in a practical situation, and uses this to make recommendations that tally with the business model that the company is trying to implement. This requires a lot of customization in the modeling approach. On the other hand, information system implementers need to take into account what information is needed to estimate and implement the more and more

sophisticated models that researchers develop. It is our hope that this paper can make a contribution to this necessary dialogue.

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A Preliminary Research Study of the Implications of Web Services Innovation for General Adopters: Findings and Recommendations (Extended Abstract)

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Abstract

Among emerging Service-oriented technologies, Web Services as representative of such innovation has gained increasing attention and received extensive studies from both academia and industry. In this study, we look at Web Services innovation from a more theoretical viewpoint. Based on hypothetical presumptions, we propose a dual-core model that treats such innovation at a strategic level according to its peculiar characteristics. We question the validity of using two prevailing innovation theories, Tornatzky and Fleischer's contextual framework, and Swanson's innovation typology respectively. We argue that simply apply either of above theories would miss important attributes of Web Services; if use both, it would be too complex and lose the foci. We therefore compose a synthetic viewpoint, on the basis of Web Services primary characteristics in order to obtain a thorough understanding of this innovation and give recommendation to general adopters. We also suggest that adoption of IS innovation is conjectured to be patterned in terms of the scope of e-business enablement across organizations, particularly in small and medium-sized enterprises (SMEs). The argument is exemplified through the diffusion of Web Service innovation in order to make our analysis focused on a representative case of IS innovation among organizations as well as keep generalization for articulating further research into issues which share common attributes of Web Services.

Key words: Web Services, Information Technology, Technology Innovation, e-Business, IS Adoption.

1. Introduction

Web Services are becoming the primary way in which business processes are exposed and accessed in the enterprise. As these processes are exposed, it will become easier for organizations to integrate their business operations with those of their partners. At the same time, portals have rapidly emerged to become the Web user interface of choice for accessing enterprise-wide heterogeneous data and applications. The central challenge for IT has been, and will continue to be, the

integration of inter- and intra-enterprise applications. To stay competitive today, businesses need to be able to instantly and easily interoperate with different divisions within organization - as well as reach outside to customers, partners, and suppliers. But barriers such as inconsistent platforms, languages, and protocols often stand in the way. Web services break through these barriers by providing loosely coupled, language-neutral, and platform-independent methods for connecting people, processes, and applications behind or outside the firewall. The term "Web Services" refers¹ to the technologies that allow for making connections. More specifically, Web Services is "any service that is available over the Internet, uses a standardized XML messaging system, and is not tied to any one operating system or programming language." (Cerami 2002). Hence, Web Services² are perceived as building blocks that fundamental for creating distributed applications, which are able to be published and accessed over the Internet, as well as corporate intranets. Understandably, from this conceptual viewpoint, Web Services could be thought to construct co-operative Inter or Intra-Organizational Systems (IOS) that allow trading partners to conduct transactions through connecting separate computer applications. IOSs are telecommunication-based computer systems that are used by two or more organizations to support the sharing of data, and sometimes applications, among users in different organizations (Barrett and Konsynski 1982; Cash 1985). In order to be classified as a full-fledged IOS, Web Services must be deployed at departmental level within an organization; or at organizational level among firms. However, due to the fact that each individual organization has varied perception and policy towards introducing new technologies to existing information systems, thus the adoption depth and breadth of Web Services innovation in organizations may vary considerably. However, with no exception, such decisions are all inherently consistent with each firm's adoption strategy which is

¹ When use singular form of Web Services, it denotes a special term of an IS innovation;

² We address that a service is the endpoint of a connection, which has some type of underlying computer system that supports the connection offered. Web Services herein used as a plural form to emphasize a whole subset of their functionalities.

affected by contextual factors. A number of research work studying the adoption of IS innovations is using this fashion towards contributing knowledge to general innovation theory. As an emerging technology, theories about Web Services innovation and its adoption in organizations are still lacking. It is presumable that classical technological innovation theories can provide useful guidelines for studying Web Services innovation; new findings are able to be gained by applying empirical frameworks in Web Services study. Nonetheless, any borrowed theories should be tailored to particular context in studying a specific innovation. Implications of this proposition suggest that, when featured variants are introduced to certain empirical frameworks with respect to distinct characteristics of each innovation, the research methodology should be reconsidered, and the early frameworks might subsequently need to be amended in order to design an appropriate research model which is used to conduct the later study. In accordance with these considerations, in the study of Web Service innovation, we first identify its unique characteristics which make it distinct to all other innovations; we then examine the appropriateness of two prevailing models in studying the Web Services innovation. We later recommend a dual-core research model in order to clarify the ambiguity in understanding the adoption of Web Services innovation in organizations. During this approach, this article addresses two issues: (1) what are the major determinants affecting the scope and pattern of Web Services adoption in organizations; (2) what is the role of Web Services providers and how can they assist in constructing unified e-business platform for organizations, particularly SMEs to participate in large-scale e-commerce practices.

The phrase “Web Services” in this paper denotes the architecture that consists of a set of Internet-accessible software components, which are able to extend organizations’ Information Systems (IS) to broader external business environments. While empirical researches contributed foundations towards understanding IS innovation and its role in organizational and business process innovation in general; however most studies of such relations were confined to examining separate technological silos and their impacts within a single organization or among few organizations. Nevertheless, existing literatures explain little about the strategic adoption of those innovations at inter-organizational level within a given context. In this paper, we suggest that adoption of IS innovation is conjectured to be patterned in terms of the scope of e-business enablement across organizations, particularly in small and medium-sized enterprises (SMEs). The argument is exemplified through the diffusion of Web Service innovation in order to make our analysis focused on a representative case of IS innovation among organizations as well as keep generalization for articulating further research into issues which share common attributes of Web Services. We identified that

two main patterns are associated with the dimensions of Web Services adoption: Pattern I adoption confined to integrating discrete business processes within enterprises; Pattern II adoption is implemented across enterprises boundaries to wider business environments. Web Services herein is posited to be layered throughout organization’s information systems in an amorphous manner which is fundamental for fluid e-business functionalizing. The vantage point of each adoption pattern is associated with organization’s e-business strategy and also consistent with firm’s vision towards Web Services innovation in a long term run. Implications of this paper are two fold. First, the characteristics of Web Services are identified to be openness and modularity; second, a dual-core adoption model is developed accordingly as a road map that organizations could use to help make adoption decision. Finally, we expect longitudinal studies and qualitative case analysis in order to examine our theory. In considering these issues, we reviewed empirical researches on strategic information systems and IS adoption literatures. Based on our preliminary findings on primary characteristics of Web Services, we then present a dual-core research model. Variables and factors for evolving the adoption between patterns are also identified.

2. Literature Review

Information technology usage has been recognized by many researchers as a key dependent variable in MIS research (e.g., DeLone and McLean, 1992; Karahanna and Straub, 1999). Historically, its determinants have been empirically examined in wider contexts (e.g., Adams et al 1992; Davis 1989, 1993; Mathieson 1991; Moore and Benbasat 1996; Taylor and Todd 1995; Thompson et al 1991; Iacovou et al 1995). Most of studies have used the diffusion of innovation theory (Rogers 1983) to identify attributes of innovation that influence its adoption, however many researchers have questioned the validity of its application to complex technological innovations at the organization level (e.g., Attewell 1992; Downs and Mohr 1976). Nevertheless, empirical innovation studies attempt to investigate either individual’s or firm’s beliefs and attitude towards innovation and its adoption consequences, therefore, the temporal dimension of most adoption studies has been confined to explaining the diffusion of innovation and the interaction with single adopter (e.g., often an individual or organization unit).

However, with exceptions, there are also quite a few of researches which have assessed the adoption of IS innovation at organizational level among organizations (e.g., Swanson 1994; Rai and Howard 1993). Notwithstanding this point, as stated in a study of Open Systems adoption (Chau and Tam 1997), current diffusion theories yet not explain completely the inconsistency in report results when generalizing findings of individual adoption to the organization level

if considering the differences in unit of analysis, environment, and technology characteristics. Furthermore, as Zmud (1982) notes in his studies of the diffusion of modern software practices among IS development groups that, a set of heterogeneous innovations might be influenced quite differently by the same factors in a single organizational context; and a lack of homogeneity in either innovations or organizational contexts may result in inconclusiveness of any certain type of diffusion framework in a variety of business environments with specific organizational context involved. Thus, simply use the empirical contextual framework (e.g., Tornatzky and Fleischer 1990) to analyze innovation process would not be capable to tackle a complex technological innovation, and not able to explain clearly its diffusion pattern in organization with respect to the emphasis on the other contextual factors that existing in the same framework.

In dealing with this, Fichman (1992) argues in a review of empirical IT innovation studies that classical diffusion variables by themselves are unlikely to be strong predictors of adoption and diffusion for complex organizational technology, suggesting that additional factors, either as independent or control variables, should be added to organizational level innovation adoption studies.

Alternatively, besides continuous attempts to optimize such empirical contextual framework, Swanson (1994) proposed a three-layer IS innovation typology model. Swanson claimed that the IS innovation itself could be typed according to its usage in different organization hierarchies. The IS task-nature is a key determinant to decide the type of each IS innovation. His study contributed a new ground towards understanding IS innovations through making analysis with focus on IS innovation itself; the innovation type is associated with organizational contexts, and implies the further usage of an IS innovation. Swanson's work bridges the IS innovation characteristics and its usage, and served as a roadmap to assist understanding new IS innovations within organizational context.

However, in the study of Web Services innovation, the appropriateness needs to be examined when considering applying the above two prevailing theories to the present study. A temporal hypothesis is therefore arising that:

H1:

The empirical innovation process framework looks at a single IS innovation in three contexts (respectively: the external environmental context, the technological context, and the organizational context); while Swanson's typology theory categorizes IS innovations in terms of their tasks and organizational hierarchies. For Web Services innovation, according to its peculiar technological characteristic and thereafter implications

for further adoption, either of above theories may not be able to provide complete explanation; thus a new model that blended above two with a synthetic manner is expected, in order to leverage the foci, and fit the Web Services research.

Web Services Innovation Characteristics

Cerami (2003) describes that the role of today's World Wide Web (WWW) has transformed to what now is regarded as an intermediate platform which is "for interactive access to documents and applications ... such access is by human users, typically working through Web browsers, audio players, or other interactive front-end systems. The Web can grow significantly in power and scope if it is extended to support communication between applications, from one program to another". To this end, Web Services is defined and invented to bridge the gap to such paradigm. We herein use both capital (majuscule) letters to indicate this phrase is a special term. Web Services was initiated by leading IT vendors³ and soon became standards of W3C⁴. Regardless each vernacular use of this phrase that practitioners tout with, the story of Web Services is the story of connecting systems of diverse types. Conceptually, Web Services represents a model in which discrete tasks within e-business processes are distributed widely throughout a value net; and Web Services is consist of a stack of emerging standards that describe service-oriented, component-based application architecture. Succinctly, from a technical viewpoint, Web Services is reified by loosely coupled, reusable software components that semantically encapsulate discrete functionality and are distributed and programmatically accessible over standard Internet protocols. Unlike other technological artefacts studies in previous IS research which have a specific application, the scope of Web Services is wide, affecting every component of an IS infrastructure. Again, as Sleeper and Robins (2001) and Cerami (2003) suggested, a complete Web Services is interpreted in many aspects, and summarized as:

1. Web Services are reusable software components;
2. These software components are loosely coupled and discoverable via a simple find mechanism;
3. Web Services is able to semantically encapsulate discrete functionality;
4. Web Services can be accessed programmatically through a standardized XML messaging system;
5. Web Services are distributed over the Internet by making use of existing, ubiquitous transport protocols.

³ Examples of representative Web Services are Microsoft .NET; SUN ONE (Open Network Environment); IBM Web Services; Oracle Network Services.

⁴ World Wide Web Consortium. <http://www.w3c.org>

Identifying the Primary Characteristics of Web Services Innovation

The organizational context describes the characteristics of an organization, such as firm size, degree of centralization (or diversity), formalization, complexity of its managerial structure, and the quality of its human resources, and the amount of slack resources available internally (Chau and Tam 1997, p4; Swanson 1994, p1080). Such characteristics would have substantial influence on organization's propensity to adopting certain innovations; and the evidences about the links of these two have been reported in Tornatzky and Fleischer's (1990) study. Likewise, the adoption of Web Services innovation and its impact on organizational changes should also be consistent with classical diffusion theories. Differentiating from trade press, due to the fact that Web Services is a type of recent innovation brought to academic agenda, therefore, literatures of systematic and scholarly studies on Web Services innovation are relatively scarce. Nonetheless, in a preliminary research study, Wu and El Sawy (2003) reported that a wide range of business benefits is proposed for Web Services adoption, including easier, faster and cheaper enterprise application integration (EAI), dynamic business partnership, lowering of market entry barrier, and even industry structure change. Through their study and thorough review of existing innovations characteristics; the four salient characteristics of Web Services are identified to be:

1. IS technological process innovation: Web Services practices are currently IS technological process innovation;
2. High compatibility: Web Services has its roots in three existing IT trends (match with existing values; inheritance of past experience; compatible with other Web Services characteristics);
3. High divisibility: Web Services is a loose-bundle innovation with multiple visions and multiple associated products;
4. High customizability: Reinvention of Web Services occurs inevitably.

The last point of Wu and El Sawy's findings is not a contingency; this reflects again what has been suggested by Rogers (1983) and Swanson (1994) in their earlier studies, where Rogers (1983) contends that reinvention occurs at the implementation stage for certain innovations and for certain adopter; and Swanson (1994, p1079) states "Significantly, innovations of all three types are likely to evolve over time across their domains, as they are successively adopted. Both strong-order and weak-order effects provide impetus for this evolution, which is marked by incremental changes to the innovation's feature composition. New features are likely to be introduced to complement existing features, reconfiguring the concept and often facilitating the adoption process".

From a broader viewpoint, on the basis of preliminary research findings and the ground on which Web Services was initiated, as well as classical innovation theories depict, Web Services innovation does not necessarily need to have a fixed form or construct in the organizational adoption context; rather, it exists ubiquitously within the infrastructure of enterprise information systems in an amorphous manner, and therefore, we term this attribute as polymorphism⁵. Therefore, the primary characteristics of Web Services innovation, apart from those which have already been studied, are perceived as openness and modularity. Consequently, as a result, the deployment of Web Services among organizations would present many variations through each diffusion practice, which are selective adoption and creative implementation. The former allows potential adopters to select necessary and critical components to fit in more appropriately to the task requirements respectively; while for the latter, due to large diversity of each task's specification, Web Services implementation also needs to be configured individually that tailors to adopters' needs (for example, enterprise application integration-EAI).

3. Dual-core Research Model

The power and presence of information technology (IT) have expanded at a rapid rate that reaching every level in organizations and it has been viewed as a resource ever more critical to the success for host organizations (Carr 2003). Thus, information systems (IS) featured with increasing ubiquity are perceived to be of more strategic value. Different levels in the management hierarchy are now using IT where once its sole domain was at the operational level. The aim now is not only to improve efficiency but also to facilitate e-business effectiveness. On a more strategic level, information may be passed from an organization to its suppliers or customers in order to gain or provide a better service (Cash 1985), that assure to stay ahead in a short term than competitors and gain a long-term advantage by continual improvement. Such competitive forces include (Somogyi and Galliers 1987): (1) building barriers against new entrants; (2) changing the

⁵ This term is initially dedicated to explaining the concept that different objects do "the right thing" through an example of how a Pegasus class bridges between a Horse class (horse can whinny and gallop) and a Bird class (bird can fly) in object oriented programming (i.e., in C++ programming language). We "borrow" its meaning here in order to address that Web Services is application-centric and task-oriented vehicle for facilitating e-business automation, and adopters no necessarily need to know how it works or its implementation details. References for definition and examples of polymorphism are found at Liberty (2001, p10, p111-114, p376, p435).

basis of competition; (3) changing the balance of power in supplier relationships; (4) tying in customers; (5) switching costs; (6) creating new products and services.

These perceived benefits may best explain, to a certain extent, the reasons that motivate organizations to swiftly adopt new IT innovations as a planned approach to making their information systems additional strategic value; and continually invest in IS may therefore be posited as a business strategy in order to compete in marketplace. This however might result in a dilemma in the end – most of companies realize the importance of IS and follow the investment pattern associated with new emerging information technologies, believing this is their proprietary resource to assure a leading competition position by ruling out the threat from the others who do not possess such advantage. However with comparatively less focus on continually enhancing their core business, companies would finally realize that such IT developments policy will not provide increased profitability. In fact, it is presumable that as the utilization of information technologies is becoming increasingly ubiquitous for all stakeholders in marketplace, the strategic importance of enterprise information systems would diminish to a level of what earlier technologies have reached, and the competitive advantages brought by such gradually infrastructuralized⁶ information systems would therefore become less salient than the initial expectations. Nonetheless, interestingly, we noticed the recent progress achieved in software engineering community for migrating the use of powerful high performance computing (HPC) from dedicated scientific instrument to commoditized, pervasively used mainstream business IS infrastructure, viz. Grid Web Services Provisioning, through parties external to the host organization – vendors and providers of outsourced services (Foster et al 2001; Juhasz 2002; Xu and Hackney 2003), which is all the attempts to turn the above assumption into reality. As Attewell (1992) highlighted that the role of the innovation suppliers which in our study the service providers are to facilitate significantly in the knowledge transfer process, now are seen to be of critical importance in facilitating the process of IS infrastructuralization through service-sharing on a lease or rent basis (Xu and Seltsikas 2002).

New Approach for Web Services Research

⁶ This term herein refers to the IS services and technologies that are becoming commonly used and commoditized basic facilities that functionalize enterprises e-business process. This is represented by Web Services and available most often through outsourced service provisioning. However, the source and path of such technology diffusion may vary considerably (i.e., the theories of Rogers 1983; and the study of Attewell 1992).

The peculiar characteristics of Web Services innovation shape its adoption profoundly. First, Web Services permeates both the information technology itself and the business processes it serves. Thus, Web Services innovation spans both technological and business process domains and is unlikely to be characteristic of innovation of either. Second, Web Services integrates disparate applications within an enterprise through EAI⁷, but it is also rapidly elaborating and possessing an unusual degree of plasticity for informational layering and inter-organizational linking that articulates collaborative e-business and e-commerce. In this sense, Web Services makes enterprise information systems no longer proprietary; indeed, Web Services may be conjectured as an IS infrastructural innovation that will reshape the pattern for enterprises running e-business. Analyzing Web Services from this vantage point may help organizations obtain solid understanding of this innovation that assists making adoption decision, and subsequent adoption process. Therefore, the second hypothesis is:

H2:

Web Services is basically an IT infrastructural innovation. In order to clarify ambiguity, and interpret precisely the large variation of subsequent IS innovations that derived from Web Services innovation, the research model should be associated consistently with Web Services primary characteristics; and the research direction is led by the emphasis on the scope of e-Business enablement.

(1) Proprietary Core.

Where the IS is decentralized within a company into smaller units, and there is a stronger need to integrate disparate IS applications, the pattern 1 proprietary core is most likely taken. Web Services may be thought as a means for re-engineering organizations existing applications in order to achieve integrated e-business process (i.e. EAI) and the internal information systems retain a proprietary nature. From this viewpoint, companies would concentrate on their core-business by addressing sustainable competence with increased IS infrastructure effectiveness. In addition, this adoption pattern also allows companies to develop and maintain fairly customized software applications in order to serve particular business contents, as well as keep advantageous added-value through the differentiation. Web Services innovation is therefore understood as technological process innovation (type 1b), which is seen as an IS infrastructural optimizer that glue previously disparate business processes; and constant IS availability is therefore assured.

⁷ We herein refer to 'standard' EAI, which is based on a common set of software protocols include WSDL, SOAP, UDDI through XML messaging.

(2) Infrastructural Core

Where IS is centralized and as a slack resource with economies of scale, pattern 2 infrastructural core is likely to happen that companies retain marketing advantages with extended connectivity among business partners. Web Services adoption is represented by outsourcing infrastructuralized e-business processes that facilitated by service providers. Web Services is obtained through commoditized sharing network of application service provisioning (ASP or xSP of all kinds) community. Within such virtual organization (VO), enterprise is able to gain best of breed e-business functionalities, and conduct e-commerce activities within unified e-business environment. Although the ASP/xSP business model has received considerable debates, however, with the rise in the availability of scalable network technologies and resources, ASP/xSP has become increasingly more feasible sources for obtaining IS services (Foster et al 2001; Jayatilaka et al 2002; Xu and Seltsikas 2002; Xu 2002). This is illustrated in

Thus, prevalent adopters of pattern 2, particularly SMEs, are technologically with the 'lagging-edge' philosophy during the diffusion of innovations (Huff and Munro 1985); by taking up the role-shifting to ASP/xSP, pattern 2 adopters are given the flexibilities to meet their business issues with solution, as Clark (1992) pointed out that the most consistent adoption strategy ought to be through a planned approach to systematically integrate fortuitous business issues with the occurrence of technologies. The service provisioning is thus likely to increase the probability of such opportunistic match.

(3) Intermediate Middle Layer

Where the enterprise IS is integrated by Web Services for providing consistent IS availability that keeps proprietary but would selectively connect to external business environment, the third pattern intermediate core is most likely to happen. As Tornatzky and Fleischer (1990, p. 161) argued, because organizational slack is fungible, it therefore implies IS centralization or decentralization. The installed application system portfolio of the IS unit provides another foundation for its innovation (Swanson 1994). As a result, beyond above two recommendations, a minor domain describes a blended adoption strategy, where the enterprise mission critical information systems are connected to business partners through Web Services interface, in order to expedite e-business automation in a broader dimension.

We illustrate the domain of Web Services innovation adoption in organizations with a dual-core representation in Figure 2. in order to obtain a more intuitive perception of their relationships.

In this study, the organization's IS management strategy is identified as a major determinant that affecting the adoption pattern of Web Services innovation; and this should also be taken into account for organizations in considering the adoption dimensions in terms of the scopes of e-business enablement with hypothesis that the above presumption holds.

According to these dispersed visions of enterprises strategies towards information systems development, our study of Web Services innovation spans two domains: proprietary and infrastructural respectively. How should Web Services innovation be understood in each domain? Recalling the above discussions, Web Services innovation may involve a new IS work technology confined to enterprise boundary that remains proprietary or as a private technology; it may also involve a new collaborative service across enterprises boundaries that residing on a common standardized information systems infrastructures, forming virtual e-marketplace through joining members, and expediting integrated inter-organizational e-business processes. Each of these reshapes the content, extent, and organization of the IS task. Both two domains are not exclusive to each other. A middle layer is of permeable that exists, in the case that company may view the mission-critical information systems proprietary, and the other part as infrastructural interface linking external e-business environments.

4. Implications and Future Research Directions

In this study, we look at Web Services innovation from a more theoretical viewpoint. Based on hypothetical presumptions, we propose a dual-core model that treats such innovation at a strategic level according to its peculiar characteristics. We question the validity of using two prevailing innovation theories, Tornatzky and Fleischer's contextual framework, and Swanson's innovation typology respectively. We argue that simply apply either of above theories would miss important attributes of Web Services; if use both, it would be too complex and lose the foci. We therefore compose a synthetic viewpoint, on the basis of Web Services primary characteristics in order to obtain a thorough understanding of this innovation and give recommendation to general adopters.

Qualitative research will also help obtain additional findings and discover new features. Hypotheses arising in this article need to be further examined through appropriate methodologies. The implications of the present work will also extend to other innovation domain. We attempt to generalize a research model that is useful for the study of new innovations sharing commonalities. The implication of Web Service innovation for service providers (xSPs) is not included in this study.

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Appendix 1

Existing literatures of innovations characteristics (Reviewed by Wu and El Sawy, 2003)

Zaltman et al. (1973)	75 Articles reviewed by Tornatzky et al.	Tornatzky et al. (1982)	Rogers (1983)
<ul style="list-style-type: none"> •Cost •Returns to investment •Efficiency •Risk and uncertainty •Communicability •Compatibility •Complexity •Scientific status •Perceived relative advantage •Point of origin •Terminality •Status quo ante •Commitment •Interpersonal relationships •Publicness vs. privateness •Gatekeepers •Susceptibility to successive modification •Gateway capacity •Gateway innovations 	<ul style="list-style-type: none"> •Relative advantage •Association with major enterprise •Clarity of results •Compatibility •Communicability •Complexity •Continuing cost •Cost •Divisibility •Ease of operation •Flexibility •Importance •Initial cost •Mechanical attraction •Observability •Payoff •Pervasiveness •Profitability •Radicalness •Rate of cost recovery •Regularity of reward •Reliability •Riskiness •Specificity of evaluation •Saving of discomfort •Saving of time •Scientific status •Social approval •Triability •Visibility 	<ul style="list-style-type: none"> •Compatibility •Relative advantage •Complexity •Cost •Communicability •Divisibility •Profitability •Social approval •Triability •Observability 	<ul style="list-style-type: none"> •Relative advantage •Compatibility •Complexity •Triability •Observability

Appendix 2

IS Innovation Taxonomy (Summarized by Grover, Fiedler and Teng 1997; Originally adapted from Swanson 1994)

Subtype	Innovation Core	Description	Illustration from Swanson (1994)	Illustration used for Current Study
Type 1a	IS Administrative Process Innovation	Innovation that focuses on the management and administrative support for IS work	CIO Maintenance Systems Programming CASE DBMS Chief Programmer Team Data Administration Prototyping	IS Outsourcing
Type 1b	IS Technological Process Innovation	Innovation that focuses on the technical task, i.e., changes the nature of IS work		CASE OOPS Large Scale Relational DBMS
Type 2	IS Product and Business Administrative Process Innovation	Innovation involving IS products and services that affect the administrative core of the host organization	Accounting Systems Payroll Systems Executive Information Systems Information Centres	Executive Information Systems Teleconferencing Expert Systems E-Mail
Type 3a	IS Product and Business Technological Process Innovation	Innovation involving IS products and services that affect the core work processes of the host organization	MRP Systems CIM Systems Airline Reservation Systems	CAD/CAM
Type 3b	IS Product and Business Product Innovation	Innovation involving IS products and services that are inherent to or imbedded in the host organization's products or services	Interorganizational Systems with customer Airline Reservation Systems	None
Type 3c	IS Product and Business Integration Innovation	Innovation involving IS products and services that affect the integration or coordination of the host organization with its suppliers, distributors, or customers	Interorganizational Systems EDI	EDI

Resistance to Knowledge Management: Exploring the Motivational Dimensions of Codifying Knowledge within Professional Organizations.

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Abstract

This paper explores the relationship between employee's reluctance to contribute to knowledge management (KM) systems with their perception that KM reduces their power within, and their value to, the organization. The paper will analyse a number of KM case studies focusing on professional knowledge workers. Specifically, we examine a number of case examples of KM efforts dealing with academics, research and development scientists, and lawyers. The paper concludes with identification of a number of contingent factors that enhance or reduce the motivation of knowledge workers to contribute to KM systems. Further research and management implications are also addressed. The section below presents an extended abstract of the full paper.

1. Introduction

In recent years, knowledge has increasingly become seen as a central source of economic value within organisations and societies. Academics, social commentators, executives, and even political leaders have identified the utilisation of knowledge as the source of competitive advantage in the future. For example, the South Korean president, Kim Dae-Jung, opening an APEC conference on knowledge-based-economies, said, "As we move into the new century, it is increasingly the intangible factors that matter most as new sources of growth potential, such as knowledge, information, and cultural character." Business leaders also highlight the importance of knowledge. "Knowledge capital is our most valuable asset and it drives our organization. It's what we sell (George Shaheen, Managing Partner/CEO, Andersen Consulting, [64, p. 1]." These views are also echoed by academics [14, 18].

Given the potential value attributed to knowledge in the future, it is understandable that substantial efforts have been made to manage knowledge resources. One approach seeks to utilize innovations in information and communication technology (ICT) to capture and store knowledge in databases of the organization. This has been referred to as a codification strategy [6], where employees search and access accumulated knowledge to extract useful information as required. An example of this approach is the knowledge management system of the global consultancy firm Anderson Consulting, called

'Knowledge Xchange' [5], which comprises a variety of databases about client and project information. Codification strategies have been criticized in that such systems view knowledge as a commodity, which overlooks the deep level understanding that accompanies expertise [15]. Another KM approach, the personalization strategy, [6], seeks to gain value from this deep level knowledge, which is often referred to as "tacit knowledge". The personalization strategy of KM seeks to facilitate exchange and contact between those who have knowledge and those who need it rather than capture knowledge directly in databases. Such approaches typically comprise communities of practice [11], based around specialist topics. Users can post questions to the community, via electronic bulletin boards, to access the collective knowledge of the community of users. Answers can be circulated and discussed and the discussion can be taken off-line using more conventional communication mediums as required. This approach is used by Buckman Labs, a US based chemical supply company, which utilizes 54 online discussion groups revolving around the main products of the company. In this strategy, knowledge is spread throughout the organization rather than being isolated with selected individuals.

Whatever the specifics of the KM strategy, three aspects remain constant to all systems. First, the intention is to enhance the utilization of employee knowledge. Second, the system employs innovations in ICT in the process of managing information and knowledge. Third, the systems' ultimate effectiveness will depend on the motivations of employees to contribute information and knowledge to the KM system.

Given the substantial ICT costs that organizations may incur in operationalising knowledge strategy a substantial amount of research attention on knowledge management has focused on technological issues [12, 13, 15]. However, recently, more research attention has focused on the motivation of users [2], in KM systems. Such research, generally seeks to identify the reasons for poor employee utilization of KM systems.

2. Motivational Challenges

A variety of challenges have been identified that influence the motivation of employees to be involved in KM systems.

For example, many employees find it difficult to find time to contribute to database systems. Another issue limiting employee motivation to use KM is the lack of training and comfort with the technologies of the system. In addition to these process issues, employees are concerned that they may lose power associated with their knowledge, if they contribute to KM. As suggested by [5], "There is an incentive to evaluate the level of knowledge sharing that is "wise" given the competitive nature of the labour market. This incentive is reinforced by the rise of the advocacy of the virtues of "employability", that is, the notion that employees should think of their career in terms of the accumulation of a portfolio of skills and experiences that make them "marketable property". (p. 296). In other words, employees may feel reluctance to contribute to KM because they perceive that such contribution may decrease their value to the organization, or to the labor marketplace, or both.

In the remainder of the, paper, the validity of these concerns will be examined. It will be argued that the impact of digital technology for the employment relationship is associated with both deskilling and upgrading of workers value. Hughes and Lowe [7] refer to this as their polarization thesis. Braverman [3], discussing pre-Internet technology, outlined the case for deskilling influences of division and labour and scientific management principles. Braverman argued that the tacit and explicit knowledge of workers had been transferred to systems owned by capitalist through the use of technology in the design of work systems. For example, automotive workers who once used craft skills in the construction of cars were radically deskilled to the point that they operated as cogs in a machine. Of course the use of technology can also upgrade the value of employees by requiring enhanced skills and knowledge. Upgrading skills is associated with "knowledge workers" and to the value of knowledge in the value creation process [10, 16]. However, the increasing popularity of KM systems which are designed to capture, store, sort and disseminate corporate information residing with these high value employees, can be seen as a way of reducing the reliance by organisations on these employees. These KM systems can be construed to resemble the efforts to capture "tacit" knowledge of workers as outlined by Braverman [3].

Efforts to capture "tacit knowledge" of knowledge workers through technological systems remains elusive because of the intangible nature of this knowledge. Nevertheless, the increasing sophistication of knowledge management is resulting in many elements of knowledge work being devalued. The full paper will discuss and critically examine these impacts. For example, many of the activities of business consultants, such as accountants and lawyers, are repeated from project to project. The use of databases of past projects can help to reduce the costs associated with working on similar projects. Unfortunately, many of these organisation's clients are aware of this trend and are expecting discounted prices on services. Reduced value to customers also reduces the value of people's skills

and knowledge to the organisation.

In summary, it is argued that there is both a trend for upgrading and decrease in employee value resulting from KM systems. It is suggested that this trend is likely to grow as the codification of knowledge accelerates and sophistication of technological systems advances.

This paper explores the reluctance of professional knowledge workers to contribute to KM systems from the perspective that employees may resist giving away power inherent in their ownership of knowledge. The extant literature is reviewed and a number of case studies are presented to reflect on the issue of employee reluctance to contribute to KM efforts of organizations. Specific professional groups examined include, academics, research and development scientists, and lawyers. The paper concludes with identification of a number of contingent factors that enhance or reduce the motivation of knowledge workers to contribute to KM systems. Further research and management implications are also addressed.

3. Method

The discussion of case examples presented at the conference presentation are extracted data from a larger study examining the impact of ICT on HRM practices. The study uses semi-structured interviews with HR managers of forty mid to large Australian organizations. These interviews took on average 60 minutes to complete. Questions were directed to ascertaining the details about organizational culture, strategy changes, the make-up of HRM support services, and current and future uses of ICT within HR activities. HR activities was interpreted widely and examined not only the traditional aspects of recruitment and selection, training and development, performance management systems but also the utilization of ICT into knowledge management systems. Thus the perspectives given here reflect the HR managers perspective within these organizations. Interviews were supplemented with additional phone interviews and with collection and analysis of publicly available documents, such as web sites, annual reports and media releases and media reports.

Discussion given here relates to the interview aspects that centred on knowledge management within the organizations. Given the ethic clearance requirements for the study, organizations and respondents cannot be identified. However broad characteristics of the firms discussed are given.

4. Case Example

Organization A is a medium player in the pharmaceutical industry that has expanded operations across Australia, New Zealand, the United States, and Europe. At present the employee number is around 4,000 and is growing rapidly as the organization is engaged in a high growth

strategy via acquisitions. Indeed the central HR issue confronting the organization is the integration of new people, and cultures into the parent organization. The organization has a strong research base and is dominated by highly skilled scientists mainly from a chemistry background. The organization has recently begun knowledge management initiatives.

The KM strategy is jointly advocated by the IT and HRM departments. Interviews suggest that both groups see KM as mutually beneficial and both are cooperating on its implementation. There is a clear recognition of the differences between codification and personalization strategies among the two respondents of the organization and the both indicated that organizational leaders are aware of the concept. Indeed there has been a recent appointment of a Chief Information Officer, although it appears that this person is seen as the traditional head of the IT department. The IT department, while playing an important role in the organization, does not have a high profile in terms of senior management.

The KM initiative is focused on intranet development at the earliest stages with a clear aim to “get runs on the board” in terms of impact and getting the attention of managers. There is also a desire to create a learning organization concept, especially in terms of learning to better integrate new businesses into the parent company. The rapid growth of the company has tended to hinder integration efforts and the KM system is seen as one way to increase the integration process. The approach is to develop the KM strategy in the Australian operations then roll it out to the rest of the organization overseas. Research and development and customer relationship management are the two areas most targeted by the KM initiative. These two areas however, are not well integrated in terms of non-ICT initiatives, so it is suggested that a cultural shift in the organization is needed. However, cultural change seems low on the agenda of top management as they focus on the business realities of successfully negotiating the next acquisition.

The HR manager noted a number of obstacles to the KM initiatives. First, the question of top management support has not been clearly gained. Top management has been relatively stable despite the rapid growth and acquisitions, but does not see ICT as a significant strategic issue. Indeed, top management has a very personal focus on relationships. Specifically, those relationships require face-to-face interaction and cannot be developed via ICT. This has resulted in the preferred use of face-to-face meetings among managers, even if this means long and expensive air flights. Given the rapid growth of the company there seems to be little attention to cost efficiency that could be gained by the use of ICT to mediate communication. This attitude by top management has hindered the utilization of technology generally.

The existing KM initiative is focused on the utilization of technology to capture and sort information. This is due to the top management culture of personalization requiring

people related communication, as well the involvement of the IT group. HR group although knowing of the personalization strategy for KM tend to take the view that it is all about small steps and progress in developing KM and that the codification strategy may be the most appropriate beginning point.

The organisations’ approach seem to duplicate the description of Storey and Barnett [15] who outlined a failed knowledge initiative in a large international resources firm. They concluded that a number of issues where related to its failure. Top management support was initially forthcoming, but across the length of the knowledge project, and in face of dynamically competitive marketplace this commitment tended to decline. The authors conclude that the project was considered more as a “nice to have” than a strategically critical initiative. Failure at the senior level to monitor and protect the integrity of the project led to the escalation of micro-political maneuvers that eventually led to disintegration in the initial support for the project. For example, the project seemed to be high jacked by the IT department who commandeered expertise on the technological issues. It was viewed as trying to achieve a dominant position in strategy, methodology and budget through the project. So too in the organization under review, the lack of top management support has led to a maladaptive behavior of some users of the system. In particular, there is some reluctance to extend knowledge of the use of the system to others. Thus power users tend to gate keep access and information derived from the KM systems. This is aided by a general reluctance of individual users to acquire skills and knowledge about the system. This reflects less a direct effort of control than relying on the general inertia of adoption of a new system that seems to require more effort to use than perceived benefits. Thus an important role in the spread of KM would be to ensure that the system’s benefits are highlighted and go beyond “nice to have”.

The remainder of the paper will examine three more case studies from the rich data sourced from the HRM and ICT study.

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Performance Measurement of Outsourcing Logistics: A Model Development and Implications

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ABSTRACT

Outsourcing logistics or third party logistics (3PL) has become an important source of competitive advantages, increasing the efficiency and effectiveness of a company's logistics function. This paper aims to review research and current 3PL in Hong Kong and to provide ideas for future research. Comprehensive review in the literature has found that the linkage between 3PL service providers and its supply chain partners and 3PL quality performance are required to study further to fill research gap in current literature.

Keywords: Supply Chain, Third Party Logistics, Outsourcing, Performance Measurement

1. Introduction

Logistics and Supply Chain Management (SCM) are the critical factors for firm's success in today's business world as the result of the globalization of the economy and development of information technology [30]. From the Council of Logistics Management, Logistics is part of supply chain process in which it plans, implements, and controls the efficient, effective flow and storage of goods, services and related information from the point of origin to point of consumption in order to meet customers' requirements.

The use of third party logistics (3PL) services providers has gained the benefits above in SCM context. 3PL is defined as the outsourcing of logistics activities to another company [18]. Firms taking this approach employ an outside company to perform some or all of the firm's logistics activities. 3PL firms can provide improved inventory and lead time performance while concurrently capturing economies of scale resulting from higher volumes obtained by aggregating demand across a large number of customer.

Outsourcing of logistics activities to 3PL service providers is widely prevalent in Europe, North America and Australia since 1990s. Also, some studies have focus on logistics issues in Asia Pacific region like Hong Kong, South China, Japan and South Korea [22]. However, it seems to lack of comprehensive studies reported in the literature that have focused on the linkage between 3PL service providers and its supply chain partners in Hong Kong. Thus, this paper provides a review of research and current development of 3PL in Hong Kong and provides ideas and a basis for the future research.

2. Research on Third Party Logistics (3PL)

2.1. Review of Literature in 3PL

There is generally a dearth of literature that deals directly with the strategies and operational characteristics of 3PL. Most of the logistics literature focuses on the management of the logistical function from within supply chain [6,14,24]. Studies that directly address the 3PL tend to adopt narrow scopes and focus on specific areas. Review of the previous literature, three major aspects of research directions has been identified by 3PL. There are:

- Extent of the use of 3PL logistics services
- Decision making process for choosing 3PL service provider
- Impact of the usage of 3PL

In the *Extent of the use of 3PL logistics services*, Lieb et al. [20] compared the experience of the US and European manufacturers in using 3PL services, it identifies that the longer the relationship between 3PL and its supply chain partners, more extensive would be the use of 3PL, higher level of commitment to the relationship on either side and firms would willing to use 3PL services.

Dapiran et al. [9] have presented on overview of the 3PL usage by large Australia firms. The findings indicates that the Australian firms are comparable to US firms in their usage of 3PL services, with more than one-fifth of the firm characterizing their commitment to 3PL as extensive and one quarter of the firms allocating more than fifty percentage of their total logistics cost for 3PL. Moreover, McMullan [21] found that transportation, maintenance and warehousing were among the most outsourced functions among the clients of the consulting group in Asia Pacific. Bardi and Tracey [1] in a survey of the transportation practices of US manufacturers, found that freight bill auditing and payment, and transportation reports were among the most frequently

outsourced transportation functions. Thus, it appears that usage of 3PL service and commitment of resources increases over time as the two parties become more comfortable in their interaction with one another.

Another research on 3PL would focus on *decision-making process for choosing 3PL services*. Firms outsource logistics functions for variety of reasons. Sheffi [25] suggested several reasons for the growth of 3PL in USA. There are need to focus on core business; better transportation solutions; cost savings and improved services; development of necessary technological expertise and computerized systems the following which is beyond the scope of many companies and need for more professional and better equipped logistics services.

Richardson [24] found that 3PL brought about several benefits for the companies surveyed. The benefits included distribution saving, greater control of business, better customer service and satisfaction and the addition of expertise to supplement the capabilities of the internal organization. Other benefits included reduction in capital investment in facilities, equipment and information technology, improved customer service and delivery and reduction in the complexity of logistics operations [7,8,17, 23,24]

As the previous discussions, 3PL is a complex decision, arising out of a variety of reasons. 3PL service providers need to understand the objectives that buyers are seeking to accomplish by 3PL services.

For the *impact of usage of 3PL services on the organization*, 3PL is a strategic partnership between 3PL and its supply chain partners. Before making the decision to outsource, the impact on the organization should be considered. Bowersox [5] indicates that a

necessary imperative for the relationship to succeed is a match between the cultures of the two organizations.

Dapiran et al. [9] found that the impact of 3PL on the internal logistics performance and the logistics costs had been positive among Australia companies. However, introduction of 3PL services into a company represented an important shift in the way business was conducted, related training of the internal staff was found to be necessary.

Also, Dapiran et al. [9] found that the company must plan for the implementation of the partnership by educating the 3PL about the firm's requirements, developing programs to place redundant employees, correcting attitude of internal staff and integrating the information systems of both 3PL service providers and its supply chain partners.

In summary, there is three major aspects of research directions have been identified by 3PL: extent of the use of 3PL logistics services; decision-making process for choosing 3PL service provider and impact of the usage of 3PL. However, it is lack of a sound and comprehensive foundation for the research framework for analyzing the 3PL industry. Also, the quality performance, trends of 3PL service in future and industrial practices in 3PL is required in future research.

2.2. Research on Outsourcing Logistics in Asia and Hong Kong

As growing importance of outsourcing logistics, the extent of its usage has been widely examined in the US and Europe. Sheffi [25] describes how the 3PL industry in the US has developed and mentions several economic, regulatory and technological trends driving the development. Kakabadse studies the trends of 3PL in US

and Europe. It identifies both US and European companies provide the most preferred relationship between 3PL service providers and its supply chain partners who has an industry focused, proven track record.

In Asia, some studies have outlined the linkage between manufacturing firms and 3PL service providers in Hong Kong, South China, Japan and South Korea [22]. In the south East region, it was reported that Singapore based firms are generally satisfied with the services of 3PL service provider [29]. Also, it has a survey of 3PL services in Malaysia [27].

In Hong Kong, academic studies on logistics management in Hong Kong are confined to several commercial reports, consultation papers on specific topics. Wong et al. [33] has investigated the relationships for quality improvement in the Hong Kong supply chain by using theory of co-operation and competition. Voon and Ho [31] studies the economic impacts of logistics infrastructure development in Hong Kong. It concludes that substantial social benefits could be derived from investment in logistics development in Hong Kong. Both public and private sectors will be interested to assess the returns to their investments and to know the impact of their investments on the economy.

However, it is rather limited research focus on either logistics in supply chain context and 3PL in Hong Kong. A comprehensive study reported in the literature that has focused on the linkage between 3PL service providers and its supply chain partners and 3PL quality performance are required to fill the research gap.

3. Performance Measurement of Outsourcing Logistics

Performance measurement is defined as the process of quantifying effectiveness and efficiency of action [28]. In modern business management, performance measurement contributes on business management and performance improvement in the industries. Sink and Tuttle [26] claims that you cannot manage what you cannot measure. Harrington [13] states that “If you cannot measure it, you cannot control it. If you cannot control it, you cannot manage it. If you cannot manage it, you cannot improve it.” Thus, the importance of performance measurement is obvious for management of logistics and SCM.

In management perspective, performance measurement provides necessary information of management feedback for decision making. It plays the critical roles of monitoring performance, enhancing motivation and communication, and diagnosing problems. Moreover, performance measurement provides an approach to identifying success and potentials of management strategies, and facilitating understanding of progress and position. It cannot only assist in directing management attention, revising company goals, but also re-engineering business processes [14,16,32]. Therefore, making proper performance measurement of supply chain is necessary as it cultivates understanding between member forms in the supply chain for performance improvement and implementation [10,11,19]. An appropriate performance measurement is conducive to successful SCM implementation.

According to Beamon [2], there is inadequate literature available in performance measures selection for supply chain management. Beamon [3] categorizes the existing performance measures involving customer satisfaction and customer responsiveness, flexibility and supplier performance. Beamon [2] identifies three types of measures: resources, output and flexibility. Gunasekaran

and Tirtiroglu [12] develops a framework for measuring the strategic, tactical and operational level performance in supply chain, which mainly deals with supplier, delivery, customer service, and inventory and logistics costs.

In fact, logistics and supply chain management concepts have received significant attention in both academic and practitioners for years. Despite this attention, inter-organizational supply chain performance measurement appears to be limited instead of buyer-seller relationship. Keebler et al. [15] surveyed about 3100 logistics executives regarding their logistics and supply chain activities, and concluded that “few if any firms are measuring full supply chain network performance is significant” It implies that the existence of comprehensive supply chain performance measurement system is fewer and insignificant.

Three observations can be made from the literature regarding to supply chain performance measurement. Much attention has historically been placed on individual measures rather than on systems of measure [2]. In addition, many studies in the literature are prescriptive in nature and emphasize the attributes that good metrics and measurement system should have [4]. Furthermore, little empirical research has been conducted to holistic supply chain management system such as outsourcing logistics.

Keebler et al. [15] indicates that relatively few firms are measuring logistics supply chain performance especially outsourcing logistics. In relation to supply chain performance measurement, it has been based on a relatively limited systems perspective. Besides, very little empirical research exists in relation to supply chain performance measurement from a broader system perspective such as organizational performance

measurement.

Although academicians attempt to build new measures and metrics for supply chain management, most of current performance measurement of supply chain has some defects to meet with supply chain management requirements [15]. Current supply chain performance measurement is inadequate because it relies heavily on the use of cost as primary (if not sole) measure, it is often inconsistent with the strategic goals of the organization, and does not consider the effects of uncertainty [2].

Thus, the objective of research which determines the organizational performance measurement of outsourcing logistics in Hong Kong transport logistics industry by using organization theory approach can provide significant information for organizational performance measurement of outsourcing logistics in Hong Kong. It leads to be a better performance of outsourcing logistics service providers in Hong Kong to gain competitive advantages over others and promote Hong Kong as a transport, trading and logistics hub in this and next several decades.

4. Model and Implications

In a serviced partner perspective, outsourcing logistics is expected as a value-added process for those organizations that third party logistics (3PL) is intentionally used to enhance organizational co-operative advantages, in addition to low cost, produce / service differentiation, and focus strategies. However, this expectation may be undermined by lacking measurement of outsourcing logistics service performance to manage service vendors. In a provider perspective, on the other hand, the outstanding performance is expected outcomes of outsourcing

logistics services that should be tangibly and intangibly defined to reflect its operations.

However, there is a dearth of studies in logistics and supply chain management literature to reflect the demand of performance measurement of outsourcing logistics services. Based on literature review, we provide a research framework in organizational theory perspective, to elaborate the causal effect relationships among outsourcing logistics' capacity and services; relationship management with serviced partners, and the outsourcing logistics performance; intending to fill the gap of current literature, and to provide insightful understanding of outsourcing logistics performance measurement and management.

The 3PL capacity and services are examined with respect constructs of tangible logistics services, reliability and responsiveness of services to serviced partners; cost and value-added to service process; the core competency of 3PL service providers; and empathy and adaptiveness to environmental changes.

The relationship management is studied in terms of the commitment of 3PL to serviced partners, the extent of trust and trust development in the process of business collaboration and / or partnership; and 'Guanxi', a social culture or context related issue, in daily business and service interactions.

The outsourcing logistics service performance is investigated in two construct categories: (1) tangible outputs include financial performance, productivity and cycle time of services with industrial benchmark; (2) intangible outcomes involved reputation and goodwill of the 3PL, and the partner's appreciation of 3PL services will be included in the framework.

Hence, a study of organizational performance measurement of outsourcing logistics in Hong Kong transport logistics industry can identify the collaborative relationship among outsourcing logistics service providers and supply chain partners that affect channel relationship in the supply chain and therefore enhance the effectiveness of services delivered. It is imperative that firms have to excel in quality assurance, on which the efficient and effective flows of goods, information and financial within supply chains, it would not only improve outsourcing logistics service quality but also achieve business success.

5. Conclusion and Future Research

Outsourcing logistics has become an important source of competitive advantages, the outsourcing of logistics activities to specialized 3PL service providers can increase the efficiency and effectiveness of a company's logistics function. In order to maintain a competitive advantage, 3PL must enhance its ability to plan, take action and manage and control products, services and information from supplier through customer as an integrated process rather than as a series of discrete functions.

To achieve this, a comprehensive study reported in this paper that has focused on the linkage between 3PL service providers and its supply chain partners. And, future research will be found on change their performance measurement systems of 3PL in order to provide improve its service quality within supply chain.

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Stochastic Multilevel Programming with a Hybrid Intelligent Algorithm

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Abstract: A framework of stochastic multilevel programming is proposed for modelling decentralized decision-making problem in stochastic environment. According to different decision criteria, the stochastic decentralized decision-making problem is formulated as expected value multilevel programming, and chance-constrained multilevel programming. In order to solve the proposed stochastic multilevel programming models for the Stackelberg-Nash equilibriums, genetic algorithms, neural networks and stochastic simulation are integrated to produce a hybrid intelligent algorithm. Finally, two numerical examples are provided to illustrate the effectiveness of the hybrid intelligent algorithm.

Keywords: Multilevel programming; stochastic programming; neural network; genetic algorithm

1 Introduction

In many decision processes, there are multiple decision makers arranged within a hierarchical administrative structure. These decision makers have divergent even conflict objectives, which intervenes in the decisions to be made. This is the so called decentralized decision-making problems, which has long been recognized as an important and challenging topic in many research areas including economics [1][8][16][23], transportation [9][56][59], engineering [19][52], and so on.

Multilevel programming was first proposed by Bracken and McGill [14][15] for dealing with decentralized decision-making problems. After that, a special case called bilevel programming, which is equivalent to a two person Stackelberg game, has attracted much attention. In [10], Ben-Ayed and Blair proved that the bilevel programming problem is NP-hard. However, many numerical algorithms have been designed for solving this problem. For example, implicit enumeration scheme [17], the k th best algorithm [12][13], complementary pivot algorithm [13][28], grid search algorithm [4][5], branch-and-bound algorithm [7][25], descent algorithm [53]. General cases with multiple followers [6][32] or multilevel levels [2][4][5][57] were also discussed.

Real-world situations are often not deterministic. For instance, in economic systems, costs and demands are often subject to fluctuations and difficult to measure.

In engineering, external conditions and measurement or manufacturing errors introduce uncertainty into the problems. These situations emphasize the need for models which are able to tackle uncertainty inherent in decision systems. However, there is little research in literature about decentralized decision making problem in uncertain decision systems. In [50], Patriksson and Wynter discussed stochastic mathematical programs with equilibrium, which includes stochastic bilevel programming as a special case. In [51], Sakawa, *et al.* dealt with multilevel programming problems with fuzzy parameters by a fuzzy interactive approach [30][31][54]. The fuzzy interactive approach is formulated by combined use of the fuzzy tolerance membership functions and multi-objective decision-making, which makes the original problem much more simplified, and much easier to solve. However, it differs the traditional solution concept, Stackelberg-Nash equilibrium, because it is assumed that decision makers at all levels are essentially cooperative.

For the purpose of tackling uncertainty in decision systems, various stochastic programming models have been formulated in literature, among them we want to mention expected value model, and chance-constrained programming model [18]. Motivated by the above mentioned works, in this paper, we propose two classes of stochastic multilevel programming models including expected value multi-level programming model (EVMLP) and chance-constrained multilevel programming (CCMLP), and design an intelligent algorithm for Stackelberg-Nash equilibrium of the proposed stochastic models. Besides a new model CCMLP, the proposed EVMLP may have multiple followers, which distinguishes from stochastic mathematical programs with equilibrium [50]. Furthermore, we employ the Stackelberg-Nash equilibrium solution concept, which distinguishes our work from that of [51].

The purposes of this paper are twofolds, one is to establish an EVMLP and a CCMLP for a stochastic decentralized decision making problem with multiple followers. The other is to design efficient numerical algorithms for the Stackelberg solution. Toward that end, the following sections are organized as follows. Section 2 discusses the formulation of EVMLP and CCMLP, then the concepts of Nash equilibrium and Stackelberg-Nash

equilibrium are defined in this section. In Section 3.1, we first discuss how to approximate the uncertain functions involved in the proposed models. The motivation of the method is as follows, when searching for Nash equilibrium and Stackelberg-Nash equilibrium, we need many times of stochastic simulation to evaluate the uncertain functions. It is known that stochastic simulations are time-consuming processes. In order to speed up the solution process, we desire to use relatively simple functions, neural networks (NNs), to replace these uncertain functions after they are well-trained by input-output data produced by stochastic simulations. After that, Section 3.2 discusses approaches on computing Nash equilibrium with respect to a given control vector. Based on the above discussion, Section 3.3 discusses how to solve the EVMLP and CCMLP for the Stackelberg-Nash equilibrium. To do this, we embed the above trained NNs, and algorithms for the Nash equilibrium into a GA to produce a hybrid intelligent algorithm (HIA). At the end of the paper, two numerical examples are provided to show the effectiveness of the proposed algorithm.

2 Stochastic Multilevel Programming

In order to formulating a stochastic version of multilevel programming, we start from a deterministic one.

Consider a decentralized two-level decision system in which there are one leader and m followers. Assume that the leader and followers may have their own decision variables and objective functions, and the leader can only influence the reactions of followers through his own decision variables, while the followers have full authority to decide how to optimize their own objective functions in view of the decisions of the leader and other followers. Let \mathbf{x} and \mathbf{y}_i be the control vectors of the leader and the i th followers, $i = 1, 2, \dots, m$, respectively. We also assume that the objective functions of the leader and i th followers are $F(\mathbf{x}, \mathbf{y}_1, \dots, \mathbf{y}_m, \mathbf{b})$ and $f_i(\mathbf{x}, \mathbf{y}_1, \dots, \mathbf{y}_m, \mathbf{b})$, $i = 1, 2, \dots, m$, respectively, where \mathbf{b} is a vector represents the problem parameters.

In addition, let S be the feasible set of control vector \mathbf{x} of the leader, defined by

$$G(\mathbf{x}, \mathbf{b}) \leq 0 \quad (1)$$

where G is a vector-valued function of decision vector \mathbf{x} and 0 is a vector with zero components. Then for each decision \mathbf{x} chosen by the leader, the feasible set of control vector \mathbf{y}_i of the i th follower should be dependent on not only \mathbf{x} but also $\mathbf{y}_1, \dots, \mathbf{y}_{i-1}, \mathbf{y}_{i+1}, \dots, \mathbf{y}_m$, and generally represented by the expected constraint

$$g_i(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \mathbf{b}) \leq 0 \quad (2)$$

where g_i are vector valued functions, $i = 1, 2, \dots, m$.

Multilevel programming offers a means of studying decentralized decision systems. Assume that the leader

first chooses his control vector $\mathbf{x} \in S$, and the followers determine their control array $(\mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m)$ after that. Then a general bilevel programming has the following form,

$$\begin{cases} \max_{\mathbf{x}} F(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \mathbf{b}) \\ \text{subject to:} \\ G(\mathbf{x}, \mathbf{b}) \leq 0 \\ \text{where each } \mathbf{y}_i (i = 1, 2, \dots, m) \text{ solves} \\ \begin{cases} \max_{\mathbf{y}_i} f_i(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \mathbf{b}) \\ \text{subject to:} \\ g(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \mathbf{b}) \leq 0. \end{cases} \end{cases} \quad (3)$$

Now, assuming that the problem parameters are random, and represented by a random vector ξ . Then the objective function $F(\mathbf{x}, \mathbf{y}, \xi)$ and $f_i(\mathbf{x}, \mathbf{y}, \xi)$, $i = 1, 2, \dots, m$ become stochastic. Moreover, the stochastic constraints $G(\mathbf{x}, \xi) \leq 0$ and $g_i(\mathbf{x}, \mathbf{y}, \xi) \leq 0$ do not define the feasible set of the optimization problem of the leader and the followers mathematically. According to different decision criteria, we propose two types of stochastic programming models in the following subsections.

2.1 Expected Value Multilevel Programming

With the idea of optimizing the expected value of objective functions subject to some expected constraints, we propose the first type of stochastic multilevel programming: expected value multilevel programming (EVMLP).

Let the feasible set of control vector \mathbf{x} of the leader be defined by the expected constraint

$$E[G(\mathbf{x}, \xi)] \leq 0 \quad (4)$$

where G is a vector valued function and 0 is a zero vector. Then for each decision \mathbf{x} chosen by the leader, the feasible set of control vector \mathbf{y}_i of the i th follower should be dependent on not only \mathbf{x} but also $\mathbf{y}_1, \dots, \mathbf{y}_{i-1}, \mathbf{y}_{i+1}, \dots, \mathbf{y}_m$, and generally represented by the expected constraint

$$E[g_i(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \xi)] \leq 0 \quad (5)$$

where g_i are vector valued functions, $i = 1, 2, \dots, m$.

Assume that the leader first chooses his control vector \mathbf{x} , and the followers determine their control array $(\mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m)$ thereafter. In order to maximize the expected return of the leader, we have the following EVMLP,

$$\begin{cases} \max_{\mathbf{x}} E[F(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \xi)] \\ \text{subject to:} \\ E[G(\mathbf{x}, \xi)] \leq 0 \\ \text{where each } \mathbf{y}_i (i = 1, 2, \dots, m) \text{ solves} \\ \begin{cases} \max_{\mathbf{y}_i} E[f_i(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \xi)] \\ \text{subject to:} \\ E[g_i(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \xi)] \leq 0. \end{cases} \end{cases} \quad (6)$$

A Nash equilibrium of followers is the feasible array $(\mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*)$ with respect to \mathbf{x} if

$$\begin{aligned} & \mathbf{E} [f_i(\mathbf{x}, \mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_{i-1}^*, \mathbf{y}_i, \mathbf{y}_{i+1}^*, \dots, \mathbf{y}_m^*, \boldsymbol{\xi})] \\ & \leq \mathbf{E} [f_i(\mathbf{x}, \mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*, \boldsymbol{\xi})] \end{aligned} \quad (7)$$

for any feasible $(\mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_{i-1}^*, \mathbf{y}_i, \mathbf{y}_{i+1}^*, \dots, \mathbf{y}_m^*)$ and $i = 1, 2, \dots, m$.

A Stackelberg-Nash equilibrium to the EVMLP is the array $(\mathbf{x}^*, \mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*)$ satisfying

$$\begin{aligned} & \mathbf{E} [F(\bar{\mathbf{x}}, \bar{\mathbf{y}}_1, \bar{\mathbf{y}}_2, \dots, \bar{\mathbf{y}}_m, \boldsymbol{\xi})] \\ & \leq \mathbf{E} [F(\mathbf{x}^*, \mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*, \boldsymbol{\xi})] \end{aligned} \quad (8)$$

for any feasible $\bar{\mathbf{x}}$ and the Nash equilibrium $(\bar{\mathbf{y}}_1, \bar{\mathbf{y}}_2, \dots, \bar{\mathbf{y}}_m)$ with respect to $\bar{\mathbf{x}}$.

2.2 Chance-Constrained Multilevel Programming

Chance-constrained programming, which was initialized by Charnes and Cooper [18], offers a powerful means for modelling stochastic decision systems. The essential idea of chance-constrained programming is to optimize the optimistic return with a given confidence level subject to some chance constraints. Inspired by this idea, we propose the second type of stochastic multilevel programming: chance-constrained multilevel programming (CCMLP).

By chance constraint we mean that the stochastic constraints will hold at a confidence level provided as an appropriate safety margin by the decision-maker. Let the feasible set of control vector \mathbf{x} of the leader be defined by the chance constraint

$$\Pr \{G(\mathbf{x}, \boldsymbol{\xi}) \leq \mathbf{0}\} \geq \beta_0 \quad (9)$$

where G is a vector valued function, $\mathbf{0}$ is a zero vector, and β_0 is a confidence level at which it is desired that the stochastic constraints hold. Then for each decision \mathbf{x} chosen by the leader, the feasible set of control vector \mathbf{y}_i of the i^{th} follower should be dependent on not only \mathbf{x} but also $\mathbf{y}_1, \dots, \mathbf{y}_{i-1}, \mathbf{y}_{i+1}, \dots, \mathbf{y}_m$, and generally represented by the chance constraints

$$\Pr \{g_i(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \boldsymbol{\xi}) \leq \mathbf{0}\} \geq \beta_i \quad (10)$$

where g_i are vector valued functions, β_i is a confidence level at which it is desired that the stochastic constraints hold, and $i = 1, 2, \dots, m$.

Because of the stochastic parameters characterized by $\boldsymbol{\xi}$, the objective function is stochastic, which results that $\max_{\mathbf{x}} F(\mathbf{x}, \mathbf{y}, \boldsymbol{\xi})$ is meaningless. A natural idea is to provide a confidence level α_0 at which it is desired that $F(\mathbf{x}, \mathbf{y}, \boldsymbol{\xi}) \geq \bar{F}$, where the confidence level α_0 is provided as an appropriate safety margin by the leader. Then the objective of the leader is to maximize \bar{F} with a chance constraint as follows,

$$\Pr \{F(\mathbf{x}, \mathbf{y}, \boldsymbol{\xi}) \geq \bar{F}\} \geq \alpha_0, \quad (11)$$

where \bar{F} is referred to as the α_0 -optimistic return of $F(\mathbf{x}, \mathbf{y}, \boldsymbol{\xi})$. Then for each decision \mathbf{x} chosen by the leader, the objective of the i^{th} follower is to maximize the α_i -optimistic return of $f_i(\mathbf{x}, \mathbf{y}, \boldsymbol{\xi})$, \bar{f}_i , with a chance constraint as follows,

$$\Pr \{f_i(\mathbf{x}, \mathbf{y}, \boldsymbol{\xi}) \geq \bar{f}_i\} \geq \alpha_i, \quad (12)$$

where α_i is a confidence level provided as an appropriate safety margin by the i^{th} follower.

Assume that the leader first chooses his control vector \mathbf{x} , and the followers determine their control array $(\mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m)$ thereafter. In order to maximize the α_0 -optimistic return of the leader, we have the following CCMLP,

$$\left\{ \begin{array}{l} \max_{\mathbf{x}} \bar{F} \\ \text{subject to:} \\ \Pr \{F(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \boldsymbol{\xi}) \geq \bar{F}\} \geq \alpha_0 \\ \Pr \{G(\mathbf{x}, \boldsymbol{\xi}) \leq \mathbf{0}\} \geq \beta_0 \\ \text{where each } \mathbf{y}_i \ (i = 1, 2, \dots, m) \text{ solves} \\ \left\{ \begin{array}{l} \max_{\mathbf{y}_i} \\ \text{subject to:} \\ \Pr \{f_i(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \boldsymbol{\xi}) \geq \bar{f}_i\} \geq \alpha_i \\ \Pr \{g_i(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \boldsymbol{\xi}) \leq \mathbf{0}\} \geq \beta_i. \end{array} \right. \end{array} \right. \quad (13)$$

A Nash equilibrium of followers is the feasible array $(\mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*)$ with respect to \mathbf{x} if

$$\begin{aligned} & \max \{\bar{f}_i \mid \Pr \{f_i(\mathbf{x}, \mathbf{y}_1^*, \dots, \mathbf{y}_{i-1}^*, \mathbf{y}_i, \mathbf{y}_{i+1}^*, \dots, \mathbf{y}_m^*, \boldsymbol{\xi}) \geq \bar{f}_i\} \geq \alpha_i\} \\ & \leq \max \{\bar{f}_i \mid \Pr \{f_i(\mathbf{x}, \mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*, \boldsymbol{\xi}) \geq \bar{f}_i\} \geq \alpha_i\} \end{aligned} \quad (14)$$

for any feasible $(\mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_{i-1}^*, \mathbf{y}_i, \mathbf{y}_{i+1}^*, \dots, \mathbf{y}_m^*)$ and $i = 1, 2, \dots, m$.

A Stackelberg-Nash equilibrium to the CCMLP is the array $(\mathbf{x}^*, \mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*)$ satisfying

$$\begin{aligned} & \max \{\bar{F} \mid \Pr \{F(\bar{\mathbf{x}}, \bar{\mathbf{y}}_1, \bar{\mathbf{y}}_2, \dots, \bar{\mathbf{y}}_m, \boldsymbol{\xi}) \geq \bar{F}\} \geq \alpha_0\} \\ & \leq \max \{\bar{F} \mid \Pr \{F(\mathbf{x}^*, \mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*, \boldsymbol{\xi}) \geq \bar{F}\} \geq \alpha_0\} \end{aligned} \quad (15)$$

for any feasible $\bar{\mathbf{x}}$ and the Nash equilibrium $(\bar{\mathbf{y}}_1, \bar{\mathbf{y}}_2, \dots, \bar{\mathbf{y}}_m)$ with respect to $\bar{\mathbf{x}}$.

3 Hybrid Intelligent Algorithm for Stackelberg-Nash Equilibrium

It is known that multilevel programming, even in the simplest case, is NP-hard [10]. Thus, successful implementations of multilevel models rely largely on the development of efficient algorithms. In the past two decades, many intriguing numerical algorithms have been developed. These algorithms may fall into four categories:

- vertex enumeration approach, which aims to seek a comprising vertex by simplex algorithm based on adjusting the control variables [13][17];

- transformation approach, which transforms the lower level problems into constraints for the higher level by use of Karush-Kuhn-Tucker conditions or penalty functions [3][12][21][23].
- heuristic approaches like gradient techniques [20][22][29][55], and branch and bound method [6][7][21][23][25].
- intelligent algorithms like genetic algorithm [32][52], and simulated annealing [60], which are especially suited for solving NP-hard problems like the multilevel programming problems.

As an extension of multilevel/stochastic programming, stochastic multilevel programming will further complicate ordinary multilevel programming. Correspondingly, resolution strategies will in many cases require some approximate methods for solving stochastic multilevel programming models. In the following subsections, we take the EVMLP as an example to discuss the numerical solution methods.

3.1 Uncertain function approximation

By uncertain functions we mean the functions with uncertain parameters. The uncertain functions in stochastic multilevel programming (6) and (13) may fall into three types. Due to the complexity, we design stochastic simulations for computing the uncertain functions.

The first type of uncertain function is

$$U_1 : (\mathbf{x}, \mathbf{y}) \rightarrow \mathbf{E}[F(\mathbf{x}, \mathbf{y}, \boldsymbol{\xi})]. \quad (16)$$

In order to compute it, we design a stochastic simulation as follows,

- Step 1.** Set $U_1 = 0$
- Step 2.** Generate $\boldsymbol{\omega}$ from Ω according to the probability measure Pr .
- Step 3.** Compute the function value $F(\mathbf{x}, \mathbf{y}, \boldsymbol{\omega})$ and denote it by c .
- Step 4.** $U_1 \leftarrow U_1 + c$.
- Step 5.** Repeat the second to fourth step for M times, where M is a sufficiently large number.
- Step 6.** return $U_1 \leftarrow U_1/M$

The second type of uncertain function is

$$U_2 : (\mathbf{x}, \mathbf{y}) \rightarrow \max \{ \bar{F} \mid \text{Pr} \{ F(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \boldsymbol{\xi}) \geq \bar{F} \} \geq \alpha \}. \quad (17)$$

A procedure of stochastic simulation is given as follows.

- Step 1.** Generate $\boldsymbol{\omega}_1, \boldsymbol{\omega}_2, \dots, \boldsymbol{\omega}_M$ from Ω according to the probability measure Pr , where M is a sufficiently large number.
- Step 2.** For each $\boldsymbol{\omega}_k$, compute the function value $F(\mathbf{x}, \mathbf{y}, \boldsymbol{\omega}_k)$ and denote it by c_k .

Step 3. Set M' as the integer part of αM

Step 4. Return the M' -th least element in $\{c_1, c_2, \dots, c_M\}$.

The third type of uncertain function is

$$U_3 : (\mathbf{x}, \mathbf{y}) \rightarrow \text{Pr} \{ F(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \boldsymbol{\xi}) \geq \bar{F} \}. \quad (18)$$

We also design a stochastic simulation as follows.

- Step 1.** Set $M' = 0$
- Step 2.** Generate $\boldsymbol{\omega}$ from Ω according to the probability measure Pr .
- Step 3.** Compute the function value $F(\mathbf{x}, \mathbf{y}, \boldsymbol{\omega})$ and denote it by c .
- Step 4.** If $c < \bar{F}$, set $M' \rightarrow M' + 1$.
- Step 5.** Repeat the second to fourth step for M times, where M is a sufficiently large number.
- Step 6.** return M'/M

Although stochastic simulations are able to compute the uncertain functions, they are a time-consuming process. In order to speed up the solution process, we need relatively simple functions to approximate the uncertain functions. Multilayer feedforward NN, which was initially designed by Minsky and Papert [49], is essentially a nonlinear mapping from the input space to the output space. It has the high speed of operation after they are trained. It has been shown that the multilayer feedforward NNs with an arbitrary number of hidden neurons are universal approximators for continuous functions (Cybenko [11], Hornik et al [27]). For our purpose, multilayer feedforward NNs are used to approximate uncertain functions, and then are substituted for the work of simulation in the solution process. For detailed discussion on uncertain function approximation, the reader may consult Chapter 3 in the book [33] by Liu.

In order to train NNs to approximate uncertain functions, we should first determine a region Θ on which to approximate the uncertain function $U(\mathbf{x}, \mathbf{y})$. The region Θ may be a bit too large so that it has simple forms like multi-dimensional hypercube. Then the computer can easily sample points (\mathbf{x}, \mathbf{y}) from the hypercube, where the vector \mathbf{y} is not necessarily the Nash equilibrium of the followers with respect to \mathbf{x} . In order to get a set of input-output data, we designed a computing procedure as follows.

Step 1. Set $k = 1$.

Step 1. Generate a random point $(\mathbf{x}_k, \mathbf{y}_k)$ from the hypercube Θ .

Step 2. Compute the function value by stochastic simulation and denote it by z_k .

Step 7. Repeat Step the first to sixth step for N times.

Step 7. Return the set of input-output data $\{(\mathbf{x}^{(k)}, \mathbf{y}^{(k)}, z^{(k)}) \mid k = 1, 2, \dots, N\}$.

Now we hope to train a feedforward NN to approximate the function $U(\mathbf{x}, \mathbf{y})$. Given the number of neurons and architecture, then the network weights may be arranged into a vector \mathbf{w} . Thus the output of mapping implemented by the NN may be characterized by $U(\mathbf{x}, \mathbf{y}, \mathbf{w})$. A training process is to minimize the error function

$$Err(\mathbf{w}) = \frac{1}{2} \sum_{k=1}^N |U(\mathbf{x}^{(k)}, \mathbf{y}^{(k)}, \mathbf{w}) - z^{(k)}|^2 \quad (19)$$

so as to find a weight vector \mathbf{w} that provides the best possible approximation of $U(\mathbf{x}, \mathbf{y})$. Sometimes, we are interested in the average error defined as

$$Err(\mathbf{w}) = \frac{1}{N} \sum_{k=1}^N |U(\mathbf{x}^{(k)}, \mathbf{y}^{(k)}, \mathbf{w}) - z^{(k)}|. \quad (20)$$

Backpropagation algorithm is the original learning algorithm for multilayer feedforward NN. It is essentially a gradient descent minimization method. Here we use the backpropagation algorithm for the NN with one hidden layer. In order to speed up the learning process, we use an improved error function

$$E_k = \frac{1}{2} [\lambda(z^{(k)} - U(\mathbf{x}^{(k)}, \mathbf{y}^{(k)}, \mathbf{w}))^2 + (1 - \lambda)\Phi(z^{(k)} - U(\mathbf{x}^{(k)}, \mathbf{y}^{(k)}, \mathbf{w}))^2] \quad (21)$$

where $\Phi(x) = \ln(\cos(\beta x))/\beta$, $\lambda = \exp(-\mu/E^2)$ is an adaptive parameter, μ and β are constant numbers between 0 and 1, for example, $\mu = 1$, $\beta = 4/3$.

Step 1. Initialize \mathbf{w} , and set $\mu = 1$, $\beta = 4/3$, $\alpha = 0.05$, $\eta = 0.01$, $E_0 = 0.05$, $\lambda = 1$, and $k = 0$.

Step 2. $k \leftarrow k + 1$.

Step 3. Adjust the weights \mathbf{w} .

Step 4. Calculate the error E_k .

Step 5. If $k < N$, go to the second step.

Step 6. Set $E = \sum_{k=1}^N E_k$.

Step 7. If $E > E_0$, then set $k = 0$, $\lambda = \exp(-\mu/E^2)$ and go to the third step.

Step 8. End.

For detailed exposition to backpropagation algorithm, the reader may consult the books [58].

3.2 Computing Nash equilibrium

Define symbols

$\mathbf{y}_{-i} = (\mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_{i-1}, \mathbf{y}_{i+1}, \dots, \mathbf{y}_m)$, $i = 1, 2, \dots, m$.

For any decision \mathbf{x} revealed by the leader, if the i^{th} follower knows the strategies \mathbf{y}_{-i} of other followers, then the optimal reaction of the i^{th} follower is represented by a mapping $\mathbf{y}_i = r_i(\mathbf{y}_{-i})$, which should solve the subproblem

$$\begin{cases} \max_{\mathbf{y}_i} E[f_i(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \xi)] \\ \text{subject to:} \\ E[g_i(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \xi)] \leq 0. \end{cases} \quad (22)$$

In order to search for the Stackelberg-Nash equilibrium of an EVMLP, we should first compute the Nash equilibrium with respect to any decision revealed by the leader. It is clear that the Nash equilibrium of the m followers will be the solution $(\mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m)$ of the system of equations

$$\mathbf{y}_i = r_i(\mathbf{y}_{-i}), \quad i = 1, 2, \dots, m. \quad (23)$$

In other words, we should find a fixed point of the vector-valued function (r_1, r_2, \dots, r_m) . In order to solve the system of equations (23), we should design some efficient algorithms. The argument breaks down into three cases.

Case I. If we have explicit expressions of all functions r_i , $i = 1, 2, \dots, m$, then we might get an analytic solution to the system (23). Unfortunately, it is almost impossible to do this in practice.

Case II. In many cases, no analytic solution of (23) can be obtained. Thus the system of equations (23) might be solved by some iterative method that generates a sequence of points $\mathbf{y}^{(k)} = (\mathbf{y}_1^{(k)}, \mathbf{y}_2^{(k)}, \dots, \mathbf{y}_m^{(k)})$, $k = 0, 1, 2, \dots$ via the iteration formula

$$\mathbf{y}_i^{(k+1)} = r_i(\mathbf{y}_{-i}^{(k)}), \quad i = 1, 2, \dots, m \quad (24)$$

where $\mathbf{y}_{-i}^{(k)} = (\mathbf{y}_1^{(k)}, \dots, \mathbf{y}_{i-1}^{(k)}, \mathbf{y}_{i+1}^{(k)}, \dots, \mathbf{y}_m^{(k)})$. When we solve some given problem on a computer, we might employ the iterative method. The procedure of the iterative method is given as follows.

Step 1. For a given control vector \mathbf{x} , initialize a feasible vector $\mathbf{y} = (\mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m)$.

Step 2. Calculate $\mathbf{y}'_i = r_i(\mathbf{y}_{-i})$.

Step 3. Calculate $\sum_{i=1}^m \|\mathbf{y}'_i - \mathbf{y}_i\|$.

Step 4. $\mathbf{y} \leftarrow \mathbf{y}'$.

Step 5. Repeat the second to fourth step until $\sum_{i=1}^m \|\mathbf{y}'_i - \mathbf{y}_i\| \leq \varepsilon$ where ε is predetermined small number.

Step 6. Return the vector $\mathbf{y} = (\mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m)$ as the Nash equilibrium.

However, generally speaking, it is not easy to verify the conditions on the convergence of the iterative method for practical problems. If we indeed find a solution, then the problem is solved. Otherwise, we have to try other methods.

Case III. If the iterative method fails to find a fixed point, we may do it by solving the following minimization problem,

$$\begin{cases} \min R(\mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m) = \sum_{i=1}^m \|\mathbf{y}_i - r_i(\mathbf{y}_{-i})\| \\ \text{subject to:} \\ \mathbf{E}[g_i(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \boldsymbol{\xi})] \leq 0 \\ i = 1, 2, \dots, m. \end{cases} \quad (25)$$

If an array $(\mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*)$ satisfies that

$$R(\mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*) = 0, \quad (26)$$

then $\mathbf{y}_i^* = r_i(\mathbf{y}_{-i}^*)$ for $i = 1, 2, \dots, m$, and $(\mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*)$ must be a solution of (23). In a numerical solution process, if an array $(\mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*)$ satisfies that

$$R(\mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*) \leq \varepsilon, \quad (27)$$

where ε is a small positive number, we can also regard it as a solution of (23). That is, if the minimizing solution $(\mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*)$ of the minimization problem (25) is such that equation (26) or inequality (27) hold, then $(\mathbf{y}_1^*, \mathbf{y}_2^*, \dots, \mathbf{y}_m^*)$ is a solution of (23). Otherwise, the system of equations (23) might be considered inconsistent. In other words, there is no Nash equilibrium of followers in the given bilevel programming.

Now let us take attention to the optimization problem (25). On the one hand, the objective function $\sum_{i=1}^m \|\mathbf{y}_i - r_i(\mathbf{y}_{-i})\|$ involves m mappings $r_i(\mathbf{y}_{-i})$, $i = 1, 2, \dots, m$, which we cannot expect to have perfect properties such that the objective function have good mathematical properties. On the other hand, the feasible set defined by the system of constraints $\mathbf{E}[g_i(\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_m, \boldsymbol{\xi})] \leq 0$, $i = 1, 2, \dots, m$ may not be convex. For solve model (25), we have to employ some algorithms, which does not require specific mathematical analysis, but can provide good solutions of complex optimization problems.

GA is a stochastic search and optimization procedure motivated by natural principles and selection. GA starts from a population of candidate solutions rather than a single one, which increases the probability of finding a global optimal solution. Then GA improves the population step by step by biological evolutionary processes such as crossover and mutation, in which the search uses probabilistic transition rules, and can be guided towards regions of the search space with likely improvement, thus increasing the probability of finding a global optimal solution. In brief, the advantage of GAs is just able to obtain the global optimal solution fairly. In addition, GAs do not require the specific mathematical analysis of optimization problems, thus can be easily used to solve complex decision systems. Herein, we use genetic algorithms to search for the Nash equilibrium. For detailed exposition of GAs, interested readers may consult books [24][26][48].

For the optimization problem (23), each subproblem of the followers is a parametric optimization which may be solved by existing means of mathematical programming when the parameters are given. Since they are problem dependent, we do not discuss them here. Given a control vector \mathbf{x} , in order to solve the optimization problem (23) for the Nash equilibrium of the followers, we give the following GA procedure.

Step 0. Input a feasible control vector \mathbf{x} .

Step 1. generate *pop_size* chromosomes $\mathbf{y}^{(j)}$, $j = 1, 2, \dots, \text{pop_size}$ at random from the feasible set.

Step 2. Compute the system of equations $r_i(\mathbf{y}_{-i})$, $i = 1, 2, \dots, m$ for each chromosome $\mathbf{y}^{(j)}$, and then the objective values $\sum_{i=1}^m \|\mathbf{y}_i - r_i(\mathbf{y}_{-i})\|$, $j = 1, 2, \dots, \text{pop_size}$.

Step 3. Compute the fitness of each chromosome according to the objective values.

Step 4. Select the chromosomes by spinning the roulette wheel.

Step 5. Update the chromosomes by crossover and mutation operations.

Step 6. Repeat Steps 2–5 until the best chromosome satisfies inequality (27).

Step 7. Return the Nash equilibrium $\mathbf{y}(\mathbf{x}) = (\mathbf{y}_1(\mathbf{x}), \mathbf{y}_2(\mathbf{x}), \dots, \mathbf{y}_m(\mathbf{x}))$.

3.3 HIA for Stackelberg-Nash Equilibrium

For any feasible control vector \mathbf{x} revealed by the leader, it is reasonable for us to suppose that there always exists a Nash equilibrium with respect to it. Denote the Nash equilibrium with respect to \mathbf{x} by $(\mathbf{y}_1(\mathbf{x}), \mathbf{y}_2(\mathbf{x}), \dots, \mathbf{y}_m(\mathbf{x}))$, then the EVMLP (6) can be simplified as follows,

$$\begin{cases} \max_{\mathbf{x}} \mathbf{E}[F(\mathbf{x}, \mathbf{y}_1(\mathbf{x}), \mathbf{y}_2(\mathbf{x}), \dots, \mathbf{y}_m(\mathbf{x}), \boldsymbol{\xi})] \\ \text{subject to:} \\ \mathbf{E}[G(\mathbf{x}, \boldsymbol{\xi})] \leq 0. \end{cases} \quad (28)$$

The uncertain objective function $\mathbf{E}[F(\mathbf{x}, \mathbf{y}_1(\mathbf{x}), \mathbf{y}_2(\mathbf{x}), \dots, \mathbf{y}_m(\mathbf{x}), \boldsymbol{\xi})]$ involves not only uncertain parameters, but also a complex mapping $\mathbf{x} \rightarrow (\mathbf{y}_1(\mathbf{x}), \mathbf{y}_2(\mathbf{x}), \dots, \mathbf{y}_m(\mathbf{x}))$, which makes the optimization problem difficult to solve. Therefore, GA is a good choice for solving such model for the Stackelberg-Nash equilibrium, although it is a relatively slow way.

Now we integrate stochastic simulations, NNs, and GAs to produce an HIA for solving general EVMLPs. In the HIA, input-output data of uncertain functions are first generated by stochastic simulation. Then NNs

are trained on these sample sets to approximate uncertain functions. After that, the trained NNs, and the iterative method (or GA) for Nash equilibrium are embedded into a GA so as to search for Stakelberg-Nash equilibrium efficiently. The procedure of the HIA is given as follows.

Step 1. Generate input-output data of uncertain functions.

Step 2. Train NNs by backpropagation algorithm.

Step 3. Initialize *pop_size* chromosomes $\mathbf{x}^{(i)}$, $i = 1, 2, \dots, \text{pop_size}$ randomly.

Step 4. Compute the Nash equilibrium with respect to each chromosome $\mathbf{x}^{(i)}$ by Algorithm 3 (or 4), and then the objective values $\mathbf{E}[F(\mathbf{x}^{(i)}, \mathbf{y}_1(\mathbf{x}^{(i)}), \mathbf{y}_2(\mathbf{x}^{(i)}), \dots, \mathbf{y}_m(\mathbf{x}^{(i)}))]$ via the trained NNs, $i = 1, 2, \dots, \text{pop_size}$.

Step 5. Compute the fitness of each chromosome according to the objective values.

Step 6. Select the chromosomes by spinning the roulette wheel.

Step 7. Update the chromosomes by crossover and mutation operations.

Step 8. Repeat Steps 4–7 for a given number of cycles.

Step 9. Return the best chromosome as the optimal solution.

4 Numerical Examples

The computer code for the HIA to general EVMLPs with multiple followers has been written in C language. In order to illustrate its effectiveness, we provide two numerical examples performed on a personal computer.

Example. We consider a stochastic decentralized decision making problem in which there is one leader and three followers. Assume the control vector is $\mathbf{x} = (x_1, x_2)$, and the control vectors of the three followers are $\mathbf{y}_i = (y_{i1}, y_{i2})$, $i = 1, 2, 3$. Its EVMLP is given

as follows.

$$\left\{ \begin{array}{l} \max_{x_1, x_2} \mathbf{E} [(x_1 + y_{11} + y_{21} + y_{31} + \xi_1)^2 \\ \quad + (x_2 + y_{12} + y_{22} + y_{32} + \xi_2)^2] \\ \text{subject to:} \\ x_1 + x_2 \leq 10, x_1 \geq 0, x_2 \geq 0 \\ \text{where } y_i = (y_{i1}, y_{i2}) \ (i = 1, 2, 3) \text{ solve} \\ \left\{ \begin{array}{l} \max_{y_{11}, y_{12}} \mathbf{E} [\sqrt{x_1^2 + y_{11}^2 + 2y_{12}^2 + \eta_1^2}] \\ \text{subject to:} \\ y_{11} + 2y_{12} \leq x_2, y_{11} \geq 0, y_{12} \geq 0 \\ \max_{y_{21}, y_{22}} \mathbf{E} [\sqrt{x_1^2 + y_{21}^2 + 2y_{22}^2 + \eta_2^2}] \\ \text{subject to:} \\ 2y_{21} + 3y_{22} \leq x_2, y_{21} \geq 0, y_{22} \geq 0 \\ \max_{y_{31}, y_{32}} \mathbf{E} [\sqrt{x_1^2 + y_{31}^2 + 2y_{32}^2 + \eta_3^2}] \\ \text{subject to:} \\ 3y_{31} + 4y_{32} \leq x_2, y_{31} \geq 0, y_{32} \geq 0, \end{array} \right. \end{array} \right.$$

The stochastic parameters in the above model are given as follows:

$$\left\{ \begin{array}{l} \xi_1 \sim \mathcal{N}(3, 1) \\ \xi_2 \sim \mathcal{N}(4, 1) \end{array} \right\} \text{ and } \left\{ \begin{array}{l} \eta_1 \sim \mathcal{U}(0, 1) \\ \eta_2 \sim \mathcal{U}(1, 2) \\ \eta_3 \sim \mathcal{U}(2, 3). \end{array} \right.$$

In order to solve this problem, we generate input-output data for the uncertain functions

$$\begin{aligned} U_0 : (\mathbf{x}, \mathbf{y}_1, \mathbf{y}_2, \mathbf{y}_3) &\rightarrow \mathbf{E} [(x_1 + y_{11} + y_{21} + y_{31} + \xi_1)^2 \\ &\quad + (x_2 + y_{12} + y_{22} + y_{32} + \xi_2)^2] \\ U_1 : (\mathbf{x}, \mathbf{y}_1) &\rightarrow \mathbf{E} [\sqrt{x_1^2 + y_{11}^2 + 2y_{12}^2 + \eta_1^2}] \\ U_2 : (\mathbf{x}, \mathbf{y}_2) &\rightarrow \mathbf{E} [\sqrt{x_1^2 + y_{21}^2 + 2y_{22}^2 + \eta_2^2}] \\ U_3 : (\mathbf{x}, \mathbf{y}_3) &\rightarrow \mathbf{E} [\sqrt{x_1^2 + y_{31}^2 + 2y_{32}^2 + \eta_3^2}]. \end{aligned}$$

by stochastic simulation. Then we train four NNs to approximate the uncertain functions U_i , $i = 0, 1, 2, 3$, respectively. Table 1 gives the number of input-output data, input, hidden, and output neurons of the four NNs, and the error defined by (19). In order to further illustrate the accuracy of the trained NNs, three types of samples are used for testing. The first is to select 1000 input-output data from the train set randomly. The second is to sample 1000 new input-output data from the predetermined domain. Another 1000 input-output data is generated by sampling 1000 feasible control vector, computing out their corresponding Nash equilibrium, and then the function values by stochastic simulation. From the comparison results of the average errors of the three type of samples in Table 2, we can see that the maximum average error defined by (20) is less than 2.8%. So the NNs are good approximations of the four uncertain functions.

uncertain functions	input-output data	input neurons	hidden neurons	output neurons	sum_squred error
U_0	3000	8	10	1	2100
U_1	3000	4	7	1	7.54
U_2	3000	4	7	1	2.16
U_3	3000	4	7	1	1.96

Table 1: Parameters in the four NNs of example 1

uncertain functions	number of samples	average error_1 (%)	average error_2 (%)	average error_3 (%)
U_0	1000	0.1855	0.3735	2.4455
U_1	1000	0.9681	1.8205	1.3860
U_2	1000	0.5692	1.1595	1.7615
U_3	1000	0.3858	0.7639	2.7921

Table 2: Comparison errors of three type of samples of example 1

In the GA procedure for the Stackelberg-Nash equilibrium, there are some parameters such as the population size (*pop_size*), the probability of crossover (P_c), the probability of mutation (P_m). In Table 3, we compare solutions when different parameters are taken with the same generations as a stopping rule. It appears that all the optimal solution and the optimum differ little from each other. In order to account for it, we present a parameter, called percent error, i.e. (actual value - optimal value)/ optimal value $\times 100\%$, where the optimal value is the minimal one of all the six maximum obtained above. The last column named by "error" in Table 3 is just this parameter. It follows from Table 2 that the percent error does not exceed 0.2% when different parameters are selected, which implies that the HIA is robust to the parameter settings and effective to solve model (6).

According to the computing result in Table 3, we can see that x_1 is very close to 0, and that x_2 is very close to 10. A direct computation of the control vector $(x_1, x_2) = (0, 10)$ shows that the optimal return of the leader is 652.77, the Nash equilibrium of the followers is

$$(\mathbf{y}_1^*, \mathbf{y}_2^*, \mathbf{y}_3^*) = (9.9999, 0, 4.9999, 0, 3.3333, 0),$$

and the optimal return of the three followers are 9.9876, 5.5016, and 4.1140, respectively.

5 Concluding Remarks

In this paper, two classes of stochastic multilevel programming models were first proposed for dealing with decentralized decision making problem in stochastic environment. In order to solve general the proposed models for the Stackelberg-Nash equilibrium, an HIA was designed by integrating stochastic simulation, NNs, GA, and iterative method. One numerical example showed that the HIA is robust and effective.

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<i>pop.size</i>	P_c	P_m	gen	optimal solution	return	error(%)
30	0.3	0.1	400	(0.0009, 9.9982)	652.25	0.10
30	0.3	0.2	400	(0.0003, 9.9981)	652.65	0.18
30	0.2	0.1	400	(0.0003, 9.9999)	652.75	0.20
50	0.3	0.2	400	(0.0002, 9.9997)	652.75	0.20
50	0.3	0.1	400	(0.0010, 9.9989)	652.70	0.19
50	0.2	0.1	400	(0.0212, 9.9787)	651.42	0.00

Table 3: Comparison solutions of example 1

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Internet Click-Through and Product Information Searching Behavior

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Abstract

The study aims to explore the factors that may trigger one to click through internet advertisements when one is searching for production information on the web. We begin our exploration with Nelson's ([5]) renowned theory where it asserts that goods with "search" qualities produce more search efforts than goods with "experience" qualities would do. The study shows that this assertion may not be true in the internet due to some specific features of the net.

1. Introduction

Internet advertising in recent years has become an important alternative to traditional advertising media, such as newspapers, magazines, television and so on. As the number of visitors in the internet increases, internet advertising also becomes the major metaphor to reach certain consumers who used to acquire information from magazines and newspaper but switch to internet nowadays. Nevertheless, the lack of effective measure for the performance of internet advertising dims advertisers' confidence for the new advertising medium. To this end, academics ([3]; [7]) have tried to align this new advertising medium along with its traditional rivals. It is enticing of doing the alignment with the traditional media, because if one could position this new media on the landscape composed of those traditional advertising media properly, one could conveniently apply traditional measurements directly or with minor adjustments onto this new medium.

Instead of attacking the measurement problem straightforwardly with the alignment approach above, rather, the present study seeks to explore the determinants affecting consumer's product information search behavior on the webs. Particularly, we would like to examine a specific feature – the click-through – which is a function that is only available in the internet advertising to conduct our observation of consumer's information search behavior. While traditional advertising media are difficult to trace viewers' encountering with the advertisements, the internet's click-through function provides an excellent tracing mechanism that can record web visitors' moves among web pages. This particular mechanism is achieved by monitoring and recording the so called IP (Internet

Protocol) address inherited by each web page. With this mechanism advertisers are able to investigate the advertising banners or icons on certain web pages whether or not they are perceived by web visitors. In other words, the click-through could be more precise tool in discovering whether or not a web visitor does aware of the presence of the advertisements on web pages. For the smart mechanism we are enticed to revisited Nelson's renowned theories about product information search behavior ([5]) as follows.

Nelson([5]) uses dress and canned tuna fish as examples to demonstrate that product quality information may be distinguishable as "search" quality and "experience" quality. A typical consumer who is looking for a dress may seek to try the dress with some fitting efforts whereas one is for a canned tuna fish may just buy the canned tuna fish and experience it at home. The key is whether or not the procurement is led with a prior search effort. The search effort typically comes with searching costs. Hence, Nelson's theory suggests that customers may reduce the sampling size for different brands when searching cost increases. Applying the theory to the internet advertising case, one may expect more click-through for the search goods than for the experience goods. In other words, when consumers are shopping on the web, they may choose to click on advertising banners or icons more often for search goods, e.g., dress, than for experience goods, e.g., canned tuna fish.

2. Research design

To test our hypothesis, we design a laboratory experiment to collect the necessary data for the testing. According to the Theory, experience goods are those products that their utilities to consumers cannot be justified before uses whereas searching goods can be compared solely according to product specifications. In the experiment, we firstly ask 60 experiment participants (call them subjects hereafter) to present they attitudes toward search and experience with respect to twenty-four products that are on the list of the most popular products on the web. The list is published by a government sponsored information provider.

^a Correspondent author.

We pick six products for our next stage experiment. Of the six products, two (computer magazine, Taipei-Kaohsiung fly ticket) are in the search goods domain where they show high scores on the search attitude, two (color in-jet printer, mobile phone) are in the middle where they toward neither the search nor the experience ends, and the other two (notebook computer, computer games) in the experience goods domain with high average experience attitude.

In the second stage, we ask another 33 subjects to participate the shopping experiment. The new subjects are asked pretending that they are perspective consumers for the chosen six products and need to collect product information on the web. Subjects browse through the internet to search for the product information. All of the web pages that subjects have been through are recorded as the log files in dedicated computers. In particular, the IP addresses with respect to each web page that subject visited are recorded. The log files are our raw data for

further analyses. Subjects are asked to finish the search within 90 minutes and are paid with NT\$ 300 dollars. (The regular pay for students in campus is around NT\$ 80 dollars for reader's reference.) After the search for six products' information is finished, subjects are ask to fill a questionnaire (translated from Zaichkowsky's ([4]) scale for Personal Involvement Inventory) about product involvement, subjective conceptions of the adequacy of information on the web, satisfaction regarding the information they gain through their searching, and some demographic questions.

3. Data analysis

Table 1 shows the web sites that are most popular to our subjects. The data is organized and analyzed with software – Webtrends.

Table 1 Most popular websites list (source: webtrends reports)

Most Popular Sites				
	Organization	Hits	% of Total	User Sessions
1	http://tw.yimg.com	3323	3.79%	40
2	http://www.china-airlines.com	3280	3.74%	8
3	http://w3.epson.com.tw	2615	2.98%	8
4	http://www.sogil.com.tw	1951	2.22%	23
5	http://www.enova.com.tw	1558	1.77%	12
6	http://ticket.ezfly.com	1514	1.72%	20
7	http://www.kimo.com.tw	1251	1.42%	39
8	http://shopping.yam.com	1214	1.38%	5
9	http://shopping.pchome.com.tw	1163	1.32%	13
10	http://www.evair.com.tw	1156	1.31%	6
Subtotal for Sites Above		19025	21.7%	174
Total for Log File		87649	100%	42

The experiment is conducted with real web pages, that is, we do not limit subjects within certain web pages. Consequently, the collected raw data, the log files, contains web pages that do not carry any advertisement. Thus, the web pages collected are firstly divided into two categories: with and without advertisements. To our testing we only analyze those web pages with advertisements. We would like to investigate whether or not the subjects choose to click-through or ignore those advertisements.

In addition to the cleanup of web pages without advertisements, we divide the advertisements into two types of either banner or non-banner type advertisements. This a control variable that may help our understanding that is the formats of internet advertisements a factor affect viewer's click-through choice.

Since the click-through data carries a count format, that is, either zero or positive integers, we conduct the analyses with Poisson regressions or Negative Binomial regressions ([1];[2]). To make a proper choice between the two analyses, we could utilize the Likelihood Ratio test (T_{LR}) and the Wald (T_W) test to test whether or not the count data is over-dispersed. Test results show that $T_{LR} = 109.77 > \chi^2_{0.98(1)} = 5.41$ and $T_W = 56.66 > Z_{.99} = 2.33$. This concludes the over-dispersion property for the count data. . As a result, we choose the Negative Binomial regressions for data analysis.

4. Results

Negative Binomial regressions on the dependent variable -- the count of click-through numbers of advertisements -- are shown in Table 2. There are two models in Table 2. The difference is in the independent variables that measure search goods attitudes or experience goods attitudes toward each product.

According to Nelson's([5]) theory, we expect to

observe more advertisement click-through for the search goods than for the experience goods. However, to our surprise, the counts of advertisement click-through are not positively correlated with search goods attitudes. The coefficient is -0.06 but not statistically significant. Rather, the counts are positively correlated with the experience goods attitudes. The coefficient is 0.10 and statistically significant at 95% level.

Table 2 Negative binomial regression on click-through count data

	Search goods model			Experience goods model		
	coefficient	Std.	Z	coefficient	Std.	Z
Search goods attitudes	-0.06	0.04	-1.25	—	—	—
Experience goods attitudes	—	—	—	0.10	0.05	2.19 *
Price	0.24	0.09	2.74 *	0.23	0.09	2.69 *
Product involvement	0.04	0.08	0.48	0.04	0.08	0.45
Advertisement format (1: banner)	-0.75	0.17	-4.42 *	-0.76	0.17	-4.46 *
Gender	0.10	0.28	0.35	0.11	0.28	0.4
School years	0.13	0.12	1.11	0.16	0.12	1.41
Internet experience	-0.10	0.17	-0.58	-0.17	0.17	-0.98
Average hours on web per day	-0.03	0.10	-0.35	-0.02	0.10	-0.21
Procurement attitude (1:well planned; 0:emerged)	-0.02	0.45	-0.05	-0.00	0.45	-0.01
Get used to collect product information on web	-0.16	0.08	-1.93	-0.14	0.08	-1.73
Internet ad. as procurement reference	0.26	0.10	2.67 *	0.23	0.10	2.39 *
Click-through for brands	-0.16	0.09	-1.77	-0.17	0.09	-1.89
Preference for TV advertising	0.21	0.08	-2.01 *	0.21	0.08	2.50 *
Preference for radio station ad.	-0.05	0.09	-0.5	0.00	0.09	0.04
Preference for magazine advertising	-0.17	0.08	-2.01 *	-0.15	0.08	-1.77
Preference for outdoor ad. board	0.04	0.07	0.63	0.04	0.07	0.51
Preference for direct mailing	0.12	0.07	1.63	0.12	0.07	1.73
Pay attention to advertisement on web	-0.37	0.10	-3.83 *	-0.35	0.10	-3.65 *
Often get distracted with ad. on web	-0.07	0.08	-0.88	-0.08	0.08	-0.98
Sites of different purposes may affect click-through willingness	-0.04	0.07	-0.53	-0.03	0.07	-0.42
Has habit in clicking-through ad.	0.24	0.13	1.90	0.24	0.13	1.89
Constant	-0.38	1.01	-0.37	-0.60	1.00	-0.60
log likelihood	-529.619			-527.980		

Note. * presents p-value < 0.05

In addition to the contradiction results to our hypothesis, we have the following findings. First, price is a significant factor that would induce more advertisement click-through. The finding might be attributed to consumer's risk-averse attitude toward high value procurement. Second, banner type advertisement is less attractive to other types. This may be due to that viewers are insensate to the often seen advertisement format. Third, one who is used to collect product information on web for procurement references is more likely to click

through internet advertising banners or icons. Fourth, one who prefers internet advertising to TV advertising would incline to click through internet advertisements; nevertheless, this is not true for other media, including radio stations, magazines, outdoor advertising board and direct mailing. Finally, those who pay more attention to internet advertisements, their advertisement click-through counts drop significantly.

5. Conclusions and discussion

The contradiction result regarding the experience

goods attitude surprises us very much. Subjects made more click-through for the experience goods than the searching goods. According to Nelson's theory, consumers shall make more efforts to search for information regarding the searching goods. This is because consumers can fully identified products' utility of searching goods based on their specifications. And make fewer efforts to search for product information of experience goods, because the utility in consuming the kind of goods is difficult to communicate. Further investigation for the contradictive result was then conducted.

We went through those web pages that subjects had click through and found that for most of the searching goods, it is much easier for web-page information providers to construct complete information regarding the goods that the web sites aim to offer. For instance, a site called "EZtravel" is a local travel agent that provides fly tickets information. Web visitors can obtain a complete side-by-side comparison list regarding the flights during a certain period that visitors indicate; the visitors do not need further information search for the good.

However, on the other hand, for experience goods, it is much difficult for web-page information providers to construct a web site contains thorough information regarding the goods that the site is dedicated to. This is due to the difficulty in giving a full description of an experience good. Interestingly, internet is also a wonderful place for the sort of goods. A perspective consumer may seek other users' experience through some discussion forums. For instance, photo.net is a popular web site for people with photography hobby. The forums of the site provides thousands users' experience and comments regarding all sorts photography equipments. Our investigation showed that subjects spent most of their time in surfing around to gather the information they need for experience goods. As a result the number of click-through is less for searching goods compared to experience goods, which looks contradictive to Nelson's Theory.

In addition to the finding contradictive to Nelson's ([5]) theory, our results show a list of factors that may trigger or retard web viewers' interests in clicking through advertisements. We found that the price of goods increase the likelihood of click-through, and person with habit in collecting product information for one's procurement references, and person with preference of internet advertising over TV advertising are prong to click through

advertisements. Banner type advertisements retard viewers' inclination to click through and one who pays more attention to internet advertisements, their advertisement click-through counts drop significantly

Our study may contribute to the understanding of Nelson's Theory by amending a moderation factor to the Theory's projection, that is, the need for experience sharing and the cost to achieve the sharing.

Besides, the result may help to advice practitioners in advertising to aware his/her strategy in conducting advertisement on the web. According to our result, searching goods are much simpler to implement advertisement campaigns. It is less costly for searching goods to be promoted on the web. On the other hand, experience goods would take up more efforts to provide product information. It would be helpful to construct user forums to share their experience to convince perspective customers.

Even today, after the internet has been commercialized for almost a decade, the potentiality of the internet advertising, such as the banners and icons, may not be fully recovered. Internet advertising, for instance, provides an interactive environment where advertisement viewers can be promptly presented with the information they are interested in. Meanwhile, advertisers are obliged to the well built internet barebones system, so that they can deliver their internet advertisements inexpensively. Furthermore, internet advertising is not constrained with space and time horizon. On traditional media, magazines for example, the advertisements fade away with the deterioration of magazines. Also, the space that a magazine can provide is very limited; Advertisers may like to impress their perspective customers with more information. For all these merits that the internet advertising can provide, there is a dearth for our attention in discovering the full potentiality in it.

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The Optimization of Information Systems Outsourcing Strategies: A Constraint-Based Evolutionary Approach

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Abstract

Information systems (IS) outsourcing is an important issue of IS practices in organizations. To achieve better IS outsourcing performance, it is critical for organizations to develop appropriate outsourcing strategies. A prediction model is useful to forecast the possibility of a failure or to point out unforeseen problems. Based on a prediction model of IS outsourcing success, this study applied a constraint-based evolutionary approach for backward tracking the optimal values of organizational IS attributes that best approximate the target success level of IS outsourcing. One hundred forty-six real IS outsourcing cases, each with 22 features and 8 outcome features, are collected. The proposed system demonstrated that valuable suggestions can be made regarding the increase or decrease levels of adjustable IS attributes for organizations outsourcing their IS functions.

1. Introduction

Information systems (IS) outsourcing is an important option in managing the increasingly complex IS functions of organizations. Decisions for organizations to outsource part or all of IS functions are typically motivated by advantages in the competitive business environment. The main reasons for a corporation outsourcing IS functions include cost savings, accessing to new technologies and IS/IT expertise, focusing on its core business, improving IS service, and et al. [20]. However, without convincing possibilities of gaining such advantages, few organizations are willing to commit enormous resources and risk the loss of control over an important management function [23]. To make better IS outsourcing decisions and to achieve higher IS outsourcing performance, it is critical for organizations to develop appropriate IS outsourcing strategies.

Basically, appropriate IS outsourcing strategies can be formulated if effective models in predicting IS outsourcing success are employed. A prediction model can be used as a “What-If” mechanism to forecast the possibility of a failure outcome or to point out unforeseen problems. Our previous research developed a case-based system with a two-level weights design to predict IS outsourcing success [10, 11]. With the IS attributes of organizations as the case features, the proposed prediction model is able to forecast the potentially resulted benefits of IS outsourcing.

Based on the prediction model, this study further applies an evolutionary-based optimization technique to find out the decent values of adjustable IS attributes that best approximate the target success level of IS outsourcing. This is a parameter design problem that requires a backward tracking mechanism in search for the corresponding optimal values of adjustable input variables to match the target values of the outcome variables. That is, the optimal value of each adjustable input variable in the prediction model can be found to meet the expected outcome of IS outsourcing success within its valid value range if exists. The constrained-based genetic algorithms (CBGA) approach is employed for reducing the huge search space occurred in a parameter design problem.

The next session discusses the nature of IS outsourcing, strategy and success. This is followed by the methodology section that describes the CBR, a review of our previous study, that is, the case-based prediction model of IS outsourcing success, then the CBGA approach intended to resolve the parameter design problem in the domain of IS outsourcing. The final two sections discuss the experiment, the potential use of the results, and the possibilities for future research.

2. IS Outsourcing, Strategy, and Success

Today IS outsourcing has changed in many ways. For example, outsourced IS services are more likely to be telecommunication planning and applications [18], systems integration [8], and covering multiple systems and larger assets [7]. These changes make IS service providers increasingly involve in the business operations of the outsourcing corporations. The corporations therefore be more dependent on the capabilities of their IS service providers. Traditional “make or buy” thinking of IS outsourcing ignores the long-run and possible strategic implications [13]. IS outsourcing has become more strategic important than the view in the past.

As the scope and complexity of IS outsourcing expand, the reasons for corporations outsourcing their IS functions focus on business and technical considerations in addition to mere financial purposes. Financial benefits include cost saving and control, the economy of scale for IS resource and et al [9, 5]. Technical benefits include improving IS service, accessing to new technologies and technical talent [15]. Business benefits refer to the ability of a firm to focus on its kernel business and the enhancement of IT

capabilities [9, 21].

Grover et al. [9] assessed IS outsourcing success in terms of attainment of these benefits and defined success of outsourcing as the satisfaction with benefits from outsourcing gained by an organization as a result of deploying an outsourcing strategy. Their result showed that the relationship between the extent and success of outsourcing is likely to vary with different IS functions especially with system operations/ network management and maintenance. Lee [16] also examined the relationship between knowledge sharing and IS outsourcing success. His findings indicate that the service receiver's ability of absorbing the needed knowledge has a significant effect on IS outsourcing success.

In addition to the IS outsourcing extent and the knowledge sharing ability, a successful IS outsourcing practice also needs to address some important issues such as outsourcing evaluation [3], risk assessment [6], IS service provider selection [12], contract negotiation [14], and partnership cultivation [24]. However, most IS outsourcing researches focused on the decision model, the contract design and the relationship development required for effective outsourcing rather than IS resources management within an organization. This study employs a constraint-based evolutionary approach to determine the optimal values of organizational IS attributes. The result can be applied in guiding the IS resource allocation and investment so that the performance of the delivered IS resources can best approximate the target success level of IS outsourcing.

3. Methodology

3.1 Case-based Reasoning

CBR is a problem-solving method that is similar to the analogical decision making process. CBR can be considered as a reasoning process shown in Figure 1 [4].

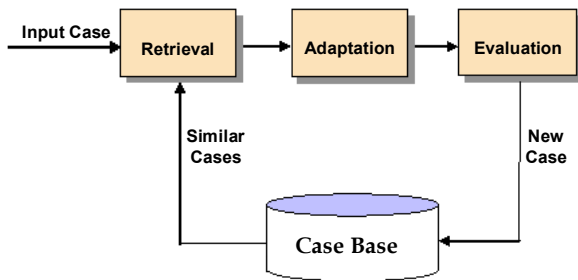


Figure 1. The CBR process

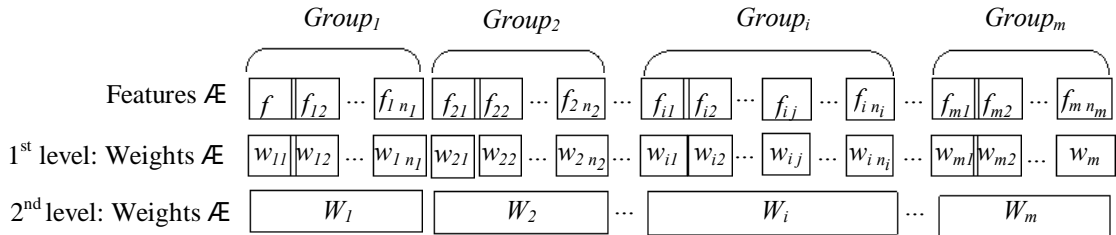


Figure 2. Two-level weight design

A description of the current problem as the input case is put into the CBR systems. The system retrieves the similar cases stored in a case base and then adapts similar cases to construct a solution for the current problem. The solution is later evaluated through feedback from the user or the environment. The new case can be incorporated into the case base for the use in future problem-solving.

A case is represented with features tied to a context. A case base consists of previous cases and their corresponding solutions. For each input case, features are used as indexes for retrieving similar cases. A weight is usually assigned to each case feature representing the importance of that feature to the match of the input case and retrieved cases. To design an appropriate case-retrieval mechanism in the retrieval stage, there are many evaluation functions for measuring the degree of similarity. An example of a similarity function containing the weights in the formula is shown in the following equation (1).

$$\sqrt{\sum_{i=1}^n W_i \times (f_i^I - f_i^R)^2} \quad (1)$$

where W_i is the weight of the i th feature, f_i^I and f_i^R are the value of feature i in the input and retrieved case, respectively.

3.2 A Review of Previous Study

3.2.1 Two-level Weight Design

Hsu et al. [10, 11] have developed a case-based system with a two-level weight design to predict IS outsourcing success. To apply CBR to the IS outsourcing domain, IS outsourcing cases are collected from the questionnaire consists several IS attributes constructs within which question items are incorporated. These items are used to measure the constructs that are adapted from IS outsourcing literatures [2, 19, 17, 1, 9].

In the two-level weight design, as shown in Figure 2, there are several features sets ($Group_i$) according to the specific domain knowledge tied to the constructs. Each feature (f_{ij}) has a weight (w_{ij}) representing the importance of that feature to its corresponding group in the first level. In the second level, each feature set also has a weight (W_i) representing the aggregate importance of the group to the match of the input and retrieved cases.

where $i = 1$ to m , m is the total number of feature groups in a case. $Group$ is the i^{th} feature group. $j = 1$ to n_i , and n_i is the number of features in the i^{th} group. f_{ij} is the value of the j^{th} feature in the i^{th} Group. w_{ij} is the weight of the j^{th} feature in Group i , and capital W_i is the weight of the i^{th} Group.

In Figure 3, a similar notation is applied to the outcome features. Assume that there are q outcome features, where $i = 1$ to q , q is the total number of outcome features, and O_i is the i^{th} outcome feature value.

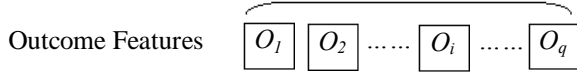


Figure 3 . Outcome feature

3.2.2 The Case-based Prediction Model

The overall system framework of the case-based prediction model is presented in Figure 4. The system consists of four major processes: *similarity process*, *weighting process*, *adapting process*, and *evaluation process*. The first two are corresponding to the retrieval phase in Figure 1.

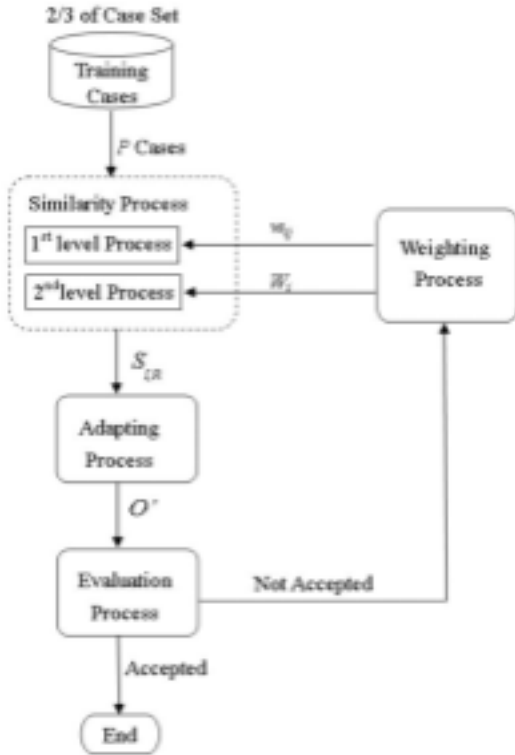


Fig 4. System architecture of prediction model

To effectively retrieve similar cases, the Similarity Process computes the similarity ($S_{i,R}$) between the input case and retrieved cases. The Weighting Process generates the weights to support the Similarity Process in which the GA is employed to determine w_{ij} and W_i . The $S_{i,R}$ is computed through two levels. In the first level, the similarity process computes similarities for each feature group ($S_{Group i}$) based on equation (2). In the second level, the similarity process computes the aggregate similarity

($S_{i,R}$) between the input and retrieved cases based on equation (3).

$$S_{Group i} = \sqrt{\sum_{j=1}^{n_i} w_{ij} \times \frac{1}{1 + |f_{ij}^I - f_{ij}^R|}} \quad (2)$$

$$S_{i,R} = \frac{\sum_{i=1}^m W_i \times S_{Group i}}{\sum_{i=1}^m W_i} \quad (3)$$

where $i = 1$ to m , m is the total number of feature groups in a case. $j = 1$ to n_i , n_i is the number of features in the i^{th} group, w_{ij} is the weight of the j^{th} feature in Group i , f_{ij}^I and f_{ij}^R are the values of the j^{th} feature in Group i for the input and retrieved cases, respectively. $S_{Group i}$ is the degree of similarity for the i^{th} Group, W_i is the weight of the i^{th} Group, and $S_{i,R}$ is the aggregate similarity degree between the input and retrieved cases.

The Adapting Process aims to apply the outcome features of the most similar cases to generate a solution for the current problem, that is, the expected outcome features for a certain input case. This process adopts the cases with top 10% $S_{i,R}$ to generate a solution for the input case. If there are k cases with top 10% $S_{i,R}$, the expected outcome feature O_i' is computed based on equation (4). The composite outcome feature O' is computed by averaging the sum of all the expected outcome features O_i' , as shown in equation (5).

$$O_i' = \frac{\sum_{t=1}^k [S_{i,R}^t \times O_i^t]}{\sum_{t=1}^k S_{i,R}^t} \quad (4)$$

where $t=1$ to k , k is the number of cases with the top 10% $S_{i,R}$, $S_{i,R}^t$ is the t^{th} case with 10% $S_{i,R}$. O_i^t is the i^{th} outcome feature of the t^{th} case with the top 10% $S_{i,R}$. O_i' is the i^{th} expected outcome feature.

$$O' = \frac{\sum_{i=1}^q O_i'}{q} \quad (5)$$

where $i=1$ to q , q is the number of outcome features and O' is the composite outcome feature.

The Evaluation Process compares the expected outcome feature with the real one. As shown in equation (6), the Mean Absolute Error (MAE) is applied to evaluate the result.

Minimize

$$Y = \frac{\sum_{t=1}^p |O_t' - O_t|}{p} \quad (6)$$

where $t=1$ to p , p is the number of training cases. O_t' and O_t are the expected and real outcome feature of the t^{th} training case, respectively. Y is the Mean Absolute Error (MAE).

Chromosomes of the GA are designed for encoding the two-level weights. The fitness function is defined as the equation (6). The entire learning process stopped after 500 generations and generated the best approximate two-level

weights. Once these derived values were applied, this case-based prediction model demonstrated more accurate results than the equal weights approach and the regression method [10, 11].

3.3 A CBGA Approach

The overall CBGA system framework is presented in Figure 5. The CBGA approach integrates the constraint-based reasoning technique into the GA process. In general, the GA deals with constraints either by integrating a penalty into the fitness function (denoted as soft constraints) or by abandoning those invalid chromosomes after the whole population has been generated (denoted as hard constraints). The CBGA uses the constraint-based reasoning technique to perform the chromosomes filtering before each chromosome is constructed. For every gene in a chromosome, the CBGA checks the defined valid range to assure that chromosomes are made valid. That is, chromosomes are made to satisfy the requirements of constraints. Instead of checking chromosomes after they are constructed, the CBGA

excludes invalid chromosomes being made and therefore considerably reduces the search space compared with the general GA approach. The CBGA approach is especially suitable for solving a parameter design problem in which the search space could become very huge as the number of adjustable input variables increases.

Figure 6 illustrates the CBGA chromosome filtering process. A constraint-based reasoning technique called the local propagation is adopted. The local propagation uses the information local to the constraints to define the valid gene range (G_j domain). According to the restricted valid range denoted by the satisfactory universe S_{G_j} , the value of gene g_j is replaced by a value randomly selected from S_{G_j} if the gene value is inconsistent with the constraints. By continuously executing the validation process on chromosome $C_i(g_{i1}, g_{i2}, \dots, g_{ij}, \dots, g_{im})$ in sequence ($j=j+1$), the new chromosome C'_i is thus able to satisfy the constraints. As a result the local propagation offers an efficient way to guide the GA toward searching for the optimal solution by reducing the search space already filtered because of the constraints.

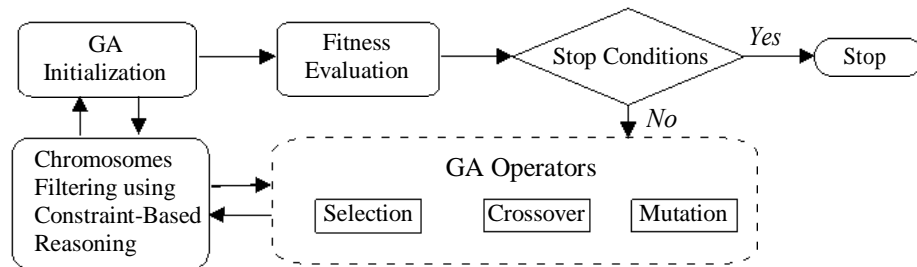


Figure 5. The CBGA system framework

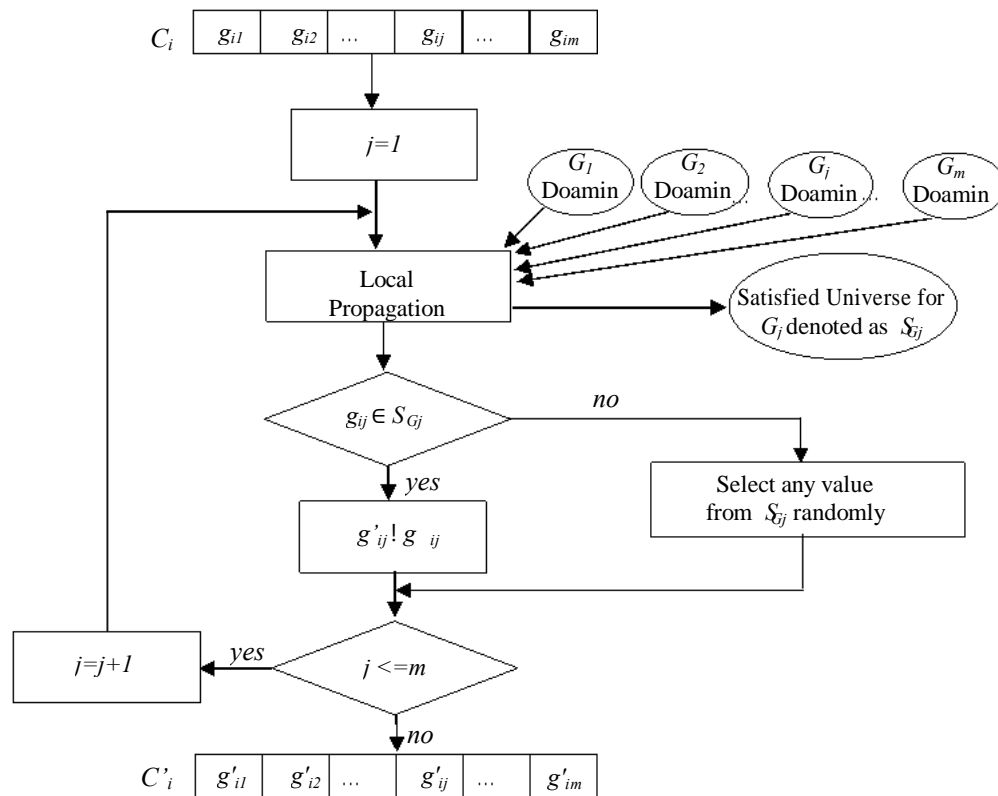


Figure 6. The chromosome filtering process

To apply CBGA to the IS outsourcing success domain, chromosomes are designed for encoding the values of the adjustable IS attributes. Their valid value ranges are considered as possible constraints. The fitness function is defined as the equation (7) in which the case-based prediction model ($CBR()$) is used to determine the predicted success level (O') for each chromosome (C') in the population. And O represents the target success level of IS outsourcing which has been set in advance. The function is to minimize the overall difference between the predicted outcome and the target one.

$$\text{Minimize} \\ \text{fitness} = |O - O'|; \text{ where } O' = CBR(C') \quad (7)$$

4. The Experiments and Results

4.1 Case Description

Companies may outsource various services and products. To differentiate IS outsourcing from the diversity of outsourcing, the characteristics of the outsourcing target, IS attributes, are the basic components in describing the IS outsourcing situation. As shown in Table 1, four IS attributes are proposed as features for the IS outsourcing case, including IS asset specificity, IS measurement problem, IS strategic importance, and IS capability. The alphanumeric marks in the brackets used in Table 1 are the same as that used in Figures 2.

Table 1. Features for the IS Outsourcing Case

IS Asset Specificity($Group_1$)	
Hardware & Other Equipments($f_{1,1}$)	
Required IS Knowledge & Skills($f_{1,2}$)	
Required Domain Knowledge & Skills($f_{1,3}$)	
Operational Procedure($f_{1,4}$)	
Trainings of IS Personnel($f_{1,5}$)	
IS Requirements of Business($f_{1,6}$)	
IS Measurement Problem($Group_2$)	
Procedures of Most IS Activities($f_{2,1}$)	
Change Frequency for Above Procedures($f_{2,2}$)	
Output Quality Prediction($f_{2,3}$)	
Proportion of Routine Tasks($f_{2,4}$)	
Efficiency of IS Problem Solving($f_{2,5}$)	
IS Strategic Importance($Group_3$)	
The Way of Doing Business($f_{3,1}$)	
Product or Service Differentiation($f_{3,2}$)	
Timing of Market Entry($f_{3,3}$)	
Imitation by Competitors($f_{3,4}$)	
Contribution to Product or Service($f_{3,5}$)	
Connection to Business Strategy($f_{3,6}$)	
IS Capability($Group_4$)	
Hiring of Best IS Personnel($f_{4,1}$)	
Learning of Advanced IT($f_{4,2}$)	
Periodical Education Training($f_{4,3}$)	
Morale of IS Personnel($f_{4,4}$)	
Problem Solving Capability of IS Personnel($f_{4,5}$)	

IS asset specificity. This attribute refers to the degree to which an IS asset can be applied to alternative uses or users with loss of value. The specificity arises when firms have their IS assets for customized usage. The asset items are selectively adapted from Loh [17], Aubert et al. [2], and Ang and Cummings [1].

IS measurement problem. This attribute indicates the difficulty (or problems) of measuring the IS services and their output qualities. The minor is the IS measurement problem, the clearer the procedures of most IS activities. The measurement problem items are derived from Aubert et al. [2].

IS strategic importance. This attribute means the importance of using IS for a corporation to achieve its strategic goals. The strategic importance items are integrated from Loh [17] and Nam et al. [19].

IS capability. This attribute refers to the IS knowledge and skills capacity possessed by the IS personnel in a corporation. The IS capacity items are primarily adapted from Nam et al. [19].

The outcome features, IS outsourcing success, describes the eight IS outsourcing benefits including the degree of (a) focusing on kernel business, (b) the enhancement of IS capability, (c) accessing to the channels of IS professionals, (d) the economy of scale for human resource, (e) the economy of scale for IS resource, (f) the control of IS expenditure, (g) reducing the risk of outdated IS/IT, and (h) accessing to the channels of key IS/IT. These benefit items are primarily adapted from Grover et al. [9].

4.2. Case Collection

Based on the above case description, a cross-sectional questionnaire was developed for collecting IS outsourcing cases from a group of large-sized organizations in Taiwan. Formal interviews with five IS managers were conducted to provide valuable ideas and insights into developing the questionnaire. Ten other IS managers were pre-tested with the entire questionnaire to ensure the face validity. The sample population consisted of 1729 large organizations in Taiwan, including the top 1000 firms in the manufacturing industry, top 500 in the service industry, top 100 in the financial industry, and 129 government institutions. The final questionnaires were distributed to IS managers at 576 organizations by systematically sampling one third of this population. Each IS manager was asked to rate on a scale of 1-5 about his or her perception with the questionnaire items. One hundred forty-six IS outsourcing cases were collected, yielding an effective response rate of 25.57% (146/571).

4.3 CBGA Control Parameters

Chromosomes are designed for encoding the values of the adjustable IS attributes. The fitness function is defined as the equation (7). The key defined CBGA parameters consist of the population size, crossover rate, and mutation rate. A theory that can concisely guide the assignment of these values is rarely seen [22]. Initially, the

following values were adopted in this research. The population size was 100, crossover rate was 0.6, and mutation rate was 0.01. The entire process stops either that the solution converges or after 500 generations.

4.4 An Example and Potential Use of the Result

This research suggests that appropriate organizational IS attributes can be found to best approximate the target success level of IS outsourcing. The success level of IS outsourcing is rated on a scale of 1-5 regarding attainment of the eight IS outsourcing benefits. Assume an organization is not satisfied with benefits from outsourcing gained as a result of deploying an outsourcing strategy. In order to explore the appropriate organizational IS capability at the success level of four for instance, the CBGA system can generate suggestions about the optimal levels of the capability items of in Table 1, including the effort to recruit the best IS personnel ($f_{4,1}$) and to learn the advanced IT ($f_{4,2}$), the frequency to provide periodical education training ($f_{4,3}$), the endeavor to raise IS personnel moral ($f_{4,4}$) and to improve the problem solving capability of IS personnel ($f_{4,5}$). Chromosomes are designed for encoding the values of the five adjustable IS capability

items, which may use a number of -1 ~ 1 (that is the range of -100% ~ +100%) to represent the recommended change direction and percentage. The constraints can be set as their feasible ranges of adjustment (that is any ranges between -100% ~ +100%). The results make suggestions regarding the increase or decrease levels of these IS capability items for organizations to modify their IS resource allocation decisions and investment plans. This research provides the information with highly strategic values as IS outsourcing becomes a more strategic important practice to organizations.

5. Future Research

As shown in Figure 7, the entire system consists of the CBR prediction module and the proposed optimization module. Users can issue queries to inquire the possible outsourcing outcomes as well as to wait for the optimization module to prompt the suggestion leading to target outcomes. In the future, the proposed system is planned to be installed on the Web portal for public access after thorough system verification and testing.

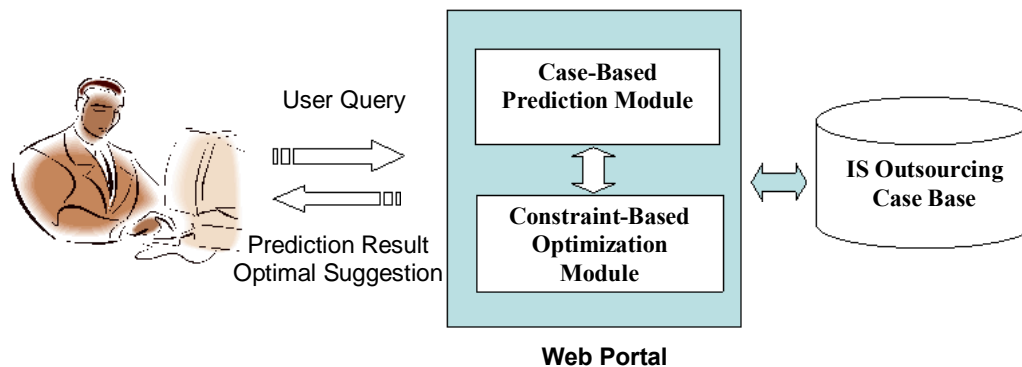


Figure 7. Entire Integrated Systems

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System Simulation with Optimization Mechanism for Option Pricing

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Abstract

The Monte Carlo approach is a valuable and flexible computational tool in modern finance, and is one of numerical procedures used for solving option valuation problems. In recent years the complexity of numerical computation in financial theory and practice has increased and require more computational power and efficiency. Monte Carlo simulation is one of the numerical computation methods used for financial engineering problems.

The drawback of Monte Carlo simulation is computationally intensive and time-consuming. In attempt to tackle such an issue, many recent applications of the Monte Carlo approach to security pricing problems have been discussed with emphasis on improvements in efficiency. This paper presents a novel approach combining system simulation with GA-based optimization to pricing options. This paper shows how the proposed approach can significantly resolve the option pricing problem.

Keywords: Option Valuation, Financial Engineering, Monte Carlo Simulation, Genetic Algorithms

1. Introduction

As pointed out by Hull and White [19, p.237], many option pricings appear to present intractable pricing problems. Therefore, most of them lack straightforward closed form solutions. The various approaches including analytic approximations [3] [22] and numerical procedures [5] [9] [10] [27] have been suggested for calculating option prices when there is no closed form solutions. In recent years the complexity of numerical computation in financial theory and practice has increased enormously, putting more demands on computational speed and efficiency. One of the numerical computation procedures, the Monte Carlo approach, was suggested by Boyle [5], and has proved to be a valuable and flexible computational tool in modern finance. The method simulated the process generating the returns on the underlying asset and invokes the risk neutrality assumption to derive the value of the option.

Numerical methods are used for a variety of purposes of finance. The Monte Carlo approach is a useful tool for many of numerical calculations, evidenced in part by the voluminous literature of successful applications, such as the stochastic volatility applications [11] [18] [20] [29], the valuation of mortgage-backed securities [28], the valuation of path-dependent options [21], the portfolio optimization [25], and the valuation of interest-rate derivative claims [8].

The Monte Carlo approach is flexible and easy to implement and modify. In addition, the increased availability of powerful computers has enhanced the attractiveness of the approach. Anyhow, there are some disadvantages of the approach but in recent years progress has been made in overcoming them. One drawback is that for very complex problems a large number of replications may be required to obtain precise results. Different variance reduction techniques have been developed to increase precision. Two classical variance reduction techniques are the control variate approach and the antithetic variate approach. The introduction of an appropriate control variate provides a very efficient variance reduction technique. However, in some problems it may be difficult to find a suitable control variate. Another alternative approach, the antithetic variate is often easier to apply since it concentrates on the procedure used for generating the random deviates. Essentially this technique relies on the introduction of negative correlation between two estimates. The performance of antithetic variate is better than Monte Carlo approach, but not good as control variate approach.

All these numerical approach have a dual objective of accuracy and computation speed. Therefore, improvements in numerical efficiency are of interest in solving option pricing problems for existing numerical procedures. The main purpose of this paper is to show how system simulation with optimization mechanism can be used to improve the efficiency of the numerical approach. And the result of our experiments has proved that our proposed approach has the better performance either in accuracy or speed of computation than Monte Carlo approach and antithetic variate approach.

2. Methods for Option Evaluation

2.1 System Simulation

Real-world problems always contain too many uncertain factors to be simply described by decision models. Simulation is one of the possible ways to be used to model real-world problems. Many aspects are concerned when adopting simulation approach to a complex problem [26].

- (1) It can be used to experiment with a new design or scheme before implementing it.
- (2) It can be used to enable the study of the internal interactions of a complex system or subsystem within a complex system.
- (3) It provides the analyst with a tool to conduct various experiments that can be done in real time.
- (4) Organizational and environmental changes can be simulated and the effect of these changes on the model's behavior can be observed.
- (5) It can be used as a tool to validate analytic results.
- (6) Simulation provides a flexible mean to experiment with the system or its design. Such experiments can reveal and predict valuable information to the designer, user, manager and purchaser.
- (7) Simulation is a cost-effective tool for capacity

planning and tuning of system or subsystems.

In addition, system simulation has several major advantages as listed as follows [26] :

- (1) Flexibility: It permits controlled experiments.
- (2) Speed: It permits time compression operation of a system over extended period of time.
- (3) It permits sensitivity analysis.

However, system simulation has some disadvantages. These are listed below [26] :

- (1) It may become expensive in terms of computer time and manpower.
- (2) There are some hidden critical assumptions that may affect the credibility of the simulation outputs.
- (3) It may encounter extensive development time.
- (4) It may encounter difficulties in model's parameters initialization.
- (5) Not all of parameters are considered when developing system simulation.

Although system simulation has those shortcomings as mentioned above, there are still some ways to improve these drawbacks. GAs can be adopted to enhance its lack of search efficiency to bring better outcomes. For input of parameters, the previous fixed parameters can be replaced with different statistic distribution to more closely reflect real world situations. The process of system simulation is shown in Fig. 1.

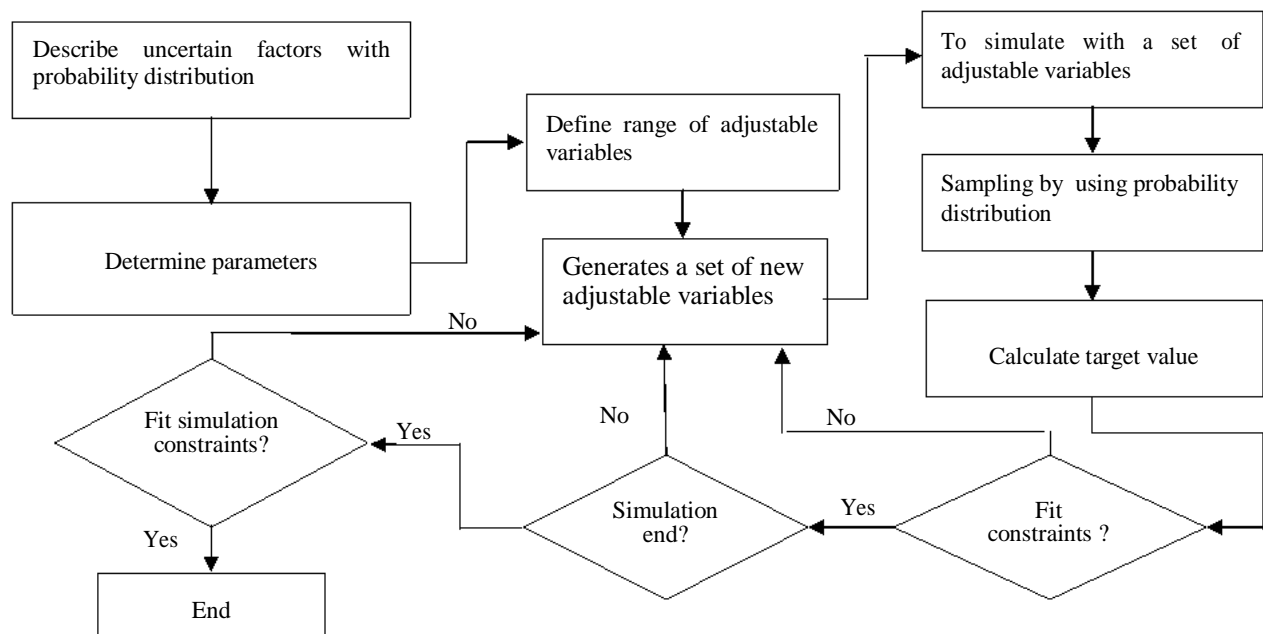


Fig. 1 The Concept of System Simulation

2.2 Monte Carlo Simulation

System simulation takes different environmental factors into consideration to produce different outcomes. We can observe the pattern of environmental changes by system simulation technique. System simulation provides an elastic environment and system to show the results

that is valuable information for managers [2] [6].

There are three main methods for system simulation technique. They are Monte Carlo simulation [1] [2] [29] [31], trace-driven simulation [24] and discrete event simulation [24]. Monte Carlo simulation is a static system simulation technique and does not include time factor. It's widely used in statistic models

whose property will not shift as time goes. It can also be used in non-probability expression (by statistic technique). It allows users to set up statistic distribution or object function along with randomly generated values and iterative computation to figure out all possible solutions. In this way, computers will test every set of inputs to achieve optimization.

System simulation technique can reflect various kinds of solutions or projects under uncertainty [24]. Its solutions, however, are not necessarily the optimized ones. Combining with optimization techniques is then becoming worth developing. Some lectures in addition reveal that using GAs when optimizing can speed up the time to search for solution [31].

In the iterative simulative process, the statistic distributions in variables will be sampled with one new value during every system simulation. This action is a method to simulate risks. After all variables are given values, they will be the inputs of the optimization process. Monte Carlo simulation can be applied to optimization problems with uncertainty and huge search space. When combining system simulation and GAs, we can solve problems with uncertainty quickly by guiding the direction of expected solutions. This has been proposed in [30][32].

2.3 Genetic algorithms

Optimization is a process of finding out an optimum solution from a problem where the searching space is likely enormous. Most of these problems contain many variables, which are restricted by some given constraints [13] [14] [22].

Genetic algorithm (GAs) is one of optimization algorithm [12] [25]. It uses fitness function to determine the direction of searching and does organism-like computation. It converts “The fittest survives” from Darwin to simulate reproduction, crossover and mutation of chromosomes. Through the above computation process, it selects out successful evolving chromosome, that is, the desired chromosome [16]. There are three basic operators in GAs computation process:

- 1.Reproduction: it duplicates one chromosome directly.

- 2.Crossover: it takes two chromosomes to exchange their genes to produce the other two chromosomes.

- 3.Mutation: some genes in a single chromosome may change to produce the other different chromosome.

After generations of reproduction, crossover and mutation, genes in chromosomes change and the chromosome is selected with the highest fitness value. It can promise a chromosome with better genes than before. In this way, GAs is a method to search for optimized solution and can be applied to problems with enormous solution space. The concept of GAs process is shown in Fig. 2. It uses a loop from fitness evaluation to

stop condition along with mechanisms of reproduction, crossover and mutation to make a new solution (new generation) evolve.

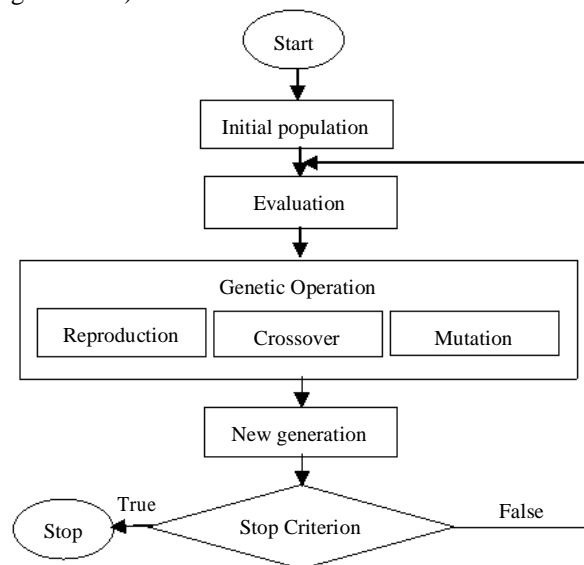


Fig. 2 The Genetic Algorithm Process

2.4 Simulation Optimization

Simulation optimization is an optimization in itself; however, it requires additional mechanism to make the entire optimization process much closer to real world [1]. The concept of simulation optimization can be conceptualized in Fig. 3.

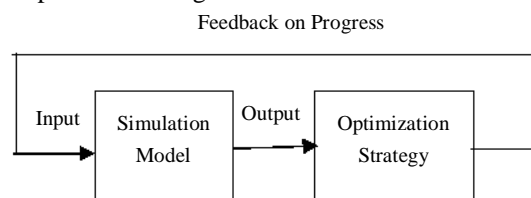


Fig. 3 The Concept of Simulation-Optimization
abstracted from [34]

The optimization strategy is improved through generations. The improving process is, however, slightly different from other original GAs methods. It is influenced by the simulation model that iteratively sample values from statistic distributions of the optimization model. The iterative samplings are called iterations in this paper, and one single simulation consists of iterations. The amount of iterations in one single simulation can be arbitrary, however, the more the better. That's because from statistic viewpoint, more sampling values can represent more statistic population and can reflect much closer to the real-world situation. The concept of simulation combined with GAs is illustrated in Fig. 4.

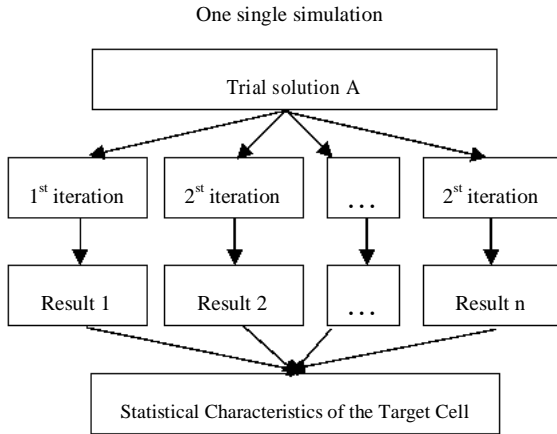


Fig. 4 The Iteration Concept

It can be briefly described that one single simulation equals to one chromosome in GAs, but simulation consists of additional computations, that is, iterations. As a result, the fitness value for each generation is no longer one value but statistical characteristics, such as mean, standard deviation, variation, skewness, kurtosis and so on. Usually the mean is a good choice for its stable property to stand for population. Therefore, the proposed methodology attempts to employ simulation-optimization concept in the option pricing problem.

3. Methodology

3.1 European Call Option Evaluation Model

Consider European Call Option [17] dependent on a single market variable S (stock price) that provides a payoff at time T . Assume that interest rates are constant, and we can value the derivative as follows:

- (1) Sample a random path for S in a risk-neutral world. Using the properties of the lognormal distribution that we can generate the distribution of stock prices one period hence by forming the random variables,

$$S_{t+1} = S_t \exp\left((r - 0.5\sigma^2)\Delta t + \sigma\epsilon\sqrt{\Delta t}\right) \quad (1)$$

where ϵ is a normally distributed random variable with zero mean and unit variance. S_t represents the current stock price and Δt is the stock price changes in a small time.

- (2) Calculate the payoff from the European Call Option (i.e. $\max[S_T - E, 0]$). E represents exercise price.
- (3) Repeat steps 1 and 2 to get many sample values of the payoff from the derivative in a risk-neutral world.
- (4) Calculate the mean of the sample payoffs to get an estimate of the expected payoff in risk-neutral world.
- (5) Discount the expected payoff at the risk-free rate to get an estimate of the value of the derivative.

3.2 Simulation Optimization

In this study we adopt simulation optimization method in order to research European call option pricing problems. Although system simulation has some advantages such as flexibility, speed, and sensitivity analysis etc., it may encounter difficulties in model's parameters initialization and not all of parameters are considered when developing system simulation. Genetic algorithms could provide strong multi-dimensions search ability to find fitness parameters and an optimal combination from different parameters. Therefore, system simulation could integrate with genetic algorithms, not only to make up genetic algorithms without simulation framework, but also to express problems with high uncertainty to raise system fault tolerance ability. System simulation integrated with genetic algorithms will bring both sides advantages, not only to construct models more fit in real world, but also to find better decision information.

The integration of system simulation and genetic algorithms procedure framework is shown in Fig. 5, and the execution steps are illustrated as blow:

- (1) To describe uncertain factors characters, then search fitness probability distribution, and determine simulation statistics parameters (ex. a mean value, standard deviation).
- (2) Determine input variables, and settle adjustable variable's range of value.
- (3) Generate a set of new adjustable variables with genetic algorithms.
- (4) To estimate new population's fitness function.
- (5) To test if new population meet conditions? if not matched, then repeats step 4.
- (6) To simulate with a set of new adjustable variables.
- (7) Sampling with probability distribution and compute target value.
- (8) If target value out of range of adjustable variables, then repeat steps 3~8, otherwise go to the next step.
- (9) To check if simulation procedure is completed or not? If yes, then go to next step, otherwise repeat step 6~9.
- (10) To check if target value is within the scope of simulation? If yes, then go to the next step, otherwise repeat step 3~10.
- (11) If the value is optimal, then end, otherwise repeat step 3~10 until the value is optimal.

The simulation optimization methodology as mentioned above uses system simulation to do sampling and the genetic algorithms to find adjustable variables, which procedure is shown in Fig. 6. It could help to understand how system simulation integrated genetic algorithms method finds the best value. Here, the system simulation technique is Monte Carlo simulation. Its main concept is to sample very large size of data from the given statistic distribution (that is, stock price here) and they apply these values to the optimization solution mentioned before. Doing so will make the optimization process of simulation much closer to the real world situation.

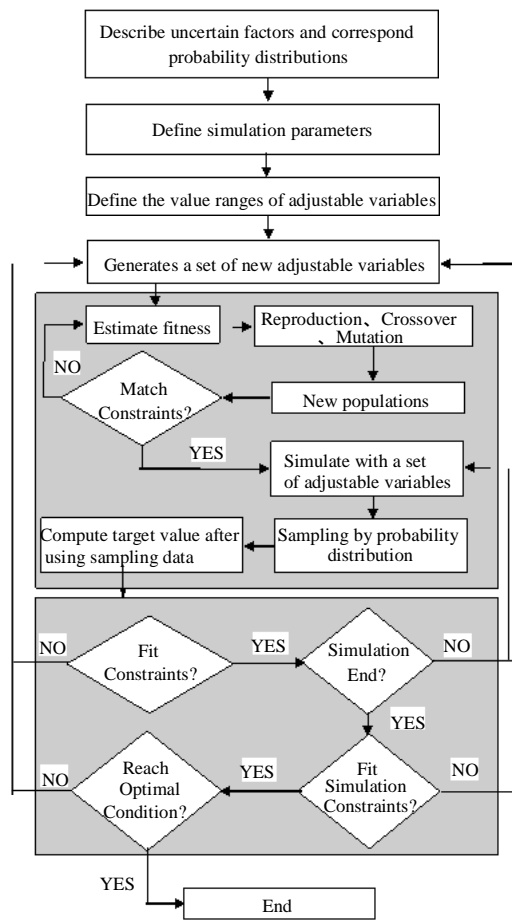


Fig. 5 The System Simulation Optimization Process

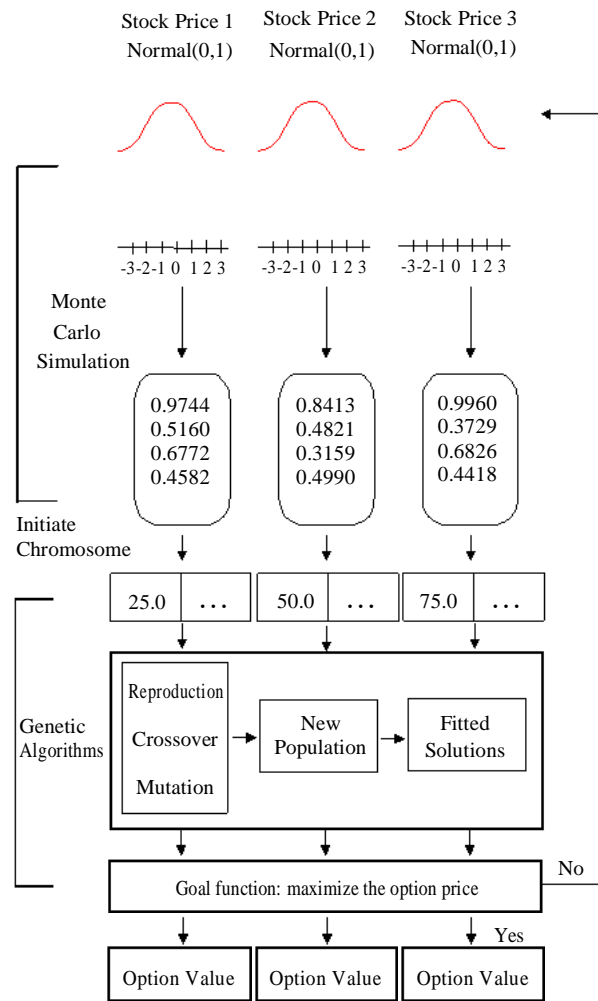


Fig. 6 The Process by Monte Carlo Integrated Genetic Algorithm

4. The Experiments

4.1 Data Sets

Eq.1 is used to obtain the estimates of European call options values on dividend paying stocks.

Let

S_t = the current stock price at time t ($S = 25, 50, 75$ respectively)

r = the risk-free rate per quarter compounded continuously ($r = 0.015$),

σ^2 = the (assumed constant) variance rate per quarter on the underlying stock ($\sigma^2 = 0.025$)

D_t = the dividend payable at time t ($D = 0.25$),

E = the exercise price of the option ($E = 50$),

T = the expiration date of the option.

In this case, the assumption used is same as that mentioned in the Boyle's article [5, p328-329]. It is

assumed that time is measured in the unit of one quarter. Assume that S_t represents the stock price just after the quarterly dividend D_t has been paid. To set up the simulation method in this case a value of S_{t+1} is generated. If this value is greater than D_{t+1} then $(S_{t+1} - D_{t+1})$ is used as the initial value in the beginning of the second period and the procedure continues until a value of S_t is obtained. If at some stage S_{t+m} ($m = 1, 2, \dots, (T-t-1)$) is less than or equal to the corresponding dividend payment D_{t+m} , then the process stops. In this case another simulation trial is started again from time t . A series of simulation trials is carried out in this way and the expected value of $\text{Max}[S_T - E, 0]$ is found. This quantity is then discounted at the risk-free rate to yield an estimate of the option value [5].

4.2. Optimization Model Parameters Settings

The proposed optimization model applies GAs evolutionary mechanisms; as a result, some parameters in a formal GAs model must be determined first. They are population size, crossover rate and mutation rate respectively. Because the model is a hybrid of GA and simulation techniques, the iteration number is a required parameter to be defined. All settings are specified as follows:

Table 1 Model Parameter Settings

Population size	50
Crossover rate	0.5
Mutation rate	0.06
Iteration number	500

The iteration number here is set to 500; however, the number can be variable. That is the optimization model which will stop the iterations when the expected statistic characteristics converge. Assigning a fixed value here is to make further comparison easier later on.

4.3 The Comparison

A comparison was made among the performance of the Monte Carlo approach, control variate, antithetic variates, and GA-Based optimization to pricing options. For this comparison, the estimates of option values on dividend paying stocks in the case of European call options were obtained. The data we used is same as that given in the Boyle's article [5]. The results we obtained are compared with those results as listed in the article.

Table 2 indicates the results of the simulation method for selected values of the underlying parameters. It is assumed that $r = 0.015$, $\sigma^2 = 0.025$ per period, $D = 0.25$ per period and $E = 50$. The estimates of options with even maturities ranging from 2 to 20 are provided.

From the results as shown in Fig. 7, 8, 9, we can see the best performance is control variate, which provides a very efficient variance reduction technique in this problem. In some problems it may be difficult to find a suitable control variate. The alternative method, the antithetic variate method, is often easier to be applied since it concentrates on the procedure used for generating the random deviates, but its performance is not good as the proposed GA-Based methodology.

5. Conclusion

Although Monte Carlo simulation model provides a flexible tool to obtain numerical estimates of a European call option on a stock which pays discrete dividends, it is very time-consuming. Based on the example given in the Boyle's article [5], when the current stock price is 50 and option has 20 periods to maturity, the option value of the crude Monte Carlo estimate (5000 trials) is 17.190 with standard deviation 0.479. Therefore, the 95 percent confidence limits are 17.190 ± 0.958 . Reducing the range of these confidence limits to ± 0.05 would require increasing the number of trials from 5000 to 1,835,500. A number of effective techniques for reducing the variance of the estimates have been developed. One of the most effective methods is control variate. However, it is very difficult to find a suitable control variate in real case.

In this paper, we propose the powerful approach based upon the coupling of a Monte Carlo simulation with a genetic algorithms-optimization procedure for solving complex option pricing problems. The genetic algorithm considers a population of chromosomes, each one encoding a different alternative design solution. For a given design solution, the Monte Carlo simulation allows us to evaluate the system performance over a specified mission time, in terms of a pre-defined net profit function. This latter constitutes the objective function to be maximized by the genetic algorithm through the evolution of the successive generations of the population.

In order to avoid an explosion of Monte Carlo simulation runs and an overwhelming use of computer time, each potential solution proposed by the genetic algorithm is explored only by few hundreds Monte Carlo simulation. Due to the fact that during the genetic evolution the superior chromosomes appear repeatedly many times, statistically significant results for the solutions of interest (i.e. the best ones) are obtained. This approach coupled with the 'evolutionary guidance' in the search procedure by the genetic algorithms allows one to efficiently perform the analysis of a realistic system in reasonable computing times.

In the future, we try to apply simulation optimization methodology to handle American call options problems. The problems of this kind of option, which can be exercised at any time during its life, would become more complicated and challenging.

Table 2 Option values using Crude Monte Carlo , control variate, antithetic variate method, and GA-Based simulation; 5000 trial per estimate.

S/E	Number of periods to maturity	Crude Monte Carlo estimate	Standard deviation of crude Monte Carlo estimates	Control variate method	Standard deviation of using control variate method	Anti-thetic variate method	Standard deviation of using Anti-thetic variate method	GA-Based optimization	Standard deviation of using GA-Based optimization
0.50	2	0.004	0.002	0.003	0.00004	N/A		0.154433	0.001248
	4	0.087	0.014	0.075	0.0002			0.730537	0.009494
	6	0.273	0.031	0.266	0.001			1.404183	0.015707
	8	0.539	0.047	0.542	0.001			2.247438	0.024833
	10	0.879	0.066	0.869	0.002			3.304752	0.033606
	12	1.202	0.081	1.222	0.003			4.26557	0.040313
	14	1.547	0.094	1.591	0.004			5.180937	0.050361
	16	1.897	0.108	1.964	0.006			6.046652	0.06431
	18	2.281	0.130	2.330	0.007			6.586973	0.072767
	20	2.873	0.157	2.689	0.010			8.116041	0.085043
1.0	2	5.121	0.114	5.028	0.0003	5.093	0.06	7.797639	0.060528
	4	7.427	0.170	7.251	0.001	7.254	0.092	11.037971	0.0814082
	6	9.247	0.215	9.000	0.002	9.101	0.126	14.11116	0.100583
	8	10.793	0.258	10.494	0.003	10.609	0.150	17.25313	0.12242
	10	11.923	0.297	11.815	0.004	11.716	0.170	19.61279	0.151521
	12	13.135	0.330	13.006	0.006	12.974	0.194	22.59007	0.188225
	14	14.281	0.361	14.094	0.007	14.050	0.215	24.24747	0.208428
	16	15.079	0.389	15.106	0.009	15.013	0.231	26.21128	0.224026
	18	15.945	0.428	16.038	0.010	16.018	0.260	28.80928	0.25622
	20	17.190	0.479	16.903	0.013	17.030	0.287	30.61221	0.284947
1.5	2	26.445	0.240	26.369	0.0004	N/A		29.55248	0.127712
	4	28.250	0.333	27.818	0.001			29.43402	0.156068
	6	29.832	0.405	29.299	0.002			35.55066	0.207981
	8	31.257	0.470	30.715	0.003			37.45568	0.235312
	10	32.319	0.528	30.048	0.005			39.86465	0.256224
	12	33.491	0.578	33.298	0.006			41.93361	0.283278
	14	34.835	0.624	34.465	0.008			45.51148	0.30051
	16	35.503	0.666	35.578	0.009			45.68854	0.347882
	18	36.382	0.722	36.616	0.011			47.46086	0.372783
	20	37.989	0.798	37.582	0.014			49.56996	0.418978

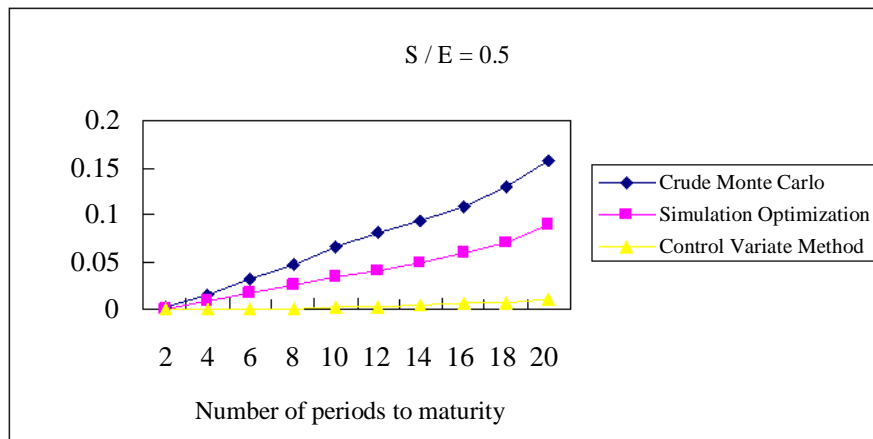


Fig. 7 The comparison of Standard deviation($S/E=0.5$)

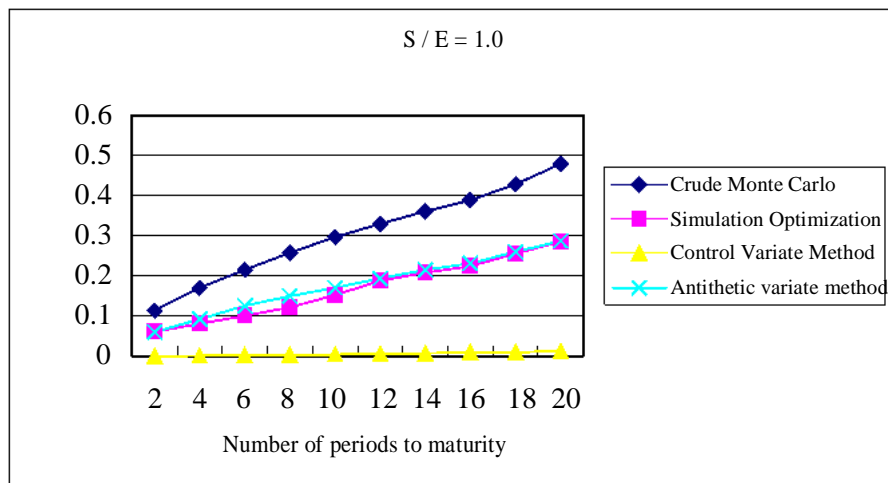


Fig. 8 The comparison of Standard deviation($S/E=1.0$)

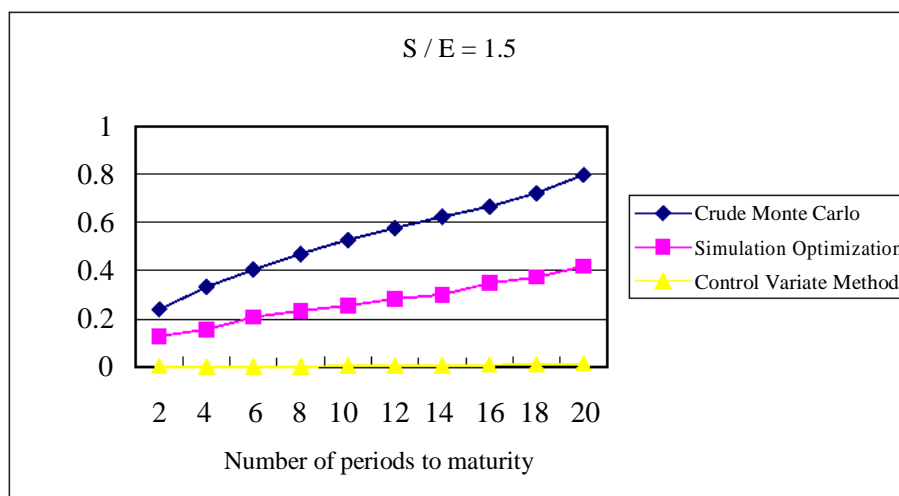


Fig. 9 The comparison of Standard deviation($S/E=1.5$)

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Building Virtual Private Networks to Support Mobile VPN users in a Group with Quality of Service Guarantees

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Abstract

Flexible, secure and cost effective in comparison to traditional solutions, IP-VPNs exhibit many of the traits enterprises are seeking today. Mobile VPN users have special requirements relating to resource adoption and customization. In this paper we have discussed how mobile agent technology can be applied to IP-VPN in finding a route for a tunnel with QoS features and also how can it provide service capabilities to mobile users. In our approach, we have considered the requirement from a group of VPN users. We have developed a framework to use active packets that can help us in discovering an optimal QoS route based on the available bandwidth and link cost. Also we have described an alternative approach for resource management between two agents. Taking into account, the structuring mechanisms enabled by standard mobile agent platforms, like regions, agencies grouped within regions, and places belonging to agencies, we have applied these structural principles to our target mobile communications environment. We have assumed that service providers have access to node's control environment, algorithms and states. A possible framework for supporting mobile user groups after the deployment of the VPN is suggested in this paper. We have considered the concept of Place Oriented VPNs that are based on agent technology and can be built on top of existing VPN infrastructure.

1. Introduction

The Internet revolution has dramatically altered the networking requirements & opportunities of the enterprise. The deployment of new IP applications and the availability of tremendous capacity i.e. high connectivity has promised to facilitate the exchange of critical information both within the enterprise and throughout its sphere of influence. However, this way of expanding the value of a network as a business asset does present challenges. There are many ways of handling this. IP-VPN is one of the better solutions. In this sluggish corporate spending environment, Internet Virtual Private Networks continue to attract attention as a way to reduce remote access costs for enterprise networks. But while the number of implementations is clearly on the rise and VPN technology has become well understood, it also continues to be in many respects, a work in progress. A VPN is a communications network, built for the private use of the enterprise, over a shared public infrastructure [8]. There are two primary applications covered by this

definition: remote access connectivity and site-to-site connectivity (see Figure 1). VPNs can be categorized into three types as Remote Access, Intranet, and Extranet. Remote access connects remote users to corporate LAN, Intranet connects branch offices to corporate LAN, and the Extranet VPN gives access to business partners.

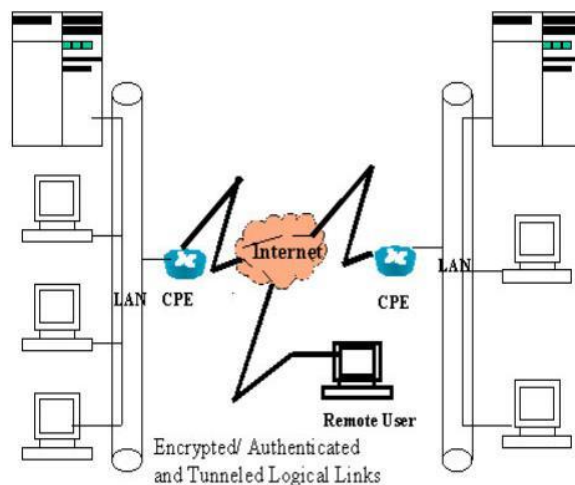


Fig.1. An Example of IPVPN

The motivation for building VPNs is numerous. However, a common thread in each is the requirement to make some portion of the public network 'invisible' to outside people, while taking advantage of the efficiency of a common communication infrastructure. The two basic motivations are (a) cheap cost and (b) need for communication privacy. The general conclusion [1] is that a collection of virtual networks implemented on a single common physical communications plant is cheaper to operate than the equivalent collection of smaller physically discrete communications plants, each serving a single network client.

The majority of theoretical work being done recently on the performance enhancement of the VPNs concerns security [2]. Researchers have focused on devising different architectures for different deployment scenarios. Little has been done to provide QoS support in a VPN

environment and also to support roaming users (users who often move from one network to another). The main problem we face in supporting mobile users is the technology integration. These traveling VPN users must be supported in small groups or separately. We discuss here, how can we use agent technology and active networking concept to support our roaming users to get the VPN services from the corporate network. Also the tunnel that is to be formed between source and destination should guarantee maximum quality of service requirements. VPNs are designed mostly with static users in mind and little has been done to integrate mobile users or to provide mobile user support after their deployment. The problem here is that the availability of information and communication services varies from place to place and from time to time. The major requirement here is that for dynamic reconfiguration of the new environment and customization.

The advent of high-speed networking technology has enabled many multimedia applications like video conferencing, medical imaging and VOIP. These applications have different performance requirements of bandwidth, delay, jitter and loss rate, which leads to an important issue of how to support QoS on the modern high-speed virtual private networks.

It is known that the original Internet is a “best-effort” network, which has no QoS support for different classes of services. However, there may not exist one solution to all the problems of QoS support, because the application-specific state of QoS should be frequently changeable or easily deployable when needed, while the conventional network is simple and stateless. Now, recent research has shown that the programmable “Active Networks” may be a better solution to guarantee QoS in the VPNs.

2. Related Work

2.1 Place Oriented VPNs

A PO-VPN is an alternative virtual private network [4]. It differs from a legacy VPN where the legacy VPN has its own resources which are managed by its own users in a policy related way. But current VPNs are not sufficiently flexible, have long set up and deployment times, are not dynamic enough to accommodate rapid changes, and can’t be controlled by the users. It is again more difficult to manage if the VPN spawns different networks with different policies. PO-VPNs are a right solution for this problem. These are built on top of existing physical networks and are controlled by agents.

2.2 Active Networks

Active networks are a novel approach to network architecture in which the switches of the network perform customized computations on the message flowing through

them. The first piece of this architecture is a protocol that would replace original “passive” IP packet with the “active” object code. The motivation of active networks is to permit applications to inject programs into the nodes of networks and then to support faster service innovation by making it easier to deploy new network services. Active networks are highly programmable networks that perform computations on the user data that is passing through them. In contrast, nodes of the traditional networks, such as ATM switches or IP routers, are closed, integrated systems, whose functions and interfaces are determined through standardized processes. These nodes transport packets (or cells) between end-systems and the processing of these packets is limited to operation on the header, primarily for the routing purposes. Specially, the network nodes neither interpret nor modify the packet payloads. Active networks, in the other hand, break this tradition by letting the network perform customized computation on the packets, including their payloads. There can be mainly two approaches to active networks: discrete and integrated, depending on whether programs and data are carried discretely.

Programmable switches – a discrete Approach: In this approach, the existing packet formats are remained and it provides a discrete mechanism that supports the downloading of programs, which separates the injection of programs from the processing of messages.

Capsules – An Integrated Approach: In this approach, the existing “passive” packet will be replaced with the “active” miniature programs, called “capsules”, which are encapsulated in the transmission frames and executed at each node along their path. User data, the payload, will be computed and embedded in the capsules.

2.3 Agent System

Mobile agents [3] are software components that act alone or in communities on behalf of an entity and are delegated to perform tasks under some constraints or action plans. The essential characteristics of these agents are mobility that allows them to move from one node to another and continue their execution. An agent is a process that enables users to control their system, and at the same time, to allow sharing of resources, that is it controls the access to resources of a remote computer, and also provides protection. An agent system consists mainly of places. A place is a context in which an agent is executed [4]. This context can provide services like access to local resources. A place consists of place name and address of agent system within which the place resides. A place can contain other places. All places follow parent child relationship. The assignment of places to agent system is done by ways like dynamically as they enter into different nodes based on some criteria like originating from same user or statically assigned per entity i.e. per user or per enterprise.

2.4 Active Node

The active node consists of a programmable router at the lowest layer, above which a node OS lies, which again supports Execution Environments. At the top, we have the application programs running [4].

3. Our Approach

VPNs are designed with static users in mind and almost all the recent VPN technologies do not support mobile users, i.e. once the VPN is deployed if the user is moving into another network (a third party) then again the same VPN has to be reestablished with the new network as the source. To do this, we must also have the required client software available at the new node and also it should support VPN connections. If everything is right, we then have to reestablish the whole VPN connection starting from the scratch. This scenario of VPN deployment can also be called as Flexible VPN. This requires resource adaptation and customization. To make this feasible, we have applied the concept of Agent technology & Active networks. The Mobile agents used are active, mobile, and can travel. They may reside in a host or client computer, and roam other computers, networks, or the Internet to execute their tasks. They are frequently used to collect data, information, or changes. The use of these agents have several advantages like reducing the network load, overcoming network latency, encapsulating protocols, executing asynchronously and autonomously, dynamic and heterogeneous. These mobile agents can migrate along with mobile users, adopt local and remote resources dynamically and generally manage and mediate all requirements of mobile users.

3.1 Mobile User Support

To support mobile users, we have allowed each user to act within his own place. This place hosts one or more cooperating agents that keep track of user's requirements and current status. Agents here take the role of customer, the service provider and the network provider. These agents reconfigure the services that user wants in the new environment. They also see that the adoption is optimal in the new environment. The reconfiguration is fully transparent to the users.

A VPN with mobile users comprises of a graph with changing nodes. As the user moves, we face the challenge of re-assigning the connections between the nodes in order to provide the same services. This whole process does take place without the notice of the user. To support mobility, we have to dynamically and flexibly provision VPNs. The deployment should take minimal time. There are multiple network and service providers in the underground infrastructure on top of which we want to build our VPN. Here, we consider three agents UA (user agent), VPN SPA (service provider agent), and NPA (network provider agent). The process for supporting mobile users is two fold:

3.1.1 Initial VPN provisioning

1. UAs negotiate and decide upon a common set of requirements and services desired by the users.
2. All UAs elect a leader using the Bully leader election algorithm (using the priority number, election and coordinator messages), and the leader is called as GA, the group agent.
3. Then GA tries to find out an optimal tunnel path for the VPN topology on the basis of bandwidth and link cost covering all the UAs. Here, GA issues self-routable packets, which travel in the network and get happiness levels from NPAs. The self-routable packet contains a time stamp according to which it has to follow back to GA. GA also negotiates with VPN NPAs to find out different resource supports.
4. Now GA interacts with the SPA in order to find out which topology supports the desired services. At the end of this phase, GA has a network topology that supports the services desired fulfilling the SLAs demanded by the user or customer or the UA.
5. GA then, integrates all the information received and uses a rule-based system to process the information. The happiness levels are averaged and the deviation is measured. The rule based system acts as a control element using this deviation as input.
6. It then issues active packets based on the rule-based system, which tries to restore the happiness levels. The happiness is here nothing but the bandwidth consumption and link cost. Thus routes are added and deleted from the routers dynamically to redirect the load so that the VPN is happy or well behaved. The GA does this thing. It can also consider other parameters like error statistics, reputation of nodes, cost security etc in deciding an optimal path for the VPN.
7. Finally GA requests service and network providers to set up the services and the connections. As, a last step, GA informs all UA that the VPN is ready to use, after which it may die or remain alive as a central authority to monitor future requests and topologies.

3.1.2 Dynamic VPN adoption

When a user moves from one network to another, his services must be maintained in the new environment. The steps below are needed to achieve this:

1. When a user moves from the home network, all the User Agents stop after getting a "operation stop" signal from the system. All the UAs then inform the GA, the central agent that the user is no more active in his home network.
2. When the user logs into another network after migrating, this new location address is sent back to the User Agents

those were available in the previous domain but were stopped.

3. With this information, all the user agents migrate themselves to the new environment after authenticating themselves in the new domain.

4. The UA after establishing itself over the new domain examines the services needed by the user and whether these are supported & provided by the new domain. If yes, it configures those in the new environment. If not, UA may ask the old node to get the active code that implements the missing services in the new domain. This is where, active networks concept comes into play. The other possibility is having an agent based resource management system as depicted below:

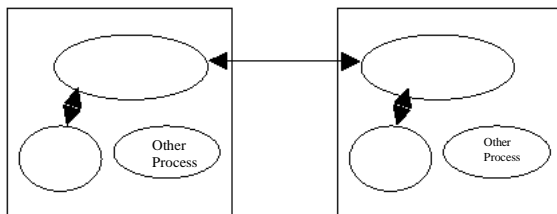


Fig. 2. Relationship Between Different Processes

Local agent must perform the following actions:

- a. Locate a remote computer with the required resources
- b. Negotiate with that Computer to borrow the resources
- c. Invoke the service requested by the client
- d. Handle the Exception Conditions (resource revocation, and location of a new host and deportation of the guest process) in a way that is transparent to the client and guest

The remote agent process has to lend the resources and protect the interests of the computer owner. In particular it should perform the following actions:

- a. Receive the borrowing request from an agent
- b. Analyze the request to determine whether the resource can be granted
- c. Create an appropriate execution environment for the guest process (Creating a new process and supplying the guest with capabilities to access other components of the system, according to the request specification, e.g. network connections to the client so that the guest and client can communicate directly).
- d. Exception handling, for example attempts to access

resources, which the guest was not allowed to utilize, revocation of rights.

Providing remote resources or services in the above type of agent based resource management system can be categorized into three phases as Negotiation, Resource Utilization, and Resource Release with different messages being labeled as shown in Figure 3.

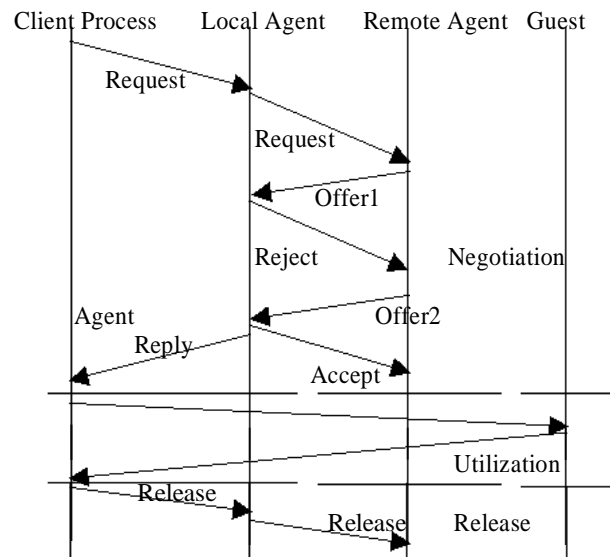


Fig.3. Negotiation and Utilization Messages

5. Finally, after establishing the new environment either with the help of active codes getting transferred or with the help of a distributed message communication model as described in the above step, UA informs GA, which in turn multicasts this new VPN node to rest all affected UAs. This is done to enable all UA to configure their local services to comply with the new topology of the VPN.

3.2 Active Quality Of Service Routing

Steps 3 to 6 of section 3.1.1 (Initial VPN provisioning) has been considered as Active QoS routing, which is based on the concepts of active networks, where the behaviors of network elements, such as routers and switches, can be modified and manipulated dynamically by injecting customized codes into the network elements. The basic functionality of active QoS routing is to find a network path to satisfy the given constraints that are required by the QoS requirements of a specific connection. In traditional routing, packets are delivered by using routing tables that are located on routers along the chosen route and the routing tables are formed only by the route information that is based on hops, source and destination address. But here selecting a path that provides QoS requires additional information, which are the traffic quality requirements such as bandwidth, delay, jitter and cost etc. In addition to the routing table, in AQR, the network elements also keep the state representation of the whole network or their sub-network and also with the

routing algorithms the best feasible route from a given source to a destination that satisfies the QoS constraints is chosen. In addition, most active QoS routing algorithms consider the optimization of resource utilization. Here we would like to introduce two of the AQR technologies.

One of the technologies is using Active Packet that is packet with a piece of executable code in its header. Basically, the idea of this technology is to find the best path according to QoS specifications by sending Active Packets from the source to destination, each time the first packet reaches the destination it sends a reply packet carrying the updated QoS and path information back to the source address. Thereafter, the subsequent packets will follow this path. With a certain interval, the Active Packets are sent again to detect the network state, then, the source may change the path according to the reply packet information.

The other one is using agent code at chosen routers through the network. Basically the agent is an independent executing code that can autonomously perform in response to events. With AQR, for the router to select the best path, the QoS parameters and traffic specifications are the most important factors, so these parameters are going to be kept in the agent routers' routing table. For example, the QoS parameters are residual bandwidth, loss probability, delay, Jitter, security status and cost etc. The traffic specifications can be categorized as video conferencing, FTP, email, audio stream and video stream or voice etc. As a result, the routing tables become multiplex and complex, which are called as search matrix as shown in the figures below.

Table 1. Search Matrix

	R0	R1	R2	R3
R0		R01	R02	R03
R1	R10		R12	R13
R2	R20	R21		R23
R3	R30	R31	R32	

In the above table, the entry R01 to R32 refer to the costs incurred by traffic delivering between two routers in the sub- networks, for example R01 is the cost of traffic from R0 to R1. The following table illustrates every kind of the cost. As shown below, the cost depends on the QoS requirements and the types of traffic. With all these information the router will decide which path is the optimal and effective route, but probably not the shortest path, for the specific traffic. Off-course, every connection will not include every cost, it depends on the grade of QoS service that this connection requests. Like the routing table in OSPF (Open Shortest Path First) algorithm, the matrices are going to be updated with a certain interval. Otherwise the rapid changing link parameters will cause incorrect routing decisions.

Table 2. Different Kinds of Cost for Different Traffic

	Bandwidth	Cost	Delay	Hops
Video-Conf	M00	M01	M02	M03
FTP	M10	M11	M12	M13
Email	M20	M21	M22	M23

3.2.1 Active Packet Format

An active packet is the basic entity on which the whole Active Network Infrastructure is built. The structure of this packet is as follows:

Seq No.	Type	Uniqueid
Groupid		pn
Data		

Fig. 4. Active Packet Format

SEQ NO is an integer field that denotes the sequence number of the packet. The protocol used for their transmission is UDP hence proper assembling requires some ordering as datagrams arrive out of order. TYPE field can carry binary values of 0 and 1, where Zero denotes that payload is some code while one denotes that it is either normal user data or data used by some code previously sent. UNIQUEID field is used to authenticate the packet as having a valid ID. The field is also helpful in constructing the filenames for various protocols sent by multiple users. GROUPID field assists the above field of uniqueid in verification and differentiating among protocols sent by multiple users over the network. PN is the priority number over of the packet. DATA is the normal user data. Only here it is wrapped around with another layer of headers for active identification of this packet.

These packets are wrapped in a UDP packet and sent for transmission. UDP is chosen to wrap it because the packet can itself control the reliability by the code in it. Also if the code is written in perspicacious manner the packets can also self-route itself based on the conditions imposed by the code & data placed in it. Here, the idea is to place intelligence in the packet, and not on the devices controlling the packet.

3.2.2 Server & Client Implementation

Server and client programs are used to send and receive active packets at various machines. Both the server and the client implementation are required at both the ends if they want to communicate. This is so because the nature of packet object is recursive, in the sense it can go to destination and try to contact back the master.

These two programs can be together called as the execution environment. The server process listens to connections from various hosts and receives packets from them. If they contain code then the packets are not only saved on the machine but also compiled and executed to change the behavior of the machine.

These daemons receive the active packets wrapped under the UDP cover. They open the UDP layer and read the active layer headers. Validate the packet. Set an environment with access restrictions as laid by the system administrator for these packets at that end host.

As shown in figure below, the execution environment consists of three processes namely daemon process, server process and client process, which are running together and using IPC (inter process communication) between them. First the daemon listens at UDP layer and picks up all active packets and delivers them to EE of the machine. The EE SERVER process of the machine understands the code in the packet. If valid the code is sent for further processing else the active packet is dropped. The EE manipulator segregates the packet into code and data and forks a copy of it. The child process exec's to load on the executor and executes the code inside the packet. If this packet has code, which demands for new packet formation and delivery, then the EE CLIENT side is used to frame such packets and deliver them to UDP via DEAMON process for delivery. The acknowledgements of the active packets are in turn active packets again and use the same EE CLIENT side process.

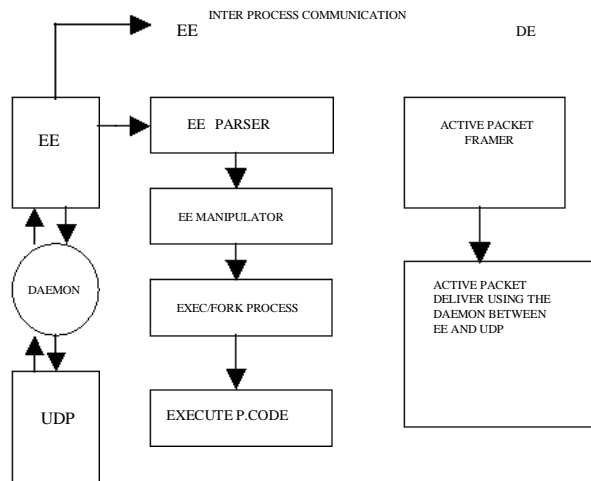


Fig. 5. Structure of Execution Environment

3.2.3 Route Optimization & Routing Agent

Route optimization is implemented using two QoS parameters i.e. bandwidth & cost of the link. Their tables are maintained as explained in one of the sections above on Active QoS routing. Routing Agent is a simple C code that is transferred using the client to server where it is assembled and installed. The routing agent queries the route optimization algorithm, giving it the destination and

asking it for next best possible router to move at. The Route Optimization code can be transferred prior to Routing agent on the routers on the path and installed over there using the active network scheme. The Routing agent just queries this to find the next possible position. The routing algorithm returns a structure called "routeLink" which has the information regarding the next IP to go to and bandwidth available along with the cost of the link. The routing agent also connects back to the home address to tell the current router specification where it is. As this initial packet follows the whole route it keeps sending the "communicator Packets" regarding the information of links it is traversing. The failure or loss of this initial packet shall not lead to catastrophic failure of the whole system as the information about the whole route is being queued at the end point.

As the information is built up at the end node the rest of the data packets can follow the route that is built up. After some time another routing agent can be sent to get the route, as changes are possible over the path because of ascertain behavior of the parameters on which the system is working.

4. Results and Conclusion

The Internet as of today does not support secure communication between a group of mobile users with minimal effort. We have considered the notion of PO-VPNs suggested in [4], an alternative form of VPNs whose aim is to provide an infrastructure for groups with special characteristics like short time to live, low population etc.. These PO-VPNs can be deployed on top of existing VPNs and offer customized services in a flexible, interoperable and cost effective way. We have implemented the active QoS routing (section 3.2) using Unix socket API. As a result of this implementation, we found a path for a VPN tunnel (between a mobile user and corporate office) satisfying the QoS requirements as demanded by the user's SLA. To fulfill the requirement of mobile user group, a virtual environment with the help of active networks and intelligent agents can be a better option as described in our approach. Also in our approach, an alternative to active networks is suggested, where for resource management in the new environment the agents can communicate with each other as described in step 4 of section 3.1.2. But this option is a slower one because of message communication overhead. This can only be preferred when we have access restrictions or security problems in supporting active networks concept. It can be seen that active networks have many advantages over the traditional networks to support QoS. Firstly, it is an adaptive scheme that can support many classes of services. Secondly, it is more scalable than RSVP and possible to develop a simpler architecture to enable QoS than using IntServ and Diffserv together. Thirdly, active networks support user-driven computation and provide more powerful way for user to shape the traffic for particular QoS requirements. As a future work, we plan to implement

a simulated environment for supporting mobile VPN users group under a legacy VPN set up which will include tunneling, and encryption algorithms as well. This will also embed our QoS routing part presented in section 3.2 (VPN path selection). Also we would like to analyze the performance of the VPN supporting mobile users when the number of mobile users is large.

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A Proposed Framework of Service Quality for a Hospital Visiting

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Abstract

This paper attempts to integrate concepts of service quality and in-depth interviews with experts master on hospital management or medical care to build a framework for influencing factors of service quality for outpatient clinical care and empirically explore it. Data are collected through a survey of a large-scale medical center located in a megalopolis area that is actively involved in research and development of medical care. Five dimensions of service quality are constructed as process of healthcare, waiting for inspection and administration, environment of clinical visiting process, hospital environment, and supporting personnel by Factor Analysis in this study. The dimension of waiting for inspection and administration included service quality of inspection units, waiting time for inspection and inspection documentation. To improve and to computerize inspection process might upgrade customer satisfaction. Waiting for a doctor diagnosis is included into environment of clinical visiting process, so a comfortable waiting corner and plenty of seats near to a diagnosis waiting room might reduce complaints of a long waiting time for a doctor diagnosis. The convenient transportation and enough parking spaces are important for clinical visiting a large-scale hospital located in a megalopolis area.

1. Introduction

In Taiwan, the amount of spending on healthcare has tremendously increased in the past few years. Although healthcare and medical treatment business generates more and more profits, a medical center still concern her market share within her geography area. How to enhance the service quality for increasing her market share and to retain the loyalty from original patients are become a big challenge for managers in most of medical centers. Researches have demonstrated the strategic benefits of quality in contributing to market share, return on investment, lowering operating costs, and improving productivity, so enhancing on service quality in healthcare can be a path to achieve the goal.

Market share and loyalty are related to satisfaction of a consumer expected service and perceived service, therefore, this research tries to cover the findings of studies on service quality. The research methodology is comprised of three approaches:

- (1). Literature review for building a Research Model.
- (2). In-depth Interviews with experts master on health management or medical care to validate and justify

the Research Model.

- (3). Questionnaire Survey based on the Research Model and Factor Analysis was used to explore the influencing factors of service quality for hospital visiting.

Goal of this research is hence to present the Research Model for influencing factors of enhancing service quality in a medical center. These factors may create valuable information for hospital administrators to build appropriate strategies for their businesses.

2. Literature Review

Research has demonstrated the strategic benefits of quality in contributing to market share and return on investment as well as in lowering operating costs and improving productivity [1, 10, 14]. Most of literatures on services suggest three underlying themes: (1) Service quality is more difficult for the consumer to evaluate than goods quality, (2) Service quality perceptions result from a comparison of consumer expectations with actual service performance, and (3) Quality evaluation are not made solely on the outcomes of a service; they also involve evaluations of the process of service delivery. Consumers compare the service they expect with perceptions of the service they receive in evaluating service quality. Researchers and managers of service firms concur that service quality involves a comparison of expectations with performance [2, 5].

Satisfaction is related to the size and direction of the disconfirmation experience where confirmation is related to the person's initial expectation [3, 7, 8, 11, 13]. Parasuraman, Zeithaml and Berry [12] attempted to obtain an extensive exploratory investigation of quality in four service businesses and by developing a model of service quality. A set of key discrepancies or gaps exists regarding executive perceptions of service quality and the tasks associated with service delivery to customers. Five gaps are (1) consumer expectation-management perception gap will have an impact on the consumer's evaluation of service quality, (2) management perception-service quality specification gap will affect service quality from the consumer's viewpoint, (3) service quality specifications-service delivery gap will affect service quality from the consumer's standpoint, (4) service delivery-external communications gap will affect service quality from a consumer's standpoint, (5) expected service-perceived service gap that a consumer perceives in a service is a function of the magnitude and direction of the gap between expected service and

perceived service. Expected service-perceived service gap depends on the nature of the gaps associated with the design, marketing and delivery of service.

Three quality dimensions are also proposed by researchers [5,9] as physical quality, which includes the physical aspects of the service (e.g. equipment or building); corporate quality which involves the company's image or profile; and interactive quality which derives from the interaction between contact personnel and customers as well as between some customers and other customers. Gronroos [5] also postulated that two types of service quality exist; technical quality, which involves what the customer is actually receiving from the service, and functional quality, which involves the manner in which the service is delivered. Research of Parasuraman et al. [12] also revealed that, regardless of the type of service, customers used basically similar criteria in evaluating service quality. The criteria seem to fall into 10 key categories which are labeled "service quality determinants". They are reliability, responsiveness, competence, access, courtesy, communication, credibility, security, understanding and tangibles. 10 important items of quality in healthy services are proposed by Hyde [6] as knowing the patient's needs, designing to meet them, faultless service, reliability, certified performance, clear instructions, suitable packing, punctuality, Efficient back-up service, and feedback.

3. Research Model

According to 10 key categories of "service quality determinants" revealed by Parasuraman et al. [12], several health managers and medical experts related to healthcare were selected for in-depth experts' interview to find resources for provide a satisfied healthcare service is summarized in Table 1. Based on the mapping between 10 key categories of "service quality determinants" revealed by Parasuraman et al and resources of healthcare service, an initial healthcare satisfaction model for a patient's hospital visiting is proposed as Figure 1. Expected service quality of healthcare is defined as the importance of a patient's cognitive feeling about hospital environment, waiting time and services from hospital resource during his visiting. Experienced Quality of healthcare is defined as the experience of services from hospital resource during his visiting. Degree of satisfaction is defined as the difference between the expected service quality and the experienced service quality of a patient during his visiting. Hospital environment includes public facilities and complaint solving by resources of healthcare service in Table 1. Patient attribute includes identify, gender, age, marital status, education, residency, occupation, clinic section visiting today, and reasons for this hospital visiting. Identity of a patient attribute is classified as patient himself, patients' family members or patient's accompanist. Resources of hospital and clinical operations related to each dimension in expected or experienced service quality were constructed by 10 important items of quality in healthy services which proposed by Hyde [6] and validated by in-depth

Table 1 Determinants and sources of service quality

Service quality determinants	Source of healthcare service
Access (approachability and ease of contact) -waiting time for services is acceptable -convenient office visiting hour	waiting time
Communication (keeping customers informed in language they can understand) -explaining the service thoroughly -complaint handling nicely	complaint solving
Competence (possession of the required skills and knowledge to perform the service) -knowledge and skill of service personnel -knowledge and skill of supportive personnel	medical staffing, supportive staffing
Courtesy (politeness, respect, consideration, and friendliness of contact personnel) -clean and neat appearance of personnel	medical staffing, supportive staffing
Credibility (trustworthiness, believability, honesty) -characteristics of service personnel -Attitude involved in interaction with customers	medical staffing, supportive staffing
Reliability (firm honors its promises, firm performs the service right the first time) -accuracy in billing -keeping records correctly	medical staffing, supportive staffing
Responsiveness (willingness or readiness of employees to provide service) -transferring patient's slips immediately -calling the customer back quickly	medical staffing, supportive staffing
Security (freedom from danger, risk, or doubt) -physical safety -confidentiality	public facilities, medical staffing, supportive staffing
Tangibles (the physical evidence of the service) -appearance of personnel -tools and equipment used to provide the service	public facilities, medical staffing, supportive staffing
Understanding/knowing the customer (the effort to understand the customer's needs) -learning the customer's specific requirements -providing individualized attention -recognizing the regular customer	medical staffing, supportive staffing

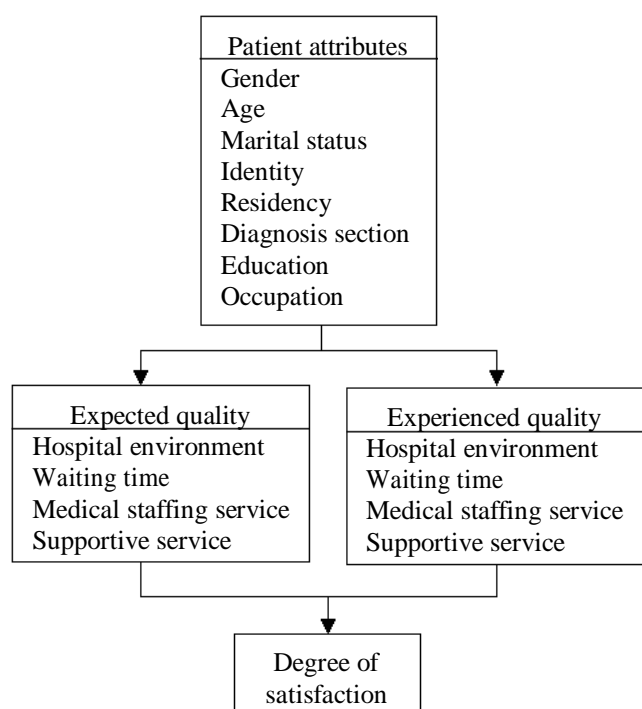


Figure 1 Initial hospital visiting satisfaction model

interviews with personnel of hospitals.

Excellent public facilities (public telephone, water fountain, toilet, etc), service quality of clinical appointment via phone are classified in hospital environment dimension. Waiting time of a patient's hospital visiting can be classified as service quality of clinical appointment via Internet, via personal register, or via clinic nurse, waiting time for a doctor's diagnosis, waiting time for payment billing, waiting time for blood drawing and urine checking, waiting time for X-ray, waiting time for medicine feeding. Medical staffing service includes doctor's medical skill, doctor's show up on time, doctor attitude, doctor kindly treatment, doctor's detailed diagnosis and explanation, nurse's friendly attitude, privately respected by nurses, convenient process for applying documentation of diagnosis or patient history, detailed descriptions for medicine taking. Supportive service quality includes registering windows, inspection operations, x-ray operation, Pharmacy, Q & A Desk, or complaint solving.

4. Primary Questionnaire Survey and Research Findings

A questionnaire with 33 questions was designed to conduct the initial framework of this study. Identity of a patient attribute is classified as patient himself, patients' family members or patient's accompanist. Residency is classified as city, countryside, or suburban, etc. Diagnosis section is defined as the diagnosis section that a patient is visiting today. Questions of the expected service quality operation are measured by five-point Likert scales to classify the degree of importance (4: absolutely important, 0: no influence), and five-point Likert scale of the experienced service quality during this visiting is used,

Table2 Reliability of the initial model

Item	Dimensions of clinic operation	Expected quality	Experienced quality
1—10	Hospital Environment	0.9006	0.8505
11—18	Waiting Time	0.8939	0.8166
19—27	Medical nursing service	0.9375	0.9002
28—33	Supportive Service	0.9025	0.8348

Table 3 Process of healthcare dimension

Item	Factor loading	Expected quality (Mean)	Experienced quality (Mean)	Satisfaction gap
Doctor's medical skill	0.72	3.71	3.21	-0.50
On time doctor's show up	0.75	3.47	3.03	-0.44
Doctor attitude	0.88	3.67	3.31	-0.37
Doctor kindly treatment	0.91	3.64	3.27	-0.37
Doctor's detailed diagnosis and explanation	0.89	3.70	3.17	-0.53
Friendly nurse attitude	0.80	3.56	3.23	-0.33
Privately respected by nurses	0.78	3.62	3.15	-0.47
Detailed descriptions for medicine taking	0.67	3.52	2.88	-0.64
Dimension total		3.61	3.16	-0.46
Eigenvalue	13.047			
% variance	39.538%			
Cronbach α	0.9228			

too. (4: Very satisfactory, 0: Very dissatisfactory).

The content of this questionnaire was constructed from literature reviews and in-depth interviews with several professors or experts who master on Hospital Management or Medical Care, thus validity of experts is acceptable. Data were collected through a survey of patients visiting different diagnosis sections with inspection operations and medicine feeding during their visiting in a large-scaled medical center in Taiwan. 700 questionnaires were delivered and 537 were collected (94.2%). 506 are considered effective (34.14%). For

Table 4 Waiting for inspection and administration dimension

Item	Factor loading	Expected quality (Mean)	Experienced quality (Mean)	Satisfaction gap
Waiting time for blood drawing and urine checking	0.69	3.07	2.64	-0.44
Waiting time for x-ray	0.75	3.05	2.70	-0.35
Waiting time for medicine feeding	0.64	2.99	2.58	-0.41
Convenient process for applying documentati on of diagnosis and patient history	0.70	3.24	2.71	-0.53
Registering windows service quality	0.81	3.19	2.65	-0.55
Inspection operations service quality	0.87	3.33	2.73	-0.60
X-ray operation service quality	0.82	3.31	2.78	-0.54
Dimension total		3.17	2.68	-0.49
Eigenvalue	2.917			
% variance	8.840%			
Cronbach α	0.8844			

examining the degree of satisfaction on hospital visiting, the number of effective questionnaire is reduced to 227 with effective answers in both sides. There are 91 from male patients and 129 from female patients. Pearson correlation analysis, Factor Analysis and Analysis Of Variance (ANOVA) are utilized to analyze the data. Pearson correlation analysis was also applied to validate correlation between the pairs of each two questions among 33 questions. Principal Components Analysis is used for extracting dimensions with eigenvalue > 1 and Promax. Level of significance is all up from 0.05 to 0.01, so Promax method in Factor Analysis was selected. ANOVA analysis and T test is used to test hypotheses. The reliability Cronbach's α for each dimension in the initial research model are shown on Table 2.

Five dimensions are extracted; they are named as process of healthcare, waiting for inspection and

Table 5 Environment of clinical visiting process dimension

Item	Factor loading	Expected quality (Mean)	Experienced quality (Mean)	Satisfaction gap
Comfortable and plenty seats in the waiting room	0.67	2.93	2.69	-0.25
Clearly sign for position of clinic	0.70	3.30	2.77	-0.53
Completely health facilities	0.76	3.63	2.98	-0.65
Perfectly public facilities (public telephone, water fountain, toilet, etc)	0.67	3.20	2.72	-0.48
Service quality of clinical appointment via phone	0.65	3.25	2.90	-0.35
Service quality of clinical appointment via personal register	0.63	3.11	2.58	-0.53
Service quality of next clinical appointment via nurse	0.70	3.15	3.00	-0.14
Waiting time for doctor visiting	0.64	3.18	2.41	-0.76
Waiting time for payment	0.63	2.99	2.48	-0.51
Dimension total		3.19	2.73	-0.47
Eigenvalue	1.843			
% variance	5.584%			
Cronbach α	0.8843			

administration, environment of clinical visiting process, hospital environment, and supporting personnel. The results were presented from Table 3 to Table 7 by each dimension. According to the results of tables, a proposed hospital visiting satisfaction model is reconstructed as Figure 2. Six primary hypotheses are also addressed from this proposed research model and shown in Table 8. Testing of the hypotheses was carried out via

Table 6 Hospital environment dimension

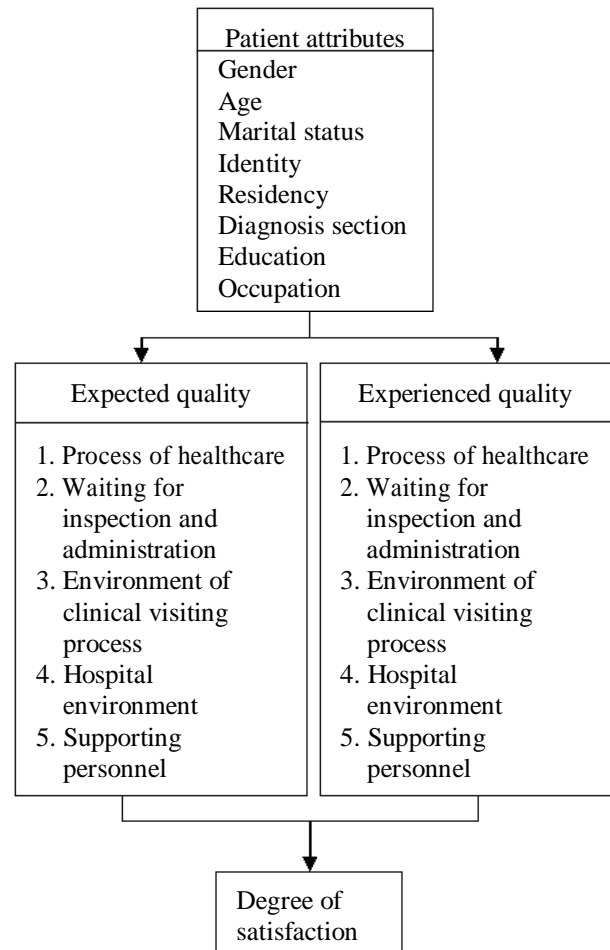
Item	Factor loading	Expected quality (Mean)	Experienced quality (Mean)	Satisfaction gap
Convenient transportation	0.61	2.98	2.40	-0.58
Enough parking spaces	0.64	3.14	1.66	-1.48
Brightly light	0.83	3.16	2.74	-0.42
Cleanly environment	0.85	3.45	2.74	-0.72
Moderately air-conditional	0.75	3.17	2.77	-0.41
Dimension total		3.18	2.46	-0.72
Eigenvalue	1.508			
% variance	4.568%			
Cronbach α	0.7988			

ANOVA and T Test; the summaries of analysis are shown on Table 9 and Table 10.

In a significant level of 0.05, the results of T test indicate that patients with different gender have significantly different expected service quality for process of healthcare, for waiting for inspection and administration, for environment of clinical visiting process, and from supporting personnel. Female patients have higher expectation of service quality for these four dimensions than these for male patients. Results of T test also reveal that patients with a different resident location have significantly different expected service quality for hospital environment; experienced service quality for process of healthcare, and experienced service quality from supporting personnel.

Table 7 Supporting personnel dimension

Item	Factor loading	Expected quality (Mean)	Experienced quality (Mean)	Satisfaction gap
Service quality of clinical appointment via Internet	0.62	2.90	2.80	-0.10
Pharmacy service quality	0.78	3.30	2.75	-0.54
Q&A service quality	0.79	3.25	2.92	-0.33
Complaint solving	0.76	3.26	2.65	-0.60
Dimension total		3.17	2.78	-0.39
Eigenvalue	1.304			
% variance	3.951%			
Cronbach α	0.7963			

**Figure 2 Proposed hospital visiting satisfaction model**

Patients who lived in city have a higher expected quality of hospital environment than one who doesn't live in city. In the other words, patients who don't live in city have a higher experienced quality for process of healthcare, from supporting personnel than one who lived in city. In other words, patients who don't live in city that the hospital located have a higher degree of satisfaction. The reason is the shortage of parking lots and traffic jam around the area that the hospital located.

Results of ANOVA analysis denote that patients with a different occupation have significantly different expected service quality for process environment of clinical visiting, and experienced service quality of waiting for inspection and administration. Patient whose occupation belongs to business or industry has a lower expected service quality for environment of clinical visiting process than one with other occupations. And a public official has a lower experienced service quality of waiting for inspection and administration than one with other occupations. In the other words, public officials feel waiting for inspection and administration during his hospital visiting longer than what he expects, but students are willing to wait for longer during their visiting. Results also indicate that patients attending a different diagnosis section have significantly different expected service

Table 8 Hypothesis testing

Hypothesis		Accept
Hypothesis 1: No significant difference between gender on the expected service quality		
1-1	No significant difference between gender for process of healthcare	No
1-2	No significant difference between gender for waiting time	No
1-3	No significant difference between gender for environment of hospital visiting process	No
1-4	No significant difference between gender for hospital environment	Yes
1-5	No significant difference between gender from supporting personnel	No
Hypothesis 2: No significant difference between resident location on the expected service quality		
2-1	No significant difference between resident location for process of healthcare	Yes
2-2	No significant difference between resident location for waiting time	Yes
2-3	No significant difference between resident location for environment of hospital visiting process	Yes
2-4	No significant difference between resident location for hospital environment	No
2-5	No significant difference between resident location from supporting personnel	Yes
Hypothesis 3: No significant difference between resident location on the experienced service quality		
3-1	No significant difference between resident location for process of healthcare	No
3-2	No significant difference between resident location for waiting time	Yes
3-3	No significant difference between resident location for environment of hospital visiting process	Yes
3-4	No significant difference between resident location for hospital environment	Yes
3-5	No significant difference between resident location from supporting personnel	No
Hypothesis 4: No significant difference between occupation on the expected service quality		
4-1	No significant difference between occupation for process of healthcare	Yes
4-2	No significant difference between occupation for waiting time	Yes
4-3	No significant difference between occupation for environment of hospital visiting process	No
4-4	No significant difference between occupation for hospital environment	Yes
4-5	No significant difference between occupation from supporting personnel	Yes

Table 8 Hypothesis testing (cont.)

Hypothesis		Accept
Hypothesis 5: No significant difference between occupation on the experienced service quality		
5-1	No significant difference between occupation for process of healthcare	Yes
5-2	No significant difference between occupation for waiting time	No
5-3	No significant difference between occupation for environment of hospital visiting process	Yes
5-4	No significant difference between occupation for hospital environment	Yes
5-5	No significant difference between occupation from supporting personnel	Yes
Hypothesis 6: No significant difference between diagnosis section on the expected service quality		
6-1	No significant difference between diagnosis section for process of healthcare	Yes
6-2	No significant difference between diagnosis section for waiting time	Yes
6-3	No significant difference between diagnosis section for environment of hospital visiting process	Yes
6-4	No significant difference between diagnosis section for hospital environment	Yes
6-5	No significant difference between diagnosis section from supporting personnel	No

Table 9 T test summary

Item	T	Sig. (2-tailed)
Gender vs. expected service quality for process of healthcare	-2.10	0.037*
Gender vs. expected service quality for waiting time	-2.19	0.030*
Gender vs. expected service quality for process environment of hospital visiting	-2.29	0.023*
Gender vs. expected service quality from supportive personnel	-2.57	0.011*
Resident location vs. expected service quality for hospital environment	2.65	0.009**
Resident location vs. experienced service quality for process of healthcare	-2.00	0.047*
Resident location vs. experienced service quality from supportive personnel	-2.00	0.046*

Note: *. Alpha is significant at the 0.05 level (2 tailed).

**. Alpha is significant at the 0.01 level (2 tailed).

quality from supporting personnel. Patients visiting Pediatrics, Obstetrics and Gynecology sections have a higher expected service quality from supporting personnel than one visiting other sections. So, service quality training is needed to enhance in these two departments.

Table 10 ANOVA summary

Item	F	Sig. (2 tailed)
Occupation vs. expected service quality for environment of hospital visiting process	3.646	0.003**
Occupation vs. experienced service quality for waiting time	2.615	0.026*
Diagnosis section vs. expected service quality from supportive personnel	2.760	0.043*

Note: *. Alpha is significant at the 0.05 level (2 tailed).

**. Alpha is significant at the 0.01 level (2 tailed).

5. Conclusion

A hospital visiting satisfaction model is proposed by literature reviews, medical experts' in-depth interviews, and an experimental study in this research. Five dimensions of service quality are constructed as process of healthcare, waiting for inspection and administration, environment of clinical visiting process, hospital environment, and supporting personnel. The dimension of waiting for inspection and administration included service quality of inspection units, waiting time for inspection and inspection documentation. To improve and to computerize inspection process might upgrade customer satisfaction. Waiting for a doctor diagnosis is included into environment of clinical visiting process, so a comfortable waiting corner and plenty of seats near to a diagnosis waiting room might reduce complaints of a long waiting time for a doctor diagnosis. The convenient transportation and enough parking spaces are important for clinical visiting a large-scale hospital located in a megalopolis area.

The findings of this study reveal female patients have higher expectation of service quality for process of healthcare, for waiting for inspection and administration, for environment of clinical visiting process, and from supporting personnel than these for male patients. Patients who don't live in city that the hospital located have a higher degree of satisfaction. Public officials feel waiting for inspection and administration during his hospital visiting longer than what he expects, but students are willing to wait for longer during their visiting. Service quality training is needed to enhance in Department of Pediatrics and of Obstetrics and Gynecology.

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An Architectural Framework of a Decision Support Platform for e-Business

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Abstract

The rapid development of e-Business urges the need for online integrative partnership and collaborative business process management. These trends call for a new dimension of decision support: online multiplicative decision interoperability. We define it as a decision support platform for e-Business, which facilitates inter-organizational decision making process allowing dynamic partnership. As it is not the common decision support system we familiar with, we propose a new architectural framework of this decision support platform. This framework carries a set of unique characteristics that should be incorporated in the design and development of such platform.

Keywords: decision support system, inter-organizational system, e-Business, platform

1. Introduction

World Wide Web revolutionizes business trading, from a reactive information based e-commerce portal in the early 1990's, to the interactive buy-sell e-commerce website of mid 1990's. At the beginning of the 21st century, business-to-business e-commerce further foretells the impact of Internet technology deep into the core business of every industry. A new dimension – integrative website – is beginning to emerge [15] [17]. Coupled with interactivity, websites seek to develop capability to integrate business processes online. This new integrative era witnesses the emergence of e-Business processes such as e-supply-chain-management, e-collaboration and e-reengineering. The online management of e-Business is needed. For example, a management e-Platform for the logistics industry is being proposed [15] [16]. One issue that is critical to the integrative era is how to enable decision making in the dynamic electronic environment where partnership is formed and collaborative management of cooperating business processes is conducted.

Online decision support system is still at its infancy for corporations. The design of an online decision support (DS) for e-Business requires a different approach to that of a stand-alone DSS [4] [23]. We believe that online DS is likely to play a significant role in the next phase of e-evolution. Particularly, DS is a key to the provision of online knowledge management and sharing, a critical

e-Business process of the future. As companies leverage the knowledge-rich Web to conduct effective e-Business processes, websites with knowledge management capability will proliferate. Companies and industries will need to re-engineer their internal and external processes to tap into this powerful resource.

In this paper, we investigate the nature of decision making process in this new emerging era where online e-Business prevails. Online decision support takes on a different identity in the new electronic environment (e-environment) where needs and situations are dynamic. We call this new decision support apparatus the e-DSP. E-Decision Support Platform is a platform where decision support is enabled within this e-Business operating environment. In the following sections, we first describe the current business environment on the web and the needs that arise. We then develop the underpinning of the role of e-DSP. Characterization of e-DSP will follow with a proposed architectural framework for technical design consideration.

2. New e-Business requirements

As the development of e-commerce has become well established, the business world is now focusing on how to enable e-Business. With effective e-Business, a company can strengthen and improve customer relationships, streamline supply chain, automate processes, improve efficiencies, flexibility, scalability and availability [28]. Therefore, everyone is fascinated to join the e-environment. This accelerated participation quickens the emergence of new requirements in e-Business, especially in the decision support realm. A new dimension of decision support emerges – no longer as singular in nature as traditional DSS, but as a multiplicative partnership in an e-Platform environment. An e-Platform is a virtual space where participants conduct any-to-any interactive activities. Two key contributing e-Business trends to this e-decision support platform, or e-DSP, will be discussed next.

2.1 Collaborative business model

In the 21st century, companies believe specialization and outsourcing is one way to make their business success and long lasting. Thus, companies tend to emphasize on their core competencies and reduce operating costs by

outsourcing them to strategic partners who have top talent and state-of-the-art technology [2]. Closer collaboration among companies greatly increased with Web technology, creating a need for online management of business processes. This collaboration, working together with intellectual efforts, highlights the needs and difficulties of system integrations between different companies. This kind of system integrations becomes more complicated if they need to make decision together dynamically. There is no existing organizational management systems can support this new model of business practice.

2.2 Dynamic alliance

World Wide Web also gives companies opportunities to reach and contact companies and customers all over the world. In other sense, each company now also face with plenty competitors worldwide. Many companies realize that forming fixed partnership with few companies can no longer tackle the fast pace and on demand business environment. Instead, ad hoc companies tend to temporarily chain up to fulfill the requirement of an e-Business process so as to collaboratively satisfy the customer's needs and maintain their individual competitiveness in this market. Undoubtedly, during this partnership formation, decision making processes are plenty and diversified. Also, the membership of the partnership stabilized most likely after rounds of online strategic positioning and BCR evaluation (optimization steps individually and globally with respect to the partnership). The traditional DSS still can maximize the benefits for a single corporation, but no long can meet the demand of this new multiplicative decision making in an electronic environment. Conclusively, the necessity of a new approach to facilitate consensual decision making among collaborating partners is needed. The approach must solve three key issues that we will describe next.

3. Multiplicative decision making issues

The singular nature of traditional DSS can no longer be able to handle the multiplicative needs of online e-Business management. There are three key issues that one needs to deal with:

3.1 Multiplicity of Business Processes Needs to be Managed

Due to the competitive nature of business world, people began to realize that it is definitely not enough to focus on their own solely. They recognized that collaboration - sharing resources with intellectual effort - between different parties is a very important practice for them to survive in this new economy. This collaborative measure allows companies to develop shared vision and build

interdependent system to address issues and opportunities [6] [12] [26]. As a result, many single business models are linked up and integrated to form a value chain in order to satisfy customer's needs - a chain of multiplicative business processes. Moreover, the time lag between the downstream request and the upstream response has to be minimized. However, the reality is that different companies are running their own systems with totally different design and languages. This incompatibility makes integration online complicated, let alone integrative decision making. It takes designers and solution providers great deal of effort trying to link up different systems with success only in a few EAI and information systems [14] [22]. There is not yet any real-time and efficient inter-organizational system integration emerges. As most of the designers and solution providers are still struggling with the application integration; they are far from dealing with the online decision integration.

3.2 A Common Goal Needs to be Derived for Partners' Consensus

Today, things are no more as simple as one company face one type of customer with the support of one supplier. Many value chains are formed in e-Business practice. In this kind of chains, each party plays the role of a customer, a company and a supplier at the same time. Decisions involved in each role can be totally different and sometimes conflicting. This gives rise to a conflict of interests. First, all decision-making processes are inter-related in the value chain processes. Each process is affected by both its customers and suppliers. Next, it is also affected by its multiple roles playing in this chain. It becomes much more difficult to handle if the conflicts comes from each company is actually having different goals on the process. Therefore, a reliable conflict management tool across companies is needed to facilitate individual parties arrive at a mutually acceptable common goal. This idea also has similar view with Dr. Hua Lee's belief that an intelligent e-market, one kind of the e-Business processes, should have decision support systems to evaluate alternative contract terms, and facilitate both parties to come to agreements quickly [13].

3.3 An Integrative Partnership Needs to be Reached

With e-Business, the composition of partners is evolving online with the purpose of matching and optimizing of partnership. We address this as integrative partnership. This partnership needs collaboration with people and systems from various part of the world with different knowledge background. Such collaboration is required to occur towards real time, ad hoc, dynamic, multi-directional flows of data and information. Dynamic

collaboration also implies the partnership changes as the formulation of a business deal is in progress. Many processes involve a number of different partners participation, and most of the time they are making their own decision without knowing others decision. Therefore, a decision-making tool that facilitates various parties make decision collaboratively is critically necessary.

4. Defining of e-DSP

In here, we propose a platform for decision support in an electronic environment, or e-DSP, to provide the solution to a multiplicative decision making need. An e-DSP is a virtual platform that allows participants in e-Business to individually and collectively to make the best decision. e-DSP provides the necessary tools and mechanism to facilitate this decision making process online, on-demand and real-time. e-DSP has these key features – 4th party, net-enabled web environment, collaborative business process management, integrated decision making process and integrative partnership.

First of all, it must facilitate various companies group together dynamically to make decision. Next, unlike the traditionally DSS [4] which only focus on individual benefits, it must help all the parties involved in the decision making process to arrive an agreement by providing choices which benefit everyone. At the same time, it also needs to help resolving inter-organizational conflicts brought on by the business in an e-environment. Such decisions sport a different identity and demands different attentions, creating a genre of its own. Considering the nature of such decisions making processes, it can be very complicated which definitely cannot be solved by a single DSS. Instead, as it requires different parties' involvement along the whole process, a platform design will be more appropriate.

As the purpose of this platform is to facilitate various parties make decision, it does not have real participation or interest on particular decision. Thus, we propose a 4th party e-Decision Support Platform (e-DSP), a decision infrastructure that allows online business process and decision integration so as to facilitate inter-organizational decision making with dynamic partnership.

To the best of our knowledge, there is no existing conceptualization of such a platform for decision support. There are ongoing research related to this approach by Leung [15] [16] [17]. In the next section, we will provide a guiding architectural framework for the technical design and implementation of such e-Platform.

5. Design of e-DSP – An Architectural Framework

Our e-DSP design is based on two aspects: DSS and inter-organizational environment with partnership

formation. First of all, it should inherit all the basic DSS functions. After studying the trend of DSS development [1] [7] [20] [21] [23] [27], the most similar model to e-DSP is the distributed DSS stated by Pinson in 1997. They included diversified expertises, multi-agent approach, global goal and sub goal concepts, conflict resolution mechanism which all are relevant to our study [20]. However, its target users are still within one organization or enterprise, their global goal and sub goals have similar aims and it is the top management to make the final decision. In addition, Markus[9] also suggested a organizational decision process pattern : Emergent Knowledge Process (EKP). It is an emergent process of deliberations with no best structure or sequence with highly unpredictable potential users and diversified information requirements [9]. Although there are some similarities between EKP and e-DSP, they are quite different from the design purpose. EKP is designed for organizational users with no prior knowledge, so the system must implicitly guide users to desirable direction based on general principles. While e-DSP is designed for inter-organizational decision makers with different level of prior knowledge and there is no restrictions or guides to the desirable solution. On the other hand, the use of AI tools was also mentioned by Nikos [11], who gave a more detailed description on how to combine AI tools and OR techniques in an open GDSS. Their findings provide us some understanding on how to combine various DSS tools into one enterprise context. Next, Saxton [25] and Paul B [18] suggested the third party roles play in the decision making and cyberspace respectively. Saxton suggested 3 roles: expert, provocateur and legitimizer [25]. Paul suggested 4 roles: cybermediaries, cybercommunication, reputation tracking and online mediation arbitration of disputes [18]. As the e-DSP is a 4th party platform, it should facilitate and support 1st to 3rd parties work on it. Thus, we include some of the roles suggested above into the e-DSP design, while for the other roles, we will make use of the existing 3rd party applications which provide those service.

e-DSP should also adopt the current technology and system design for inter-organizational e-Business [5] [8] [10] [19] [24]. Both Marielle[8] and Gyeung-Min[5] mentioned about architecture for inter-organizational coordination, but not inter-organizational collaboration. Later, Finnegan[3], suggested an inter-organizational System (IOS) planning proposal which clearly suggested how to form such kind of system and define individual organization's role, yet the incorporation of an essential element: DSS needed to be introduced. Thus, a new framework is proposed. The architectural framework is intended as a reference for technical design consideration, providing a guiding approach of key system components to implement.

5.1 The e-DSP Architectural Framework

e-DSP is formed by three components: a supportive data store, a analysis model and a collaborative and integrative decision model as shown in Figure 1. First, inherit the structure of traditional DSS and the characteristics of a decision supported by IT, e-DSP also consists of the basic data store and analysis models to support decision making process. It also can make use of the information and analysis model supplied by other companies. Whereas the most important and new component is the collaborative and integrative decision model. It comprises of three features: collaborative business process management, integrated decision making process and integrative partnership which is a optional part. In the next section, we will further characterize this new component.

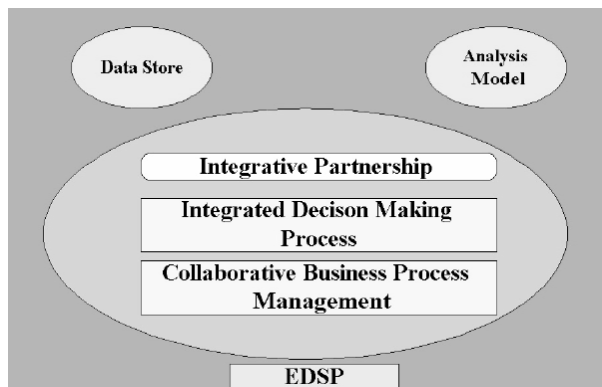


Figure 1. e-DSP architectural framework

5.2 Characterization of collaborative and integrative decision model

Here we characterize the new component according to the following three features: collaborative business process management which facilitate inter-organizational business and decision making process integration in a timely manner with reliable result; integrated decision making process which facilitate collaborative decision making with ability to perform integration and conflict resolution; integrative partnership which allow various companies group together dynamically to make decision by chaining up different companies and DSS with e-DSP dynamically.

1. Collaborative Business Process Management

This feature has the following characteristics:

- Process Integration: For some business processes which involve decision making, e-DSP should able to integrate with different decision and analytical tools from various DSS by understanding their decision and range of acceptance so as to know where can improve or adjust.
- Process Synchronization: With process synchronization, various systems or human can understand and coordinate with each other dynamically through the web in making the

decision. It also need to set stage parameters and attributes for decision making and keeps track of progress. Sometimes, e-DSP has to facilitate and mediate so as to help them arrive at a common decision.

- Process automation: Time has become very critical as customers are having high expectation and requirements on providers with very low tolerance on waiting. Therefore, process automation by standardization and agreement can accelerate the whole process.
- Fulfillment Trust: With such dynamic partnership building, all participants must build trust other partners in the group that each one has the capability to fulfill the task distribution based on the decision made. This trust establishment is very important because if only one of participants fail to complete the task, it brings to the failure of the whole chain. With this trust, we can ensure the reliability of the business decision making.

2. Integrated Decision Making Process

It includes a set of mechanisms which consists of two main parts:

- Complex Goal-oriented: the nature of problems that e-DSP helping to solve always comprises of global goal and sub goals which involved different parties' benefits. Therefore, it must have the ability to separate them by applying its knowledge and intelligence to identify their inter-relationship and dependence. In order to meet this need, it must equip with various decision tools and optimization methods to find out the best decision. With this, participants with different knowledge background can also make use of it to make decision together.
- Guided Conflict Resolution: It should adopt the various conflict management techniques, like those mentioned in [20], in order to solve problems produced by single goal and global goal towards a business process. It should be able to identify and detect the conflict areas with respect to different parties. It should also have a defined mechanism which set steps and stages for solving the conflict.

3. Integrative Partnership

This feature has the following characteristics:

- Any-to-any Interaction: Allow interaction among more than one and non-determinant number of parties by having an open public communication channel with the ability to uniquely identify each one dynamically on the web.
- Dynamic Group Morphing: With reference to IOS planning processes stated by Finnegan in [3], different parties can dynamically group up together on the web in order to serve specific customer's need. Each chain is unique and only valid for duration of particular business or job. Thus, a company can have different role in different business processes. e-DSP must support any number of participants, human or agents forming groups in various ways: sequential chains, webs or networks.

Besides the above characteristics, there are still other

points needed to take into considerations while designing and implementing such platform, they are mentioned in the next section.

6. Remarks

The neutrality nature of e-DSP is apparent from its 4th party structure. The role of each participant and their relationship with each other must be transparent to the e-DSP, and in some cases, for all partners. e-DSP is built for a web-based environment, it is assumed to equip with all the current computer and web technologies. These technologies facilitate e-Business activities and encourage collaboration and integrations between partners. Yet we need to further investigate so as to make improvements on the stability, interoperability and reliability of channel establishment, data communication between partners.

With a general understanding of e-DSP's characteristics we believe that it is indispensable to the development of e-Business by facilitating collaborative decision making with dynamic partnership. The framework provides technical design to develop such decision platform with respect to different industry needs. We will explore the current and emerging technology required to implement this platform.

7. Reference

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Proposing a Paradigm for e-Collaboration

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Abstract

E-Collaboration has been attracting more and more attention and interest of academic researchers and industry practitioners. However, the paradigm of e-Collaboration has yet to be established. Various researches often incline to label subjective research studies relate to inter-organization interaction or integration with the hot title. To clarify terminology used and to remove ambiguity on e-Collaboration, the paper aims to provide a cohesive framework of e-Collaboration from the perspective of inter-organizational integration. The framework highlights the core feature of e-Collaboration—joint intellectual efforts, which has been neglected by existing studies. Moreover, a mathematical modeling approach is further used to illustrate the differences among each levels of integration in a two-party context. The descriptive and modeling approaches both attempt to establish a paradigm for e-Collaboration. And the future research directions will be indicated based on the paradigm.

Keywords:

e-Collaboration, Integration, Paradigm

1. Introduction

Several related concepts appeared under the umbrella of collaboration, such as e-Collaboration and collaborative commerce, attracting more and more attention from academic researchers and practitioners [9] [11] [15] [25] [26]. However, there is no consensus of what e-Collaboration is. Different interpretations lead to difficulty in the differentiation of related concepts such as cooperation, contribution, coordination, cooperation and collaboration. A paradigm of e-Collaboration must be established.

As we all know, the incommensurability of paradigms is crucial to the development of scientific theories. “Scientists who pursue different paradigms are, in a sense, living in different worlds.” They cannot communicate nor share insights on “the problems to be solved, the theories to be employed, or the terminology to be used” [1] [20]. Hence, to benefit the pullulation of e-Collaboration in electronic environment, an agreeable and acceptable paradigm of e-Collaboration is needed to facilitate idea communication, theory development and knowledge accumulation within the research community.

The paper firstly surveys the current views on

e-Collaboration. Consequently we attempt to bring the diverse views into a unified framework of e-Collaboration, based on levels of inter-organizational integration. And a mathematical modeling approach is further used to illustrate the details of framework in a two-party context. Both descriptive and mathematical illustrations of e-Collaboration framework provide concrete theoretical foundation for paradigm of e-Collaboration. Furthermore, the framework can be used to organize current research findings and share insights on future directions.

2. Literature Review

2.1 Importance of e-Collaboration

Collaboration plays a major role in many differing business processes. Various research on collaboration spanned across topics that include manufacture production [3] [7] [21], supply chain management, logistics management [6], process reengineering [8] [24]. Highly competitive markets impose new requirements on inter-organizational relationship among ventures [4] [17]. Especially those processes that now operated in an electronic environment, online inter-organization activities often involve various degrees of e-collaboration. Such collaboration involved sharing of information, resource, risk and responsibility should be achieved in a more effective and efficient manner using electronic means. The success of inter-organizational systems [13], a kind of implementation of e-Collaboration, for example, is essential for co-operative ventures in electronic environment.

2.2 Diverse views of e-Collaboration

Although quite a number of researchers have offered their insights on e-Collaboration, few have directly indicated a specific definition. A common understanding has not been reached. Pinsonneault and Kraemer [25] and Dasgupta et al. [10] referred to “collaboration among individuals” as they are being “engaged in a common task using electronic technologies.” Blevins [23] highlighted the newness of e-Collaboration as “electronic automation of collaboration interactions”. And Lee and Whang [22] specifically took e-collaboration as an application of e-business existing in such functions as information sharing, collaborative decision-making and product change management. However, the diverse views mainly

consider e-Collaboration as simply a sum of collaboration and electronic technologies and do not indicate or expose the core feature of collaboration. More importantly, “common task” is not the sufficient condition of e-Collaboration. And we cannot classify some process or applications in the scope of e-Collaboration simply based on its using in information sharing, collaborative decision-making or electronic automation of collaboration interactions. The above interpretations contribute to understand some features of e-Collaboration, but they do not touch on the essential feature of e-Collaboration, joint intellectual efforts. And the problem of using the same term to indicate different levels of interaction, limits the ability to compare, and build or improve, on existing concepts.

Existing studies pay little attention on the different levels of integration, and the outcomes based on various kinds of technologies with respective to integration could not be collectively claimed as impacts of e-Collaboration. Lefebvre et al. [23] assessed the impacts of the eight so-called web-based collaboration tools on innovativeness and performance of firms in a telecommunications equipment supply chain. However, these tools facilitate the enforcement of the different levels of integration, not sole for collaboration.

In addition, research on taxonomies and classifications of e-Collaboration systems embodied most information systems, and classified the systems in such dimensions as technical consideration, group issues, application, time/space, etc., but do not in the perspective of integration [2] [19] [12]. Such classifications further deepen the diversity of views on e-Collaboration.

3. A Framework of e-Collaboration

To begin our attempt to conceptualize the idea of e-Collaboration, we base our development on the insights of Taylor-Powell [26]. They contributed an important edification on interpreting the concept of collaboration in an intact framework—integration. They ranked communication, contribution, coordination, cooperation and collaboration by the different extents of integration and preliminarily described their differences. To allow a clear differentiation of different efforts in collaboration, the specialties of each level must be established. A framework of e-Collaboration will be proposed to clarify terminology used and to remove ambiguity on e-Collaboration. An essential uniqueness in our approach is the specification in the framework for e-Collaboration — joint intellectual efforts, a feature that is not considered by existing research in imprudence.

3.1 Levels of Integration

In our framework, communication is the lowest level, supporting dialog and common understanding in general. Contribution benefits participant parties by mutual support based on communication. And coordination integrates parties in deeper extent by matching needs and adjusting activities. To achieve common goals, higher

integration — cooperation is required by parties. When the demanding requirements deduce the joint intellectual, comes collaboration and e-Collaboration in electronic environments.

Thus, e-Collaboration can be referred to the process of working together with joint intellectual efforts in electronic environments. Information technologies are used to facilitate the parties to work together and to contribute joint intellectual efforts. And the benefits of e-Collaboration are, for example, to facilitate the offering existing or newly created common products or services with reallocation of controlled resources, even with new production skills or marketing methods.

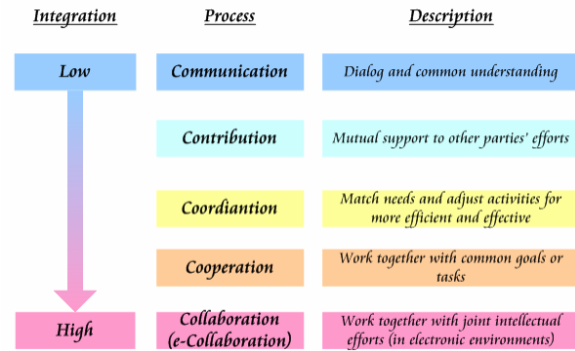


Figure 1: Description of Levels of Integration

However, researchers may hold different interpretations on common understanding, mutual support, working together or joint intellectual efforts. Thus, we develop a cohesive interpretation by using mathematical modeling approach, to delineate the different levels of integration and to quantify the activities within each.

3.2 Mathematical Modeling

Assumption

Let us assume two parties integrate to maximize the respective sum of individual outputs originally. Each of them produces the products or services by some specific production skills with the controlled resources as inputs. Let: B_i denotes the vector of resources of party i ; X_i denotes the vector of outputs of party i ; and A_i denotes the matrix of coefficient of production of party i ($i=1$ or 2 , in this case).

Then the decision making of production of each party can be modeled in L-P equations.

$$\begin{aligned}
 \text{Max } Z_1 &= f_1(X_1) & \text{Max } Z_2 &= f_2(X_2) \\
 \text{s.t. } A_1 X_1 &\leq B_1 & \text{s.t. } A_2 X_2 &\leq B_2 \\
 \text{or } A_1 X_1 + C_1 &= B_1 & \text{or } A_2 X_2 + C_2 &= B_2 \\
 C_1 &\geq 0 & C_2 &\geq 0 \\
 B_1 &\geq 0 & \text{and } B_2 &\geq 0
 \end{aligned}$$

Where C is the slack variables of the L-P equations.

Modeling Communication

Communication in electronic environments can establish common understanding on some terms or facts. Thus, it can be abstracted as exchanging and

understanding declaration of variables in our model.

Modeling Contribution

With the contribution mechanism, parties involved in integration can share their information by exchanging some values of common variables. These exchanged values can support parties to make decision more efficient and effective. A better optimal solution of L-P equations can be reached, compared to the stand-alone situation. Such level of integration—contribution, has been shown to have positive impacts and benefits for parties, e.g. on information sharing in supply chain.

Modeling Coordination

Coordination mainly focuses on finding out feasible solutions on adjustment of activities, removal of duplication, or allocation of resources to improve the performance of resource usage. In L-P modeling, the possible degree of adjustment of resources is represented by the scale of slack variables.

Modeling Cooperation

Cooperation refers to working together with joint goals. Thus it is logical to deduce that the objective functions of two parties must have at least one common component to denote the existence of joint goals. And both should reallocate their controlled resources beyond the limitation of slack variables to meet the requirements of joint goals.

Modeling Collaboration

Collaboration differs to other levels of integration in incorporating joint intellectual efforts. In producing products or offering services with controlled resources and skills on hand, the joint intellectual efforts can be shown specifically in creating new joint products or new services (X_4), generating or enrolling new production skills (A_4), coming up new marketing methods to joint products or services (F), and optimizing the production process of joint outputs.

Consequently the variables need to be redefined to show the possible change of collaboration. X_1 will be divided into X_{11} for local products, X_{13} for existing common products and X_{14} for new created common products. So will X_2 as X_{21} , X_{23} and X_{24} . Then the common output X_3 is the sum of X_{13} and X_{23} , and X_4 the sum of X_{14} and X_{24} . Concurrently f_1 may break into f_{11} and f_{13} , f_2 into f_{21} and f_{23} , B_1 into B_{11} for local products and D_{12} for common products, and B_2 into B_{21} for local products and D_{22} for common products. Therefore, the optimization of common products is

$$\begin{aligned} \text{Max } & f_3'(X_3) + f_4'(X_4) \\ \text{s.t. } & A_3'(X_3) + A_4'(X_4) \leq D_{12} + D_{22} \\ & 0 \leq D_{12} \leq B_1 \\ & 0 \leq D_{22} \leq B_2 \end{aligned}$$

For party 1, it will make its optimal solution for the amount of each output.

$$\begin{aligned} \text{Max } & Z_{11} + Z_{13} + Z_{14} = f_{11}(X_{11}) + f_{13}(X_{13}) + f_{14}(X_{14}) \\ \text{s.t. } & f_{11}(X_{11}) + f_{13}(X_{13}) + f_{14}(X_{14}) \leq Z_1 \\ & A_{11}(X_{11}) \leq B_{11} \\ & B_{11} + D_{12} \leq B_1 \\ & \frac{\partial Z_{11}}{\partial B_{11}} \leq \frac{\partial (Z_{13} + Z_{14})}{\partial D_{12}} \\ & X \geq 0, \quad B \geq 0, \quad D \geq 0 \end{aligned}$$

For party 2,

$$\begin{aligned} \text{Max } & Z_{21} + Z_{23} + Z_{24} = f_{21}(X_{21}) + f_{23}(X_{23}) + f_{24}(X_{24}) \\ \text{s.t. } & f_{21}(X_{21}) + f_{23}(X_{23}) + f_{24}(X_{24}) \leq Z_2 \\ & A_{21}(X_{21}) \leq B_{21} \\ & B_{21} + D_{22} \leq B_2 \\ & \frac{\partial Z_{21}}{\partial B_{21}} \leq \frac{\partial (Z_{23} + Z_{24})}{\partial D_{22}} \\ & X \geq 0, \quad B \geq 0, \quad D \geq 0 \end{aligned}$$

4. Remarks

The proposed paradigm clearly describes the differences of concepts at various levels of integration. And the modeling framework further details the different requirements of information sharing, resource sharing, process management, and marketing of products or services in different levels. Moreover, the paradigm can illustrate some promising potential research issues in e-Collaboration: (1) benefits or impacts of each level of integration, including e-Collaboration; (2) interdependency and interaction between e-Collaboration and intra-organizational structure or inter-organizational relationships; (3) establishment, manipulation and assessment of information infrastructures or systems of e-Collaboration. In addition, from the viewpoint of development, issues such as the negotiation of forming partners, adjustment or change of intra-organizational structure and inter-organizational relationships, implementation guideline of information systems, and acceptance and adoption of e-Collaboration are alike in importance in e-Collaboration research.

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Measuring Loyalty to Mobile Services

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Abstract

Customer loyalty has been recognised as an important driver of company profitability. In the electronic environment the importance of attracting loyal, profitable customers is essential, because the acquisition costs are even higher than in traditional business. The wireless environment offers all kinds of companies possibilities to serve their committed customers independent of time and place and strengthen the customer relationships with supporting mobile services or wireless marketing communication. A key challenge is how to identify loyal customers and keep them loyal in the mobile environment. Therefore, it is important to develop accurate measures for loyalty that identify the characteristics of customer loyalty in a new wireless environment that takes into account the context based nature of mobile service usage situations as well as attitudinal loyalty towards a brand and commitment to the service provider. So far, traditional loyalty measurement scales have not been tested in the mobile service context and modifications are needed. This study explores the nature of loyalty to mobile services and suggests a scale for measuring it.

1. Introduction

"Where, in the past, customer loyalty was just one weapon to use against competitors, today it has become essential to survival" [29] p.179].

It has been suggested that customers are less loyal in electronic environments, because it is easier to find information about competing products and companies. Research has shown that in the electronic environment it is more expensive to acquire new customers than in the traditional environment. In addition to customer acquisition costs, customers tend to choose well known brands that they trust [30] [29]. It also seems that after people become more experienced in using the Internet they concentrate the visits to just a few websites. In the mobile environment switching from one service provider to another is considered easy and building customer relationships is challenging. Nevertheless, electronic environment is supposed to have a tremendous potential for creating customer loyalty, because of the possibility of provision of quality information and standardisation of firm-customer interaction. [15] Currently, mobile services are offered mostly by tele operators. However, the

wireless environment offers all companies new opportunities to strengthen their customer relationships with the means of supporting mobile services or wireless marketing communication.

The importance of customer loyalty for company profitability is widely accepted. Customer loyalty is believed to accumulate revenues and to lower the costs of serving customers [16] [28] [11] [10]. Companies should target customers that are likely to do business with the firm in the long run and they should earn customers' trust by offering consistently superior service experiences [28] [30]. Building a loyal customer base requires investments and is profitable only when customer relationships last long enough to cover the costs of relationship building (identifying customers' needs, customising offerings, monitoring performance). Companies can benefit from identifying the customers that are most willing to maintain a relationship. [5] A key challenge is thereby to identify the potentially loyal customers and understand how loyalty can be enhanced.

Mobile services are relatively new to most customers in many markets and many are trying these services for the first time. It is important to examine the determinants of customer loyalty in order to enhance it and build sustaining customer relationships by offering positive experiences to the right customers from the beginning. There is a lack of empirical research on the concept of loyalty in a mobile service context. Most empirical research on electronic services has focused on the Internet, whereas mobile services have received less attention. So far, surveys have mainly tested the willingness of respondents to adopt certain mobile services [27] [1]. There is a lack of empirical research that considers loyalty to mobile service providers or brands that takes into account the context based nature of mobile service usage. The measures need to be developed further in order to capture the attitudinal loyalty towards a service and commitment to the service provider. In-depth studies of the nature of loyalty in mobile services from a customer's point of view are necessary to advance research in electronic services in general, and more specifically to enable customer-oriented development of mobile services as well as loyalty enhancing relationship marketing.

2. Aim of the study

The aim of the study is to explore the nature of customer loyalty to mobile services and to suggest a scale for measuring it.

3. Mobile Services

The mobile phone is nowadays used for many more purposes than just a communication device as mobile content and entertainment services are developed further. U.S. currently lags behind Japan and Western Europe in terms of mobile data usage, but all in all prospects for mobile services seem positive in the future. Ovum projects that by 2007 world-wide revenues generated from mobile services (information & entertainment) will rise from USD 16.7 billion in 2003 to total USD 77.8 billion in 2007. [31] Most potential is seen in mobile commerce, location based services and entertainment. [19]

Current mobile services are offered for example by tele operators, mobile portal owners, mobile service providers as well as companies offering their customers supporting services via the mobile phone. Usually, services can be accessed regardless of which tele operator the customer uses. Even tele operators face the challenge of building brand loyalty in the market, where switching tele operators has become popular. Tele operators are currently spending more to differentiate their services and sell premium services that build revenue.[18] The focus of this paper is on loyalty to mobile services in general, regardless of who offers them.

3.1. Definition of Mobile Services

There does not yet exist a conceptual agreement on the term mobile commerce. Generally, the nature of mobile commerce is that services can be accessed anywhere, at any time. Mobile services are often referred to as wireless services. Nevertheless, wireless is not necessarily mobile. The definition of mobile includes the notion of mobility and emphasises the importance of communication-in-motion. [2] Wireless service can be for example an Internet service accessed via a wireless local network (LAN) area by a laptop computer at an airport. Mobile service on the other hand is, in principle, entirely independent of physical location, e.g. obtaining a stock quote over a mobile phone sitting in a bus on the way to work. Mobile service usage is not restricted to mobile phone users. Services can be accessed with all kinds of handheld devices with wireless applications e.g. personal digital assistants (PDA). Nevertheless, because penetration of other handheld devices are still small compared to mobile phones, this paper will mainly concentrate on services that are accessible via a mobile phone. I define mobile services as any kind of service that can be accessed via a mobile device, and that is delivered in interaction between an organisation and a customer.

Thereby including customer relationship communication and excluding text messaging to private persons.

Some existing mobile services are presented in Figure 1 in order to illustrate the special conditional nature of mobile services. Mobile commerce unleashes the limitation of physical barriers present in electronic commerce, because the customer can carry the service around as he or she moves from one place to another. Services can be accessed anytime, anywhere in a location-independent manner.

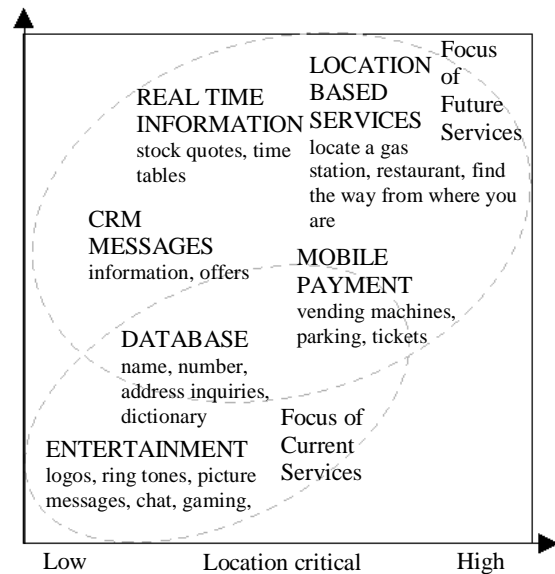


Figure 1: The Domain of Mobile Services

In the mobile environment the following things, which are depicted as the three axes in Figure 1, are considered to be important compared to other options (Internet and traditional channels):

- 1) Location: the relative location of the user, when the service is used.
- 2) Time: the relative immediacy of the needed service and the task that is being completed. [21]

Next, some of the mobile services depicted in Figure 1 are described more in detail. Entertainment services are very dominant in the current mobile service market. Normally customers order logos, ring tones and similar services where and when they want to, but ordering these services is not location or time critical. They can be ordered anywhere. Location based services on the other hand, are a good example of highly location and time critical mobile services. In a situation when a task has to be done, or information obtained, immediately in a certain location, the benefits of mobile services are distinguished best. For example, you can with the help of a location based service locate yourself or others (e.g. spouse, children, elderly people) in case of an emergency and get information how to take the shortest way to the place you want to go to. Mobile payment is often used in situations when cash is not available, or just because it is

convenient to pay parking fees, metro or bus tickets with the mobile phone, or because you are in a hurry and do not have the time to purchase the ticket beforehand. Real time information refers to information ordered to the mobile phone that is highly time critical, e.g. Ordering stock quote information or information about flight delays. Customer relationship communication to customers who have given permission to contact them through the mobile channel can be for example SMS message that your car is ready to be picked up from the garage or alerts on a limited time promotional airline fare or a SMS reminder that the seminar you have signed to begins at 9 o'clock and gives instructions how to get there and maybe even asks you to reply to the SMS message, if you prefer red or white wine at conference dinner. Information that is acquired from databases, e.g. name, number or address information inquiry services are not that dependent on location, but normally ordered in a situation when you expect to get the information easily within a reasonable time.

The most fruitful domain of mobile services is a highly time critical and highly location critical service that is perceived highly valuable by the customer. The competitive advantage of the mobile channel compared to other channels is highlighted in services that offer these kinds of solutions. The services that until now have reached the great mass of customers (e.g. entertainment services) will naturally exist in the future as well and will be perceived valuable be the right target group. But from the loyalty viewpoint, the most important mobile services in the future will be services, that serve the customer better, more personally and enhance the relationship between the service provider and the customer as well as support other service channels in time and location critical contexts.

4. Literature Review

Next, the concept of loyalty is defined based on previous literature. The nature of loyalty is discussed more in detail in order to highlight the special context based nature of mobile service usage situations. A list of suggested scale of items for measuring loyalty to mobile services is presented at the end of this paper.

4.1. Customer Loyalty

Traditionally customer loyalty has been defined as repeat purchases [24]. Nowadays, the loyalty concept in marketing research typically includes the two-dimensional nature of customer loyalty consisting of a physical and mental dimension. Even though researchers have included the attitudinal factor, companies still often tend to assess loyalty based on behavioural measures.

Day [8] was one of the first to emphasise the importance of attitude in addition to loyal behaviour and to distinguish between intentional and spurious loyalty.

The following quote depicts the attitudinal aspect of loyalty i.e. commitment.

"Loyalty is a deeply held commitment to rebuy or repatronize a preferred product / service consistently in the future, thereby causing repetitive same-brand or same brand-set purchasing, despite situational influences and marketing efforts having the potential to cause switching behaviour." [24, p. 34]

Commitment can result from either dedication (affective commitment) or constraints (calculative commitment). Attitudinal loyalty is equivalent to affective commitment. [5] Attitudes influence behaviour and several researchers have found positive relationships between attitudes i.e. commitment and behavioural loyalty [17, 23].

Mobile services are often based on a contract with the service provider or the services are used on a pre paid account. Such constraints, make it hard to change service providers, and are indicators of calculative commitment. Bendapudi and Berry [5] suggest that constraint based relationship maintenance can lead to staying in the relationship, but dedication based relationship maintenance leads to enhancement of it through affective commitment. Therefore, attention should mostly be given to affective commitment.

In this study commitment refers to "a buyer's enduring desire to continue a relationship with a seller accompanied by his willingness to make efforts at maintaining it" [23, p. 64]. This conceptualisation includes the attitudinal aspect of loyalty and it has been successfully used in a recent study by Odekerken-Schröder [23]. Similar definition has been used e.g. by Morgan and Hunt.[22].

In this study customer loyalty is defined as a combination of loyal behaviour and commitment. Hence, a loyal customer is someone, who believes that an object firm's products continue to offer the best choice alternative and thereby ignore communications from competitive firms. [24]

4.2. Consequences of Loyalty

Loyalty can be expressed in multiple ways, including saying positive things about the company to others [6], recommending the company or service to others [25], paying a price premium, and remaining loyal to the company. [37]

Zeithaml et al. [37] developed a conceptual model of the impact of service quality on behaviour that signals whether customers intend to remain with or defect from a company. The scale items for the model depicted word-of-mouth communication, purchase intentions, price sensitivity, and complaining behaviour. To clarify the

relationship between loyalty and its consequences, the measures should in my opinion be separated into different constructs. This view is supported by e.g. Hennig-Thurau et al [17] who defined word-of-mouth as a consequence of commitment [17]. Harrison-Walker [36] also posit that affective commitment as an antecedent of word-of-mouth communication. Dick and Basu [9] also claim that consequences of loyalty include word –of-mouth, resistance to counter persuasions and search motivation. Moreover, attitudinal loyalty has been proven to lead to willingness to pay a higher relative price [7] [12]. Therefore, in this study word-of-mouth communication and willingness to pay more are considered to be consequences of loyalty. Switching behaviour is considered to be a possible consequence of low commitment.

Switching to another service provider is considered easy in the mobile service context. However, the learning process in general, including downloading the necessary software and settings to be able to use new mobile services requires time and effort. The help and advice of friends is very important when people are trying mobile services for the first time. Hence, it can be assumed that positive word-of-mouth communication is more important in the mobile service context than it is in traditional or e-business context.

Moreover, in a mobile service context the awareness of brands and service providers and knowledge how to use the services is essential for initial use. Previous research [26] shows, that the most common problems in using mobile services are that people do not remember how to access the services, or perceive using the mobile services very difficult. Price sensitivity might be of less importance in mobile services than in traditional services, because they are often used in a context when other media is unavailable.

4.3. Special Characteristics of Loyalty to and Consequences of Loyalty to Mobile Services

In the future, when people get used to using the mobile technology, users of mobile services will be more illoyal, informed, impatient and goal oriented. They will expect independence, control, experiences, personalisation, freedom of place and a digital co-operation partner. The greatest value for customer is created when communication, information and transaction are integrated in the physical and social context where the customer is. [35] Especially the access to real-time information services can be criteria to choose a service provider. The perceived value of mobile services will rise if the customer can access relevant information that is specified to a certain place and time.[33]

People are currently trying the services for the first time and when the novelty effects wear down, probably only the best services offered by the best known service providers will be used frequently in the future. In the

Japanese market some loyalty effects of mobile services have already emerged. Hence, iMode users personalise their phones with entertaining icons, ring-tones, cartoons, buddy programs and individual browsing preferences, which has lead to the lowest global churn rate. In general, personalised services are expected to create strong customer relationships that encourage transactions and prevent customers from switching to different services. [3].

However, loyalty is complex to estimate in a market, where there are many different actors contributing to the delivery and invoicing process. The complex invoicing principles in Europe do not really support the development of mobile services. In Japan, the business structure is clearer than in Europe. NTT DoCoMo provides a central portal through which the service providers offer their services [3]. Invoicing may also base on prepaid account. However, the pre-paid account does not allow specific tracking of use of the services, which probably makes it more difficult to assess the behavioural loyalty to the services offered.

In mobile services, loyalty consists of a loyal attitude towards the service provider or brand as well as loyal behaviour – ordering the same service frequently or always as the situational need arises for the service. Loyal behaviour in mobile services may be expressed by ordering a variety of services from the same service provider, ordering the same service again or ordering more sophisticated services from the service provider. Attitudinal loyalty has been proven to be an especially important factor influencing customer relationship in services where customer relationships are often based on service contracts with the service provider [12].

In general, it is easy to track behavioural loyalty of some mobile services, for example how many times and how frequently the owner of the tele operator's account has ordered a mobile service (e.g. paying your parking fair, bus ticket or vending machine purchase with a mobile phone), because the transactions are often invoiced on a monthly phone bill. Tele operators, mobile service providers and mobile portals have the best opportunities to combine customer information with their consumption data. Other companies have difficulties in accessing the consumption data, because they have no invoicing relationship with the customers.[33] Nevertheless, it is difficult to define who in fact has ordered the service and even more difficult to assess how the customer perceived the service and if he or she is going to use it again. These kinds of core mobile services are today mainly targeted to new customers. Supporting mobile services, which are offered to current customers (e.g. real time information about account balance, or information sent to the mobile phone when your car is ready to be picked up from repair) are easier to track, because it is possible to link the customer data and the service usage data. However, these behavioural measures of mobile service use do not reveal how committed the

customers are to the service provider and what their purchase intentions are in the future. Neither do they reveal the share of wallet or if the customer is also using competing mobile services. Therefore, other measures for customer loyalty are needed to complement the behavioural loyalty measures.

Commitment can be expressed e.g. telling friends and colleagues positive things about the usage experiences of mobile services, giving advice how to use the services, expressing willingness to pay more for customised services, replying to CRM-messages, forwarding valuable information to your friends, updating the mobile phone configurations to be able to access e.g. picture messages etc.

The consequences of loyalty: word-of-mouth communication, price sensitivity and switching are depicted by traditional behavioural intentions battery suggested by Zeithaml, Berry and Parasuraman [37]. However, Harrison-Walkers [36] set of items generated to measure separately activity (enthusiasm and detail) and praise (favourableness) word-of-mouth were included in the scale items. Activity items are specified to measure how often the word-of-mouth communication takes place and to how many people the word-of-mouth sender communicates to. Praise items are designed to measure the favourableness of the word-of-mouth. These constructs were included, because in a context based environment, word-of-mouth is a more complex construct than in the traditional environment. In Internet and mobile channels it is easier to forward messages to many friends and therefore the number of recipients, the frequency of the communication as well as the quantity of information provided are all important components of word-of-mouth measures. [36]

Switching intentions in mobile services are often expressed as intentions to switch service provider even if the service provided is satisfactory. Even if the mobile service meets the customer needs and is delivered excellently, problems often arise in customer service and transactions in the billing phase. Therefore, it can be assumed that customers are committed to mobile services in general, but not necessarily committed to the service provider. Nevertheless, it is difficult to make a distinction between commitment to a service brand and to a service provider. Usually, the service provider markets mobile services and thereby the service and service provider are perceived as the same. However, the mobile services offered today, do not differ much from one service provider to another and thereby differentiation is mainly based on the brand perceptions as well as the image of the service provider. Opportunities exist to more personalised services and customer relationship management communication via the mobile channel.

5. Suggested Measurement Scale

The scale items for measuring loyalty are suggestions based on current loyalty literature. However, some modifications to the traditional measures have been done based on researchers' experiences from a preliminary pilot study about customer loyalty to mobile services [26]. The results indicated that many respondents agreed strongly that they would use the services again, but they would not necessarily choose the same service provider again. Furthermore, the choice of service channels is important, because mobile services are often used in situations where other service channels are not accessible. Therefore, the loyalty measures are divided into three separate sections: service provider specific questions, mobile service specific questions and channel specific questions. The commitment measures have been given special attention because attitudinal loyalty is especially important in service environment. If customers do not feel committed to the service provider, the relationship will not last.

The scale items were developed so that the questions fit different kinds of mobile services, but are so general that users of different services can answer the same questions. The scale items in the Appendix 1 are preliminary suggestions for measuring loyalty to mobile services. The scale items will be developed further and the reliability of the measures will be tested later on with the help of a separate survey that will be conducted on end users of different mobile services.

6. Conclusions and Suggestions for Further Research

Models that are built based on empirical research of traditional services are rarely applicable as such for assessment of new electronic services. This paper contributes to earlier research on loyalty by suggesting a measurement scale for loyalty to mobile services. However, the reliability of the suggested measures should be tested empirically preferably with samples including end users of different type of mobile services provided with several service providers. The relationships between loyalty and consequences of loyalty as well as the relationship between commitment and behavioural loyalty in mobile services need to be viewed critically and researched further in the future.

Appendix 1: Scale items

Mobile service is any kind of service that can be accessed via a mobile device, and that is delivered in interaction between an organisation and a customer. Thereby including customer relationship communication and excluding text messaging to private persons.

Each item will be accompanied by a 7-point likelihood scale (1= totally disagree and 7= totally agree).

(-) = will be reverse coded.

Dimension	Scale item	Source
	SERVICE PROVIDER SPECIFIC QUESTIONS service provider = the organisation that offers the service to the customer (tele operator, mobile portal, other company offering a mobile service)	
Commitment	I consider this service provider my first choice to order mobile services	Modified from [20, 37]
	I am proud to use the services of this provider	[36] [13]
	I care about the fate of this service provider	[36]
	I like the way this service provider organisation operates	[36]
	I feel loyal to this service provider	[13, 23]
	It would be difficult for me to change to another service provider	modified from [32] [4] [36]
	Changing to another service provider would be impractical	[36]
Behavioural	Next time, when I need such services, I will choose this service provider	[34]
Intentions	I intend to continue ordering from this service provider over the next few years	[14]
	As long as the present service is offered, I doubt that I would switch service provider	[14]
	I will order more services from this service provider in the future	modified from [37]
Switching	I will order less services from this service provider in the future (-)	modified from [37]
	I will order mobile services from another service provider in the future that offers better benefits (-)	modified from [37]
WOM	I will recommend the service provider to someone who asks my advice	modified from [37]
	I say positive things about this service provider to other people	modified from [37]
(activity)	I mention this service provider to others quite frequently	[36]
(activity)	I've told more people about this service provider than I've told about most other service providers	[36]
(praise)	I have only good things to say about this service provider	[36]
(praise)	I am proud to tell others that I use this service provider's services	[36]
Price sensitivity	I will continue to order services from this service provider even if the prices increase somewhat	modified from [37] [12]
	I will accept higher prices if this service provider raises its' prices	[12]
	SERVICE SPECIFIC QUESTIONS Service = the mobile service the respondent has used (e.g. Paying for parking fee, buying a metro ticket, ordering a ring tone, ordering stock quotes)	
Commitment	I use the same service via different channels (internet, store, phone) depending on where I am, when the need for the service arises.	
WOM	I will recommend this particular mobile service to someone who asks my advice	[37]
	I say positive things about this particular mobile service to other people	[37]
	I would gladly help friends and relatives to use this mobile service for the first time	
Price sensitivity	I will continue to order this mobile service even if its prices increase somewhat	[37] [12]
	I would pay a higher price for the mobile service than competitors charge for the benefit I currently receive from this service provider.	[37] [12]
	CHANNEL SPECIFIC QUESTIONS	
Commitment	I consider the mobile channel my first choice to order this service	Modified from [20, 37]
	It would be difficult for me to order this service via other channels (internet, store)	
Behavioural	Next time, when I need this service, I will order it via mobile channel.	[20]
Intentions	I will order more mobile services in the future	[37]
Switching	I will order less mobile services in the future (-)	[37]
WOM	I will recommend mobile services in general to someone who asks my advice	[37]
Price sensitivity	I will continue to order services via the mobile channel even if the prices increase somewhat	[37] [12]
	I would pay a higher price for the mobile service than for the benefit I currently receive via other channels.	[37] [12]

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Game Industry in Asian Tigers: Analysis and Suggestions

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Abstract

According to a recent report, the game industry, including PC games and video games, have already grown larger than the movie industry in the last a few years. The phenomenon represents that the game industry will be one of major entertainment industries in the very near future. Asian Four Tigers, including Korea, Taiwan, Hong Kong, and Singapore, have all developed the game industry as one of their future industries. As we have seen in other traditional industries, each country has experienced different levels of success, and faced different situations in this highly competitive battlefield. This study is an attempt to examine the potential of Korea, Taiwan, Hong Kong and Singapore in the game industry and to investigate the problems they might encounter on the way to attain globalization. Also, some suggestions are also made in the paper for those four Asian Tigers to improve their future competitiveness in the global markets of the game industry.

1. Introduction

The game industry is booming in a thunder-fast pace no matter in what kind of formation or on what kind of platform. According to Interactive Digital Software Association's research, 225.1 million of computer and video games were sold in 2001 in U.S. alone, which means the industry made 6.35 billion dollars from the sale [11]. According to the Market Intelligence Center (MIC) of the Institute of Information Industry, the global market for game consoles and software reached over \$26 billion in 2001. PC and video games accounted for about 80 percent [6].

Americans bought a record \$10.3 billion worth of video games, consoles and accessories in 2002 - more than they spent on going to the movies [3] - a figure which has become an important indicator that shows the era of a brand new type of entertainment is coming. Moreover, the global sales revenue of the game industry was estimated to reach to \$34.3 billion in 2003, 12 percent more than 2002 [21]. Compared with most industries that suffered in these years because of the world recession, the steady growth of the game industry could attract much more attention than ever before very easily. According to a latest research from Pew Internet, male college students in U.S. spend on an average of 15 hours per week on playing games [12]. Based on this substantial amount of number, more and more companies all around the world,

such as Sony and Microsoft, because conscious that the video and PC game industry could be one of their most important arenas in the near future and are trying to focus on this market in order to keep their leading positions in related industries.

Any company in any specific industry which could possibly connect to the game industry would not give this market up easily and many of them are eager to invade this territory in order to capture the market share in the early period. One of those examples is Nokia's latest cell phone N-Gage, which is the game controller-like cell phone designed specially for game playing. Compared with the platform of PC or video games, this is still the virgin land of the game industry with a great deal of potential.

2. The Importance of the Game Industry in Asian Tigers

Asian Tigers had played critical roles in Asian economy for many years mainly by manufacturing, especially Taiwan and Korea. Although two countries had made substantial profit by exporting electronic components that was ordered by the U.S. and companies from other countries, not much innovation or creativity were involved in it. According to the old experiences, incomes from this style of industry usually could not stand for a long period of time. The movement of those companies and investment into China could be a clear warning signal for two countries to become aware of this nature of the trend.

The rise of the game industry in these few years could give two countries a great chance to transform their IT industry to another new era. Since these two countries had already cultivated IT related infrastructures from the '90s, the environments are comparably more mature than other countries in East Asia. The online population in Taiwan was 8.59 million by the end of 2002, accounting for 37.35% of the total population. The broadband population was 2.10 million, accounting for 24% of the total online population [22]. These figures mean that about one-fourth of the people who had access online were using broadband service. Since the online gaming market is growing steadily since 1997 when Electronic Arts published the world's first successful multiplayer online role-playing game, the available rate of the broadband Internet service also became a critical indicator for the game industry. According to research done by Point-Topic in September 2002, Korea, Taiwan,

and Hong Kong are the top three in the list of DSL available rates worldwide. The U.S. was not in the list of top ten [17].

Compared with most major industrialized countries in the world, the size of Asian Tigers is tiny. The largest one in four, South Korea, which is only about the size of Hungary or half of New York [13]. Therefore, physical resources in the Four Tigers are scarce and high-value-added industries are eagerly needed. As Switzerland did with the watch and chocolate industries, the value added by games with the combination of programming, art, and entertainment could lead to a substantial profit for these countries, since both the game, watch, and chocolate are all the industries that add the maximum value to a single product.

2.1. Korea

Except for Japan, Korea and Taiwan play the major roles in the game industry in East Asia, especially Korea. Although Taiwan was in the leading position in the game industry among the Tigers in the early 1990s, Korea had already taken its place and expanded enormously. The Korean gaming industry posted revenue of \$833 million in 1999 and \$2.5 billion in 2001. The game developers there exported \$130 million in 2001 alone. According to the data from an assistant manager of Korea Game Development and Promotion Institute, a non profit association in the game industry that is entirely subsidized by Korean government, there are 2,600 game related companies in Korea, 1,900 companies are developing games and 700 companies are publishing at the point of January 2003. There are also eight companies developing video games for Sony's PS2.

Although both Taiwan and Korea are comparatively strong in the game industry among Tigers, Korea has more resources than the other three. The Korean government plays a very important role after 1998 in developing its game industry by supporting game companies and PC rooms (Internet Café). Young men in Korea even could avoid the obligation to serve in the military after passing the national test and working in the game industry for more than five years [10]. Moreover, the game developing courses were also offered in the high schools since ten years ago [20]. By combining these resources, Korea has a very special sustainable competitive advantage on developing its game industry, and it could be very helpful for it to transform its IT manufacturing industry into a content generating industry.

The prospering of the electronics industry could also have a great impact on the game industry. Contributed by the advanced technology, gaming platforms are not limited on PCs or TVs in recent years. Mobile phones could be a good example. Since Samsung had already made a great success by making a \$35 billion revenue worldwide in 2001[23] and had occupied the second largest market share, next to Motorola, in the U.S. market

[25], there could be a chance for Korean game companies to integrate their games into cell phones without cooperating with cell phone companies in other countries.

2.2. Taiwan

The competitive advantages of Taiwan are very similar to those in Korea. Both of these two countries had dedicated semiconductor experience to the IT industry for many years. However, the resources in these two countries could be definitely different in several aspects. Compared with the Korean government, the Taiwanese government spent little on game related investments. Game companies in Taiwan suffered by lacking budgets and quality personnel. The education aspect could be one of the major weaknesses on developing game industry in Taiwan. Although there were some schools and institutes began to educate students on game developing by setting up game related majors, the contribution was quite limited since the priority was still focused on short-term profit making. Since Taiwan is not the leading country in the game industry, instructors from other countries might be needed in order to make a breakthrough in this highly technological and entertainment oriented industry.

Taiwan was also one of those countries that set the IT industry as its primary target developing industry in the 21 century. The transformation from the high-tech manufacture industry is needed in the era that more and more people would agree that digital contents are more valuable than physical equipment. The success of the game industry also could be a critical indicator of Taiwan's innovation and transformation.

2.3. Hong Kong and Singapore

Hong Kong and Singapore are far behind Korea and Taiwan in the game industry. Although about 70% of households in Singapore have at least one PC inside [1] and 62% in Hong Kong [24], most of the games played by people who live here are still from the U.S., Europe, Japan, Taiwan, or Korea. Although there are still some game companies in Hong Kong and Singapore, the inability to reach their customers results from the lack of strong publishing companies is one of the major problems for them to make profits. Since most people here speak Chinese, they rely heavily on publishing companies from Taiwan in order to enter the Chinese markets, which include China, Hong Kong, Singapore, Indonesia, Malaysia, and Taiwan. Some companies in Hong Kong and Singapore target their market globally. Therefore, they would try to make their games locally, but publish them globally. The recent example would be the game Capitalism that was made by Enlight Software in Hong Kong, but published by UBI Soft, a France based global game publishing company that makes the game so that it could be bought worldwide.

Both the Singapore and Hong Kong governments were conscious about the trend of this prospering industry and

had invested some capital in it. The Government of Singapore Investment Corporation had invested in NCsoft Corporation, the Korean leading game company, by accumulating a 5% stake of it in the year of 2002 [19]. The Hong Kong government also set up the Secretary for Commerce, Industry and Technology to develop multimedia entertainment, including the game industry. Hong Kong also led game related companies to join the Electronic Entertainment Expo and Tokyo Game Show, which were two of the most important game expositions held annually in Los Angeles and Tokyo, Japan. Hong Kong, which has the second large entertainment film industry in the world [8], has an advantage as more and more films combine computer technologies in them. Movies like Final Fantasy in 2001, Matrix, and others integrated a great amount of advanced computer technologies making audiences used to accepting those fancy pictures. As the relationship between the film and game industries in these years grew closer, people there who were used to making films to entertain people could be familiar with the ways to do so in the game industry. The experiences in the film industry could be one of the most important assets for Hong Kong to get into the game industry in these few years.

3. What fields are cultivatable for game companies in four Tigers?

3.1. Hardware

Asian Tigers have no local-brand game console manufacturer. Manufacturers in Taiwan are concentrating on supplying OEM game consoles and accessories for Sony's PlayStation 1 and 2, Microsoft's Xbox and Nintendo's GameCube [7]. Since the worldwide console market was already dominated mainly by Sony, Microsoft, and Nintendo, it could be less possible for companies from Four Tigers to innovate any new console platform and to maintain competitiveness at the same time. Although the market of the game accessories is not what most game companies focus on, companies making game accessories like Logitech and Thrusmaster are still making good profits by producing joysticks for PC gaming. Four Tigers could concentrate on this part and do as innovative as possible within limitations.

However, it is not totally impossible for the Tigers to keep far from the console platform market. The Korean company Samsung Electronics could be one of Sony's toughest competitors in the very near future. Samsung had already got rid of the image of inferior goods by spending a great deal of money on advertising and developing new marketing strategies. It also has the technology to produce the large size plasma TVs and slim laptops that made Michael Dell shock and place the order from it immediately. Moreover, Samsung also had invested part of its resources on the game industry. The World Cyber Game competition held in Korea annually as the game Olympic could be one of those examples.

Once Samsung integrated all of its experience and expertise, a strong power can be generated, but its management decision making processes and financial structures still need to match NASDAQ's high standard in order to be a public company in the US [5].

3.2 Software

3.2.1. Platform – PC or Console?

There are only a few companies within Tigers to make console games. The amount of companies in Korea that are making console games are about eight, less than five in Taiwan, and no clue shows that there are any companies in Hong Kong and Singapore doing so.

Unlike PC with its open environment that any company can make games to fit its standard, the developing environment on console games is much closer and thus has more limitations. The obstacles of making console games therefore could be much more than making a PC version and thus could explain the phenomenon that there are only eight companies in Korea making console games.

3.2.2. Genre

According to NPD Tech World's research, the most popular game genre was sports on consoles and strategy on PC in 2001 [16]. Popular genres of the games differ from platform to platform mainly because of the nature of the functions created from the platform or game itself. People would not expect a video game player would use a mouse and plug a USB keyboard into the machine to play real-time strategy games. It would be also difficult for PC game players to control Jason Kidd, a star basketball player in NBA, to have some fancy movements before scoring by pressing a series of keys on the keyboard.

Not only the closed and inconvenient developing environment of the console games made the Tigers avoid developing them, but the sports genre also limited them. There are no such international famous sports in those four countries and area like the NBA, MLB (Major League Baseball), or European League soccer so that many people who do not live in America or Europe still could recognize those players easily. Therefore, the characteristics of comparable non-boundary strategy games (STG) or role-playing games (RPG) became the most popular genre of those game developing companies in the Tigers. The situation would likely still be the same in the future unless Asian professional sports could be well accepted by the whole world, or companies could not make it possible to make other genre of games with a hope to be competitive in the global market.

3.2.3. Online, Match, or Single Player Games

Since the success of Ultima Online made by Origin System and published by Electronic Arts in 1988, online

games became one of the most promising and competitive markets in the game industry. DFC Intelligence is saying that the online game market will grow from \$875 million (in 2002) to over \$5 billion worldwide in 2008. DFC, for reference, has reported before on the growth of the gaming industry and Nintendo's continued financial strength despite weak performances by GameCube. The majority may still have to do with PC-based subscription services, but there is a rapid increase in support of online capabilities by console systems. DFC also forecasts that the installed base of online-capable videogame systems will be over 100 million worldwide by 2008 [18].

Although the single player games and match games still have their markets, everybody's attention is on the online game market in recent years. For a game company, counterfeiting and piracy is one of the most serious problems it needs to solve, especially if its market is in Asia. Since the structure of an online game is totally different from a match game or a single player game, the company's revenue could be secured very well. An online game consists of two parts of programs. One part of the programs is installed in users' PCs or consoles make them as the client machines, while the other part is in the companies' headquarters or in ISPs (Internet Service Providers) machines and make them as the server machines. There is no access for any player to play any online game without connecting the client machines with the server ones through the Internet. Once a player's PC connects with the server, a unique ID and password will be requested. Therefore, it is useless for a player to just simply copy those client programs in a desire to get into the game.

Korea and Taiwan are doing very well on online game market. NCsoft Net, a Korean leading game company had 36 million subscribers on its online game-Lineage, 3 million of these subscribers were from Taiwan [14]. Because of the income secured and easy addictive characteristics of online gaming, it had already become a gold mine to many game companies. Moreover, the life cycle of a successful online game is usually about five years or longer (Ultima Online since 1998, Everquest since 1999), which also means the risk of inventing a brand new game could be eliminated once one online game could be accepted by enough players. According to the reasons listed above, the online game market could be one of the most important markets for game companies in Asian Tigers.

4. Where are the Markets?

For most companies in the game industry, game titles usually were designed for at least two similar markets in different countries. Game companies like Soft-World International Corp. from Taiwan could export their games easily to Hong Kong, China, Singapore, Malaysia, or even Indonesia and sell them to those Chinese origins. Theoretically speaking, game markets between these

countries could be circulated easier than marketing a game from Korea or other countries. However, because of the internationalization it became much easier to get information from other countries in the 21st century as boundaries between countries with minimum cultural differences could be eliminated. The best example to explain this phenomenon could be the Korean game market in Taiwan and China. By translating their contents into Chinese characters, the Korean game companies had already had 48.65% of the online game market share in China [2]. They also had 65% of the market share in Taiwan [9]. Since many Korean games were developed based on non-existing fantasy medieval stories, they minimized the resistance from different cultures and therefore could be accepted by consumers in other countries. The local markets for Asian Tigers are too small for companies to make substantial profits from them. Companies not only in the game industry, but also in other industries in Asian Tigers are all trying to sell their products regionally or even globally. Samsung Electronics could be an example of doing so.

For game companies in Asian Tigers, the easiest way to sell their games and to get acceptable profits could be to sell them regionally. Many game companies from Korea and Taiwan already did so and are making substantial profits. Although there is no successful example that can show companies from the Tigers get succeeding in the global market so far, Lineage II, a fantasy based online role playing game that made by NCsoft from Korea could be a new hope later in this year. NCsoft tried to use Lineage, its well-known and most popular game title in Asia to enter the U.S. market in 2000. However, mainly because of its relatively poor graphics and non-dynamic game play it failed in America. After that, the company obtained a lot of support from Richard Garriott, the creator of the world's first successful online game to develop Lineage II and is almost ready to start a new battle in the U.S. market. It could be an important milestone for Asian game companies to examine if their techniques of making games could match the needs of the global markets after several years' efforts this time.

5. How to Market Games in the Global Markets

Like other industries, the marketing aspect of the game industry is very dynamic and could be very challenging. The strategy that Asian game companies used to give their online game software away to players with a minimum or even with no charge is not suitable for the U.S. market. As a game company, a subscriber for an online game needs to pay the maintenance fee monthly and therefore it could generate a stable income for a game company. Based on this way of thinking, the income from the retail software is comparatively unimportant and it also could be an obstacle if the company wants to gain the largest market share with a standard software charge.

The situation in the game industry in U.S. is somewhat like that in Japan in other industries. Most people would believe a quality game always has a higher price. That is why Star War Galaxies, the latest online game published by Lucas Arts charges its subscribers for the software only at the price of \$49.99. Comparably, NCsoft charged its subscribers no software fee in 2000 when it came to the U.S. market for the first time. Subscribers just need to download the software of Lineage and pay the maintenance fee monthly. The media gave it a negative comment almost immediately and said it is a poor game that looks like there is always gauze in front of the screen because of the bad resolution. Other companies that wish to public their games globally should notice the impact of adopting different marketing strategy in different markets.

Unlike Korean and Taiwan, many other countries do not have as many Internet cafés as they have. Moreover, customers' activities in the Internet cafés are also different from country to country. Because of the high density of the Internet café and the major activities in it is playing games, it plays as one of the most important channels for game companies in Korea and Taiwan. However, the situation is not the same outside those two countries. Take the U.S. for instance, where consumers rely heavily on traditional retail stores or online virtual stores to purchase their game software. The cooperation within game developers, publishers, and distributors is comparably more important than it is in the East. Companies also need to adjust their resources in order to be suitable under this kind of environment.

6. The Problems Game Companies May Encountered

Although the game industry is in the field of entertainment as the movie industry, problems these companies face are always as serious as those in other industries. The government policy and legal problems could be one of the major problems that game companies need to face.

The U.S. District Judge Robert Lasnik issued an injunction blocking enforcement of the Washington State law banning the sale of certain violent video games to minors. The law was due to take effect on July 27, 2003, and would have imposed a \$500 fine on retailers selling games depicting violence against law enforcement officers to anyone under the age of 17 [15]. Although there are still some disputes on this topic, it could somewhat had an impact on the whole game industry while it is still not illegal to sell mature rated DVD or VHS to minors so far.

As we mentioned in the former part in this paper, the sociocultural problem is also a very critical aspect for a game company to take more attention. Tony Hawk's Pro Skate, published by Crave Entertainment, was one of the best-selling games in North America and had a supreme reputation, but it would not be the same if this game went

to the East. The same situation happened on The Sims, which was developed by Maxis and published by Electronic Arts. More than seven million copies of The Sims have sold in the U.S., making it the top-selling PC game of all time. Combined with all the expansions (Living Large, House Party, Hot Date, Vacation, and Unleashed), Electronic Arts has sold an outstanding 17 million units. However, this title sold less than 0.1 million copies in Taiwan when it was published there. Consumers in Taiwan who live in small apartments obviously do not consider the virtual reflects the facts of their daily lives while all avatars in it live in American style villas.

7. Conclusions and Suggestions

The game industry used to be the last choice for quality college students to work for. Parents might think that there is no future if their children like to work in a game related company. However, according to Fortune's latest research, the leading company in the game industry-Electronic Arts (NASDAQ: ERTS) - was announced in the list of 100 Best Companies to Work For in 2003 [4]. Game related jobs even had already become one of the first choices for top college graduate students to work with. In those four Asian Tigers, most competent college graduates go into the game industry. Actually, it is not strange to find that lots of CEOs of game companies in those countries are graduates from prestigious colleges and university in the world, including Ivy League schools in the States. It is certainly not an industry for making toys for children only any more.

For Asian Tigers, the education and investment could be the most important part for them to catch up at beginning stage of booming. Like other industries, the game industry would be more and more professionalized and therefore professional knowledge would be needed. Only by setting formal, serious and scientific methods on developing games could be successful in the future.

Setting professional schools or departments in the university also could be very helpful for developing quality workers in the future. Korea is already doing so, but Taiwan, Singapore, and Hong Kong still have a long way to go.

The attitudes of the governments are also very critical. Taiwanese government is seriously lagging on this aspect while governments in Korea, Singapore and Hong Kong invested a great amount of money in the game industry in these years. Without support from governments, companies would find it very difficult to overcome problems like capital collecting and related regulations.

The potential for Korean game companies is very huge, especially in these years. After NCsoft launches its Lineage II in late 2003, it is clear that Korean-made games have already become internationalized or still has its regional markets. Taiwan's development in game industry would be much better if the government could support its game companies instead of seeing them as toy

making companies. Referring to Hong Kong and Singapore, because of the scarcity of resources no matter on capital or human resources, they could develop very specialized expertise in certain areas such as visual design, music composing or animation in the whole game making chain. Outsourcing would be needed once the game industry getting more advanced.

Generally speaking, Korea, Taiwan, Hong Kong or Singapore all have great potential and some of them even already have solid foundations in the game industry, especially the online gaming market. Governments and companies should seize the chance and adopting suitable methods in order to gain the benefits of this newly risen industry in time.

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The Internet and the Strategies of Firms: Does Technological Orientation of the Firm Make a Difference?

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Abstract

Designed to track how growth of the Internet and the burst of the dot.com bubble might affect strategies of the firms, this study found that most respondents want to become more entrepreneurial and risk-taking when exploiting the opportunities afforded by the Internet. Based on the findings of the study, we note that firms that are more entrepreneurial will assimilate the Internet as a technology. The Internet is an enabling technology that provides a set of tools that could be used in any industry as part of a firm's strategy, and the brick and mortar firms must integrate the Internet so as to enhance the distinctiveness of the strategy of the firm.

1. Introduction

It is safe to suggest that despite the recent bust of dot com firms, the Internet has become a popular tool for not only individuals who want to stay in touch with friends and families, but for corporations to execute business transactions with other corporations and customers. Some believe the Internet's growing popularity in the corporate arena is due to its ability to reduce cost of internal coordination as well as executing transactions. A study by the Center for Research in Electronic Commerce at the University of Texas estimated that web-commerce or e-commerce in 1999 totaled US \$301 billion. This number includes the sales from industrial and consumer goods and services as well as the equipment and software that provide support to e-commerce and e-business.

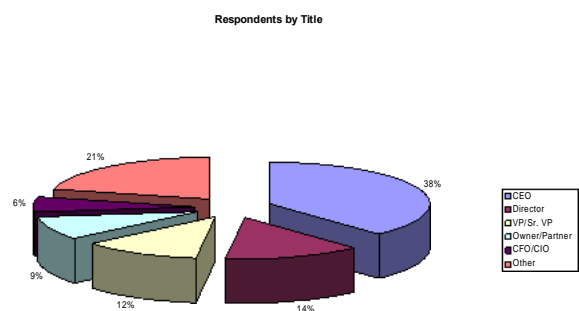
The growth of the Internet has not only spurred new entrepreneurial firms, such as Amazon.com and ebay.com, but the fact is that the existing brick and mortar firms are also significant players in the game. For example, successful use of the Internet technologies by firms, such as Cisco Systems, Inc., and FleetBoston Financial Corp., indicates that the "entrepreneurial" use of the Internet need not be limited to only a handful of startup firms. Cisco Systems adopted Internet technologies to gain efficiency in their customer and vendor management system. According to a special report in the Business Week, Cisco generates and fulfills 68% of its orders through the web and resolves 70% of its service calls online [1]. Business Week also reports that FleetBoston

Financial Corp. combined its online banking services with its online brokerage business, Quick & Reilly, to create a customer base of more than a million.

Introduction of a new technology can bring ambiguity about products, services and customers [2]. While new entrants (mostly entrepreneurial firms) can easily support a new technology because they don't have to abandon or modify any existing technology, the more successful and established firms tend to maintain the established technologies and to an extent avoid dealing with new and disruptive technologies [3]. The Internet – a new technology - has however, been successfully adopted by some established brick and mortar firms, such as Cisco and FleetBoston. The authors of this report examined the motivation of the existing brick and mortar firms in embracing the Internet and how these firms plan to exploit the opportunities afforded by the Internet.

2. Sample

The findings of this study are based on a survey conducted in collaboration with the Eastern Technology Council in Fall 2001, after the bust of the dot.com era.

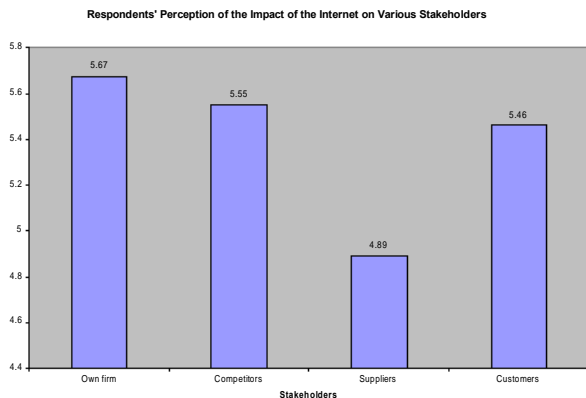


As shown in the figure above, a majority (38 percent) of the 180 survey respondents were CEOs. The average respondent for this survey was 42 years old with over 20 years of work experience. Twenty-seven percent of the respondents were females, and thirty-seven percent had a graduate degree. The average sale of participating firms in 2001 was \$1.35 billion.

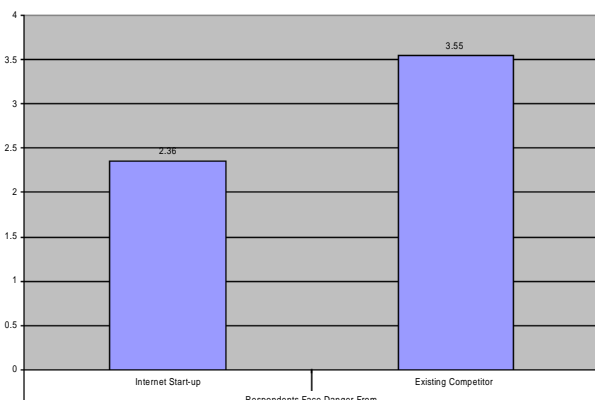
3. Findings

3.1. Perceived Impact of the Internet

The respondents seem to perceive the Internet to have the greatest impact on their own firms and the least on their suppliers (see Figure below).

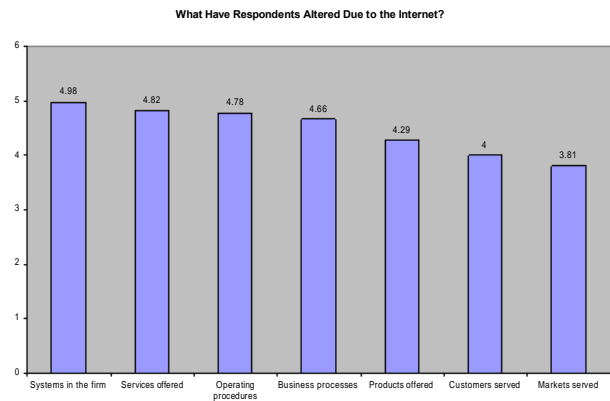


When prompted further, the respondents seemed to admit that they face a greater threat from their existing competitor that has adopted the Internet rather than an Internet start-up (see Figure below).



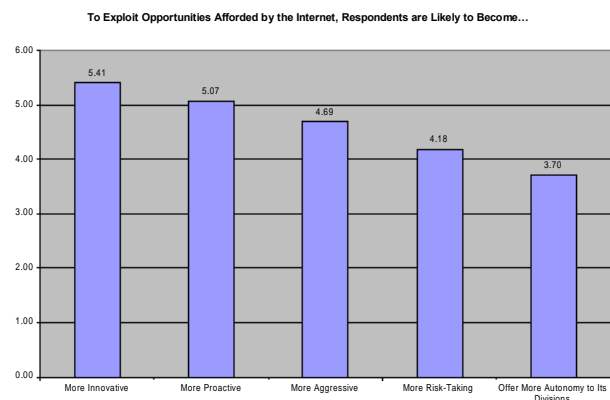
3.2. What have they Changed (or Will Change) in Response to the Internet?

In response to the changes in environment due to the Internet, the respondents seem to have altered their systems and procedures more so than the products or markets served (see Figure below). When asked about their plans and strategies to exploit the opportunities afforded by the Internet, the respondents are likely to become more innovative and proactive rather than offer more autonomy to its divisions.



3.3. Alliance with an Internet Firm or Takeover?

When asked about their plans to exploit the opportunities afforded by the Internet, respondents favored to create an alliance with an Internet firm rather than create a completely new start-up.



When new innovations (such as growth of the Internet) are very different from a firm's usual brick and mortar business, it is likely that the firm will not have sufficient internal resources to create a completely new corporate venture, external to the bounds and constraints of the existing company.

3.4. Does Technological Orientation Make a Difference?

Among many interesting revelations, high-tech survey respondents stated that their firms would most likely exploit the opportunities afforded by the Internet by creating (top three in order of preference):

1. an alliance with an Internet firm
2. a complete in-house start-up
3. an acquisition of a competitor actively using the Internet (close third).

Low-tech firms had the same first choice for the same question — an alliance with an Internet firm, while the acquisition of a competitor actively using the Internet was the second top choice. Creating an equity-based joint venture with an Internet firm was a close third for low-tech firms.

4. Conclusion

Many inferences can be obtained from the findings of this study. First, the growth in the Internet seems to concern the existing brick and mortar firms that perceive a threat from their competitors that have adopted the Internet. At the time of the survey, participating firms had changed their systems and operating processes in response to changes in the business environment due to the Internet rather than the geographic markets served. They also seem to consider being more innovative and proactive, i.e., being more entrepreneurial, to exploit the opportunities created by the development and growth of the Internet. Further, firms are more inclined to seek out external partners rather than focus on Internal Start-ups to exploit the opportunities afforded by the Internet. Finally, there are differences in perceptions of the firms depending upon their technological orientation.

In conclusion, we contend that firms that are more entrepreneurial will assimilate the Internet as a technology. The Internet is an enabling technology that provides a set of tools that could be used in any industry as part of a firm's strategy, and the brick and mortar firms must integrate the Internet so as to enhance the distinctiveness of the strategy of the firm [4]. The same sentiment is reflected in the following quote [5]:

Today it is easy to believe e-business is not all that impactful. The reality is that e-business is a tremendous tool for cost reduction. It's a tremendous tool to help you get closer to your customer. It's a tremendous tool for what used to be called Old Economy companies to apply to our current processes. The winners will be those that view the Internet as a complement to, and not a cannibal of, their traditional way of competing.

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Strategies to Enhance E-commerce in Rural Areas

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Abstract

Recent economic statistics and future projections by experts indicate that opportunities for economic growth in the future is going to come mainly from businesses of the “new economy” that utilize the powerful strategy of e-commerce. The recommendations in this article emanate from extensive primary research in the rural parts of North East USA with special focus on the rural parts of Pennsylvania. The primary research is combined with secondary research of the status of e-commerce in rural parts of several other countries thereby rendering the recommendations generically applicable.

1. Introduction

It is important to determine if the rural parts of a state, country or region have the necessary ingredients to participate in the “new economy” and reap the economic benefits that certain other regions of the world are experiencing. For example, the rural parts of Pennsylvania State had been a leader in the steel and coal industries of the 20th century but have been slow in adapting to e-commerce and attracting high-technology businesses. Small businesses that dominate the economy in most rural parts need to be capable of engaging in e-commerce and be convinced about the business advantages of engaging in e-commerce. There are very few studies that assess the awareness of e-commerce issues in rural areas and develop strategies to enhance e-commerce activity. This comprehensive study fills that void. This article describes the results, conclusions and recommendations from this study.

2. Problem Description

The following are some broad issues that were dealt in this study:

- a. The need to and the process used to understand the perception and assess the readiness of rural business owners pertaining to e-commerce especially in the areas of: a) safety and security of the Internet, b) access and availability of technological and human resource infrastructure, c) tax and government incentives and d) business advantages of engaging in e-commerce.
- b. Assessing the needs of small businesses pertaining to communication and Internet-related infrastructure in the region, and availability of human resources (staffing, hiring & training needs), government support, and incentives.
- c. Benchmarking e-commerce activity and infrastructure in their region with other “successful” regions in their country and similar regions in other parts of the world.
- d. Making policy recommendations to region, state and federal governments that can help enhance e-commerce activity in rural regions.

3. Related Literature

Literature is replete with articles pertaining to advantages, success stories and drawbacks of e-commerce. However, almost all of these articles are descriptive in nature or they present basic statistical results. Also, most articles address either the technological aspect of e-commerce or issues pertaining to dot.com businesses. A brief literature review related to issues pertaining to e-commerce and small business is presented in the following paragraphs. However, a detailed bibliography is attached in the appendix.

In spite of the recent economic downturn, the US Census Bureau reports that “retail e-commerce (B2C e-commerce) sales in the US during the final three months of 2001 (Q4) came to over \$10 billion, slightly more than one percent of the country's total retail sales of \$860 billion. The latest e-commerce figures from the US government are the highest ever, by a margin of over \$1.1 billion, since the bureau began keeping such records in late 1999. Moreover, while total retail sales in the US were up only 5.3 percent from the same time in 2000, e-commerce sales saw a 13 percent increase” [12]. In addition, the Forrester Research estimates the Business-to-Business (B2B) e-commerce revenue to increase from \$109 billion in 1999 to \$2.7 trillion in 2004 (forrester.com). For these to occur, the small businesses constituting about 50% of the nation's economy, need to participate in e-commerce in a significant way. Long reports the findings from a 1999 Computer Reseller News survey [29] that although 55% of the small businesses polled (mostly with 25 or fewer employees) were using the Internet for business, e-commerce still may be in “the feeling-out stage” for most of them. Wallace [56] discusses the lack of diverse routes in rural areas of the country through separate switching links to AT&T, MCI, Cable & Wireless, etc. This lack of alternate switching links is a drawback for these rural businesses since their Web sites will not have the highest level of availability. Several businesses have started providing web-based services and

solutions for small businesses [6], [19], [[23], [57]. However, many of these businesses focus their activities on “high-tech” areas such as Seattle, San Francisco, etc. [44].

Many countries in the world and the states in the U.S. are encouraging e-commerce activity by providing tax breaks. In addition, please observe the following examples of government assistance in developing e-commerce. Singapore is developing infrastructure, providing education, and creating an e-savvy culture [39]. Canada is developing an unique relationship between the government’s space agency and Telesat Canada which will enable Telesat to support initiatives such as e-commerce through its satellite services to citizens in urban, rural and remote communities in the country [7]. The Australian federal and state governments, in partnership with industry, are encouraging the use of e-commerce among small and medium enterprises through a combination of training and awareness programs, access to web-based information resources, etc.

In 1999, Ernst & Young’s e-Commerce Coalition addressed two issues of greatest concern to business and government: (1) the impact of e-commerce on state and local government tax revenues, and (2) the challenge of reporting and collecting sales tax (especially by small businesses) in the online world [32]. Proponents of e-commerce vehemently oppose taxing e-commerce as they claim it to be a major hurdle for small businesses in utilizing the Internet for their competitiveness. Since sales tax represents more than 25% of total state tax revenues across the US [38], critics of the Internet Tax Freedom Act have delineated negative effects of loss of sales tax revenues for the state governments such as cutting funding for state schools, hospitals, fire/police departments, etc. (e.g., [2]).

The benefits and challenges of e-commerce are discussed and debated at length in the literature. However, the reported empirical research in the area of E-commerce is minimal while that pertaining to small businesses and e-commerce is infinitesimal. The Winter 2000 Newsletter of AACSB-I, the premier accrediting body of business schools, underscores the need for the type of research outlined in this current proposal—“...the best research that can be done with e-commerce now is fundamental research that has an applied emphasis.” This e-commerce project had a strong applied research emphasis.

4. Research Methodology and Focus

- A comprehensive mail survey was sent to a stratified sample of 5,000 rural businesses in nine industry categories (the response rate was close to 10%).
- In-depth telephone and personal interviews of rural businesses that have been successful in deploying e-commerce were conducted to better understand the perceptions and needs of small businesses. The interviews also addressed the region-specific

opportunities provided and the challenges posed for rural businesses to engage in e-commerce.

- In depth telephone interviews of technology businesses were conducted to understand their telecommunication infrastructure and their pertinent service offerings to rural businesses in the region.
- Secondary research of relevant catalogs, brochures, journals, magazines and web sites was conducted to determine the educational offerings, and the telecommunication and human resource infrastructure in the region pertaining to e-commerce.
- A policy-making focus group session was conducted to: a) discuss the research findings pertaining to e-commerce deployment in the region, b) have an interactive dialogue on relevant e-commerce issues among a diverse, knowledgeable and influential group of individuals and c) devise strategies to develop policy recommendations to enhance e-commerce activity in rural parts of the state. The focus group participants included state legislators, representatives from Department of Community and Economic Development, county planning offices, e-commerce experts, business college dean, small business owners, venture capital experts and technology experts.

Five prominent regional parameters that the rural businesses indicated as important ingredients for e-commerce growth were explored in more depth:

- ! Conducive business climate
 - ! Readily available venture capital
 - ! Knowledgeable/skillful workforce
 - ! Strong collaboration/networking among a region’s public and private sectors
 - ! Image of the region possessing a technology culture
- Internet security issues that the businesses were concerned with while conducting e-commerce:
- ! Secured trading and access of information
 - ! Assurance of confidentiality
 - ! Precision of authentication
 - ! Guarantee of integrity
 - ! Reliability of service
 - ! Minimal threat of virus attack and other e-crime
 - ! Trouble-free back-up and data recovery services

5. Findings & Conclusions

- It is evident that e-commerce is more prevalent in manufacturing, service and Finance, Insurance and Real-estate (FIRE) than in other sectors. The agriculture sector is far behind all other sectors in engaging in e-commerce.
- Businesses are engaging in mainly the marketing aspects (B2C—business to consumer) of e-commerce (e.g. advertising / selling / customer service) and very little in the supply chain management (B2B—business to business) aspects of e-commerce.
- The top reasons for businesses to engage in e-commerce are improving flow of information, enhancing organization’s image and increasing productivity. These three were also the top benefits experienced. Surprisingly, increased sales and access to new market

were not reported as top reasons to engage in e-commerce.

- Statistical analysis confirmed that businesses that had identified a specific initial reason for deploying e-commerce reaped greater corresponding benefits in that category.
- Top reasons for businesses to not engage in e-commerce include: a) strategically not important for business (overwhelming reason), b) uncertainty of Internet's performance, reliability and security, c) lack of affordable technical infrastructure and d) lack of knowledgeable and skillful workforce.
- There is no real barrier in the rural areas to get started in e-commerce—technology is available in all rural areas. Practically every point in the rural region can be served by telecommunication providers, but the cost of service can be extremely prohibitive in some remote areas.
- Inadequate bandwidth and lack of redundancy to assure uninterrupted service were the two major technological deficiencies.
- Businesses, in general, are in favor of not taxing e-commerce and do not believe that it will result in lost revenues for the state and local governments.
- There is a general lack of awareness on e-commerce legal issues—e.g., legality of e-signatures in some regions.
- Businesses successful in deploying e-commerce attributed their success to management basics—performing careful strategic analysis and cost/benefit analysis.
- If the region as a whole does not have an image of being high-tech, it results in disadvantages such as lack of critical mass of technology businesses and lack of availability of skilled workforce and consultants.
- Many rural businesses outsource their web-hosting activities to third-party providers, many of whom were located outside the rural regions.

6. Recommendations

To promote e-commerce among rural businesses, the following are suggested:

- Educate entrepreneurs and small business owners & managers about the strategic importance of e-commerce and its potential benefit to businesses.
- Develop resources for providing short-term, practically oriented, hands-on training and free consultancy to small, rural businesses to adopt e-commerce.
- Develop and promote initiatives to encourage public-private funding for developing technological infrastructure in the region.
- Encourage public-private partnership to develop more sources of venture capital to promote high tech businesses.
- Attract and keep the younger generation in the region.

- Aggressively foster the right image—changing the image of “blue collar workers” to “smart people living a smart life” is very useful.
- Do no tax e-commerce.
- Publicize a few e-commerce success stories to serve as a role model to attract other e-businesses.

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A Group Decision Making Approach for Dealing with Fuzziness in Decision Process

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Abstract

In order to deal with various imprecise opinions and preferences of decision makers in group decision-making process, this paper proposes a fuzzy group decision-making approach. The approach has three advantages from existing approaches. First, it can handle simultaneously group members' fuzzy preferences for alternative solutions, fuzzy judgments for solution selection criteria and fuzzy weights for their roles in group decision-making to arrive a group consensus decision. Second, it allows group members to generate selection criteria for the best solution rather than assume them to be given before a group meeting. The third is that it uses general fuzzy number to express linguistic terms which is used to describe the fuzziness of individual preferences, judgments and weights in group decision-making. It therefore accepts any forms of fuzzy number, including triangular fuzzy number, rectangle fuzzy number and continuous fuzzy number, when applying the group decision-making approach.

1. Introduction

As the complexity of organizational decision making increases the need for decision meetings and for working in groups increases [12]. A 'decision group' is the term for a "small, self-regulating, self-contained task-oriented work group" that "typically focuses on organizationally assigned decision-making tasks" [1]. Generally, the goal of a decision group is to determine an optimal solution to a decision problem called a group decision.

A group decision is often based on a set of optimal alternative solutions for a decision problem. The set of solutions can be generated by a suitable model and made by multiple decision makers [3]. A set of selection criteria is used for assessing, or ranking, the alternatives. These criteria can be generated by the group during the meeting, or determined before the meeting. alternatives. Group members can be each awarded a weighting. The final group decision will be made through aggregating group members' preferences on alternative solutions under their weights

and judgments on selection criteria. The final decision is expected to be the most acceptable by the group.

In real environments, group decision-making has to confront various conditions [7]. As the process of decision-making is centered on human beings, with their inherent subjectivity and imprecision in the articulation of opinions, one of the conditions is fuzziness. There is much more in the fuzziness of group decision making process than just the fuzziness of models. The decision makers may be each awarded a fuzzy weighting, say, 'an important person' or 'a very important person'. The decision makers would like to express their preferences to alternatives by linguistic terms, such as 'good' or 'very good' [10]. The evaluation for alternatives is under a set of criteria and decision maker may have uncertain comparison results for these criteria individually. Particularly the decision-making procedure has to be performed through many uncertain negotiations among a group of decision makers [6]. Conflicts of interest are inevitable, and support for achieving consensus and compromise is required. Further information can trigger an alternative solution which appears preferable to the current best, or a new selection criterion is proposed.

Literature has shown that fuzzy mathematical models, in particular, fuzzy numbers are identified as the most proper way to deal with linguistic terms. A relatively practical introduction of fuzzy set theory [14] into conventional decision-making models was presented by Bellman et al. [2], Yager et al. [13] and Zimmermann [16]. Following this, further research was carried out in the area of fuzzy decision-making in the last twenty years. Existing fuzzy group decision-making approaches have handled respectively each of the three main aspects of the fuzziness in arriving a group decision-making: individual fuzzy preferences on alternative solutions (such as [5], [11]), individual judgments on solution selection criteria (such as [8], [4]), and individual roles in attempting to reach optimal solutions (such as [9]). Linguistic terms have been used in each of the three aspects of fuzziness in group decision-making [10][15].

However, there are two limitations in existed research. The first limitation is that the fuzziness regarding personal weights, alternatives and criteria in group decision-making

is studied respectively, but they can exist simultaneously. Another is that the fuzziness in generating criteria during a meeting has less attention. The third limitation is that only triangular number form of fuzzy number is used to describe linguistic terms in related algorithms. Using triangular numbers to express fuzzy values is a simple way and easy to be calculated, but it cannot describe wholly all characteristics of fuzzy values. Particularly, many fuzzy values cannot be expressed by triangular numbers.

This study proposes a fuzzy group decision-making approach to handle wholly the three fuzzy properties discussed above, support selection criteria generation during a group meeting, and allow various forms of fuzzy numbers to be used. The approach is designed to achieve the following goals: (1) to make the final solution to reflect the various roles of group members in a decision-making process; (2) to reach a ‘better’ solution by aggregating the various opinions of group members; (3) to improve the decision quality by allowing the knowledge expression by linguistic terms; (4) to suit more real situations of group decision-making by support criteria generation, and (5) to generalize the applications of fuzzy group decision-making approaches by allowing any forms of fuzzy numbers to describe the fuzziness.

2. An integrated multi-criteria fuzzy group decision-making approach

Let $S = \{S_1, S_2, \dots, S_m\}$, $m \geq 2$, be a given finite set of solutions for a decision problem and $P = \{P_1, P_2, \dots, P_n\}$, $n \geq 2$, be a given finite set of decision makers. The proposed approach consists of seven steps within two levels:

Level 1: selection criteria generation

Step 1: Each decision maker P_k ($k = 1, 2, \dots, n$) proposes one or more selection criteria ($C_{k_1}^k, C_{k_2}^k, \dots, C_{k_p}^k$). These criteria are then put into a criterion pool. These criteria are sorted based on the number of group members proposing the criterion for each criterion. Finally top-T criteria, $C = \{C_1, C_2, \dots, C_t\}$, are chosen to be selection criteria for the group.

Level 2: Individual Preference Generation

Step 2: Decision maker P_k ($k = 1, 2, \dots, n$) determines the weight of selection criterion C by using the Analytic Hierarchy Process (AHP) method.

By pairwise comparison of the relative importance of selection criteria, the pairwise comparison matrix $E = [\tilde{e}_{ij}^k]_{t \times t}$ is established, where \tilde{e}_{ij}^k represents quantified judgments on pairs of selection criteria C_i and C_j or “*”. The comparison scale belongs to a set of linguistic terms that contain various degrees of preferences required by the decision maker P_k ($k = 1, 2, \dots, n$). The linguistic terms for variable “preference” are shown in Table 1 or “*” represents decision maker P_k ($k = 1, 2, \dots, n$) don’t know the relative

importance of selection criteria C_i and C_j .

Table 1 Linguistic terms for the comparison scale of selection criteria

Linguistic terms	Fuzzy numbers
Absolutely not important (ANI)	a_1
Not important (SNI)	a_2
Less important (WNI)	a_3
Important (EI)	a_4
More important (WI)	a_5
Much more important (SI)	a_6
Absolutely important (AI)	a_7

Consistent weights w_i^k ($i = 1, 2, \dots, t$) for every selection rule can be determined by calculating the geometric mean of that e_{ij}^k ($j = 1, 2, \dots, t$) is no “*” of each row of the matrix $[\tilde{e}_{ij}^k]_{t \times t}$, and then the resulting fuzzy numbers are normalized and denoted as $\tilde{w}_1^k, \tilde{w}_2^k, \dots, \tilde{w}_t^k$, where $\tilde{w}_i^k \in F_T^*(R)$ and

$$\tilde{w}_i^k = \frac{w_i^k}{\sum_{i=1}^t w_i^k}, \text{ for } i = 1, 2, \dots, t; k = 1, 2, \dots, n.$$

Step 3: Against every selection rule C_j ($j = 1, 2, \dots, t$), a belief level can be introduced to express the possibility of selecting a solution (i) under rule (j) for a decision maker (k). The belief level b_{ij}^k ($i = 1, 2, \dots, m$, $j = 1, 2, \dots, t$, $k = 1, 2, \dots, n$) belongs to a set of linguistic terms that contain various degrees of preferences required by a decision maker P_k ($k = 1, 2, \dots, n$) or “*”. The linguistic terms for variable “judgment” are shown in Table 2 or “*” represents the decision maker P_k ($k = 1, 2, \dots, n$) don’t know a belief level for expressing the possibility of selecting a solution (i) under rule (j).

Table 2 Linguistic terms for the belief levels of selection criteria

Linguistic terms	Fuzzy numbers
Very low (VL)	b_1
Low (L)	b_2
Medium low (ML)	b_3
Medium (M)	b_4
Medium high (MH)	b_5
High (H)	b_6
Very high (VH)	b_7

Step 4: Belief level matrix (b_{ij}^k) ($k = 1, 2, \dots, n$) is aggregated in to belief vector (\bar{b}_j^k) ($j = 1, 2, \dots, t$, $k = 1, 2, \dots, n$).

$$\bar{b}_j^k = \tilde{w}_{i_1}^k * b_{i_1}^k + \tilde{w}_{i_2}^k * b_{i_2}^k + \dots + \tilde{w}_{i_s}^k * b_{i_s}^k,$$

where b_{ij}^k ($i = 1, 2, \dots, s$) is no “*”.

Based on belief vectors, the decision maker P_k ($k = 1, 2, \dots, n$) can make an overall judgment on the solutions,

called an individual selection vector. All individual selection vectors can compose a group of selection matrixes $(\tilde{b}_j^k)_{n \times m}$.

Level 3: Group Aggregation

Step 5: As group members play different roles in an organization the relative importance of each decision maker may not equal in a decision group. Some are more important than the others. Therefore, the relative importance weighting of each decision maker should be considered. The linguistic terms $\tilde{v}_k, k = 1, 2, \dots, n$ are shown in Table 3.

Table 3 Linguistic terms for the weights of decision makers

Linguistic terms	Fuzzy numbers
General decision person (GP)	c_1
Weakly important person (WP)	c_2
Strongly important person (SP)	c_3
The most important person (TP)	c_4

The normalized weight of a decision maker $P_k (k = 1, 2, \dots, n)$ is denoted as

$$\tilde{v}_k^* = \frac{\tilde{v}_k}{\sum_{i=1}^n v_{i0}^R}, \quad \text{for } k = 1, 2, \dots, n.$$

Step 6: Considering the weights of all decision makers in a group, we can construct the weighted normalized fuzzy decision vector

$$(\tilde{r}_1, \tilde{r}_2, \dots, \tilde{r}_m) = (\tilde{v}_1^*, \tilde{v}_2^*, \dots, \tilde{v}_n^*) (\tilde{b}_i^j)_{m \times n},$$

where $\tilde{r}_j = \sum_{k=1}^n \tilde{v}_k^* \tilde{b}_i^k$.

Step 7: In the weighted normalized fuzzy decision vector the elements $\tilde{v}_j, j = 1, 2, \dots, m$ are normalized positive fuzzy numbers, and their ranges belong to closed interval [0, 1]. We can then define fuzzy positive-ideal solution (FPIS, r^*) and fuzzy negative-ideal solution (FNIS, r^-) as:

$$r^* = 1 \quad \text{and} \quad r^- = 0.$$

The positive and negative solution distances between each \tilde{r}_j and r^* , \tilde{r}_j and r^- can be calculated as:

$$d_j^* = d(\tilde{r}_j, r^*) \quad \text{and} \quad d_j^- = d(\tilde{r}_j, r^-), \quad j = 1, 2, \dots, m$$

where $d(\tilde{a}, \tilde{b}) = \left(\int_0^1 \frac{1}{2} [(a_l^L - b_l^L)^2 + (a_l^R - b_l^R)^2] dl \right)^{\frac{1}{2}}$ is

the distance measurement between two fuzzy numbers.

Step 8: A closeness coefficient is defined to determine the ranking order of all solutions once the d_j^* and d_j^- of each decision solution $S_j (j = 1, 2, \dots, m)$ are obtained. The closeness coefficient of each solution is calculated as:

$$CC_j = \frac{1}{2} (d_j^* + (1 - d_j^-)), \quad j = 1, 2, \dots, m.$$

The solution S_j that corresponds to the largest CC_j is the best satisfactory solution of the decision group. If the solution cannot be accepted by the group, two actions can be taken. One is to alter the selection criteria. For example, add or remove a selection criterion. Another is to remove one or more of the worst alternative solutions and redo the process. The 'worst' solution is that which corresponds to the $\text{Min}\{CC_j; j = 1, 2, \dots, m\}$.

3. An Application of the Approach

Two solutions S_1, S_2 have been obtained as alternatives by a group which is organized by three members, P_1, P_2 and P_3 . The group will select one from S_1, S_2 under three selection criteria C_1, C_2, C_3 . The three members have different weights and are allowed to express their individual fuzzy preferences for the two solutions and imprecise judgments for the goals of the three criteria using linguistic terms. The approach allows any forms of fuzzy numbers to describe these linguistic variables. Table 4, 5 and 6 show what we used.

Table 4 Linguistic variables and related fuzzy numbers for the comparison scale of selection criteria

Linguistic variables	Fuzzy numbers
Absolutely not important (ANI)	$\bigcup_{l \in [0,1]} l \left[0, \frac{\sqrt{1-l}}{10} \right]$
Not important (SNI)	$\bigcup_{l \in [0,1]} l \left[\frac{\sqrt{l}}{10}, \frac{\sqrt{9-8l}}{10} \right]$
Less important (WNI)	$\bigcup_{l \in [0,1]} l \left[\frac{\sqrt{8l+1}}{10}, \frac{\sqrt{25-16l}}{10} \right]$
Important (EI)	$\bigcup_{l \in [0,1]} l \left[\frac{\sqrt{16l+9}}{10}, \frac{\sqrt{49-24l}}{10} \right]$
More important (WI)	$\bigcup_{l \in [0,1]} l \left[\frac{\sqrt{24l+25}}{10}, \frac{\sqrt{81-32l}}{10} \right]$
Much more important (SI)	$\bigcup_{l \in [0,1]} l \left[\frac{\sqrt{32l+49}}{10}, \frac{\sqrt{100-19l}}{10} \right]$
Absolutely important (AI)	$\bigcup_{l \in [0,1]} l \left[\frac{\sqrt{19l+81}}{10}, 1 \right]$

Table 5 Linguistic variables and related fuzzy numbers for the belief levels of selection criteria

Linguistic variables	Fuzzy numbers
Very low (VL)	$\bigcup_{l \in [0,1]} l \left[0, \frac{\sqrt{1-l}}{10} \right]$
Low (L)	$\bigcup_{l \in [0,1]} l \left[\frac{\sqrt{l}}{10}, \frac{\sqrt{9-8l}}{10} \right]$
Medium low (ML)	$\bigcup_{l \in [0,1]} l \left[\frac{\sqrt{8l+1}}{10}, \frac{\sqrt{25-16l}}{10} \right]$

Medium (M)	$\bigcup_{l \in [0,1]} l \left[\frac{\sqrt{16l+9}}{10}, \frac{\sqrt{49-24l}}{10} \right]$
Medium high (MH)	$\bigcup_{l \in [0,1]} l \left[\frac{\sqrt{24l+25}}{10}, \frac{\sqrt{81-32l}}{10} \right]$
High (H)	$\bigcup_{l \in [0,1]} l \left[\frac{\sqrt{32l+49}}{10}, \frac{\sqrt{100-19l}}{10} \right]$
Very high (VH)	$\bigcup_{l \in [0,1]} l \left[\frac{\sqrt{19l+81}}{10}, 1 \right]$

Table 6 Linguistic variables and related fuzzy numbers for the weights of decision persons

Linguistic variables	Fuzzy numbers
General decision person (GP)	$\bigcup_{l \in [0,1]} l \left[\frac{\sqrt{16l+9}}{10}, \frac{\sqrt{49-24l}}{10} \right]$
Weakly important person (WP)	$\bigcup_{l \in [0,1]} l \left[\frac{\sqrt{24l+25}}{10}, \frac{\sqrt{81-32l}}{10} \right]$
Strongly important person (SP)	$\bigcup_{l \in [0,1]} l \left[\frac{\sqrt{32l+49}}{10}, \frac{\sqrt{100-19l}}{10} \right]$
The most important person (TP)	$\bigcup_{l \in [0,1]} l \left[\frac{\sqrt{19l+81}}{10}, 1 \right]$

Step 1: by using the AHP method, three pairwise comparison matrices are established:

$$E^1 = E^2 = E^3 = \begin{pmatrix} EI & EI & * \\ EI & EI & * \\ * & * & EI \end{pmatrix} = \begin{pmatrix} a_4 & a_4 & * \\ a_4 & a_4 & * \\ * & * & a_4 \end{pmatrix}.$$

Through computing the geometric mean of each row of the matrices, the normalized resulting numbers are obtained. As

$$\begin{pmatrix} w_1^1 \\ w_2^1 \\ w_3^1 \end{pmatrix} = \begin{pmatrix} w_1^2 \\ w_2^2 \\ w_3^2 \end{pmatrix} = \begin{pmatrix} w_1^3 \\ w_2^3 \\ w_3^3 \end{pmatrix} = \begin{pmatrix} \sqrt[3]{a_4 a_4} \\ \sqrt[3]{a_4 a_4} \\ a_4 \end{pmatrix}$$

$$= \begin{pmatrix} a_4 \\ a_4 \\ a_4 \end{pmatrix} = \begin{pmatrix} \bigcup_{l \in [0,1]} l \left[\frac{\sqrt{16l+9}}{10}, \frac{\sqrt{49-24l}}{10} \right] \\ \bigcup_{l \in [0,1]} l \left[\frac{\sqrt{16l+9}}{10}, \frac{\sqrt{49-24l}}{10} \right] \\ \bigcup_{l \in [0,1]} l \left[\frac{\sqrt{16l+9}}{10}, \frac{\sqrt{49-24l}}{10} \right] \end{pmatrix}$$

and $\sum_{i=1}^3 w_{i0}^{1R} = \sum_{i=1}^3 w_{i0}^{2R} = \sum_{i=1}^3 w_{i0}^{3R} = 2.1$. So we have

$$\begin{pmatrix} \tilde{w}_1^1 \\ \tilde{w}_2^1 \\ \tilde{w}_3^1 \end{pmatrix} = \begin{pmatrix} \tilde{w}_1^2 \\ \tilde{w}_2^2 \\ \tilde{w}_3^2 \end{pmatrix} = \begin{pmatrix} \tilde{w}_1^3 \\ \tilde{w}_2^3 \\ \tilde{w}_3^3 \end{pmatrix} = \frac{1}{2.1} \begin{pmatrix} a_4 \\ a_4 \\ a_4 \end{pmatrix}$$

Step 2: Assesses

$$\begin{pmatrix} b_{11}^1 & b_{12}^1 & b_{13}^1 \\ b_{21}^1 & b_{22}^1 & b_{23}^1 \end{pmatrix} = \begin{pmatrix} M & VL & ** \\ VH & ** & M \end{pmatrix} = \begin{pmatrix} b_4 & b_1 & ** \\ b_7 & ** & b_4 \end{pmatrix},$$

$$\begin{pmatrix} b_{11}^2 & b_{12}^2 & b_{13}^2 \\ b_{21}^2 & b_{22}^2 & b_{23}^2 \end{pmatrix} = \begin{pmatrix} ** & M & VL \\ M & VH & ** \end{pmatrix} = \begin{pmatrix} ** & b_4 & b_1 \\ b_4 & b_7 & ** \end{pmatrix},$$

$$\begin{pmatrix} b_{11}^3 & b_{12}^3 & b_{13}^3 \\ b_{21}^3 & b_{22}^3 & b_{23}^3 \end{pmatrix} = \begin{pmatrix} VL & ** & M \\ ** & M & VH \end{pmatrix} = \begin{pmatrix} b_4 & ** & b_1 \\ ** & b_4 & b_7 \end{pmatrix}.$$

Step 3: We have

$$\bar{b}_1^1 = \tilde{w}_1^1 b_{11}^1 + \tilde{w}_2^1 b_{12}^1 = \frac{1}{2.1} (a_4^2 + a_4 a_1),$$

$$\bar{b}_2^1 = \tilde{w}_1^1 b_{21}^1 + \tilde{w}_3^1 b_{13}^1 = \frac{1}{2.1} (a_4^2 + a_4 a_7),$$

$$\bar{b}_1^2 = \tilde{w}_2^2 b_{12}^2 + \tilde{w}_3^2 b_{13}^2 = \frac{1}{2.1} (a_4^2 + a_4 a_1),$$

$$\bar{b}_2^2 = \tilde{w}_1^2 b_{21}^2 + \tilde{w}_2^2 b_{22}^2 = \frac{1}{2.1} (a_4^2 + a_4 a_7),$$

$$\bar{b}_1^3 = \tilde{w}_1^3 b_{11}^3 + \tilde{w}_3^3 b_{13}^3 = \frac{1}{2.1} (a_4^2 + a_4 a_1),$$

$$\bar{b}_2^3 = \tilde{w}_2^3 b_{21}^3 + \tilde{w}_3^3 b_{23}^3 = \frac{1}{2.1} (a_4^2 + a_4 a_7).$$

Step 4: Assesses: The important weight v_1 of P_1 is TP ; the important weight v_2 of P_2 is GP and the important weight v_3 of P_3 is GP . Then

$$v_1 = c_4, v_2 = v_3 = c_1, \text{ and } \sum_{i=1}^3 v_{i0}^R = 2.4,$$

therefore

$$v_1^* = \frac{c_4}{2.4} = \frac{a_7}{2.4}, v_2^* = v_3^* = \frac{c_1}{2.4} = \frac{a_4}{2.4}.$$

Step 5: We have

$$\tilde{r}_1 = v_1^* \bar{b}_1^1 + v_2^* \bar{b}_1^2 + v_3^* \bar{b}_1^3 = \frac{1}{2.1 \times 2.4} (a_7 + 2a_4)(a_4^2 + a_4 a_1)$$

$$= \bigcup_{l \in [0,1]} l \left[\frac{(16l+9)\sqrt{19l+81} + 2(16l+9)^{\frac{3}{2}}}{5040}, \right.$$

$$\left. \frac{10(49-24l) + 10\sqrt{(1-l)(49-24l)} + 2(49-24l)^{\frac{3}{2}}}{5040} \right.$$

$$\left. + \frac{2(49-24l)\sqrt{1-l}}{5040} \right],$$

$$\tilde{r}_2 = v_1^* \bar{b}_2^1 + v_2^* \bar{b}_2^2 + v_3^* \bar{b}_2^3 = \bigcup_{l \in [0,1]} l \left[\frac{3(16l+9)\sqrt{19l+81}}{5040} \right.$$

$$\left. + \frac{2(16l+9)^{\frac{3}{2}} + (19l+81)\sqrt{16l+9}}{5040}, \right.$$

$$\left. \frac{30(49-24l) + 100\sqrt{49-24l} + 2(49-24l)^{\frac{3}{2}}}{5040} \right].$$

Step 6: We get

$$\begin{aligned}
d_1^* &= d(\tilde{r}_1, r^*) = \int_0^1 \frac{1}{2} \left[\left(\frac{(16l+9)\sqrt{19l+81} + 2(16l+9)^{\frac{3}{2}}}{5040} \right. \right. \\
&\quad \left. \left. - 1 \right)^2 + \left(\frac{10(49-24l) + 10\sqrt{(1-l)(49-24l)}}{5040} \right. \right. \\
&\quad \left. \left. + \frac{2(49-24l)^{\frac{3}{2}} + 2(49-24l)\sqrt{1-l}}{5040} - 1 \right)^2 \right] dl = 0.8727 \\
d_2^* &= d(\tilde{r}_2, r^*) = 0.6295 \\
d_1^- &= d(\tilde{r}_1, r^-) = \int_0^1 \frac{1}{2} \left[\left(\frac{(16l+9)\sqrt{19l+81}}{5040} \right. \right. \\
&\quad \left. \left. + \frac{2(16l+9)^{\frac{3}{2}}}{5040} \right)^2 + \left(\frac{10(49-24l) + 10\sqrt{(1-l)(49-24l)}}{5040} \right. \right. \\
&\quad \left. \left. + \frac{2(49-24l)^{\frac{3}{2}} + 2(49-24l)\sqrt{1-l}}{5040} - 1 \right)^2 \right] dl = 0.1546 \\
d_2^- &= d(\tilde{r}_2, r^-) = 0.4423
\end{aligned}$$

Step 7: Finally, we have

$$CC_1 = \frac{1}{2}(d_1^- + (1-d_1^*)) = 0.1409 \quad \text{and} \quad CC_2 = 0.4064.$$

Since CC_2 is higher than CC_1 , the group selects the solution S_2 as the most satisfactory solution for the research planning problem.

4. Conclusions

The paper proposes a general group-making approach to deal with fuzziness of decision maker's preference for alternatives, decision makers' judgment for selection criteria, and decision maker's weighting. The approach aggregates these fuzzy elements into a group decision which is the most acceptable for the group. As the approach supports criteria generation during a group meeting it is very practical. In particular, it is suitable for any types of fuzzy number, in the practice, decision maker can choose a most suitable one for specific decision problems and in specific environment

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Process Chart for Controlling Wafer Defects using Fuzzy Theory

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Abstract

Manufacturers of integrated circuits (IC) frequently utilize c-charts to monitor wafer defects. The clustering of wafer defects increases with the surface area of the wafers. The clustering of defects causes the Poisson-based c-chart to show many false alarms. Although Neyman-based c-chart has been developed to reduce the number of false alarms, it has some shortcomings in practical use. This study presents a process control chart that applies Fuzzy theory and the engineering experience to monitor the clustered defects on a wafer. The proposed method is simpler and more efficient than that of the Neyman-based c-chart. A case study of an IC company in Taiwan demonstrates the effectiveness of the proposed method.

Keywords: Integrated circuits; wafer; defect; statistical process control; defect clustering; Fuzzy theory

1. Introduction

As the information industry grows rapidly, manufacturers of IC are focusing on upgrading their production capabilities in response to strong competition. Therefore, increasing wafer yield is becoming an important issue.

Wafer yield is defined as the percentage of dies that pass the final specification test. The wafer manufacturing process includes hundreds of steps, such as alignment, lithography, etch, deposition, doping and others. In such a complex process, some defects are inevitably produced on the wafer surface, sometimes causing the wafers to be faulty and reducing their yield. Consequently, the number of defects is a significant factor in determining the wafer yield. As IC technology has developed, the surface area of wafers has increased and the clustering of defects has becomes apparent. Hence, like the number of defects on the wafer surface, the clustering of defects affects the wafer yield.

IC manufacturers usually employ c-charts to monitor wafer defects. The use of c-charts assumes wafer defects to be randomly and independently distributed; that is, the number of defects is assumed to follow a Poisson distribution. However, real defect clustering violates this assumption, sometimes causing too many false alarms. Albin and Friedman [1] presented a modified c-chart that is based on a Neyman Type-A distribution to solve this problem. The Neyman-based c-chart widens the control limits and reduces the number false alarms obtained using the Poisson-based c-chart. However, the Neyman-based c-chart can monitor only the variation in the number of defects among wafers, and cannot detect variation in the location of defects within a wafer.

This study applies Fuzzy theory and engineering experience to construct a process control chart that can effectively monitor the clustered wafer defects and defect clustering simultaneously and thus overcome the shortcomings of the Neyman-based c-chart. The proposed method is simpler and more efficient than that of Neyman-based c-charts.

2. Related Work

This section describes a cluster index for measuring the extent of defect clustering, Poisson-based c-chart, Neyman-based c-charts and Fuzzy theory.

2.1 Cluster Index

Stapper [3] indicated that the clustering of defects on a wafer becomes more pronounced as the surface area of the wafer increases. Defect clustering violates the assumption on which the c-chart is based: the defects are not independently or randomly scattered on a wafer. Some cluster indices are developed to measure the extent of the clustering of defects. Of these cluster indices, the cluster index proposed by Jun et al. [2], denoted by CI, is proven to be more effective than any others. Moreover, CI does not require any assumptions to be made about the

distribution of defects.

CI is computed as follows. Given that n defects are present on a wafer, and the coordinates of each defect in a two-dimensional plane are given by (X_i, Y_i) for $i=1, 2, \dots, n$, rearrange X_i and Y_i in ascending order to obtain $X_{(i)}$, $Y_{(i)}$, where $X_{(i)}$ represents the x coordinate of the i th defect, and $Y_{(i)}$ is the y coordinate of the i th defect. Hence, the intervals V_i and W_i

$$V_i = X_{(i)} - X_{(i-1)}, i = 1, 2, \dots, n$$

$$W_i = Y_{(i)} - Y_{(i-1)}, i = 1, 2, \dots, n$$

where $X_{(0)}$ and $Y_{(0)}$ are set to zero.

CI can now be expressed as follows.

$$CI = \min \{ \text{coefficient of variation of } V_i \}^2, (\text{coefficient of variation of } W_i \}^2 \}$$

The mean and variance of V_i can be written as \bar{V} and S_v^2 , respectively. The mean and variance of W_i can be written as \bar{W} and S_w^2 , respectively. Then, the CI can be expressed as follows.

$$CI = \min \frac{S_v^2}{\bar{V}^2}, \frac{S_w^2}{\bar{W}^2}.$$

When the defects are uniformly distributed, the CI index equals one. If CI exceeds one, the defects are clustered. A larger CI corresponds to more severe clustering.

2.2 Poisson-based c-chart

In IC manufacturing, the number of defects is the quality characteristic on which the conventional c-chart is typically based. The number of defects used to construct the c-chart must be Poisson-distributed, and so have a probability distribution function given by,

$$p(N = n) = \frac{e^{-m} m^n}{n!},$$

where n represents the number of defects on the surface

and m represents the average number of defects on a wafer.

According to the properties of Poisson distribution, the upper control limit (UCL) of the c-chart can be obtained as follows.

$$UCL = m + 3(m)^{\frac{1}{2}}.$$

Recently, as the surface area of wafers has increased from 4 inches to 12 inches, the clustering of wafer defects has becomes more apparent, such that using the c-chart to monitor the number of defects produces many false alarms.

2.3 Neyman-based c-chart

A modified c-chart based on Neyman Type-A distribution was developed to reduce the number of false alarms. The Neyman Type-A distribution is a member of family of compound Poisson distributions. Albin and Friedman [1] proposed a Neyman-based c-chart that improved on the Poisson-based c-chart. The Neyman Type-A distribution assumed that the number of defect clusters follows a Poisson distribution with mean 1 , and that the number of defects in each cluster is also Poisson-distributed with mean f . The probability distribution function of a Neyman Type-A distribution is as follows.

$$P_n(lf) = P_r(N = n) = \sum_{j=1}^{\infty} e^{-1} \frac{1^j}{j!} e^{-f} \frac{(jf)^k}{n!},$$

where n represents the number of defects on a wafer's surface; 1 represents the average number of defects on a wafer, and f represents the average number of defects per cluster.

The expected value and variance of Neyman Type-A distribution are given as follows.

$$E(x) = lf, \quad V(x) = lf(1+f).$$

The ratio of $V(x)$ to $E(x)$ is $(1+f)$, so the Neyman-based c-chart widens the control limits on the Poisson-based c-chart and can therefore effectively reduce the number of false alarms that would otherwise be determined by the Poisson-based c-chart. However, the method proposed by Albin and Friedman still has some shortcomings. They considered the number of defects on a wafer as the quality characteristic, on which to determine the control limits of the Neyman-based c-chart. Their method monitors only the variability of defects among wafers. The variability of the number of defects within a wafer cannot be detected.

2.4 Fuzzy Theory

Zadeh [5] first developed Fuzzy theory, which is utilized to deal with Fuzzy events. This section briefly reviews Fuzzy theory.

2.4.1 Fuzzy Set

Fuzzy theory is based on Fuzzy sets. The characteristic function of a crisp set is defined to be either zero or one, and the relationship of the characteristic function to a Fuzzy set is determined with reference to a dichotomy. However, the concept of dichotomy here differs from that typically used. The human language includes many vague words. Therefore, Zadeh used a membership function to represent the intensity: with which one element belongs to one set; a stronger intensity corresponds to a membership function closer to one; a weaker intensity corresponds to a function closer to zero.

2.4.2 Fuzzy logics and Fuzzy inference

A Fuzzy proposition has two forms; one is the atomic Fuzzy proposition and the other is compound Fuzzy proposition. Fuzzy logic is defined as follows.

1. If a compound Fuzzy proposition uses “and” to combine two atomic Fuzzy propositions, such as ‘X is A’ and ‘y is B’, then the membership function can be defined as $m_r(x, y) = \min(m_A(x), m_B(y))$, $(x, y) \in X \times Y$.
2. If a compound Fuzzy proposition uses “or” to combine two atomic Fuzzy propositions, such as ‘X is A’ or ‘y is B’, then the membership function is $m_r(x, y) = \max(m_A(x), m_B(y))$, $(x, y) \in X \times Y$.
3. If a compound Fuzzy proposition uses “implies” to combine two atomic Fuzzy propositions, such as ‘X is A’ implies ‘y is B’, then the membership function is $m_r(x) = \min(1, 1 - m_A(x) + m_B(y))$, $(x, y) \in X \times Y$.

Fuzzy inference is similar to inference in binary logic. The difference between these two inferences is that a Fuzzy inference involves contiguous sets, unlike in binary logics, wherein sets are defined absolutely and as opposing each other. A Fuzzy inference includes Fuzzy steps; many Fuzzy steps are combined in a computable system. Some value is imagined to be input into this system. Figure 1 depicts the process of Fuzzy inference.

Fuzzy inference provides a different method of control from the traditional method. A Fuzzy inference system includes experts’ knowledge, operators’ experience, the membership function and the development of rules; therefore, the Fuzzy inference system is essentially intelligent.

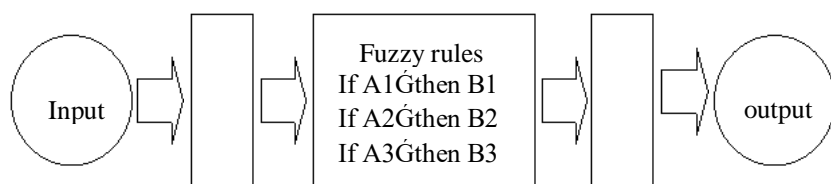


Figure 1. The process of Fuzzy inference

3. Proposed Procedure

This study develops an efficient method for monitoring the clustered defects. Fuzzy theory is utilized to construct a control chart to monitor simultaneously the number of defects across various wafers and defect clustering. The proposed procedure is described as follows.

Step 1: Obtain the wafer map using the KLA 2110 wafer inspection system.

The KLA 2110 wafer inspection system can provide in-line wafer inspection information, including the number of defects, their sizes, their locations and their types.

Step 2: Determine the number of defects and compute CI.

Step 3: Construct the membership functions that correspond to the number of defects, CI and output of the process.

Both the number of defects and clustering are important characteristics that might affect wafer yield. This study therefore considers these two quality characteristics as the input variables of the Fuzzy inference system and the output of the process as the output of Fuzzy inference system. The number of defects can be classified using seven levels – very-low, low, medium-low, medium, medium-high, high, very-high (see Fig.2), and the membership function of each Fuzzy set is constructed accordingly.

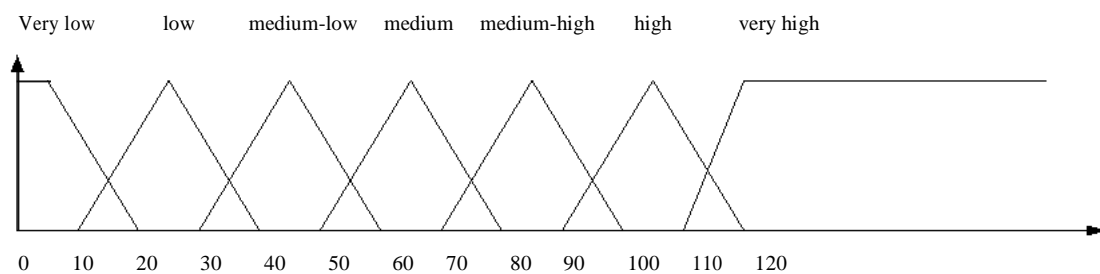


Figure 2. Seven levels of numbers of defects

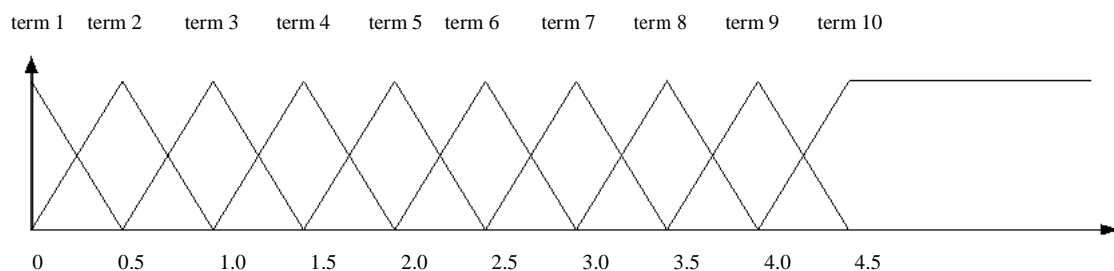


Figure 3. Ten statements about clustering phenomena

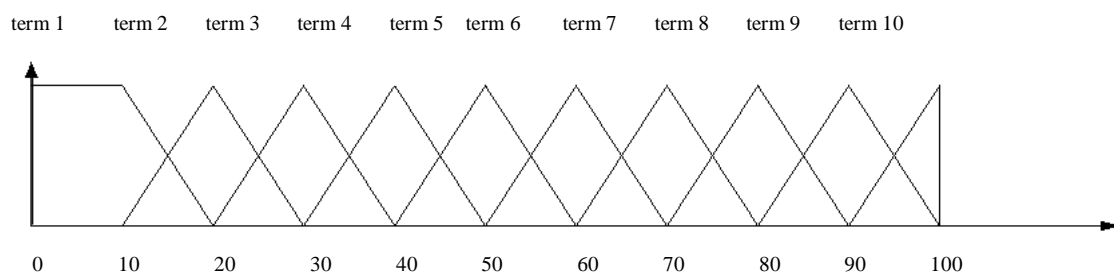


Figure 4. Ten output levels

Clustering phenomena can be classified using ten statements, term 1 to term 10 (Fig. 3), and the membership function of each Fuzzy set is constructed accordingly.

The output can be classified into ten levels, represented by terms 1 to 10 (Fig. 4), respectively, the membership function of each Fuzzy set is constructed accordingly.

Step 4: Establish a warehouse of rules.

When many defects are present, without clustering, the process is considered to be out of control; when a few defects are present but clustering is significant, the process is said to be under control; the corresponding rules generated to monitor the process can be expressed as follows.

R_1 : IF Defect is very high AND CI is term 1, THEN Value is term 10

R_2 : IF Defect is very high AND CI is term 2, THEN Value is term 10

.

R_1 : IF Defect is medium AND CI is term 10, THEN Value is term 2

.

R_{70} : IF Defect is very low AND CI is term 10, THEN Value is term 1

Step 5: Make Fuzzy inference

In the system for controlling the manufacturing of wafers, (established using Fuzzy theory, the number of defects and the CI value are determined. For example, if a wafer is detected; the number of defects is 93, and the CI value is 0.866, then an input, (93, 0.866), is generated; this input activates four rules, as follows.

RKIF Defect is medium-high AND CI is term 2 , THEN Value is term 10

RKIF Defect is medium-high AND CI is term 3 , THEN Value is term 9

RKIF Defect is high AND CI is term 2 , THEN Value is term 9

RKIF Defect is high AND CI is term 3 , THEN Value is term 9

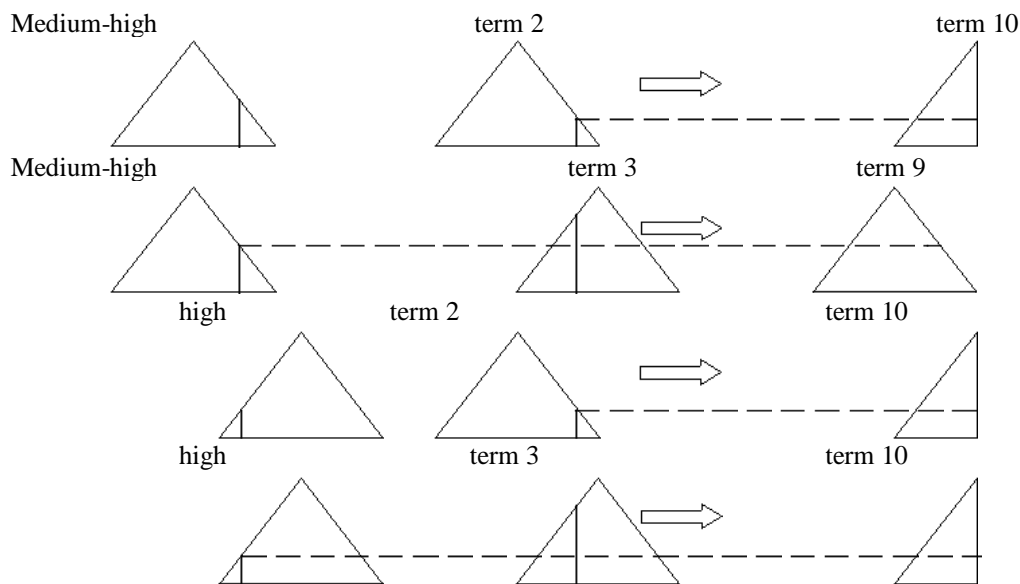


Figure 5. Fuzzy inference rules

Fig. 5 presents these four rules.

A new Fuzzy set can be obtained by utilizing Fuzzy set from the four rules, as shown in Fig. 6

Step 6: Draw the Fuzzy control chart and construct the control limits.

After the defect data are collected, the defect data are transformed into output of the Fuzzy inference rules using the six steps described above. Hence, a moving range ($\bar{X}-R_m$) control chart can be constructed to monitor simultaneously the number of defects and clustering. If all of the data plotted on the chart fall within the control limits, then these control limits can be regarded as the limits of the process control chart; if one or two points lie outside of the control limits, then the causes must be found and corrected.

Step 7: Establish rules for determining that the process is out of control.

Consider Fig. 7, for example. If a point falls inside the control limits, then the process is said to be under control.

If points fall outside the control limits, then the process is said to be out of control. With reference to Fig. 7, suppose points 1 and 2 are out of control and fall beyond the upper control limit; then, the process's being out of control is caused by an excess of defects; assume that points 3, 4 and 5 are out of control and fall below the lower control limit; then, defect clustering is determined to have made the wafer manufacturing process unstable.

4. Conclusion

The clustering of wafer defects increases with the surface area of wafers. The clustering of wafer defects not only impacts the yield of the IC production line, but also causes the Poisson-based c-chart to fail to monitor the wafer process effectively. Albin and Friedman [1] developed the Neyman-based c-chart as an improvement on the Poisson-based c-chart. The Neyman c-chart widens the control limits of the Poisson-based c-chart and reduces the number of false alarms. However, that Neyman c-chart cannot detect the clustering defects between wafers.

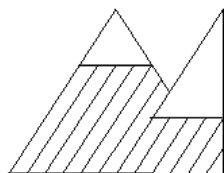


Figure 6. Union chart

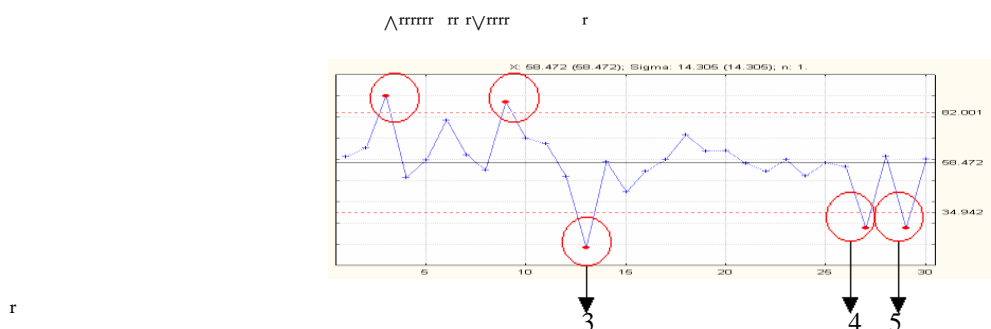


Figure 7. A $\bar{X}-R_m$ control chart for monitoring simultaneously the number of defects and clustering

The contributions of the proposed method can be summarized as follows.

1. The Fuzzy system incorporates the knowledge of experts and the experience of engineers, and can therefore effectively monitor simultaneously the number of defects and the extent of clustering. The proposed Fuzzy control chart can also reduce the workload associated with constructing two separate process control charts to monitor the number of defects and clustering.
2. Engineers with little knowledge of Statistics can apply the proposed Fuzzy control chart easily. This chart is very helpful in judging real process conditions.
3. The proposed control chart is simpler and more efficient than both the Poisson-based c-chart and the Neyman-based c-chart.

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An Examination of the Effects of IT Intensity and Organizational Absorptive Capacity on CRM Practices

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Abstract

Electronic business (e-business) brings many new opportunities as well as several challenges to business organizations. Many organizations have turned to customer relationship management (CRM) to leverage their market orientation, customize their products and services, and build loyalty programs. However, capitalizing on the opportunities will require organizational investments in information technology (IT) and absorptive capacity. This study examines the effects of investments in IT (IT intensity) and absorptive capacity on CRM practices, particularly market orientation, customization and loyalty programs. The results suggest that a positive relationship exists among them. Thus, organizations should devote resources toward developing their IT investments and absorptive capacity to benefit from their CRM practices.

Keywords: Customer relationship management, information technology, organizational absorptive capacity, market orientation, customization, loyalty programs.

1. Introduction

Electronic business (e-business) brings many new opportunities as well as challenges to business organizations. Its Internet-enabled global reach opens many new marketplaces and as a result draws upon a broader customer base. For 2003, Forrester estimates total worldwide business-to-customer (B2C) spending at US\$133.6 billion worldwide, of which \$78.1 billion will be generated in North America, \$23.9 billion in the Asia-Pacific region and \$29.6 billion in Western Europe. Forecasts expect total B2C spending to reach \$561.8 billion (\$219.8 billion North America, \$185.2 billion Asia-Pacific, \$138.3 billion Western Europe) by 2006. Gartner [8] predicts the current 216.7 million adult worldwide Internet users to double in 2005. Thus, ample opportunities will exist for businesses that pursue global electronic markets.

Yet, with B2C e-business, organizations are finding themselves immersed in highly competitive, consumer-driven markets, often competing against virtual organizations comprised of horizontally or vertically integrated partnerships. Successful e-business organizations must now pay particularly close attention to defining clearly their products and services in such a way that allows them to establish market niches, long term

customer relationships and leadership positions. To move closer toward these advantages, many organizations have turned to customer relationship management (CRM), a marketing concept enabled by information technology (IT) and often described as a competitive tool that permits an organization to stay in tune with its customers and customize its products and services to meet their needs and expectations.

Much of the success behind e-business and CRM can be attributed to continual advances in IT and organizational knowledge. Generally, greater investments in IT afford greater technical capabilities. However, the investments must be made according to a presiding plan or architecture for the organization to reap its rewards. Hence, IT intensity or the degree to which an organization invests in IT may be a critical determinant to its success with CRM as IT represents the technological means for achieving success.

Yet, possessing IT may not be sufficient. Another critical factor may lie in its *know-how*, knowledge to recognize, understand and apply usable information. Organizational absorptive capacity, an organization's aggregated ability to recognize and assimilate new information, and apply its ensuing knowledge to commercial ends [4], represents the development of organizational knowledge. Often, investments in research and development (R&D) and other learning experiences help build organizational knowledge. Products of absorptive capacity include innovations within internal processes, and innovative products and services [3], [4], [10], and reflect the organization's ability to leverage and exploit its knowledge. As a result, absorptive capacity can strongly influence an organization's business practices.

The purpose of this paper is to examine the relationships among IT intensity, absorptive capacity and CRM practices. CRM practices represent an important aspect of CRM as they define how an organization directs its use of CRM to gain a competitive advantage, and impact its performance with CRM. This study presents and empirically tests a research model of the described relationship.

2. IT Intensity

IT intensity refers to the degree to which an organization invests in its IT infrastructure and applications. Because CRM is an IT-enabled concept that embodies relationship marketing (RM) principles, the IT infrastructure on which it is built plays a critical role as it

defines the extent of its capabilities, particularly its ability to support and promote organization-wide information and knowledge sharing. Henderson and Venkatraman [9] suggest that an IT infrastructure consists of two parts: a technical infrastructure, and a human infrastructure. The technical infrastructure represents the tangible, shared, physical resources, which includes hardware, operating system software, network and telecommunication technologies, data and core software applications [7]. Its objective focuses on effectively integrating and interconnecting the organization to support information sharing via its telecommunication network [30]. Furthermore, the technical infrastructure reflects an organization's IT architecture on which specific business activities and applications are built [5].

In contrast, the human infrastructure addresses the necessary skills and knowledge required to develop and maintain applications, manipulate data, and support end-users. The development and acquisition of these skills allows the organization to benefit from its technical infrastructure [17]. Osterman's [17] survey of organization's adopting new IT reveals differences in productivity gains and quality improvements when human resource policies are supported. The difference between organizations with low commitments to human resource policies, and either low or high investments in new IT was negligible. Thus, the human infrastructure should shadow the technical infrastructure and adjust with the adoption of newer IT.

The influence of IT on marketing activities has steadily grown over the years. IT often allows organizations to introduce continuous improvements to their marketing practices in their quest to secure a competitive advantage, principally in marketing process automation and marketing intelligence [1]. While marketing process automation helps link marketing activities to facilitate information sharing (i.e., efficiencies), marketing intelligence targets enhanced decision making through tools that provide greater insights. Process automation facilitates the coordination and cooperation among business units through the exchange of information. Other applications reduce the human element to improve information flow, including preserving its accuracy and reliability. In contrast, intelligence involves scanning the environment for information on forces that influence the organization's products and services [6], [12], and includes search activities linked to the discovery of new information, forecasts of consumer and market trends, studies in consumer behavior, the competition's offerings or a business partner's new capabilities. In many cases, continual advances in IT have led to more sophisticated marketing applications of IT [14], [15], [33].

IT has helped advance the role of marketing in the organization and opened new opportunities through the exchange and discovery of information. However, these advances come as a result of directed investments in IT, and the development and maintenance of an IT infrastructure.

3. Organizational Absorptive Capacity

Organizational absorptive capacity allows organizations to leverage their knowledge (i.e., recognize and assimilate new information, and apply knowledge) in the form of innovative responses, particularly to benefit from the insights they gather through their experiences and awareness of environmental trends. Cohen and Levinthal [4] state that the absorptive capacity of an organization results from the cumulative learning activities of individuals and the transfer of the ensuing knowledge within the organization through a common language. An organization benefits from these activities as they reinforce existing knowledge and allow further *absorption* of new knowledge. The effect of learning on knowledge development is that knowledge can be applied toward recognizing, acquiring and assimilating new and pertinent information to increase the organization's knowledge capacity, both its breadth and depth. Information can be related to the external, such as market trends and technology breakthroughs, or internal environment. In essence, the more frequently learning occurs, the greater the accumulation process, which in turn increases the organization's opportunity to yield applications of knowledge to new scenarios [2]. Furthermore, the greater the knowledge possessed and shared throughout the organization, the more it will be inclined to *absorb* new knowledge.

Although absorptive capacity is a common element to all organizations, its effect will vary relative to the resources an organization invests in developing it. Without acknowledging or foreseeing the future benefits derived through these investments (i.e., sustained innovativeness), an organization may find itself in a less capable position of achieving a competitive advantage. Thus, absorptive capacity may have an impact on how well an organization benefits from CRM.

4. CRM Practices

CRM practices underlie the extent to which an organization applies CRM to support its marketing activities. In the past, studies have identified market orientation, the customization of products and services, and customer loyalty programs as three important aspects of CRM practices.

4.1 Market Orientation

Market orientation entails the organization-wide generation, dissemination and responsiveness to market intelligence (i.e., opportunities, facts, trends, etc.), and involves information-sharing across business units engaged in orchestrated activities directed toward meeting customer needs and resulting in profits [12]. It plays a vital role in an organization as its impact on business performance has been affirmed in several studies [11], [13], [16], [19], [20], [27], [31], [32], [35], [36]. Because it directs the organization toward using information (i.e., market intelligence) to produce

innovative responses to information gathered through market intelligence and shared throughout the organization, market orientation embodies many of the concepts of organizational absorptive capacity. As Kohli and Jaworski [12] suggest, organizational factors, including senior management, interdepartmental dynamics and organizational systems, foster or discourage market orientation.

4.2 Customization

The objective of customization is to provide tailor-made products and services that appeal and more precisely fit the individual customer's needs and expectations [25]. It seeks to create a learning relationship between the organization and its customer to reach a more intimate level and gain a competitive advantage [23]. The information it gains from the relationship can then be used to customize its products and services, and add value that cannot be obtained elsewhere. Mass customization involves customizing over a broader target market. Pitta [26] suggests that IT enables mass customization as it requires the organization to collect, retain, catalog and mine large volumes of data to extract useful information that will provide it with important insights into its customers. Furthermore, mass customization relies on technology to integrate customers' preferences with the organization's production processes [26] and do it cost-effectively [23].

4.3 Loyalty Programs

In contrast, customer loyalty programs attempt to keep customers through incentives that retain them, increase their switching costs and create barriers that prevent the entry of competitors. The objective is to keep customers. Generally, retaining existing customers tends to be more fruitful and less costly than seeking new ones. Satisfied (existing) customers often purchase more over their lifetime [29], [37]. Additionally, the cost of acquiring new customers may be five times greater than that of satisfying and retaining current customers [28]. Loyalty programs often enhance customer perceptions and lead to more positive customer behaviors and better brand equity [34].

Loyalty programs, such as the frequent flier programs used in the airline industry, tend to make switching more difficult for customers by enticing their repeated business with the premiums based on cumulative *earnings* (i.e., the more points earned, the greater the premium or reward). Unless a competitor can match or exceed the program's incentives, it faces a formidable barrier of entry into the market or task to sway customers away. Thus, the driving force behind loyalty programs is the lifetime value of the relationship; the longer a customer is retained, the more profitable the relationship becomes as a result of increased purchases, reduced operating costs, referrals, price premiums and reduced customer acquisition costs [29].

5. Research Model

This study proposes that an organization's investments in IT and absorptive capacity will have positive effects on CRM practices. As both increase, CRM practices will become more effectively in tuned with meeting the needs of the organization's customers and supportive of gaining competitive advantages, and ultimately lead to achieving greater levels of CRM performance. The importance of the relationships illustrated in Figure 1 lies in the need to gain or retain a competitive advantage, particularly in highly-competitive, global electronic markets. They require organizations to understand their markets and customers (i.e., market intelligence), differentiate their products and services based on their understandings of added-value and making them difficult to duplicate, imitate or substitute, and respond to their customers' needs with innovative offerings. Yet, to achieve this level of competitiveness (i.e., CRM practices), they must be geared to compete effectively.

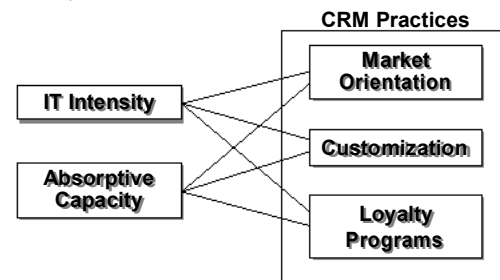


Figure 1. Research model

IT enables organizations to expand their marketing activities through automation and intelligence. In the case of market orientation, the organization must function as an orchestrated unit to maintain a competitive posture. The IT infrastructure facilitates and supports the communication and dissemination of information and knowledge among business units. It helps empower employees to quickly render decisions that are consistent with the goals and objectives of the organization through a common understanding based on shared information and knowledge, and decision support tools. Continual advances in IT have allowed organizations to develop learning relationships with their customers through the collection, retention, categorization and analysis of their information, and subsequently respond more precisely to meeting their needs and expectations. With mass customization, IT ensures customer preferences are cost effectively integrated into the organization's production processes. Knowledge of customers leads to opportunities to build their loyalty through incentives that capitalize on long term relationships. Thus, IT can be seen as an essential element to enable CRM practices that allow the organization to leverage its resources and become more competitive, particularly in global markets. Therefore, an organization's investments in IT (i.e., IT intensity) should directly influence its CRM practices, such that the greater its investments, the greater its ability

to remain competitive.

- H1: *IT intensity has a positive effect on CRM practices.*
- H1a: *IT intensity has a positive effect on market orientation*
- H1b: *IT intensity has a positive effect on customization*
- H1c: *IT intensity has a positive effect on loyalty programs*

While IT intensity represents the technical means for an organization to enable its CRM practices, absorptive capacity embodies the *know-how* or knowledge to compete. It underlies the organization's ability to recognize and apply relevant information toward developing customized products and services that focus on establishing long term relationships, and allows it to build a repository of knowledge that further expands its knowledge. In addition to *learned* knowledge of customers and environmental forces, absorptive capacity draws upon implicit knowledge that emerges from its experiences. Both types of knowledge subsequently become vital organizational resources that benefit and advance the organization when shared and disseminated among its employees. Thus, absorptive capacity tends to enhance market orientation through the directed use of information acquired from market intelligence, and lies beneath the organization's future ability to *absorb* new information. It binds information that leads to successful customization (i.e., knowing how to develop products and services based on information and knowledge) and loyalty programs (i.e., knowing how to develop incentives that improve customer lock-in). Hence, absorptive capacity plays a critical role in allowing the organization to leverage and exploit its knowledge. An organization's investment in developing knowledge will have a direct effect on its CRM practices.

- H2: *Absorptive capacity has a positive effect on CRM practices*
- H2a: *Absorptive capacity has a positive effect on market orientation*
- H2b: *Absorptive capacity has a positive effect on customization*
- H2c: *Absorptive capacity has a positive effect on customer loyalty programs*

The investments an organization places in both developing its IT infrastructure and absorptive capacity should significantly influence its CRM practices. Increases to both will improve its practices of CRM as suggested by the research model. Furthermore, both represent the underlying organizational elements that determine the extent to which an organization will eventually benefit from its CRM, and underscore their importance.

6. Research Methodology

A survey funded by the National Science Council of Taiwan was conducted of 542 financial service institutions in Taiwan. An introduction letter explaining the purpose of the survey and instructing the recipients on the survey's completion accompanied the questionnaire. The highly competitive nature of their markets and the customer-centric orientation make financial service institutions prime adopters of CRM [24].

A standard psychometric scale development procedure of Gerbing and Anderson [8] was followed to generate a series of multiple-item scales that were based on the review of the literature and interviews with several IT and marketing professionals. The items were operationalized on five-point Likert-type scales ranging from strongly disagree (1) to strongly agree (5). Pre-tests were conducted on the survey instrument among five marketing and IT managers, and subsequent refinements were made. Of the questionnaires sent, 164 usable responses were received. Missing response values contained within nine of the surveys further reduced the analysis to 155 observations.

A factor analysis with a varimax rotation (using SAS 8.2) confirmed the existence of the five hypothesized constructs: IT intensity, absorptive capacity, market orientation, customization, and loyalty programs. The factors and loadings appear in Table 1. Although three of the market orientation variables cross-loaded on the customization construct, their larger loadings give stronger support to the market orientation construct. A Kaiser's measure of sampling adequacy (MSA) of .914 strongly supports the appropriateness of the factor analysis, given the sample size of 155.

Non-response biases of the data set were examined with t-tests that compared the sample and population demographics (i.e., number of employees, capital, age of organization). No significant differences were detected.

7. Analysis and Discussion

Regression models were developed to test the six hypotheses. The models included IT intensity and absorptive capacity as the independent (predictor) variables, and organization capital and number of employees as the control variables to control their effects on the dependent variables. This ensures neither biases the results and helps increase the generalizability of the findings [18]. Because a linear relationship exists among the items of a construct, composite scores were derived from their summated responses and used in the regression models.

The data support the six hypotheses (H1a, H1b, H1c, H2a, H2b and H2c). Table 2 summarizes the results. Model I suggests that IT intensity and absorptive capacity are positively related to market orientation (H1a and H2a). The significance of their standardized coefficients indicates their support of the research model. The non-significance of the control variables (organization capital and number of employees) confirms that neither influences nor biases the results (i.e., neither has a bearing on the relationship). Also, an examination of the

variance inflation factors (VIF) reveals no collinearity problems among the independent variables. Similar results found with Models II (H1b and H2b) and III (H1c and H2c) support the research model and suggest that IT intensity and absorptive capacity are positively related to customization and loyalty programs. Interestingly, the higher standard coefficient for IT intensity in all three models indicates its greater impact on CRM practices over absorptive capacity. Thus, the data generally support the proposed research model. However, the low R-square values strongly suggest that other factors not captured in the models may account for a large portion of the variations in the model. This might be addressed in future studies.

IT intensity forms the foundation on which CRM systems are built. Yet, CRM success cannot be attributed to technology alone. How an organization applies IT as demonstrated in its practices will have a greater impact on its CRM results. The results of this study support the contention that IT investments play a vital role and have a positive effect on CRM practices; greater investments in IT lead to improved CRM practices and ultimately better CRM performance. The IT infrastructure reflects the investments and commitment an organization makes to IT, and ensures IT remains a true organizational resource. However, it is not an end unto itself, but a means to an end, such that it embodies capabilities that lead to desirable results. In particular, investments in IT support CRM in two important aspects: the internal operations and strategic planning tasks. Operationally, IT allows the organization to share data and knowledge across internal boundaries, coordinate its activities in response to market intelligence and respond as a single entity to changes in environmental forces. Strategically, continual advances in IT have opened new opportunities with tools that provide greater insight into market forces and respond competitively with customization and loyalty programs. Thus, CRM practices benefit from the degree to which the organization invests in IT (i.e., intensity).

Having the knowledge to pursue avenues that lead to products and services that better satisfy the needs and expectations of customers also plays a critical role in selecting and adopting successful CRM practices. The results of this study also lend support to the contention that an organization's investments in absorptive capacity are crucial and positively affect its CRM practices. This suggests that as organizations invest more into learning and develop their knowledge, they will be more effective in their CRM practices as they become knowledgeable in asking the right questions and selecting the right methods and information to find the right answers. Thus, absorptive capacity leads to the successful leveraging and exploitation of information. This extends from recognizing new information to expand the existing body of knowledge or capitalize on new opportunities to applying knowledge to develop innovations that ensure the long term relationships an organization cultivates with its customers. As in the case of IT intensity, investments to absorptive capacity lead to future long term benefits.

The Internet's expansive markets have lured many

organizations into e-business. With the transition to e-business, the business paradigm shifts from its emphasis on the management of physical resources to information as the primary resource. In contrast to their *brick and mortar* counterparts, e-businesses must be capable of using its information and knowledge to effectively compete in the high-stakes IT-enabled marketplace. The study of Phau and Poon [22] explored the applicability of the Peterson et. al [21] classification of products and services to Internet sales, and found that products and services having an intangible (service) value proposition and relying on relatively high differentiation were better suited for the Internet. This suggests that competing in e-business markets will be information and knowledge oriented (or intense), and implies that organizations lacking in these areas may have difficulties achieving success. Although CRM has been used to successfully gain competitive advantages in such markets, the development of its practices looms as a more dominating issue. Thus, it may behoove organizations to invest not only to carefully develop their CRM practices, but to purposefully invest in their IT infrastructure and absorptive capacity as both will affect their CRM practices.

In conclusion, IT intensity and absorptive capacity represent at least two important factors that influence an organization's CRM practices, including market orientation, customization and loyalty programs. The results of this study also suggest that other factors may influence CRM practices. Further examination of the relationships can be made to establish a causal relationship.

8. Summary

This study examined the relationships between IT intensity and absorptive capacity, and three facets of CRM practices: market orientation, customization, and loyalty programs. The analysis of survey results suggests that both (IT intensity and absorptive capacity) have positive effects on market orientation, customization and loyalty programs. Thus, it may be concluded that organizations may derive greater benefits from their CRM practices with greater investments in IT and absorptive capacity. The importance of this conclusion particularly applies to the IT-enabled e-business models which emphasize information as the organization's primary resource and the need to effectively compete in global markets.

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Table 1. Rotated factors

Kaiser's Measure of Sampling Adequacy: .914

	Factor 1 Absorptive Capacity	Factor 2 IT Intensity	Factor 3 Market Orientation	Factor 4 Customization	Factor 5 Loyalty Programs
Cronbach Alpha	.926	.915	.900	.864	.811
Eigenvalue	13.149	3.107	2.350	1.704	1.411
Variables:					
CRM absorptive capacity	0.866	.	.	.	.
CRM employee knowledge	0.838	.	.	.	.
Employee business knowledge	0.814	.	.	.	.
CRM training	0.778	.	.	.	.
CRM training quality	0.742	.	.	.	.
Cross-functional CRM involvement	0.734	.	.	.	.
Help sources	0.724	.	.	.	.
Relationship with IT staff/consultants	0.522	.	.	.	.
IT hardware and software investments	.	0.803	.	.	.
IT management	.	0.781	.	.	.
IT system integration	.	0.749	.	.	.
IT priority	.	0.736	.	.	.
IT competitive advantage	.	0.728	.	.	.
IT recruitment and training	.	0.715	.	.	.
IT information features	.	0.670	.	.	.
Measure and evaluate customer satisfaction	.	.	0.797	.	.
After sales service	.	.	0.736	.	.
Predict customer needs	.	.	0.732	.	.
Customer satisfaction objective	.	.	0.725	.	.
Responses to competitors	.	.	0.557	0.506	.
Share information	.	.	0.533	0.490	.
Cross-functional collaboration	.	.	0.501	0.414	.
Understand competitors	.	.	0.497	.	.
Products and services satisfy customer needs	.	.	.	0.771	.
Customized service	.	.	.	0.738	.
Customer satisfaction over diverse segments	.	.	.	0.620	.
Multiple channels of delivery	.	.	.	0.586	.
Organization able to meet needs of customers	.	.	.	0.566	.
Promotions for customer segments	.	.	.	.	0.773
Distinguish customers with promotions	.	.	.	.	0.672
Rewards for repeat customers	.	.	.	.	0.661
Incentive programs	.	.	.	.	0.650

Values greater than .4 shown

Table 2. Summary of regression models

		Model I Market Orientation		Model II Customization		Model III Loyalty Programs	
R-square		.366		.422		.250	
F value		21.37**		27.03**		12.35**	
Variables:		Standard coefficient	VIF	Standard coefficient	VIF	Standard coefficient	VIF
Predictors	IT Intensity	0.438**	1.427	0.478**	1.427	0.316**	1.427
	Absorptive Capacity	0.243*	1.388	0.251**	1.388	0.255*	1.388
Control Variables	Organization Capital	-0.087	2.907	-0.090	2.907	-0.025	2.907
	Number of Employees	-0.096	2.850	-0.106	2.850	-0.087	2.850

* $p < .01$, ** $p < .001$

Effect of Hedonic and Utilitarian Goals in Similarity Judgment of a Hotel-Restaurant Brand Alliance

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Abstract

The perception of fit between two entities in a brand alliance is an important factor in affecting consumers' evaluations of the partnership. Drawing from goal theories, the authors examine the role of consumption goals in driving consumers' fit perceptions in the context of hotel-restaurant brand alliances. In particular, they study two types of consumption goals—hedonic and utilitarian. The authors argue that consumption goals moderate the effect of image congruency on consumers' perceived fit between a hotel and a restaurant in an alliance. The results of this study indicate that a partnership involving incongruent brand images between a hotel and a restaurant can enhance the perceived fit ratings. However, the types of consumption goals seemed to moderate these effects. Specifically, our results show that incongruent brand images enhance consumers' perception of fit for hedonic consumption goals. Conversely, incongruent brand images failed to influence perceived fit ratings in the utilitarian goal condition. The findings of this study have several important implications for service organizations in search for ideal brand alliance partners.

1. Introduction

Partnering with well-known restaurant chains is becoming increasingly common, particularly for mid-priced hotels. For example, Hampton Inn has installed Pizza Hut Express outlets in lobbies, Holiday Inn has formed an alliance with TGI Friday's, and Ramada Inn has partnered with Bennigan's. As hotel companies have incorporated virtual tour in their world-wide web and consumers are capable of evaluating the hotels prior to their purchase, an alliance with an appropriate restaurant is therefore a challenge to hotel marketers. In particular, the perceived fit between the two entities is an important factor in affecting consumers' evaluations of the partnership. The goal of this paper is to examine the role of consumption goals in guiding consumers' fit perceptions in the context of hotel-restaurant brand alliances.

2. Review of Literature

The effect of perceived fit in influencing consumer evaluations is robust across different contexts, such as brand extensions [1], celebrity endorsements [2], event sponsorships [3], and brand alliances [4]. Indeed,

previous research has investigated several ways brands can be linked together—feature-based, usage-based, and schema- or concept-based. However, these bases of fit have their limitations. For example, a common consumption situation fails to explain the perceived compatibility of products that do not share a common usage occasion. On the other hand, feature-based fit and concept consistency lack a theoretical basis for identifying which product features or brand concepts are critical to the determination of congruency [5]. Overall, the bases of fit are often assumed as alternatives to, or exclusive of, one another. Furthermore, past research has generally neglected the possibility that incongruous brands may in fact fit.

Following the means-end model, Peterman [6] suggested that goal categories form a continuum from concrete to abstract. Some other researchers have further differentiated the abstract level of goals into hedonic and utilitarian types [7] [8] [9] [10] [11]. According to this group of researchers, a hedonic goal is the purchasing motivation for symbolism, value-expression, affective consideration, and the satisfaction of sensory or emotional wants. The focus of concern is on the enhancement of self, subjective meanings, and intangible features. Hence, the symbolic processing is holistic, synthetic, and image-based. Conversely, a utilitarian goal refers to functional and cognitive purchasing motivations. An individual whose consumption is motivated by utilitarian goals focuses on product functional performance, costs to benefits ratio, and tangible product features. For this type of goal, then, an individual generally processes information in a logical and rational manner.

Consumption goal theory is important in addressing the above issues. As has been widely documented, goals provide the context in which a consumer organizes information processing, makes categorizations, and reaches similarity judgments [12] [13]. Martin and Stewart [5] further demonstrate that perceived compatibility is a multidimensional construct and that product features, common usage situations, and brand concept are all linked by a shared goal. The number and structure of the bases of fit are different when products vary in the degree of goal congruency.

Previous studies demonstrated that situational goals (goal-derived categories) can enhance the perceived similarity of products that are visually quite different [14] [15] [16] [17]. Yet, prior research has failed to investigate the impact of hedonic and utilitarian goals on consumers' category representations. For example, can hedonic goals

diminish the perceived similarity of products that highly resemble each other? Or are these similarity representations so rigid as to preclude any top-down intervention? We address these questions by systematically varying the surface resemblance of brand alliance partners and the salience of hedonic and utilitarian goals in a given consumption context.

Drawing from goal theories, we argue that brand alliances involving partners with incongruent brand images (e.g., a classy hotel with a funky restaurant) can result in high perceived fit ratings as long as the two brands are consistent with consumers' consumption goals. Particularly, we hypothesize that

H1: When the restaurant image is consistent with customers' hedonic goals, the perceived fit ratings for a partnership with an image-incongruent restaurant are expected to be at least as high as with an image-congruent restaurant.

H2: When customers' utilitarian goals are unrelated to the restaurant image, the perceived fit ratings are expected to be greater for a partnership with an image-congruent restaurant than with an image-incongruent restaurant.

H3: When the image between hotel and restaurant is congruent, the perceived fit ratings are expected to be greater for hedonic than for utilitarian goals.

H4: When the image between hotel and restaurant is incongruent, the perceived fit ratings for hedonic goals are expected to be lower than that for utilitarian goals.

3. Methodology

A series of pretests were conducted for two purposes. First, the pretests were to determine two different types of restaurants that have either a calm (congruent image with the hotel) or lively image (incongruent image with the hotel). Second, they were to find realistic consumption goals or situations. All subjects were hospitality students enrolled in a large northeastern university.

The current study employed a 4 x 2 between-subjects factorial design. The components were consumption goals (hedonic: calm dining, dining in a lively environment; utilitarian: convenience, saving) and restaurant image (congruent and incongruent image with the hotel). A total of eight treatments were conducted.

3.1 Subjects

Participants were 350 travelers (25.3% of the total number of travelers approached) waiting for their planes at a national airport in the United States. These subjects were deemed appropriate because they are actual or potential hotel guests. Because the videos were of a hotel and restaurants in a northeastern university town, the subject pool is unlikely to be familiar with the actual hotel and restaurant operations shown in the video clips.

Consequently, potential confounding variables, such as familiarity and attached attitude, were minimized.

3.2 Instrument and Procedures

Subjects were randomly given one of the eight versions of questionnaire. The questionnaire contained two parts. In the first part, subjects were asked to evaluate a national hotel and restaurant chain. Subjects first viewed a video clip of a mid-priced hotel chain before answering a series of questions regarding the hotel image, their attitudes toward the hotel, and their behavioral intentions. Next, they viewed another video clip, one of a mid-priced chained restaurant. Neither the hotel nor the restaurant brand was disclosed to respondents. Each subject watched a clip of one of the two types of restaurant (calm or lively). A series of questions pertaining to the restaurant's image, subjects' attitudes toward the restaurant, and congruency ratings between the hotel and the restaurant followed the video clip.

In the second part of the questionnaire, subjects read a cover story explaining the brand alliance situation. Subsequently, subjects were asked to imagine themselves in one of the four consumption situations described in a scenario. They were told to imagine that the hotel they viewed in the video clip shown earlier was the one they stayed in, and that it had partnered with a national restaurant chain, which corresponded with the restaurant video they had been shown. Then, subjects were asked to indicate their perceptions of fit between the hotel and the restaurant. At the end of the survey were questions about socio-demographics.

3.3 Independent Variables

The first factor (consumption goals) involved the manipulation of four different consumption situations. The four levels of manipulation included (1) a calm goal, in which consumers were looking for a calm dining experience; (2) a fun goal, in which consumers were seeking to dine in a lively environment; (3) a convenience goal, in which consumers were only concerned about the location of the restaurant; and (4) a savings goal, in which consumers were on a tight budget. The first two goals are hedonic goals that involve a symbolic image-based mode of processing. Convenience and savings goals, however, reflect utilitarian goals in which functional performance, costs/benefits, and tangible features are the focus of concern.

The second factor refers to the restaurant's image. The two levels of manipulations were (1) a restaurant with a calm and relaxing image (similar to the hotel), and (2) a restaurant with a lively image (different from the hotel). In order to determine the image congruency between the hotel and the restaurant brand, a video clip about the hotel brand was included.

3.4 Dependent Variable

Three seven-point semantic differential scales developed from literature in event sponsorship, celebrity

endorsement, and brand extension [3] [18] [19] were used to assess brand compatibility. The question was: "In reference to your dining needs, what do you think about Hotel X and Restaurant Y?" The three semantic differential scales included: do not belong together/belong together, are not compatible/are compatible, and do not fit well/fit well.

3.5 Manipulation Checks

To ensure that the independent variables were perceived as intended, this study included four scales for manipulation checks: (a) image congruency, (b) restaurant attitude, (c) hotel attitude and behavioral intention, and (d) consumption needs. The first two were directed toward the hotel and the restaurant while the last tapped into the scenario manipulation.

3.5.1 Image congruency

To check if the hotel and restaurant images were congruent, the approach developed by Martin and Stewart [5] was employed: "What do you think about the image between Restaurant Y and Hotel X?" The seven-point semantic differential scales included: highly dissimilar/highly similar, and not at all alike/very much alike.

3.5.2 Attitudes

Consumers' attitudes toward the restaurant were measured via a series of seven-point semantic differential scales: bad/good, unfavorable/favorable, and negative/positive [20]. Similarly, these attitude scales were also used in measuring consumers' attitudes toward the hotel prior to the alliance.

3.5.3 Behavioral intentions

The behavioral and word of mouth (WOM) scales were composed of a series of seven-point semantic scales [21]. Consumers were asked about their likelihood to: "say positive things about Hotel X to other people", "recommend Hotel X to someone who seeks your advice", "encourage friends and relatives to do business with Hotel X", "stay in Hotel X again", and "consider staying at Hotel X in your travels."

3.5.4 Consumption needs

To determine if subjects prioritized their consumption needs according to the scenario descriptions, four questions on the manipulation of scenario were included. Based on the situation described in the scenario, subjects were asked to answer "to what extent do you want to dine in a peaceful environment", "to what extent do you want to dine in a lively environment", "to what extent is the restaurant being located in the hotel critical to you", and "to what extent is menu pricing a concern to you." They gave responses on a scale of 1 = not at all to 7 = very much so.

4. Results

The profile of the participants shows that nearly two-thirds ($n = 231$) of the participants were male. The average age of the respondents was 38.88, and the overall range was from 18 to 65. The majority of the participants were married (59%) and have at least a Bachelor's degree (79%). Only less than five percent of the respondents, 0.3% and 2%, were a widow/widower or had only some high school education, respectively. Approximately 57% of the participants earned more than 75K in annual household income. Overall, participants represented both genders, were married, and tended to be relatively young, well-educated, and affluent.

4.1 Manipulation Checks

A factor analysis of the participants' overall attitudes toward the hotel brand suggested a single underlying factor averaging the three attitude items (Cronbach's $\alpha = .967$). Similarly, the five behavioral intention items were combined to generate a single behavioral intention index (Cronbach's $\alpha = .959$). The manipulation checks for pre-alliance attitudes and behavioral intentions toward the hotel brand yield insignificant analysis of variance (ANOVA) results across all eight treatments ($p > .05$).

A factor analysis of the participants' overall attitudes toward the restaurant brand also suggested a single underlying factor averaging the three attitude items (Cronbach's $\alpha = .978$). The two similarity items were also combined to generate a single similarity index with a high Pearson correlation, $r = .929$ (Cronbach's $\alpha = .963$).

The t-test results for restaurant brand image show that the image-incongruent restaurant ($M = 2.704$) was rated significantly more dissimilar from the hotel ($t(348) = 12.457, p < .05$) than was the image-congruent restaurant ($M = 4.725$). Specifically, the image-incongruent restaurant ($M = 5.825$) was rated more lively ($t(347) = 18.369, p < .05$) than was the image-congruent restaurant ($M = 3.601$). On the other hand, the pre-alliance restaurant attitudes shows an insignificant t-test result between the two types of restaurant image ($t(348) = 1.662, p > .05$). Participants' attitudes toward the image-congruent ($M = 4.545$) and incongruent restaurants ($M = 4.799$) were not different. Hence, the manipulations of restaurant attributes (image, similarity to the hotel image, and attitudes) were successful.

In terms of consumption goal manipulation, all scenarios were perceived as realistic (mean > 4 for all scenarios, $p < .05$). Four manipulation checks focusing on the importance of each consumption goal (calm, lively, convenience, savings) were included. The repeated measures results yield only significant effect of consumption goals on scenario manipulation ($F(8.722, 991.354) = 44.193, p < .05$).

4.2 Perceived Fit

A factor analysis of the three perceived fit items confirmed a single underlying factor. Thus, the items

Table 1. Means and standard errors of perceived fit as a function of consumption goal and restaurant image

Consumption goal	Restaurant image					
	Calm (Congruent)			Lively (Incongruent)		
	<u>n</u>	<u>Mean</u>	<u>SE</u>	<u>n</u>	<u>Mean</u>	<u>SE</u>
Calm	49	4.96 _a	0.23	45	2.86 _b	0.24
Lively	31	4.75 _a	0.29	35	4.12 _a	0.27
Convenience	47	5.54 _a	0.24	46	3.52 _b	0.24
Savings	51	5.03 _a	0.22	46	4.00 _b	0.24

Note. Means in the same row that do not share subscripts differ at $p < .05$.

were averaged to form a general perceived fit index (Cronbach's $\alpha = .979$).

H1 asserted that when a restaurant image is consistent with consumers' hedonic goal (lively dining environment), the perceived fit ratings for a partnership with an image-incongruent (lively) restaurant would be at least as high as that for image-congruent (calm) restaurant. On the other hand, H2 predicted that the perceived fit ratings would be greater for a partnership with an image-congruent restaurant than with an image-incongruent restaurant when utilitarian goals are satisfied.

Table 1 summarizes the perceived fit ratings for all the experimental treatments. The ANOVA results reveal a significant interaction effect between consumption goals and image congruency on perceived fit ($F(3, 338) = 4.193, p < .05, \eta^2 = .036$). Specifically, planned contrasts show that a partnership with an image-congruent (calm) restaurant ($M = 4.96, SE = 0.23$) was rated significantly more fit ($F(1, 338) = 40.203, p < .05, \eta^2 = .106$) than with an image-incongruent (lively) restaurant ($M = 2.86, SE = 0.24$) when a peaceful environment was the participant's dining goal. However, when the consumption goal was to dine in a lively environment, the perceived fit ratings for a partnership with an image-incongruent restaurant ($M = 4.12, SE = 0.27$) and an image-congruent restaurant ($M = 4.75, SE = 0.29$) were not significantly different ($F(1, 338) = 2.525, p > .05, \eta^2 = .007$), in support of H1.

For utilitarian goals, the planned contrasts indicate that a partnership with an image-congruent (calm) restaurant ($M = 5.54, SE = 0.24$) was rated significantly more fit ($F(1, 338) = 37.042, p < .05, \eta^2 = .099$) than with an image-incongruent (lively) restaurant ($M = 3.52, SE = 0.24$) when the participant's consumption goal involved convenience. Likewise, when participants were concerned about price, the perceived fit ratings for a partnership with an image-congruent restaurant ($M = 5.03, SE = 0.22$) were significantly greater ($F(1, 338) = 10.001, p < .05, \eta^2 = .029$) than the fit ratings for an image-incongruent restaurant ($M = 4.00, SE = 0.24$). Hence, H2 was also supported.

H3 postulated that the perceived fit ratings would be greater for hedonic goals than for utilitarian goals when the partnership involved an image-congruent restaurant. On the other hand, H4 hypothesized that the perceived fit ratings would be lower for hedonic goals than for utilitarian goals when the partnership involved an image-incongruent restaurant.

To test these hypotheses, the cell means for the appropriate conditions were compared using a planned contrast procedure. Contradictory to H3, the perceived fit ratings for a partnership with an image-congruent restaurant were not significantly different between hedonic and utilitarian goals ($d = -0.329, F(1, 338) = 1.386, p > .05, \eta^2 = .004$). However, the perceived fit ratings for a partnership with an image-incongruent restaurant were significantly lower for hedonic goals than for utilitarian goals ($d = 0.903, F(1, 338) = 9.450, p < .05, \eta^2 = .027$). Hence, the result supports H4.

5. Discussion

The results of this study show that the perceived fit ratings for a partnership with an image-congruent restaurant were higher than the fit ratings for an image-incongruent restaurant. However, a partnership with an image-incongruent restaurant could be perceived as compatible if the incongruent restaurant image matched up to the hedonic consumption goals. For example, participants whose consumption goal was to dine in a lively environment judged the image-incongruent partnership as compatible as the image-congruent partnership. These findings are consistent with previous study [17].

When comparing the effect of hedonic and utilitarian goals, the perceived fit ratings were higher for utilitarian goals than for hedonic goals when a partnership involved an image-incongruent restaurant. On the other hand, the perceived fit ratings for hedonic goals were not different from that for utilitarian goals when a partnership involved an image-congruent restaurant.

Considered as a whole, these results suggest that, first, congruent image is not affected by any top-down intervention. Second, the effect of consumption goals is significant when hotels partner with image-incongruent restaurants. Specifically, hedonic goal-consistent image-incongruent partnership can alter the mental representations of two distinct brands. Image incongruent restaurant has lower negative impact when consumers' consumption goals are utilitarian than when they are hedonic.

6. Summary and General Discussion

The results for H1 support the general proposition that hotels partnering with image-incongruent restaurants may

not automatically be perceived as incompatible. These results are consistent with goal theories discussed previously, suggesting that consumption goals provide a context in which consumer process information and make similarity judgments [5] [12] [13]. Following these theories, hedonic goals direct consumers' attentions to symbolic aspects of brand image. Therefore, when the consumers' goals were to dine in a lively environment, a hotel with a calm image partnering with a lively restaurant appeared compatible, and subsequently would be favorably evaluated. However, results for H2 indicate that the effect of goals on consumers' perceptions of fit is dependent upon the types of consumption goals.

The current research provides empirical evidence for the development of hotel-restaurant brand alliance involving image congruency, consumption goal, perceived fit, attitude and behavioral intention toward the hotel brand, and image transference. This study broadens the latitude of goal-driven theory, as well as its application in several respects.

First, prior research has strongly suggested the intrinsically conspicuous role of surface level resemblance between two allied brands in the similarity judgments [4] [18]. Such a perspective implies considerable rigidity for shifts in similarity or compatibility perceptions based on factors such as individuals' goals. Previous researchers [17] demonstrated that personal goals and situational goals enhance the perceived similarity of goal-appropriate products even if the surface resemblance between the products is low. The present study extends the support for the notion that goals can enhance the perceived compatibility of two seemingly distinct brands for hedonic goals.

Second, goals are known to provide a context for information processing and similarity judgments. This study further sheds light onto the importance of distinguishing the types of consumption goals in future research. Specifically, it suggests that the effect of utilitarian goal is dependent upon the image discrepancy between two partnering brands in consumers' service brand evaluations.

Third, the effect of consumption goals on consumers' perceptions of fit of a brand alliance also differs between hedonic and utilitarian goals. In particular, utilitarian goals may attenuate the negative effect of an incongruent restaurant image on perceived fit ratings when the incongruent restaurant image is inconsistent with the hedonic goal. However, when the incongruent restaurant image is consistent with the hedonic goal, utilitarian goals are not capable of altering the perceived fit ratings. On the other hand, hedonic goal can enhance the perceived compatibility of two seemingly distinct brands.

7. Limitations and Future Study

There are several caveats and qualifications to the conclusions and interpretations of the current research findings. First, although this study sought to make a contribution by demonstrating an empirical support for

hypotheses derived in part from the goal-driven, only a limited set of consumption goals and only two specific types of restaurant image were investigated. Thus, generalizations must be made with caution.

Second, experimental approaches to examining marketplace phenomena are often criticized for lacking realism. In a real-life context, a brand name signifies additional information, such as familiarity, trust, predictability, and consistency. This brand equity may be a competitive factor to image congruency in influencing consumers' evaluations of a hotel brand. Therefore, future research employing real brands is greatly needed to shed light on the relative importance of brand name and image.

Third, it should be noted that the present research did not examine the effect when participants' utilitarian goals were not satisfied or the effect of utilitarian goal, per se. Although it is reasonable to infer from the current study that the symbolic image is more influential than the functional aspect of brand image for utilitarian goals, a definite conclusion can be drawn only when utilitarian goals are not met. Research attempting to validate the importance of image congruency, particularly in the service industry, would represent a substantial contribution to knowledge about service brand alliance.

Finally, hotel market segments are generally categorized into leisure, business, and convention types. The present study focused on leisure travelers and disclosed that restaurant brand recognition was not as important as expected. However, it seems plausible that business travelers do not usually spend a proportionate amount of time looking for a place to dine at. Familiarity and consistency of quality of a brand may be more critical to them. Thus, generalizability of the current results to business travelers must be made with further study.

Based on the results of the current research and its limitations, several avenues of further research are recommended. For example, future research can investigate the effect of hotel-restaurant brand alliance on consumers' evaluations of the hotel, as well as the possible image transference.

Besides the differences between leisure and business travelers, another interesting future area of research involves cross-cultural study. For example, hotel restaurants in Asia are generally considered as prestigious. Dining in a hotel restaurant is perceived as a luxury, even though the quality of food may be mediocre. On the other hand, mid-priced international restaurant chains receive equally high favorable attitudes among the consumers, but are limited in their number of outlets. If the idea of partnership between the two brands is well-accepted, it will be a means for international restaurant chains to venture into the foreign markets.

Finally, another challenging area of future research is the deep understanding of consumers' definitions of fit. Particularly, the type of relationship consumers contemplate between the hotel and the restaurant, whether a marriage, an affair, friendship, or master-slave, as well as the essential elements for the success of the

alliance are important. Qualitative research methods, such as the Zaltman Metaphor Elicitation Technique [22] [23] [24] could be useful in discerning more fully consumers' below surface thoughts and feelings relating to the alliance.

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Efficient Prediction of Quality of Service for Data Mining Web Services

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Abstract

A priori estimation of quality of service (QoS) levels is a significant issue in web services since Service Level Agreements (SLAs) need to specify and adhere to such estimates. In this paper we present novel cost formulae for estimating the end-to-end response time for distributed data mining (DDM) web services.

1. Introduction

Umesh Dayal [2] predicted that "...data analysis and mining functions themselves will be offered as business intelligence e-services that accept operational data from clients and return models or rules". The growing number of Web Service Providers (WSPs) like digiMine™ (<http://www.digimine.com>) and Information Discovery™ (<http://www.datamine.aa.psiweb.com>) who offer commercial data mining web services are testimony to this statement [8, 11, 4]. The increasing focus on data mining web services can be attributed to the recognition of data mining as an important technology in aiding strategic decision making coupled with the commercial viability of the WSP paradigm. The option of Internet-delivery of data mining services is emerging as attractive for small to medium range organisations, which are the most constrained by the high cost of data mining software, and consequently, stand to benefit by paying for software usage without having to incur the costs associated with buying, setting-up and training. While the primary focus of the commercial arena has been the delivery of data mining as a web service, there is an emerging research focus on providing data mining models as services on the Internet [14]. Thus rather than the hosting of a data mining system and delivering the results as a service, the aim is to be able to sell data mining models, which can be bought, for example, by start-up organisations operating in a given vertical domain.

In general, the operational cornerstone for WSPs is the contractual agreement between the client and the service provider, known as the Service Level Agreement (SLA). The SLA is a legally binding document and specifies the contractual obligations of the WSP with respect to the guaranteed level of service and the penalties associated with failure to comply with the contract. In the specific context of WSPs, which are governed by SLAs, QoS metrics have a direct bearing on the success in monetary terms. Therefore, the ability to accurately predict the level

of service that can be guaranteed is of immense value to WSPs. It is in this context that motivates [13] to state quality of service has "...a lot to do with a cost-benefit analysis and prediction for SLAs". The need for such predictive estimates of the quality of service that can be ensured is also clearly indicated by qualitative studies presented in [1] which surveyed user behaviour and the criteria users applied to assessing network services and pricing. One of the outcomes of this study was that "...users value predictive feedback over feedback concerned with current statistics". While predicting the quality of service a priori is an important requirement for WSPs as discussed in [1, 13], it has not been addressed by the web services community. This can be attributed to several reasons. The focus has been on system level metrics that are the key to load balancing and resource utilisation and not on application centric metrics such as the waiting time, probability of successful completion and end-to-end application response time [16, 19]. It is difficult to formalise the semantics of application centric metrics since characteristics vary from application to application. Prediction is challenging in a dynamic environment such as the Internet, where WSPs operate. This challenge is considerably increased by the consequences and pitfalls of inaccurate estimates, because of the direct relationship between prediction accuracy and revenue/loss.

In summary, WSPs require the development of techniques to estimate the quality of service that can be ensured by the service provider. This need is driven by SLAs, which have a direct bearing on the revenue of WSPs and is increasingly being stated as an issue that must be addressed [1, 13]. In this paper we present techniques for estimating the response time of data mining application services.

2. Response Time of Distributed Data Mining

In this section, we present techniques for estimating the end-to-end response time in data mining web services. At a conceptual level, the response times for different scenarios is as illustrated in the example scenario illustrated in figure 1. The client has two data sources ("Data 1" and "Data 2") and two computational resources ("Server 1" and "Server 3") that it can make available for mining. One of the datasets (Data 1) is located on Server 2 that is not available for mining. The service provider has three high-performance servers. The three servers on the service provider's side may be geographically distributed, thereby making the

communication costs variable.

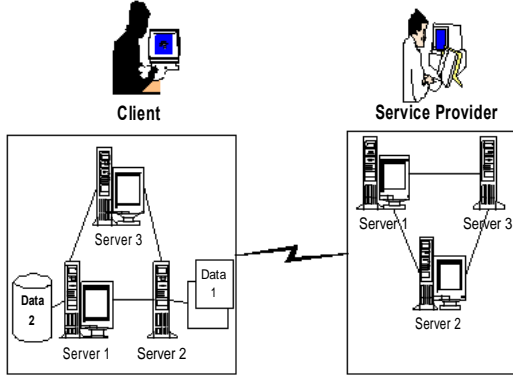


Figure 1 Data Mining Web services

There are three possible options that the client can choose:

1. The mining should be done locally using only the client's computational resources. In this case a mobile agent based approach will have to be employed in order to perform the task at the client's site.
2. The mining should be done remotely using only the service provider's computational resources. In this case, a client-server approach will have to be used and the data has to be transferred to the service provider's servers.
3. The client has no preference for the location. In this case, a combination approach of mixing the client-server and the mobile agent models can be used.

The estimation requires the identification of the cost components and formalisation of a cost model for response time in the context of distributed data mining (DDM) web services. We now formalise the cost components of the DDM response time and present estimation techniques for these cost components.

2.1 Cost Components of the DDM Response Time

In this section we specify the different cost components of the response time in distributed data mining web services. The response time of a task in a distributed data mining web service broadly consists of three components: *communication*, *computation* and *knowledge integration*.

Communication: The communication time is largely dependent on the operational model. It varies depending on whether the task is performed using a client-server approach or using mobile agents. In the client-server model the communication time is principally the time taken to transfer data from distributed servers to a high performance machine where the data mining is performed. In the mobile agent model, the communication time revolves around the

time taken to transfer mobile agents carrying data mining software to remote datasets and the time taken to transfer results from remote locations for integration.

Computation: This is the time taken to perform data mining on the data sets and is a core factor irrespective of the operational model.

Knowledge Integration: This is the time taken to integrate the results from the distributed datasets.

The response time for distributed data mining is as follows:

$$T = t_{dm} + t_{com} + t_{ki} \quad (1)$$

In Eq. 1 above, T is the response time, t_{dm} is the time taken to perform data mining, t_{com} is the time involved in communication and t_{ki} is the time taken to perform knowledge integration. The modelling and estimation of the knowledge integration (t_{ki}) variable is dependent on the size and contents of the results obtained from the distributed datasets. Given that the primary objective of data mining is to discover hitherto unknown patterns in the data [3], we consider the a priori estimation of the time taken to perform knowledge integration to be outside the scope of this paper (since knowledge integration depends on the characteristics of the results of the data mining process). Having identified the cost components of the DDM response time, we now formalise the overall estimation cost for different models and scenarios.

2.2 Cost Matrix for Representing the Composite Response Time

We now present a cost matrix for computing the composite DDM response time estimates for different strategies. The response time for distributed data mining as presented in Eq. 1 consists of three components including communication (due to either transfer of mobile agents and/or transfer of data), computation (performing data mining) and knowledge integration. The following discussion focuses on the communication and computation components and does not consider the knowledge integration component. The strategy is to compute estimates for the individual cost components and then uses the estimates to determine the overall response times for different strategies. The cost matrix to calculate the composite response time for different DDM strategies is denoted by CM and is represented as a two-dimensional $m \times n$ matrix, where m is the number of available servers and n is the number of datasets. A fundamental feature of the cost matrix that makes it applicable for both the mobile agent and client-server models is that we incorporate location information on the datasets and servers.

The elements of the cost matrix represent the estimated response time and are defined as follows:

1. Let m be the number of servers.
2. Let $S = \{S_1, S_2, \dots, S_m\}$ be the set of servers. A server S_i can either be located at the service provider's site or at the client's site. Therefore, let S^{SP} be the set of servers located at the service providers site and let S^C be the

set of servers located at the client's site. The following properties are true for the sets, S , S^{SP} , S^C .

- $S^{SP} \cup S^C = S$; the set of servers available at the client's site and the set of servers available at the service provider's site summarily constitute the total set of available servers. The obvious corollaries are $S^{SP} \subseteq S$ and $S^C \subseteq S$.
- $S^{SP} \cap S^C = \emptyset$; thus a server either belongs to the client or the service provider. It cannot belong to both.
- $S^{SP} = \emptyset$ is valid and indicates that the client is not willing to ship the data across and $S^C = S$ is also valid and indicates that the client's computational resources are unavailable or inadequate.

In order to specify the location of a server we use the following notation: $S_j \in S^{SP}$ and $S_j \in S^C$ where, $j = 1, 2, \dots, m$. This distinction is necessary for specification of how the response time has to be estimated in the cost matrix.

3. Let n be the number of datasets and let $DS = \{ds(1), ds(2), \dots, ds(n)\}$ represent the labelling of the datasets.
4. Let $ds(i)_{S_j}$ represent the location of a dataset labelled $ds(i)$, $i = 1, 2, \dots, n$ at server S_j , where $ds(i) \in DS$ and $j = 1, 2, \dots, m$. Thus datasets are uniquely identified and multiple datasets at locations can be represented.

Let $cm_{ij} \in CM$ be the estimated response time for taking a dataset located at the server j and mining it at the server i , where $1 \leq i \leq m$ and $1 \leq j \leq n$. The value of cm_{ij} is computed as follows:

$$cm_{ij} = \begin{cases} MA_{S_X \rightarrow S_i} + TR_{S_i \rightarrow S_i}^{ds(k)_{S_i}} + W_{S_i} + DM_{S_i}^{ds(k)_{S_i}}, & i \neq j, S_X \in S^{SP}, S_i \in S^C, S_j \in S^C \\ MA_{S_X \rightarrow S_i} + W_{S_i} + DM_{S_i}^{ds(k)_{S_i}}, & i = j, S_X \in S^{SP}, S_i \in S^C, S_j \in S^C \\ TR_{S_j \rightarrow S_i}^{ds(k)_{S_j}} + W_{S_i} + DM_{S_i}^{ds(k)_{S_j}}, & i \neq j, S_i \in S^C, S_j \in S^{SP} \end{cases}$$

In the above equation:

- $MA_{S_X \rightarrow S_i}$ is the time to transfer a mobile data mining agent from server S_X (which is a server of the service provider) to server S_i
- $TR_{S_j \rightarrow S_i}^{ds(k)_{S_j}}$ is the time to transfer a dataset $ds(k)_{S_j}$ located at server S_j to server S_i
- $DM_{S_i}^{ds(k)_{S_i}}$ is the time to mine dataset $ds(k)_{S_i}$ located originally at server S_i at server S_i
- W_{S_i} is the wait time at server S_i required for the completion of previous tasks and is generally more significant when $S_i \in S^{SP}$ (i.e. server S_i is located at the service provider's site).

As presented above there are three formulae for estimating

the response time for different scenarios in the cost matrix. The first one is for the case where the server S_i where the mining is to be performed is at the client's site but does not contain the dataset $ds(k)_{S_j}$ (which as indicated is located

at the server S_j). Hence there is a need to transfer the data from its original location S_j to the server S_i to perform the data mining. Further, the client's site would not have the data mining software and a mobile agent needs to be transferred from the service provider's site (represented as S_X). The second formula is for the case where the server where the mining is to be performed is at the client's site and the dataset is located on the same server (i.e. $i = j$). In this case, the mobile agent needs to be transferred but there is no need to transfer the data. The third formula is for the case where the server where the mining is to be performed is located at the service provider's site (i.e. $S_i \in S^{SP}$) and therefore the data has to be shipped across from the client's site to perform mining. The three formulae map to the three scenarios outlined earlier, namely, that of mining at the client's site, mining at the service provider's site and using both sites. The cost matrix has been designed to determine the response time for mining the datasets at the different available servers. The location of the servers and the datasets determine the cost formula that has to be applied for computing the response time. We now present cost formulae for estimating the individual cost components.

3. Estimating Individual Cost Components of Response Time

As discussed, we now present strategies for estimating the individual components of the DDM response time.

3.1 Estimating the Communication Cost

The communication cost in the DDM process varies depending on whether the client-server strategy is followed or the mobile agent model is used.

3.1.1 Mobile Agent Model

In general, the mobile agent model for DDM involves dispatching mobile agents carrying the mining algorithms to the locations of the data to perform data mining. Thus, the model is characterised by a set of mobile agents traversing the relevant data servers to perform mining. This can be expressed as m mobile agents traversing n servers (that contain datasets). In the context of data mining web services, the mobile agent model is applied when the client specifically requires the task to be performed using the client's computational resources (e.g. where the client does not want the data to leave the site). This model can also be used in cases where the client has no preference, but applying this model results in better response time. Therefore it can be seen that the mobile agent option primarily involves the servers located at the client's site. In order to estimate the transfer times for mobile agents,

consider the following:

Let N be the total number of servers at the clients site.

Let n be the number of servers where the mining is performed.

Let S represent the n servers in question i.e. $S^C = \{S_1, S_2, \dots, S_n\}$.

Let m be the number of mobile agents dispatched from the service provider's central server CES to perform mining at the set of servers S^C .

Let $t_{ma}(x, y) = MA_{x \rightarrow y}$ refers to the time taken by the agent ma to travel from node x to node y .

In order to compute the estimates in the cost matrix, we need to estimate the transfer times of the mobile agents from CES to the servers of the set S^C (i.e. we need to estimate $MA_{CES \rightarrow S^C}$).

Given that there are n servers that have datasets for mining and m agents, there are three possible alternatives within this scenario and they are:

1. $m = n$, where the number of mobile agents is equal to the number of servers. This implies that one data mining agent is sent to each server involved in the distributed data mining task.
2. $m < n$, where the number of mobile agents is less than the number of data servers. The implication of having fewer agents than servers is that some agents traverse more than one server. This option is not used often, but is modelled to allow for cases where there is an imposed ordering in the traversal. For example, a scenario where an agent must first visit server r to obtain background knowledge necessary to perform data mining at server s . This knowledge can be in the form of a concept hierarchy [5] or a database schema that defines the attributes of the database located at server s . In such cases, it is necessary to have one agent traverse several servers.
3. $m > n$, which we do not explicitly consider since this is in effect equivalent to the case 1 above with respect to travel time where there is a mobile agent available per server. That is, having modelled the travel time for a single mobile agent from one server to another it is implicit that we can estimate the travel time for several agents that have to be sent between the same servers. A possible scenario for sending more than one agent to a server may be if there are several datasets that need to be mined at the server and different agents are required to process the various datasets.

Each of the above cases has a cost function and the cost models for estimating the response time. However, in this paper, we focus on the scenario of equal number of mobile agents and data servers, since this is the most common.

This case, where data mining from different distributed data servers is performed in parallel and there is one mobile agent per server (i.e. $m=n$). The algorithm used across the different data servers can be uniform or varied. The service provider dispatches a mobile agent encapsulating the data mining algorithm (with the relevant parameters) to each

data server participating in the distributed data mining task.

In order to derive the cost function for the general case involving n data servers and n data mining mobile agents (since $m=n$), we first formulate the cost function for the case where there is one data server and one data mining agent. Let us consider the case where data mining has to be performed at the i^{th} server $S_i \in S^C, 1 \leq i \leq n$. The overall cost function for the response time to perform distributed data mining involving the i^{th} data server is computed from the formulae presented in section 3.2.3 and consists of the time to transfer the mobile agent to the server, transfer the data to the server (if the data is not originally located at the server) and perform the mining subject to any Wait time imposed. Each of these components have to be estimated in order to derive the overall estimated response time. In this section we focus on estimating the communication time for the transfer of a single data mining mobile agent $dmAgent$ from server CES to server S_i , that is $t_{dmAgent}(CES, S_i)$.

The time taken for a mobile agent to travel depends on the following factors: the size of the agent, the bandwidth between servers and the latency between the servers. The travel time is proportional to the size of the agent and is inversely proportional to the bandwidth (i.e. the time taken increases as the agent size increases and decreases as the bandwidth increases). The latency is the delay, typically expressed in Round Trip Time (RTT) and is added to obtain the transfer time. The latency has higher impact on the transfer time, when the amount of data that is transferred is small, whereas the bandwidth has a higher impact when the amount of data is large. This can be expressed as follows:

$$t_{dmAgent}(CES, S_i) \propto \text{size}(dmAgent) \quad (2)$$

$$t_{dmAgent}(CES, S_i) \propto 1 / (\text{bandwidth between } CES_i/S(3))$$

From (2) and (3):

$$t_{dmAgent}(CES, S_i) = \lambda (CES, S_i) + \text{size}(dmAgent) / \beta (CES_i, S_i) \quad (4)$$

In the above Equation 4, λ is the latency and β is the bandwidth. While bandwidth and latency can be measured, we need to determine the size of the $dmAgent$. In [StS97] the size of an agent is given by the following triple: $\text{size of an agent} = \langle \text{Agent State, Agent Code, Agent Data} \rangle$ where, *Agent State* is the execution state of the agent, *Agent Code* is the program that is encapsulated within the agent that performs the agent's functionality and *Agent Data* is the data that the agent carries (either as a result of some computation performed at a remote location or the additional parameters that the agent code requires). On adapting the above representation to express the size of the data mining agent ($dmAgent$), we now have, $\text{size}(dmAgent) = \langle dmAgent \text{ state, data mining algorithm, input parameters} \rangle$

We now extend the cost estimate for the general case characterised by n mobile agents and n distributed servers. Thus, n mobile agents encapsulating the respective mining algorithms and parameters are dispatched concurrently. Mining is performed at each of the sites in parallel and the results are returned to the central server. Thus, the transfer time per server from Eq. 4 above, is $t_{dmAgent}(CES, S_j), 1 \leq j \leq n$

n . The total transfer time is the time taken by the mobile agent that requires the longest individual transfer time. In case the agent is required to travel back to the server, the estimated travel time is computed as $t_{\text{Agent}}(S_j, \text{CES})$, $\forall j \leq n$.

We have modelled the scenarios for using mobile agents to perform distributed data mining and have presented cost formulae to estimate the mobile agent transfer times for each case. This addresses the *a priori* estimation of the communication mobile agent transfer time component in the cost matrix. The next section focuses on estimating the data transfer time, which is the second communication component.

3.1.2 Estimating Data Transfer Time

The transfer of data in the hybrid DDM model can be attributed to two reasons. Firstly, the hybrid model integrates both the client-server and mobile agent models. In the client-server model the data is transferred from the client's site to the servers of the service provider. Secondly, data transfer occurs when the data resides on a server that is not available for mining (e.g. because it lacks the necessary computational resources or it is dedicated for some other tasks) and has to be transferred to another server at the client's site. Typically, the transfer times in the first case would be more significant than the second where the transfer might occur within an organisation's intranet. In this section, we present the cost formulae for estimating data transfer times $TR_{S_j \rightarrow S_i}^{ds(k)_{S_j}}$ for transferring a dataset $ds(k)_{S_j}$ located at server S_j to server S_i . Server S_i is at the client's site and S_j may be at either the client's site or the service provider's site.

The cost formulae for transferring datasets are primarily dependent on the size of the data, the bandwidth between the servers and the latency or delay. Let $ds(k)_{S_j}$ represent the dataset that is located $S_j \in S^C$ and has to be transferred to S_i (where $S_i \in S^{SP}$ or $S_i \in S^C$). The data transfer time $t_{ds}(S_j, S_i) = TR_{S_j \rightarrow S_i}^{ds(k)_{S_j}}$ can be estimated as follows in equation 5:

$$t_{ds}(S_j, S_i) = \lambda(S_j, S_i) + \text{size}(ds(k)) / \beta(S_j, S_i)$$
 In the above equation 5, λ is the latency and β is the bandwidth between the servers S_j and S_i . Since typical dataset sizes tend to be very large, the effect of the bandwidth will be greater than the effect of the latency of the data transfer time.

We have modelled the cost formulae for the data transfer component of the DDM response time. The cost formulae presented are applicable to DDM systems irrespective of their architectural model and are unique in that, we propose to mathematically model the communication costs in distributed data mining. Further, the cost models developed also take into account the

different cases and options within each model, thereby facilitating comparison of different sub options within a given model. There has not been a comparison of communication times between the client-server and mobile agent models with respect to distributed data mining. The cost formulae developed in this section support the explicit comparison of the communication time between the client-server and mobile agent models for distributed data mining. Further, while previous costing techniques in distributed data mining have implicitly considered the communication cost in terms of the number of datasets [PaS01] or have assigned the cost in terms of bandwidth [TuG00], our approach is based on taking into account several factors including bandwidth, latency, dataset sizes and mobile agent sizes. Finally, the cost formulae proposed and developed in this chapter allow *a priori* estimation of the communication components in the cost matrix. Having modelled the response time for the communication component, we now present our technique for estimating the response time of the computational component (i.e. the cost of performing data mining).

3.2 Estimating the Data Mining Cost

In order to estimate accurately the computation cost of data mining tasks we have proposed and developed a novel rough sets based algorithm for application run time estimation [6, 9, 10]. It must be noted that considerations of space do not allow us to present an explanation of this algorithm here, however we present experimental results of applying this technique for estimating the run times of data mining tasks.

4. Experimental Results and Analysis

The viability of using these cost estimates depends on the accuracy of the estimation techniques. Thus, the estimated communication times and predicted data mining task run times must be close to actual run time for these cost formulae to form the basis for effective optimisation.

We have proposed a model for *a priori* estimation of the DDM response time by estimating the individual components. These estimates are used in the cost matrix to represent the overall response time for different strategies. As discussed, communication is an important factor in the response time for distributed data mining. We developed cost formulae for estimating the transfer times for both the models for performing distributed data mining, namely, mobile agents and client-server. In the context of data mining web services, the mobile agent model maps to the case where the task is performed at the client's site and the client-server model maps to the case where the task is performed at the service provider's site. In this section, we present experimental results of our cost formulae for estimating the transfer time for both data and mobile agents.

4.1 Estimating Mobile Agent Transfer Time

In this section, we present the estimated and actual transfer times for the data mining mobile agents implemented in our DDM system Distributed Agent-based Mining Environment (DAME) [7]. The mobile agents were developed using the Aglets™ SDK [12] and are used to carry the data mining software to remote data servers. The agents are provided with an itinerary of destinations and respective tasks to be performed in each server that it visits. The agent carries the data mining software as a serialised object. We note that while we use Aglets for experimental and implementation purposes, our cost formulae for estimating the transfer times of mobile data mining agents are not specific to any toolkit. The experimental evaluation consisted of estimating the transfer times for mobile data mining agents and comparing it with the actual transfer times to determine the mean error. The experiments were conducted using four distributed machines with the three machines connected through high speed communication links (two machines via a 100 Mbits link and one machine via a 10 Mbits link) and one machine connected via a 28.8 Kbits modem link. Two machines were located on one campus of Monash University and one machine was located in another campus and was on a different domain. The size of the information carried by the mobile agent was different in each run by varying the software that it carried and the tasks that it was required to perform. The comparative difference in the estimated and the actual results obtained from the tests are shown in figure 2.

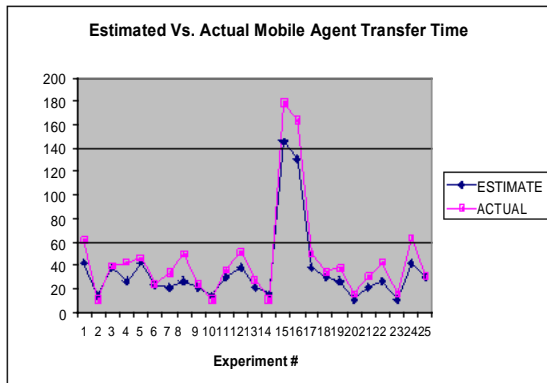


Figure 2 Estimation Accuracy for Mobile Agent Transfer Times

In summary the experimental scenario used mobile agents carrying algorithms and data varying from approximately 0.5 MB to 30 MB over connections where the highest bandwidth obtained was 7.3 Mbits/s and the lowest bandwidth was 24 Kbits. The latency was a factor only when the slow links were used. The mean error of the estimates is 10.84 sec, which shows that our strategy for estimating the transfer times is accurate. We obtained the highest accuracy for an error of 1 sec and the lowest accuracy for an error of 33 sec. It must be noted that the lowest accuracy was obtained when the network link was a 28.8 Kbits modem connection, which should be viewed in the context of comparing modem speeds with T1 speeds. Furthermore the mean error as a percentage of the mean

run-times is 23.59 percent, which is a good indicator of accuracy.

4.2 Estimating Data Transfer Time

In this section we present experimental results for the accuracy of the cost formulae for estimating the data transfer times. The data transfer times are primarily dependent on the size of the data and the network characteristics such as bandwidth and latency. In the implementation of the DAME system the data transfer is done using FTP, which we note is also used among commercial data mining service providers such as digiMine™ (<http://www.digimine.com>). The experiments were conducted by measuring the latency and bandwidth in real time between the two servers involved in the data transfers and then transferring the datasets required for mining. We conducted experiments using file sizes varying from 5 MB to 65 MB. We used two different connections—a high speed link (where the average bandwidth ranged from 6.5 – 8.3 Mbits and the latency was negligible) and a modem link (where the average bandwidth ranged from 41–45 Kbits due to internal modem compression and the latency varied from 2 to 3 sec). The comparative results between the estimated and actual transfer times for the three different bandwidth and latency characteristics shown are illustrated in figures 3 and 4.

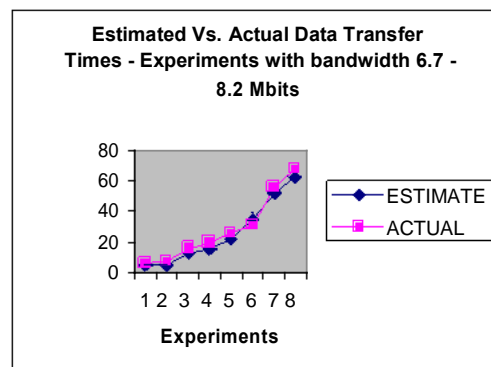


Figure 3 Experiments with Bandwidth Varying from 6.7 – 8.2 Mbits

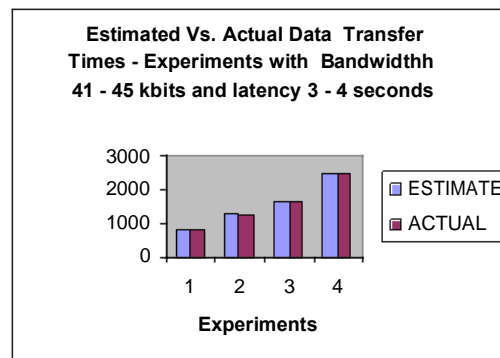


Figure 4 Experiments with Bandwidth Varying from 41 – 45 Kbits

The mean error for the experiments conducted using a high speed connection was 3.56 sec and the mean error as a percentage of the mean transfer time was 12.05 percent, which are both low indicating the high accuracy of the cost formulae. The mean error for the experiments conducted using a low speed link was 20.5 sec. However, the mean error as a percentage of the mean transfer time was 1.3 percent, which shows that the estimates are accurate. The combined mean error was 6.95 sec.

The difference in the mean error as a percentage of the mean transfer times between the two types of connections can be attributed to the fact that overall transfer times were very low with the high speed link. We have thus far presented experimental results validating the cost formulae for a priori estimation of the communication component of distributed data mining.

4.3 Estimating the Run Times of Data Mining Tasks

In this section, we present experimental results obtained by using our rough sets based application run-time estimation algorithm on data mining tasks. We compiled a history of data mining tasks by running several data mining algorithms on a network of distributed machines and recording information about the tasks and the environment. We executed several runs of data mining jobs by varying the parameters of the jobs such as the mining algorithm, the datasets, the sizes of the datasets, the dimensionality of the datasets and the machines on which the tasks were run. The algorithms used were from the WEKA package of data mining algorithms [18]. We generated several datasets of sizes varying from 1MB to 20MB. The data mining jobs were executed on four distributed machines with different physical configurations and operating systems. Three machines had Windows 2000 and one machine had Solaris 5.8. Two of the Windows machines were Pentium III with 833 Mhz processor and 512 MB memory, while the other was a Pentium II with 433 Mhz processor and 128 MB memory. The third machine was a Sun Sparc with 444 Mhz processor and 256 MB memory. The history provides the data for the estimation algorithm to predict the run time of a given data mining task. The rationale for building a history using a distributed network of nodes was two-fold. Firstly, we wanted to obtain a diverse history and test the estimation accuracy given a varied history. Secondly, it represents a realistic scenario where data mining web service providers and clients would typically operate using a distributed network of servers and would use the estimation for each node in the allocation of jobs.

For each data mining job, the following information was recorded in the history: the algorithm, the file name, the file size, the dimensionality of the data, the operating system, the version of the operating system, the IP address of the local host on which the job was run, the processor speed, the memory, the status of the server (whether it was

dedicated or not), the start and end times of the job. The history was used to conduct experiments using the run-time estimation process described in chapter 4. We used histories with 100 and 150 records and each experimental run consisted of 20 tests. The performance accuracy is illustrated in figure 5, which presents the actual and estimated run-times from one of our experimental runs.

The mean error is approximately one minute and the error as a percentage of the actual run-times is 26.4%. The result that our algorithm selected as a similarity template included the following attributes: algorithm, file size, dimensionality and available memory. It must be noted that our application run-time estimation technique like other techniques that rely on historical data [15,17] is limited by the initial need to collect a history.

We have presented experimental results that demonstrate the performance accuracy of our rough sets algorithm for estimating application run-times of data mining tasks. Thus far, the experimental evaluation has validated our technique for a priori estimation of the DDM response time. This facilitates service providers to commit to service levels that can be ensured in SLAs.

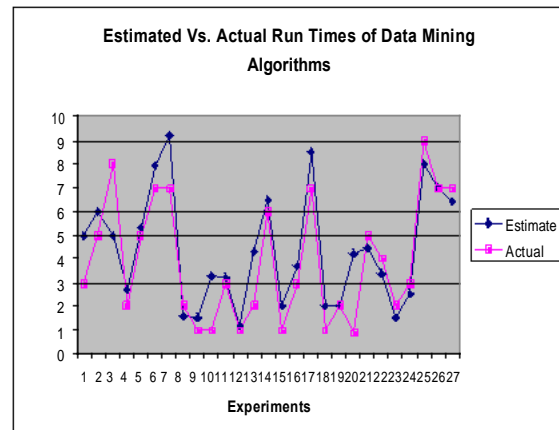


Figure 5 Performance of Run-Time Estimation for Data Mining Tasks

5. Conclusions and Future Work

This issue of estimating QoS in application services is important and one that needs to be addressed. This paper takes a first step in estimating the response time for data mining web services. The model presented in this paper is applicable to distributed, data intensive application services in general. The current focus is experimental evaluation of this work with other application services and focusing on additional QoS metrics.

6. Acknowledgements

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An Analysis of E-Business Systems Impacts on the Business Domain

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Abstract

In e-business systems, the business environment and processes not only drive the identification of system needs, but also are in turn fundamentally changed by the introduction or evolution of a system. This means that an e-business system that is under development will be highly volatile with a complex set of impacts on the various domain characteristics (and conversely, the changes in the domain impact on the nature of the desired system). We report on a detailed analysis of the literature related to these impacts. From this analysis we show how different facets of the domain of a system are impacted in different ways. As the scale and immediacy of these impacts increase we need to become more predictive of these impacts in taking them into account during the development. Our analysis will provide organisations with the basis for moving towards this increased level of predictiveness.

1. Introduction

A key characteristic of e-business is that the introduction of the system has a fundamental impact on the nature of the business processes and business models which are being supported by the system. In other words, the business environment and processes not only drive the definition of the system needs, but are in turn fundamentally changed by the system. These changes are such that not only are the system requirements changed, but the very nature of the problem that was being addressed is changed. In effect, the business "problem" defines the nature of the technical system "solution" that is desired, but the solution itself changes the characteristics of the problem space. This can be described as solutions and problems being "mutually constituted" – a concept well understood in the area of social informatics [40] and requirements engineering [9].

Whilst this concept of mutual constitution – or its expression as a technical solution leading to significant changes in the problem space – is typical of almost all systems development, it is particularly significant with e-business systems. This is because of the scale and immediacy of the impacts that e-business systems can have on their domain. Whilst most IT development exhibits these characteristics, either the process impacts are sufficiently obvious to be able to be taken into account easily, or their scale is sufficiently constrained to allow them to be initially ignored and to then be addressed once the system has been implemented. As the

scale of the impacts increases, we need to become more predictive of these impacts and take them into account during the initial development. Whilst there has been a significant body of work looking at specific impacts of e-business systems, these impacts have not been analysed in the way they impacted the organisation. This paper presents an analysis that encapsulates the dimensions of impact of both the domain of mutual influence and the domain of context. This analysis will provide the organisations with a framework for developing strategies for joint development of e-business systems and business processes. It will also serve as value-added knowledge for the companies in understanding the strengths, weaknesses, opportunities and threats that may affect their system, organisation and stakeholders (e.g. trading partners). These dimensions and their characteristics are derived from a comprehensive analysis of the literature across a wide range of disciplines.

In essence this analysis of the literature provides a basis for addressing the following research questions:

Question 1: In the development of an e-business system, what are the characteristics that impact on the organisation's business environment (system and organisation)?

Question 2: Are different facets of the domain impacted in fundamentally different ways by the introduction of e-business systems, and if so then what are the differences?

In the next section, Section 2, we will be discussing the e-business system types, the characteristics of the domain of mutual influence, domain of context and the taxonomy which we have developed from the analysis of the literature. In Section 3, we will be evaluating the facets of the domain that are being impacted by the development of e-business systems. In Section 4, we will conclude this paper and briefly present our future research plan.

2. Existing Literature

In analysing existing work on e-business systems impacts, we undertook a broadly-focused analysis of literature from diverse disciplines including: marketing, management, logistics, engineering, information systems, information technology, and manufacturing. Content analysis is used to identify web related factors and elements that impact organisations, the type of e-business systems they are related to, the extent of impact, what is being impacted and whether the impact is positive or

negative. Content analysis technique is used as it is a research method that uses a set of procedures to make valid inferences from the text, which in this paper is the literature [34]. In this paper, we have identified e-commerce systems and e-business systems as being a subset of the web systems.

2.1 Web system types

From the literature, there are several studies which identify various types of impacts and the applicability of these impacts to different types of web systems. Whilst the definition of Web system varies, a useful working definition is a system that is designed and developed using a web based technology. "Web systems are different from conventional software systems. They are developed in shorter timeframes, and with smaller budgets, meet a more generic set of requirements, and generally serve a less specific user group. They are often developed very quickly from templated solutions, using coarse-grained authoring tools, and by the efforts of a multi-disciplinary team" [31].

There is significant number of articles, which have discussed E-commerce and E-business systems. E-commerce is defined "as the buying and selling over digital media" [29]. E-business definitions often encompass e-commerce and include both front-and back-office applications that form the engine for modern business. E-business is not just about E-commerce transactions; it's about redefining old business models, with the aid of technology, to maximise customer value. E-business definition refers to a broader definition of E-commerce, which includes collaborating with business partners, and conducting electronic transactions within an organisation [46]. As there are various trading partners, e-business trade activities are categorised under business-to-business (B2B), business-to-consumer (B2C), consumer-to-business (C2B), consumer-to-consumer (C2C), people-to-people (P2P), government-to-citizen (G2C) and intra-business (organisation unit to organisation unit) [40]. Essentially these systems facilitate the inter- and intra-organisational flow of goods, services, information, coordination and collaboration.

2.2 Domain of Context vs. Domain of Mutual Influence

The domain of the system under development can be separated into two distinct sub-domains. The Domain of Context is those aspects of a systems (or organisations) which provide a context for (i.e. affect) the system, but which are not directly and immediately affected by the system (e.g. legal regulatory frameworks). The Domain of Mutual Influence is those aspects of the domain which affect the system, but which are in turn directly and immediately affected by the system (e.g. business processes, or – for most e-business systems – the external customers).

Table 1 outlines the characteristics of the Domain of Mutual Influence and the characteristics of the Domain

of Context that impact on e-business systems and the literature sources, which discuss these impacts. Characteristics identified in the Domain of Mutual Influence are characteristics that are impacted by e-business systems and organisations. Examination of existing literature highlights several facets of the domain that are impacted by the introduction or modification of e-business systems. These typically relate to the business processes, systems, operations, structure and communication between the organisation's employees and with the various trading partners, such as customers, suppliers and manufacturers. Within an organisation, e-business systems have a more direct impact. Studies that have been undertaken typically characterise impacts as either positive or negative (or strengths and weaknesses) for the organisation, depending on the types, effect and level of impact each has on the organisation.

2.3 Taxonomy

From the e-business systems discussed in the literature (and summarised in Table 1) it can be observed that the development of e-business systems have different impacts on the business environment. There are five dimensions of these impacts that form the taxonomy that we propose in this paper, which is discussed in detail in [49]. In table 1, characteristic which affect (labelled alphabetically) is identified as characteristic of a particular domain that affect the system or organisation domain. Characteristic that are affected (labelled numerically) is identified as characteristics of the system or organisation domain that are being affected. Let us illustrate the taxonomy with an example. As depicted at the top of Table 1, time and speed (of business operations) is a characteristic of the business environment that is affected by the introduction of an e-business system. This type of impact is typically most evidenced in e-business systems and most commonly affects the facets of the domain, which in this example, is the organisation and the system domain. The impact on time and speed has a generally positive effect and high level of impact on the organisation [8] [46].

3 Facets of the domain which are impacted by e-business systems

In this paper we have identified four different facets of the domain which can have impacts: the domain of mutual influence, the domain of context, the system itself and the organisation which hosts this system. In the facets of the domain column of Table 1, the facets are categorized according to the facets of the domain that is impacted, which are System, Organisation, domain that is Mutually influenced and the domain that form the Context. We explain these facets and their characteristics in detail below. For System and Organisation facets, we also discuss some of the characteristics that are mutually influenced, hence categorized as characteristics of the domain of mutual influence.

Table 1. Characteristics of the organisation and its environment that impact and/or are impacted by e-business system

Characteristics which affect	Characteristics that are affected	Facets of the Domain Impacted	Effect of Impact	Level of Impact	Sources
Goods and services delivery to market (A) Cycle time of product ordering and delivery (B) Ordering process (C)	Time and speed of org. decision-making process (1) Time of workflow process Speed of workflow process	OS/M	Positive Positive and Negative Positive	High (all aspects) High (all aspects) High (all aspects)	Byrne (2000) Jones and Kochtanek (2002) Golcic et al (2002)
Supply chain intermediation and disintermediation (D) Access levels differentiation (E) Customer value (F)	Value Exchange (2)	OS/M	Positive Positive	Medium for all aspects EXCEPT High for value offering	Gordijn et al (2000) John et al (2002) Turban et al(2000)
Service personalisation (G) Robots to monitor promotion activities (H) Multiple response generations (I)	Scalability (3)	SS/M	Negative	High for System	Arlitt et al (2001), Arlitt and Jin (2000), Challenger et al (1999), Fielding and Taylor (2000)
Work processes streamlining (J) Spread of network infrastructure use (K)	Customer Expectation (4)	OS/M	Positive	Medium (all aspects)	Gaedke and Turowski (2000)
Real time access, easy to use interfaces (L)	Usability (5)	SS/M	Positive	Medium (all aspects)	Hansen (2002)
Collaboration and communication support (M) Interface between systems (N) Linking various stakeholders (O)	Communications interface (6)	OS/M	Positive	High (all aspects)	Peng (2002) Fielding and Taylor (2000)
Unspecified system characteristics	Navigation structure (7)	S-S	Positive and Negative	Medium (all aspects)	Scharl (2001), Conklin (1987), Schwabe et al (2002)
Security threat to org. proprietary data (P) Internet infrastructure security threat (Q)	Security (8)	OS/M	Negative Negative Negative	High (all aspects)	Osmonbekov et al (2003) Chakrabarti and Manimaran (2002)
Unspecified system characteristics	Intra-organisational communication & collaboration (9)	S-S	Positive	High (all aspects) Low for all aspects EXCEPT Medium for organisation	Tang (2000) Michael (1996), Ciborra (1996)
Unspecified system characteristics	Business Process (10)	S-S	Positive	Medium (all aspects)	Fowler (1998) Coltman et al (2002) Giaglis (1999) Scheer and Habermann (2000) Swatman et al (1994)
Document routing, retrieval and approval process (R) Process of ordering (S)	Workflow process (11)	OS/M	Positive Positive Positive and Negative	Medium (all aspects)	Miers (2001) Ames et al (1997) Cunningham (1999)
Change from mass production manufacturing to demand-driven manufacturing (T)	Material purchase method (12)	O-S	Positive	Medium (all aspects)	Turban et al (2000)
Information accuracy, currency, output timeliness and relevance (U)	Information Quality (13)	S-S	Positive	Low for all aspects	Negash et al (2002)

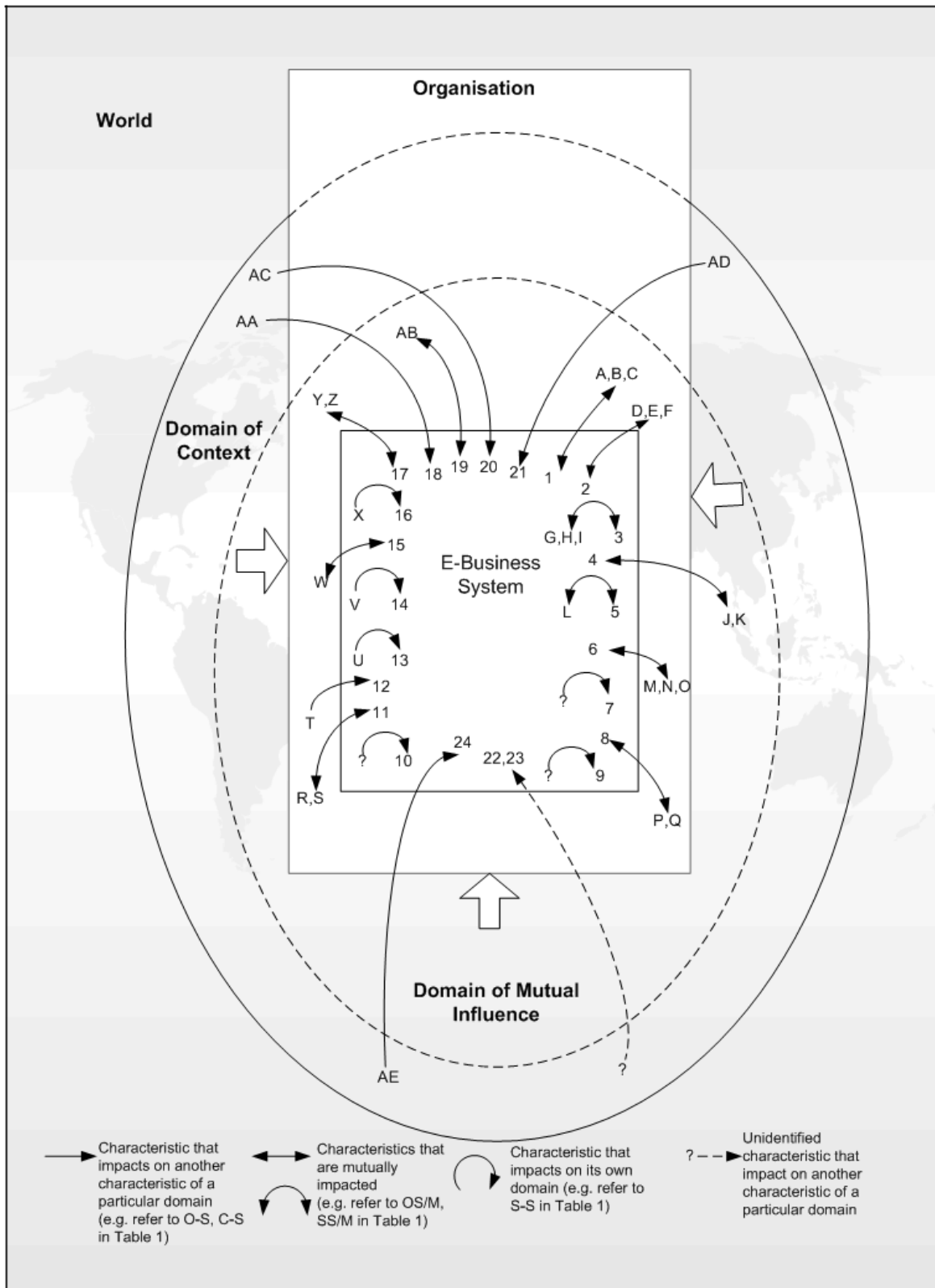
Continued from previous table

Characteristics which affect	Characteristics that are affected	Facets of the Domain Impacted	Effect of Impact	Level of Impact	Sources
Dynamic data, complex web page design (V)	System Performance (14)	S-S	Positive	High (all aspects)	Challenger et al (2002), Challenger (2000)
Management and improving org.'s relationship with customer and supplier (W)	Relationship Management (15)	OS/M	Positive Positive	Medium (all aspects) Medium (all aspects)	Dignum (2002)
Data accuracy, reliability, system flexibility, ease of use (X)	System Quality (16)	S-S	Positive	Medium for all aspects EXCEPT High for System	Negash et al (2002)
Web adoption cost, System acquisition cost (Y) Transaction cost (Z)	Cost (17)	OS/M	Positive	Medium (all aspects)	Osmonbekov et al (2002) Kalakota and Whinston (1996) Ardagna and Francalanci (2002)
Customers' need of viewing orders on own system (AA)	Integration of front and back-end office system (18)	C-S	Positive and Negative	High for System (medium organisation)	Dignum (2002)
Web applications and tools interoperability problems (AB)	Integration of different web system applications (19)	OS/M	Positive and Negative	High for System medium for organisation)	Bohner (2002), Jin et al (2002), (Bussler et al, 2003), Gaede and Turowski (2000)
Web application customisation and personalisation (AC)	Personalisation of service and product offering (20)	C-S	Positive	Medium for System	Schwabe et al (2002) Schwabe and Rossi (1998), Rossi et al (2001)
Competition from existing and new firms (AD)	Competition (21)	C-S	Negative Negative	Medium (all aspects) High (all aspects except System)	Wheelen and Hunger (1998), Chan and Peel (1998) Ing et al (2000)
Unidentified characteristics	Legal, ethical, govt regulation (22)	C-S	Positive and Negative	Low (all aspects)	Turban et al (2000), Mason et al (1995)
Unidentified characteristics	Web Technology Adoption (23)	C-S	Positive	Low for all aspects EXCEPT Medium for organisation	Jones and Kochtanek (2002)
Information visibility facilitated by speed and connectivity, evolving and changing business process (AE)	Uncertainty of business environment (24)	C-S	Negative Negative	Medium (all aspects) Medium (all aspects)	Golicic et al (2002) Achrol (1997)

Facets of the Domain Impacted explanations:

- 'S': System characteristics that impact or are impacted
- 'O': Organisation characteristics that impact or are impacted
- 'M': Characteristics identified in the Domain of Mutual Influence are characteristics that are impacted by e-business systems and organisations. The Domain of Mutual Influence is those aspects of the domain which affect the system, but which are in turn directly and immediately affected by the system (e.g. business processes, or – for most e-business systems – the external customers).
- 'C': Characteristics identified in the Domain of Context are those aspects of a systems (or organisations) domain which provide a context for (i.e. affect) the system, but which are not directly and immediately affected by the system
- OS/M: Organisation characteristic that impacts on the System characteristic but which is in turn directly impacted by the system. Hence the organisation and system characteristics are mutually influenced, thus identified as being the characteristic in the Domain of Mutual Influence
- SS/M: System characteristic that are mutually influenced by another system characteristic
- O-S: Organisation characteristic that impact on System characteristic
- S-S: System characteristic that impact on another system characteristic
- C-S: Characteristic that provides the context for the system which impact on the system.

Figure 2: Impact and Domain Boundary



3.1 System

Dynamic data, insufficient network bandwidth and poor network design impact on the system's performance [11]. Performance is a critical factor and impacts significantly on the organisation's system efficiency, particularly for websites that receive hundreds of thousands of hits per minute. It may also impact on websites that receives a moderate amount of traffic if most of the requests are for dynamic data, which are expensive to create. In improving performance of a Web site, multiple processors can be used to scale the CPU capacity of the system [11]. System developers need to be selective of the types of web servers deployed so as to service a high request rates and techniques for routing requests to servers. Web pages should be designed to convey useful information in a limited number of pages so that clients do not have to navigate through too many pages to obtain information that they looking for. Table 1, shows that dynamic data and complex web page design is a characteristic of a system that impact on the performance of the organisation's system (S-S). In Figure 2, it shows that System Performance (labelled 14) is being affected by the organisation's initiative to use dynamic data and complex web pages for its e-business systems (labelled 'V').

Security has a significant impact on e-business functions as the systems interfaces into business functions of a corporation. As a result of this, security of the business transactions and process need to be safeguarded. Security poses a high impact on the organisation and the system development as there is no security technology that can secure the system effectively. Limiting access to proprietary data and controlling the scope of information retrieval are major issues that organisation need to focus on [37]. Currently, web-based selling and purchase tools have yet to fully address the security concerns. Replacing paper documents with electronic documentation has an undesirable impact on the organisation security. This is due to the possibility of permitting open links to proprietary data, and that electronic document lacks permanency and legal legitimacy of paper. In Table 1, it shows that Security is a characteristic that is mutually impacted, hence is labelled as OS/M (refer to the Facets of the Domain Impacted column). This explains that security is a characteristic of the organisation which impacts on the system and in return it directly impacts back on the organisation.

Another critical characteristic is integration of front and back-end office system, and integration of different web applications and tools. It is critical that e-business system developers integrate processes and operations, such as integrating the catalogue with internal databases, the order information with users' profiles, and integrate the ordering process with the back office of the customer's system [18]. In Table 1, it shows that customers are a characteristic of the domain of context that affects the integration of front and back-end office system (labelled as C-S in the Facets of the Domain Impacted column). This explains that customers may

indirectly affect the organisation's system. This impact drives the changes within the organisation; hence indirectly influence the organisation to integrate its processes with the customer's back office systems. Integration of different web applications and tools can lead to significant problems for an organisation and its external stakeholders. It is therefore important that different systems are able to interoperate with each other. B2B e-business integration is a complex issue; hence web services are used as a solution for many significant integration problems [7]. There is currently little research or lessons learned that report on the deployments that could advance web services technology functionality and integrates different e-business systems. As shown in Table 1, deployment of web applications and tools (labelled 'AB') is a characteristic initiated by the organisation's that affect on the e-business system. Deployment of web applications and tools create interoperability problems. The system therefore needs to be able to effectively integrate the different web applications to determine that the organisation's and external stakeholders' system can seamlessly interoperate with each other. This characteristic mutually influence on the organisation and system domain, hence labelled as OS/M in Table 1.

The need to personalise service and product offering to customers, trading partners and employees lead to the system designer to personalise link, structure, content and behaviour of the web page [43]. E-business initiatives have a significant impact on the organisation's stability, as it increases competition thus pressuring system developers to develop web applications that offer distinct competitive advantage. The challenge is to build customisable Internet applications, such as developing a personalisable Internet application [43]. The result of this is that it might provide different navigation topologies to different users, recommend specific products according to a user's preferences, or implement multiple policies.

These personalisation tasks have an impact on the requirements of the system. An application is required to model the user and user preferences, build profiles, and find algorithms for best linking options and others. The critical issue is however, to integrate all the personalisation features into a single design. Link personalisation for example, is useful for an electronic store such as Amazon, who may wish to provide customers personal recommendations of products that they prefer. A result of this personalisation is that the product directly accessible for one user may be different from those available to a different user and that certain users will have more direct access to certain information than the others [43].

3.2 Organisation

In terms of the organisation, facets of the domain include things such as the organisational structure, communication process, operations and matters relating to people who work within the organisation context.

One of the characteristics of the organisation that is impacted by the e-business system is business process, where the e-business system is being integrated into the process. Business process performance is dependent on the optimisation of core and support business processes. It is fundamental that due attention should be paid to the core business processes, their linkages, which add value to customer's service and product delivery. In relation to this, both organisational and technical aspects are important for effective transformation by describing a synergistic method for integrating EDI (electronic data interchange) by means of Enterprise Analysis [47]. Enterprise Analysis has taken the shape of ERP (enterprise resource planning) and is being integrated with e-business concepts [42]. After various BPR (business process reengineering) and ERP lessons learned, organisations have a better understanding of the limitations of intra-organisational improvement and play an active role in the global e-business community.

Organisations have shifted their mindset in thinking that e-business is only about creating a web site. It is critical that the back-office processes are designed according to the new requirements of ERP. With e-business concept, ERP cannot remain inside organisational boundaries. Technically, ERP vendors are forced to move from a traditional client/server to browser/web server architecture so as to deliver e-business capabilities. This has direct impact on the systems used by the vendors. On the conceptual side, ERP vendors face a greater challenge to provide instruments for managing the increasing e-business complexity [42].

In Table 1, it shows that business process (labelled 10) is a characteristic that is affected by unspecified system characteristics (not identified by the literature). This unspecified system characteristic affects the way business process functions and operates on the e-business system. Business process, in turn impact on the unspecified system characteristics itself, hence business process is identified as a characteristic that is mutually influenced.

In terms of the impact of web systems on time, employees increasingly feel the pressure to get breakthrough ideas to market first [8]. Internet is a tool, whose most significant impact is speed. This is a positive impact to an organisation but have a profound impact on the employee as shrinking time demands may caused increased problems in other areas, for example employee stress. In an e-business system environment, orders will be fulfilled electronically and the 'virtual financial close' put real time sales and profit figures at fingertips via a wireless phone or voice command to a computer. By taking orders from customers online, orders can be quickly routed to the appropriate order-processing site [42]. This process has a positive impact on the organisation and work productivity of the employees as this saves time and reduces expenses so sales staff have more time to sell. In Table 1, time and speed is a characteristic of the organisation that impacts on the system, which is in turn impacted back (labelled as

OS/M). This explains that time and speed is a characteristic that have mutual influence on the organisation and system domain.

E-business generates a new way of managing customers and suppliers' relationship (refers to as Relationship Management in Table 1). This means a transformation from a company that is geared towards production excellence or innovation excellence into a company that is geared towards customer intimacy [18]. In e-business, there is no unique successful business model for companies. Just as in traditional business, e-business model depends on the products and services that the company delivers and also on the market structure [18]. The Internet and the WWW is used as a tool by companies to track the traffic through the sites for their marketing and promotion purposes. This type of tracking allows the companies to collect customers' data, such as their purchases, purchase intent, IP address, email address and others.

In a customer relationship management project embarked by a trucking company in Eindhoven, Netherland, DAF trucks use the Internet to get feedback from their customers on the product and on the transaction of performance [18]. This means that the feedback from a customer can be processed together with the customer's profile by the departments of the company that are most affected by the feedback. This has significant impact on the system, whereby the organisation's information systems that are used internally have to be connected and synchronised, for example through the use of an enterprise resource planning system throughout the company. In Table 1, it shows that Relationship Management is a characteristic that is mutually impacted, hence is labelled as OS/M. This explains that Relationship Management is a characteristic of the organisation which impact on the system and in return it directly impacts back on the organisation.

Value exchange is a characteristic that impacts on system as well as the organisation. In e-business, process of intermediation and disintermediation presents specific e-business risks for traditional sellers. For example, intermediaries such as brokers might easily disappear or re-appear in an e-business environment. This is because buyers might decide to use a middle person (intermediary) to increase their combined buying power and seek better negotiations with the sellers. Due to this issue, it is important to show who is doing what with whom as e-business is more flexible than traditional business. Actors in e-business can be of different entities but their value offerings may coincide. This will have significant impact on the e-business project if there is no differentiation in the value offered by the different entities [24].

E-business systems offer the customers a distinct customer service value, compared to traditional business systems. The types of customer service offered via the e-business systems include answering customer enquiries, providing search and comparison activities, providing technical information to customers and allowing

customers to track order status [46]. Most banks and financial institutions allow their customers to view their account balance, status of stock portfolio, loan application anywhere and at any time. FedEx for example allows their customers to track their packages. Amazon on the other hand, notifies the customer by e-mail the acceptance of their order, the anticipated delivery dates, and later on, the actual delivery date.

3.3 Domain of Context

As discussed in Section 2.2, domain of context has an indirect impact on the organisation, system and external stakeholders (eg. trading partners). The decisions and e-business initiatives have strong implication on how business activities will be conducted between the organisation and the external stakeholders. From the analysis of the literature (refer to Table 1 and Fig.2), the characteristics of the domain of context that impact on the domain of context are external competition, market structure, legal and ethical issues, web technology adoption and uncertainty.

Competition is a characteristic that impact on the industry. In a hypercompetitive industry, such as the computer software industry, competition plays an important role and has a strong impact on the corporation strength and existence in the marketplace [48]. In this industry, competitive intelligence comes from an up-to-date knowledge of environmental trends and competitive activity and a willingness to risk a current advantage for a possible new advantage. A company in current market needs to compete with domestic and global competitors in order to survive [13].

Competitors in the Internet evolve rapidly over night and this makes it difficult for organisations to keep developing and changing its competitive intelligence. It is therefore critical that organisations capture the value from customers [26]. In e-business, the value that the organisation creates and controls changes over time. Organisations therefore need to be vigilant in determining that the value they provide is not being eroded as competitors introduce new business designs, restructure their business models, and offer new value propositions [48]. In Table 1, it shows that Competition from existing and new firms has an indirect impact on the organisation's system. This characteristic therefore forms the context for the organisation's e-business system initiative.

Another domain of context characteristic is legal, ethical and other public policy issues, which form the legal framework for the organisations and indirectly affecting the system. The legal issues that relate to the e-business are privacy, intellectual property rights (copyrights and trademarks), free speech, consumer protection, and other legal issues (includes topics such as validity of contracts, jurisdiction over trades, encryption policies) and ethical issues [46] [32]. Ethical issues particularly are difficult to define as it is a branch of philosophy that deals with what is considered to be right and wrong [46]. In Table 1, it shows that an unidentified

characteristic affect the legal regularity framework of e-business system. The legal regularity framework is therefore identified as a characteristic that provides the context for the e-business system.

Web technology adoption impact on how suppliers and customers interact and do business with the organisations via the Internet. The network effect of e-business systems allows the suppliers and customers to interconnect and rely on the "system-to-system connection". The Internet also allows the companies to communicate and share information across the supply chain. Companies use Internet adoption as part of their business model to bring other companies to their network, which then let them achieve critical mass quickly. Web systems allow e-business technology to provide information visibility throughout the supply chain. The system allows supply chain members to view real time data via the Internet and it offers value for someone who can deploy solutions effectively, link someone to their trading partners, and allow them total visibility to the supply chain [23].

Dynamism of markets and the increased information visibility facilitated by the speed and connectivity of e-business present an uncertain environment [23]. With the Internet, every business process is evolving and changing. This leads to companies having to make decisions without complete information, thus making outcome more uncertain. Advances in technology leads to increased external uncertainty faced by firms [1]. This is due to the environments, which are being affected by an increasing pace of technological change, motivated by explosion of growth and the availability of knowledge. All these elements lead to the world moving towards a borderless marketplace. The impact of technological change is strengthened in global environments that are tightly interconnected and interdependent.

3.4 Impact and Domain Boundary

From the analysis of the literature, characteristics of domain of mutual influence and domain of context may impact on the same facet of domain. This explains that some of the identified characteristics do not belong exclusively to one domain. In order to identify where these characteristics lay in the boundary of different domains, we have developed the Impact and Domain Boundary Diagram (refer to Fig.2). The alphabets or numbers at the end of each arrow are characteristics that listed in Table 1 (not in any order of significance). Let us illustrate the diagram with an example.

Integration (characteristics labelled 18 and 19) is a characteristic that impact on both domain of context and domain of influence. For example, in developing an e-business system which manages customers' complex transactions, Dell Computer's customers' need their orders to be integrated to their own system. The customer therefore forms the domain of context, which impact on Dell's e-business system development initiative. This also impacted on the organisation as document management processes, which were previously managed solely on a

local database system by the employees, will now need to be fully integrated to the network and delivered to the customers via the Internet. As such, integration is a characteristic of domain of mutual influence as in this example, integration of different applications are system and organisation-related characteristics, which impact on each other.

With this e-business initiative, Dell made this database available to its customers' through customised Premier Web Pages, constructed and posted on the Internet by Dell [37]. As a result of this, the number of employees handling customers' transactions will also be significantly reduced. The Premier Web Pages are password-protected and are updated regularly to reduce the complexity of every purchase by showing detailed specifications of the customer's previous transactions. This function impacts on the e-business system itself, due to several factors, such as integrating the front and back-end systems, ensuring system security and providing and delivering fast information and services. As the transaction information is available mainly on the Internet, it is very critical that the e-business systems are reliable and has high system performance. Dell's readily accessible transaction information streamlines the procurement process thus increasing the ease and speed of the purchase [37] [18].

Conversely, system-related failure, such as network or server problems, change in government regulations and change in organisational structure may also impact on the e-business system that is in development within the organisation's function. The e-business system that is in development is therefore considered volatile whereby it is impacted by most of the characteristics, which also impact on other domains [37] [18].

4. Conclusions and Further Work

The data that was collected from the literature will become the basis of questions to be used in the next stage of our research, which is a case study. This case study will be conducted in an organisation that has recently developed an e-business project. The questions for the case study will be formulated from the literature. It is the goal of the study to reaffirm from practice the type and level of impacts that are found from the literature. In addition, there may be more specific and fine-grained impacts and characteristics that will be discovered from the organisation that could complement the literature survey. Hence, the survey of the relevant literature provides a basis for focusing on developer and client attention on the characteristics that were found from the literature. From this study, we will also be able to discover which impacts are the ones that are most likely to need careful consideration

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Online Marketing: Enthusiasm, Disappointment, and Academic Responsibility?

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Abstract

From the late 1990s up to the collapse of Internet stocks in April 2000, the professional and popular marketing press carried a stream of articles that were enthusiastic about the potential of Internet marketing for all the components of marketing; selling products and services, building brands and relationships and providing individualised information to customers. With the benefit of hindsight, and in view of the many well-publicised losses of Internet based companies, much of this enthusiasm was unjustified. This paper analyses the pattern of growing interest in, and changing assessment of, Internet marketing from both marketing and professional writers, as revealed by a retrospective study of one of the most common data bases. Academic interest in the Internet, as measured by growth in the number of articles, is seen to have lagged behind professional interest. Of more concern, however, is the apparent failure of marketing academics to have given advice which might have tempered managers' investment in what proved, for many, to be a very risky area.

1. Introduction

From the late 1990s, the academic and marketing literature, like the more general media, suggested optimistic predictions for the impact of, and future of, Internet marketing. Early predictions for the Internet suggested that it could "...transform the way we build brands and communicate them to consumers" [1]. Exhortations such as 'Catch the wave or drown' were said to be the 'advice of industry experts to retailers resisting the onslaught of the Internet' (Chain Store Age, 1998). While there is no doubt that the Internet has created many business opportunities, the most common business experience has been one of failure, particularly in the highly promoted area of Internet retailing [2]. As the realisation grew that selling directly to consumers online was a high risk, competitive market for most companies, interest grew in the potential of B2B, where, it was claimed, the Internet would have its largest impact [3]. In particular, B2B exchanges were said to be the 'killer application in the B2B Internet revolution' that 'changes everything in B2B' [4]. The growth of a number of B2B exchanges, strongly backed by powerful business buyers, seemed to justify that claim, yet we have now in turn seen the failure of many high-profile online

exchanges, with one recent study finding that only 43% of independent B2B exchanges survived in the two years following Spring 2000 [5]. Given this pattern of enthusiasm, frequent business failure, with associated falling share prices and decreased investment, it is instructive to look back and examine the extent to which articles published in the peer-reviewed literature represented, reflected, or perhaps challenged the prevailing optimism before the 2000 crash, and the extent to which this pattern has changed since the collapse of Internet stocks.

2. Early enthusiasm

There is no doubt that managers were under severe pressure to invest large sums of money in the uncertain world of Internet business. In 1996, marketing scholar and Wharton Professor George Day wrote in Harvard Business Review "For those companies whose managers write - and exploit - the new rules of the game, the evolution of interactive marketing in an electronic medium will be exhilarating" [1]. Day went on to say that the chances of incumbent established, large companies prevailing in the new electronic marketplace were small, because "such companies are prone to falling into several common traps". Day lists these traps as:

- 1) Deferring participation
- 2) Picking the wrong technology
- 3) Unwillingness to commit
- 4) Lack of persistence.

Day states that "large companies have little patience for continued adverse results" and he suggests that "pulling out of an endeavour without giving it a fair shot...wastes time and money and erodes morale". However his 'traps' appear to endorse a strategy of early and sustained investment in an uncertain technology, and persistence in the face of continued failure. This strategy has much in common with the problems of escalating commitment, but Day's conclusion was that "for many companies, the question is not whether they should participate in interactive marketing, but whether they can afford not to prevail". In the words of Yogi Berra, "predictions are difficult, especially about the future" and it is easy to be wise after the event, but with such an enthusiastic endorsement from one of the foremost marketing scholars, could a reasonable manager not invest, and continue to invest, in online marketing?

Day's encouragement to managers to invest in online ventures is perhaps extreme, but the question as to what extent academics were influential, if at all, in the discussion of Internet marketing when interest was at its peak, before April 2000, has not been addressed. To what extent, if at all, would a perusal of the academic literature have warned managers of the risk of investing in what turned out to be a risky strategy for many organizations?

3. Method

The frequency of publications covering the topic of 'Internet Marketing', as represented in the business data base ProQuest ABI Inform, was investigated, from 1993 to 2002, the last full year for which full yearly data are available. Articles were selected as being relevant to Internet marketing by a search using the terms 'Internet' and 'marketing'. The study thus uses the 'bibliometrics' approach discussed by Nisonger [6] and Jacso [7]. While this approach may cause some misclassification by neglecting some articles without these key terms which do discuss Internet marketing issues, the error is expected to be relatively constant, and hence is not anticipated to bias the results. The first part of the analysis separated articles into 'scholarly and peer-reviewed', using the Proquest classification of that type, and general articles, and assessed the pattern of growth for each type of article.

For the second part of the analysis, a research assistant blind to the purpose of the study was asked to rate all articles published in the peer-reviewed journals from 1997 using the question "How would you rate this article's attitude to the impact of the Internet on business?" Articles were rated on a seven point scale from -3 'extremely pessimistic' to 3 'extremely optimistic' with a neutral rating of zero "neither pessimistic or optimistic".

4. Results

Results for the first part of the analysis are given below, in Table 1 and Figure 1, showing the changing proportion of peer-reviewed and general articles.

Table 1: Peer-reviewed and general articles, Internet marketing, 1993-2002

Year	No Peer reviewed	Number Others	Total number	% Peer reviewed
1993	0	2	2	0.00
1994	3	58	61	0.05
1995	29	307	336	0.09
1996	35	440	475	0.07
1997	36	614	650	0.06
1998	35	637	672	0.05
1999	33	1097	1130	0.03
2000	67	1606	1673	0.04
2001	82	640	722	0.11
2002	66	347	413	0.16

In the second part of the analysis, mean scores on the average rated optimism of the article were analysed. Overall, academic articles were rated as significantly more optimistic than zero, a 'neutral' rating ($p < 0.001$). Moreover, there was an upward trend in the mean optimism rating from 1997 to a peak in 2001, shown in Figure 2.

Figure 1: Number of Internet Marketing articles

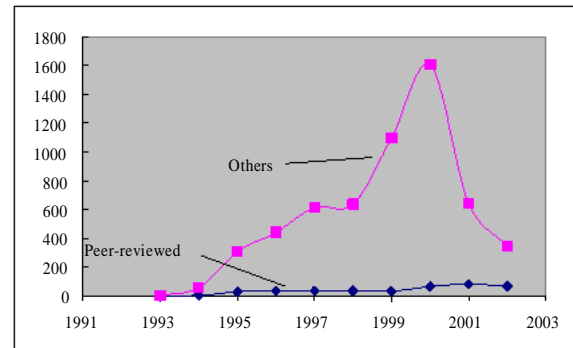
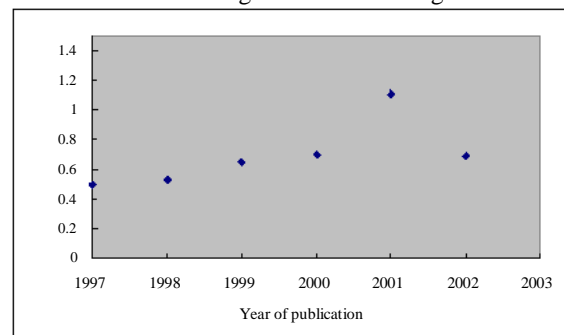


Figure 2: Mean rating of optimism of peer-reviewed articles concerning internet marketing



5. Discussion

Based on a simple count of articles, the academic literature appears to have reflected the enthusiasm of the general business press for Internet marketing to only a limited degree. The increase in numbers of Internet marketing articles in the academic literature was much less than the increase in non peer-reviewed articles. This could be interpreted in both a positive or a negative way. On the positive side, the growth in numbers of articles in the academic literature was far less dramatic, possibly reflecting less unquestioning enthusiasm for the impact of Internet marketing. On the other hand, the relatively small proportion of articles in the peer-reviewed literature, and the increasing percentage after the dot-com crash, suggests that marketing academics may have had relatively little impact on business decisions, and may instead have reflected business practice. Perhaps most worrying for academics who would like to believe that they influence business practice, the fact that the proportion of academic articles peaked in 2001, after the Internet collapse, and the absolute number of academic articles continued to

increase in 2002, when the number of articles in the general press had fallen steeply, suggests that academic publications tend to follow, rather than influence, business practice.

An examination of the level of optimism of the articles published in the peer-reviewed literature suggests that academics were not immune from the hype of the Internet boom. For every year except 1997, articles appearing in the peer-reviewed journals were rated significantly higher in optimism on the impact of internet marketing than a neutral rating of zero. A comparison of average optimism in the peer-reviewed and other literature is under way. However the results do not suggest that perusal of the academic literature would have given managers substantial cause to question the overwhelming optimism of the share market and popular press about the likely impact of the Internet on business.

6. Conclusion

The partial results available suggest a trend that should perhaps be of concern to academics. In the case of Internet marketing, articles published in the peer-reviewed press seem to lag well behind the level of interest and discussion in the general press. While this is not perhaps surprising, given the often long lead times involved in publication in academic journals, it does question the extent to which academic writing influences business decisions, or instead reacts to business decisions.

In addition, the results suggest that the peer-reviewed literature, based on a rating of optimism expressed in the articles, failed to sound a significant warning that the impact of the Internet would not be profitable for many companies. If academics hope to influence, rather than follow or reflect business practice, then attention may need to be given to decreasing the lead time on

peer-reviewed publications. However, the optimism shown by rating of the content of articles published in the peer-reviewed sources suggests that in the case of Internet marketing, authors failed to provide timely warning of the substantial risks for businesses in investment in this uncertain technology.

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An Academic Research on Business Process Reengineering

—— Based on Books Borrowing Process of Library

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Abstract

Business Process Reengineering, a hot issue in modern management, is a significant and creative idea on administration based on a series of management theories and successful carry-outs. All along, people have been used to defining and studying it in view of management, overlooking its intimate affiliation with division theory of economics. Here, the author tries to analyze the economic background and academic basis of Business Process Reengineering from a new point of view. While, the business process of any corporate is quite complicated. Here, through the case of books borrowing, the author makes an analysis of its division of labor, and probes into the relations between the four factors which are division of labor, the extent of market or throughputs, information technology and business process, and attempts to explain this administration issue by the combination of administration and economics knowledge.

1. Introduction

According to Adam Smith's theory of division of labor, the division of labor is limited by the extent of the market and throughputs, and appropriate division of labor helps to meet the demand of market. For a worker to do a series of different activities, there must be a sequence; with the emergence of division of labor, the work formerly for one worker is then disintegrated into different parts, which are taken up orderly by different workers. Such a sequential series of activities may be called as a process. It can be said that the business process exists together with the division of labor., and the process bases itself on division. However, Adam Smith's theory of division of labor overlooks technology's impacts on division of labor and business process. Under the condition of new technology, the division would not remain the same, and a simple automation or informationalization of former working manner is not enough.; at the same time, the progress of information disposal influences the changes on division as well ,with the existence of information exchanges between various activities and divisions. Accordingly, a timely and appropriate process should be created after a drastic reengineering, instead of any imitation or technical improvement of former process. In this way, the process efficiency would be largely improved, and the corporate capabilities would be strengthened.

2. The background and significance of BPR

As a creative and significant idea on administration, Business Process Reengineering has wiped over a great number of countries, and is always taken as promising. It is a fruit in management field that goes well with the times.

2.1 The pressure and challenges that corporations are facing appear as the impetus for BPR

In the world of fierce competitions, corporations are in the face of piles and piles of pressure and challenges ,from both of the outside, which features“3 C”, and the inside. The corporations are beginning to realize that , for a better survival and development, not only the advanced technology is needed, but also a flexible administration mechanism and organizational structure which responds to the circumstances promptly and suitably, is in great demand. This calls for a new management innovation cored “Business Process Reengineering”.

2.2 The rapid development of information technology provides BPR with substantial conditions

The innovation of management ideas is based on new technology possibility. The rapid development of information technology provides substantial conditions and advantageous technology support. It not only enlarges the space for process reengineering, but carries forward the realization of process management and the organizational reform as well. Just through utilizing information technology creatively and organizational management in accompany does process reengineering bring corporations a great improvement of performance.

2.3 The realistic significance of BPR

There are several elements which help to strengthen the competitive power for corporations, such as organizational structure, staff, technology, etc. Business process is only part of them. However, it covers a great deal :logistics, money flow, information flow, etc. In this way , we take business process as the life line of the whole corporation. Only by regarding and managing business

process as a systemic engineering can we strengthen the accommodation and competitive power of corporations, settle the problems and help to realize the continuous development of corporations.

3. The theoretical basis of Business Process Reengineering

As a management idea, process reengineering grows from piles of management ideas and technology methods. It is a combination of administration thinking and information technology. However, people have always ignored its intimate affiliation with division theory of economics.

3.1 The deepening of division of labor is the practical basis of Business Process

Business process comes into being and develops with the deepening of division of labor. As the demand gets bigger and bigger, the market extent and throughputs increase. The division of labor comes into being in order to promote the efficiency and meet the great market demand. The process is full of information delivers and exchanges. In correspondence with books borrowing activity in library, under various technology circumstances, the continuous progress of information technology influences the division of labor and process development.

3.2 The progress of information technology pushes on the corresponding changes of division of labor and business process

Because of the changeable economic environment and increasing amount of information, the division of labor in corporations varies. To ensure the efficient operation and effective fulfillment of the task, it is demandable for corporations to further the division of organizations and functions, which will surely lead the process to change and reform constantly. The progress of information technology provides powerful ways and means for process reengineering. With the support of advanced information technology, the regulated division and correspondent organizational management can cut the costs, elevate the resource setup efficiency, and win credits for corporations.

4. The research on books borrowing process of library

Adam Smith's theory of division of labor tells that the division of labor is limited by the extent of the market and throughputs, and appropriate division of labor helps to meet the demand of market. Under the condition of new technology, the division would not remain the same, and a timely and appropriate process should be created after a drastic reengineering, instead of any imitation or technical improvement of former process.

We will take books borrowing as an example to

analyze its division of labor, studying the information technology's impact on throughputs, division of labor, and process, and also the relations between these three factors under new technology circumstances.

First, we can summarize the general steps of books borrowing and division of labor through the analysis of the following case.

4.1 The books borrowing process between two persons

In the mutual communications, one person may raise the idea of borrowing the needed books after the other one's introduction. It is clear that the lender supplies the information of books, and the borrower catches it. This tache needs a positive participation and cooperation of the two sides. Then, the borrower raises the demand for book to the lender, waiting for the response. This is always done orally. After consideration, the lender admits the borrower's request, picks the book and hands it to the borrower, which ends the books carrying process. At this moment, the lender has memorized all the information in mind, or a receipt for a loan can also be used. When the borrower returns the book to the lender, the lender deletes the information in mind, or expires the receipt.

From the above depiction, we are able to divide the whole course of books borrowing into seven steps generally: (Chart 1)

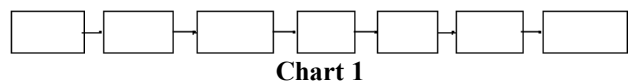


Chart 1

Here is a figure of the books borrowing process between two persons. (chart 2)

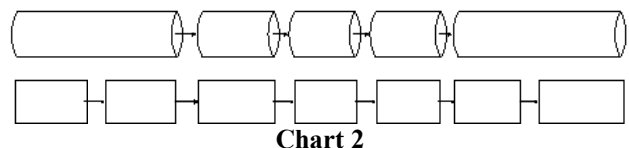


Chart 2

From the above chart, we can see that the whole process is shared by the borrower and lender. On account of the small quantity of books- throughputs and participants, there's no need to divide any sectors, and the division of labor and the process here are rather simple. In the following, let's take the case of library as an example, and analyze how the division of labor and the business process change when the throughputs grow bigger.

4.2 The books borrowing process of library

As for the books borrowing process of library, due to the variety of sizes, storages, throughputs, etc, the organizational structure and division of labor of different libraries vary, and the corresponding books borrowing process is being adapted and improved. In the following, we'll make an analysis of the corresponding adaptation of division and process as the throughputs are getting bigger and bigger.

4.2.1 The analysis on the books borrowing process of Beijing Jiaotong University's Library

Beijing Jiaotong University's Library covers an area of 12065 square meters, and has a collection of over one million books, including over 3500 types of publications home and abroad, and forty thousand internal documents, special type literature and non-book documents. It has a faculty of 70 persons, who serve the ten thousand readers of the whole university. Due to the reality, the library has a division of Office, Acquisition and Cataloging department, Circulation department, Reading department, Information consultation department, and Literature research department. How do these departments come into being and cooperate to serve the readers?

As a university library, the collection of it is so rich that it's impossible for one or only several persons to fulfill the task of collecting and cataloging all the materials. So, Acquisition and Cataloging department, with now a faculty of 12, is set up, which is one of the fundamental sectors, and also the headstream of the library's operation. Here, the Acquisition and Cataloging department, which acts as the information supplier, selects and catalogs the materials, makes sorted record cards or inputs the information into the computer (computer local net based on Dancheng DT-1000). The readers can search for the needed book's information through either the cards or the local net.

When the readers get the information of the books, they will go to the Circulation department for the books. The service manner of this department is open-shelf. The Circulation department of Beijing Jiaotong University's Library is made up of open-shelf hall, where the readers can select the books, and service counter, where the borrow-and-return procedures are carried out.

The borrower gets to the entrance of the open-shelf hall and hands the library card to the librarian for the replacing board, which in fact means raising the demand for borrowing books. After the validation of identity, the librarian admits the reader's entrance into the hall. The library has a collection of more than one million, and the throughputs of readers everyday are up to 700 persons. So, it's impossible for the librarians to carry books for each reader. In this case, within the effective supervision, the borrowers are permitted to fetch the books by themselves in the hall. At the entrance, after the librarians scan the information into the library cards, the borrowers can then leave with the books. And when the readers return the books, a similar scan on the card will be made to affirm the return.

The above process can be illustrated by the following chart. (Chart 3)

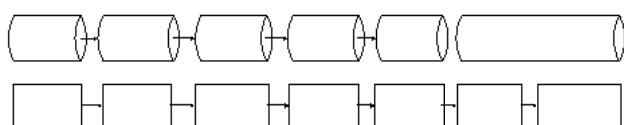


Chart 3

Compared with the activity between two persons, here at the library, as the increase of the readers and books, the division of labor between borrower and lender has been adjusted: the task of "books carrying" is passed over to the borrower within the effective supervision, which has offered more efficiency and convenience. At the same time, in order to meet the big demand of the readers on campus and deal with the complicated information more efficiently, it's necessary for the library, as the borrower, to specify the division of labor, which means to set up some specialized sectors as Acquisition and cataloging department for "information supply", and Circulation department for "request admission", "books hand-over" and "books return".

4.2.2 The analysis and comparison on the books borrowing process of National Library of China

As to different amounts of throughputs, how do the division of labor and process of National Library of China differ from those of Beijing Jiaotong University's Library? Let's make an analysis of the two reforms of its books borrowing process.

4.2.2.1 The comparison of the two books borrowing processes of National Library

The Library has the total floor area of 170,000 square meters, ranking first in the national libraries in Asia, and fourth in those of the world. It is a comprehensive research library, a national repository of the home publications, a national bibliographic center, a national center of library information networks, and the library research and development center. The Library serves for central legislature, government, key research institutions, academy, education, business and the general public. The Library has a rich collection of 22,400,000 volumes, ranking fifth in the libraries of the world. In the collection there are 270,000 volumes of rare books; 1,600,000 volumes of general ancient books; 35,000 pieces of the scripted turtle shells and animal bones. The Library opens to the public 365 day a year and its on-line services are available 24 hours a day via its linkage with various multimedia networks and on Internet. It offers a reception of 7000-8000 everyday, and the daily books throughputs are up to over ten thousand. Due to the huge size, also the rich collection and large throughputs, for better management, the library furthered its division into more specialized sectors, including both of the main operation sectors, such as Acquisition & Cataloging Department, Stack Management & Reading Service Dept, Rare Book Department, Information Service Center, etc, and management sectors, such as human resource section, finance section, office, international section, security sections, etc.

Similar to the Beijing Jiaotong University's library, Acquisition & Cataloging Department acts as the information supplier. With the improvement and popularity of information technology, the Library has introduced computer into daily work. The faculty of

Acquisition & Cataloging Department input the information on books into computer, and store it in the database to show the states of the books. And the reader can enter the local net and search for the information about the books. Then, the reader fills in the book sheet and hands it to the librarian to raise the demand for the books. The librarian inputs the information into the online database to notify the faculty who work in the place where the books are stored. As the collection of books is so rich and the throughputs are so big, for the safety of books, the readers are forbidden to enter the open-shelf hall themselves to fetch books, because it's beyond effective supervision and control of the Library. At the same time, it's impossible for the librarians at the counter to fetch books for each of the readers because of the limitation of faculty number and working intensity. To solve this problem, a special sector was set up to carry books. The faculty where the books are stored receive the demand from the counter through online database, and send the demanded books through mechanic convey belt to the counter. In this way, the working efficiency is promoted and the valuable time and human resource is saved, and the security of books is guaranteed.

The above process can be illustrated by the following chart. (Chart 4)

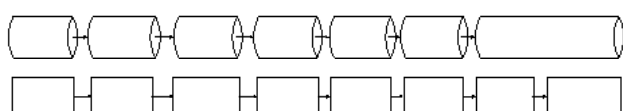


Chart 4

From the above we can see that this process differs from that of Beijing Jiaotong University's Library in two main points. First, on account of the large market size and the immense throughputs, the library furthered its division of labor, and established a specialized sector for books carrying, which ensured the safety of books and elevate the efficiency. Second, a sector for "passing message" was set up to connect the "request admission" sector and "books hand-over" sector. It is noted here that the process took advantage of the automation technique (two examples: mechanic convey belt for books carrying, local net for passing information). All these help to save time and resources, and meet the demand of readers better.

However, these measures are only some kind of automation on the original system, going by the former division style and process mode. It's only an improvement on the traditional process, saving some time by technical skills. Overlooking the crucial principles in process management, it cannot help to realize the integral qualitative flit.

With the development of information technology and wider popularity of internet, the National Library introduced the updated technological outcome to the foreign language books borrowing process by utilizing a software system from Israel. Through a thorough redesign of process, it leads to more rational and effective division and process, which embody high profits and high return.

The following is the depiction of the foreign language

books borrowing process.

With the support of information technology, the faculty of Acquisition & Cataloging Department dispose and offer the information of books by making ferret system on internet. The readers can log in the Library's website anytime and anywhere to search for the needed books information. All that a reader needs to do is clicking the names of the books, making a reservation "request" and clicking "confirmation".

In this way, the moment the readers confirm the information of books, the demand request has been submitted to the Library. Then, the readers get to the counter for the prepared books which are conveyed by the mechanic convey belt, and after the validation of identity, the readers may get away with the books.

The above process can be illustrated by the following chart. (Chart 5)

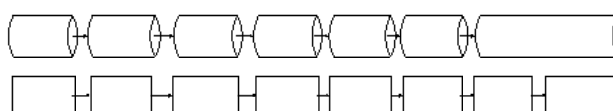


Chart 5

Compared with the former books borrowing process, the information supplier is still Acquisition & Cataloging Department. But here, it has put all the information of books on the internet database for the readers to share anytime or anywhere with the support of information service sector. "Request for borrowing" and "request permission" can be finished in seconds by the readers themselves anywhere after the "information seek", instead of getting to library's counter in person for the faculty's help. When the readers' request for books is submitted on internet, it immediately reaches the "books carrying" sector, where the faculty can easily keep up with the readers' demand through online database, with no need for the information convey by the faculty at counter. This saves time and human resource effectively, and helps to avoid the possibility of error. "Books carrying" here is taken on by the lender. Since the first four steps have been finished by the borrower on internet, so, when the borrower comes to the counter, the faculty have already got the book ready for the borrower, which is also on account of the relative small number and high value of the foreign books. When the record is made by computer, the borrower may leave with the books. On return, the record is deleted by computer, which saves time and offers convenience.

Through the above analysis and comparison, we may see that, with the continual increase of throughputs, the efficiency of the Library's past division and process has been far behind the development of Library and failed to meet the demand of readers, which has caused a waste on resources.

With the support of advanced technology, in order to fulfill the task effectively and ensure the high efficient operation of the activity, the functions between the readers and the Library, also the division of the Library's internal sectors have all been continually adjusted: the activity

shared only by several persons formerly has been organized by further specialized posts and divisions; the task that belongs to either of the lender or the borrower has been creatively transferred to the other side, taking great advantage of information technology; meanwhile, according to the reality, certain procedures have been either combined or deleted, and the process has been redesigned to make use of the resources to the most degree.

How does of the foreign language books borrowing process of the National Library of China realize a successful reengineering? In my point of view, it is mainly focused on the following four principles:

Firstly, to “have those who use the output of the process perform the process”. With the development of Library and the increase of the books collection, throughouts of the readers and books, the former service condition cannot meet the increasing demand, and a simple augment of faculty will not solve the problem virtually. With the support of information technology, the readers can log in at the National Library’s website and reserve the interested books. As the people who use the output, they themselves perform the process of “information seek”, “request for borrowing” and “request admission” in a very short time, which simplifies the process, saves time and offers much convenience to the readers. As for the Library, it saves human resource, saves the working space for faculty and waiting space prepared for the readers, and the frictions between original working interfaces (the readers and the faculty, the faculty themselves, the administrators and the staff) can be more effectively avoided, which results in cutting down the management costs and winning the credits as immaterial assets. The most importantly, the working efficiency is promoted, and the resource setup efficiency is optimized.

Secondly, to “treat geographically dispersed resources as though they were centralized”. The Library has the total floor area of 170,000 square meters, with 19 floors above ground and 3 floors under ground. The Library has 38 reading rooms, and a rich collection of 22,400,000 volumes, ranking fifth in the libraries of the world. With such a huge collection in such a huge area, it’s not easy for both the internal management and the external service. With the help of database, tele-net and information distribution management system, all the information of books collection was put into database, and embodied in the instant tele-net and information distribution management system. For both readers and librarians, they can get the detailed information and states of books easily and precisely. It not only keeps the scale benefit of the library, but also offers flexible and exact service for the customers.

Thirdly, to “subsume information-processing work into the real work that produces the information”. There are mainly two ways today to solve the problems of delay or error during the information convey: one is to improve the speed and quality of information convey with the popularity of computer and internet; the other is to optimize the linking ways between the information

production and convey by reengineering the process. The National Library of China just combines these two ways into the books borrowing process reengineering, and not only saves time and resource, but also ensures the exactness and opportuness of information.

When the readers finish making the reservation for books, the library admits their requests meanwhile. In this way, as the information producer, the readers process the information the moment it is produced. It not only avoids the possible delay or mistake during the convey of message, but also improves the efficiency and convenience. Processing the information where it is produced means service in time, and the process efficiency is greatly improved, which certainly satisfies the customers. At the same time, to ensure the reliability and authenticity of the information, a set of measures are carried out, such as validation of identity, penalty on the readers who delay or fail to fetch the reserved books.

Fourthly, to “capture information once and at the source”. This is embodied in the following three cases:

First, the management of documents. In the past, the information about books was managed by the Acquisition & Cataloging Department in paper, and the faculty in other sectors had to ask them for information. The information was disposed by many times according to different needs, which wasted a great deal of time and energy, not ensuring the veracity of information. At the utilization of online database and internet technology, the information about books is input into the online database at one time and being adjusted according to the reality, showing the updated and truest states of books. In this way, both the borrowers far away and the faculty inside the library can acquire the needed information and take advantage of it.

Another one is the utilization in the books hand-over and return. In the past, the information of books borrowing and return was captured many times by the readers and the librarians, which caused many man-made mistakes and a waste of time. In the new process, when the borrower succeeds in submitting the request on line, the personal record has been input into the database. When the borrower comes to fetch or return the books, the librarian may output the borrower’s record from the database immediately, and handles it easily. This simplified process not only saves time and resource, but also ensures the veracity of information.

The third case is the convey of books information. In the past, the librarian input the information on the book sheet which had been filled out by the borrower himself into the computer to notify the “books carrying” department. In this way, the information was disposed twice, which easily caused mistakes and wasted time and costs. The obvious reason is that it didn’t obey the principle of “capture information once and at the source”. While today, the manner of “request convey” has greatly changed. When the borrower submits the reservation request on line, the faculty at “books carrying” department immediately know about the information about the needed books, and send them to the counter by

the convey belt in no time, with no need for the counter to notify them. This not only reduces the errors, but also promotes the efficiency and cuts the costs. And the most above all is that it really offers convenience for the borrowers to log in for books any time and anywhere.

4.2.2.2 The existing problems that need to be improved

Although the process reengineering here is effective, there are still some problems in practice:

For example, there's a blind point of internet ferret on books state. Because the actual software system can only memorize whether the books are carried out of the library, not whether they are on the shelves, ignoring the case that the books may be taken to the reading room by the readers. This brings on the incoincidence of states caused by the off-shelf browse. So, it always happens that the readers get to the library for the reserved books, but the books are not prepared. Then, is it possible for us to find out the storage of books for outward borrowing the moment we submit the reservation information on internet by strengthening of technology?

Another example is the problem caused by the lack of logistics for books. It's quite convenient and time-saving for the readers to log in the Library's ferret system and reserve the needed books anytime and anywhere, but the point is that the readers have to get to the Library in person for the books, which really adds a lot of inconvenience of books hand-over. This has raised another problem on the perfection of books borrowing process: Is it necessary to supplement a tache of "books borrowing logistics" which matches with the "online books reservation"?

In my point of view, only by rigorous scientific demonstration in consideration with the feasibility in technology and economy, the applicability in environments, and the matchness of the actual resources, can these kinds of problems be settled step by step.

5. Conclusion

From the above all we can see that, in economics, the Adam Smith's theory of division of labor illustrates the affiliation between division of labor and the extent of

market, emphasizes that division brings efficiency, but ignores the importance of technology development in the changes of process as powerful tools and manners, and its driving force on the division and process change; in management, the information technology and administration ideas are creatively utilized, and the idea of process management, organization and human, also the impacts of information technology on organization are focused on, but the decisive significance of market extent and throughouts on division of labor and process is ignored. The author here, by this simple example of books borrowing, attempts to explain this administration issue by the combination of administration and economics knowledge. It means a great deal not only to corporations, but also to any organizations' division of labor and business process.

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Development of a Satisfaction Index for New Zealand I-Cafes

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Abstract

This paper examines how Internet Cafes (I-Cafés) in New Zealand can enhance their services in the market typified by growing competition both within the industry and from other industries. I-Cafés in the North Island were studied to provide the background material. Along with interviews these observations were used to derive the constituents of I-Cafés. Selected I-Cafes were benchmarked against these constituents. I-café users were surveyed to rank these constituents on their performance as well as their importance Connection speed, experience and values that include atmosphere, type of customer, pricing, friendly service and seating were found to lead to satisfaction.

1. Introduction

The Internet has “created a new way of doing old things, rather than being a technology that changes the manner in which people live their lives” [10]. The world is becoming increasingly reliant on Internet connections for business and personal communications; having Internet access is becoming a necessity, especially while traveling [3]. The Internet has provided us with a new channel of communication and keeping in touch in businesses, with friends and family. We have moved from the age of physical letters to virtual mails, from talking over the phone to virtual chatting, with such products as ICQ. The Internet has created a new dimension for traditional tasks; a way of doing things quickly and immediately. This explains the wide adoption in the use of the Internet, and thus I-Café is rapidly growing in popularity [7].

The Internet has become a major component in our daily life; some people have even become addicted to the Internet [5]. Entrepreneurs saw this as a good business opportunity and developed the concept of I-Cafés. The concept of the European style café had been successfully adopted into the New Zealand culture. Cafés are places where people gather together and chat or just simply read newspapers. More recently millions of people have begun to use the Internet to communicate at home, school or the workplace. The concept of an Internet Café or Cyber Café (referred for convenience in this paper as I-Café) is given to those cafés that provide a means of Internet access to people.

I-cafés are facing a competitive market, not just from those in the same industry but also from other businesses that provide access to the Internet. There are many issues that influence the adoption and penetration of I-Cafés in

New Zealand. The format of providing Internet access in a café environment has evolved and there are many different forms of I-Cafés. The concept of I-Café has shifted due to shifts in user groups and their changing needs. Competition has also strengthened, as other businesses want a share of this market by providing Internet access. Internet access has been made easier. You can now find standalone computers in shopping malls where you can surf the net and check email simply by putting money into the slot. Backpackers are also a market rival, providing Internet access to guests. Advances in technology, such as broadband and wireless technology will also influence the I-Café Industry. Additionally, with the increase in households that own computers and the lower costs of high-speed connections, more and more people are able to afford Internet access at home. The latest study conducted by Statistics New Zealand indicates that 47% of New Zealand households have a computer at home, and 37% of households have access to the Internet [9]. With all these factors influencing the use of I-Café, survival of individual I-Cafés is threatened. They must be competitive. To remain so, they must understand what the customers want and to define the priorities, given the limited resources available [1]. Thus the objective of this research is to discover “what are the determinants of user satisfaction?”

2. Study Methodology

A multi-methodology approach [6] [8] was used in this study: observation, interview and survey. Observation and interview were used to create the set of constituents, the survey were used to rank these constituents in terms of their importance.

2.1 I-Café Satisfaction Constituents

The collection of data was done in three distinct stages. The first stage was unstructured observation. This was conducted in the Auckland region. Prior to this the interviewer had not formulated definitive ideas on the particular aspects on which the study should focus. The second stage was the interview stage. A semi-structured interview was conducted with Interviewee A to elucidate the preliminary issues so that in-depth investigation could be designed on the variables needing further attention. The third stage was structured observations. These were conducted on 25 I-Cafés in Auckland; 5 in Wellington; 4 in Rotorua; 3 in Taupo and 2 in Hamilton to gain a deeper understanding on the I-Café industry and on the variables

that emerged in the Interview stage.

Table 1 provides a summarised version of the findings from the literature, interviewee and from researcher participation. The “+” denotes the variables considered relevant for customer satisfaction as derived from each source.

Table 1 Sources of Customer Satisfaction Variables

Constituents	Literature	Interviewee	Researcher
Speed	+		+
Service Variety	+		+
Games Variety	+	+	+
Software Variety	+		+
Atmosphere	+		+
Type of Customer			+
Price	+	+	+
Friendly Service	+		+
Payment Variety	+		+
Computer Availability		+	
Food/Drink Variety	+		+
Personal Space			+

The literature list is available in Tsui [11].

All these variables are said to influence the level of satisfaction. Thus, it is critical that they be tested.

2.2. Survey

Literature and field observation identified the measurement variables of this study; questionnaires will therefore be used to capture the user perspective for these variables. A questionnaire is the most cost effective and efficient way to obtain data from large samples.

Convenience sampling was used for this study as a complete sampling frame from the population of all I-Café users and non I-Café users would be costly to implement. Questionnaires were either administered personally or distributed in class by the instructor. Both these methods ensure a fast response rate and can be collected within a short period of time. The format of the questionnaire was based on Chung [2]. Sekaran’s [8] guidelines for developing questionnaires were followed to ensure minimal bias. Wording, categories and scale were carefully considered. A pilot questionnaire was used to check the understandability.

SPSS was used to analyse the survey data. Factor analysis [4] was used to test and reduce the operational variables. Multiple regression was used to test the significance of the operational factors to user satisfaction.

3. Analysis

The importance of each element as measured in the survey is shown in Table 2. The average importance element is measured in a 7-point scale, from 1 indicating very unimportant to 7 indicating very important. Speed has the highest mean (6.16), followed closely by price (5.97), comfortable atmosphere (5.69), personal space (5.63), availability of computers for use (5.62), friendly staff service (5.5) and seating (5.43). The range of services available (4.96), type of customer (4.8), range of software available (4.78), payment option (4.7), range of food and drinks available (4.5) and range of games available (4.5) tend to be close to neutral. None of the elements appeared to be unimportant. Factor analysis was conducted to reduce and group these variables, as the number of variables is quite large. Table 3 shows how the 13 variables loaded into 5 factors. The factors are named based on the set of variables that they contain. These factors will be used in the regression model to test against satisfaction.

Table 2 The Importance of Each Element

Variable		
Speed	6.16	88%
Range of Services Available	4.96	71%
Range of Games Available	4.46	64%
Range of Software Available	4.78	68%
Comfortable Atmosphere	5.69	81%
Type of Customer	4.8	69%
Price	5.97	85%
Friendly Staff Service	5.5	79%
Payment Option	4.7	67%
Seating	5.43	78%
Personal Space	5.63	80%
Range of Food and Drinks Available	4.5	64%
Availability of Computers	5.62	80%

Regression analysis is used to understand which factors predict the satisfaction of I-Café users. These five factors were used as independent variables and satisfaction was used as the dependent variable. Table 4 denotes the result from regression analysis.

Table 3 Factor Label

Factor Label	Factor	Variable	Loading
Experience and Value	1	Atmosphere	0.752
		Type of Customer	0.658
		Price	0.721
		Friendly Service	0.648
		Seating	0.637
Gaming Related	2	Game Variety	0.602
		Payment Option	0.803
		Personal Space	0.684
Work Related	3	Service Variety	0.886
		Software Variety	0.867
Fundamentals	4	Food/Drinks Variety	0.618
		Availability of Computer	0.798
Speed	5	Speed	0.920

The variables that seem to be related to Satisfaction are Experience and Value, and Speed. Examination of the correlation matrix in Table 4 indicates that Speed is most closely correlated with Overall Satisfaction because it has

the greatest correlation coefficient (0.399). Notice that there are no correlations between independent variables because orthogonal rotation was used in the factor analysis. This ensures that all independent variables in the regression analysis are appropriate.

Stepwise regression was then used on the 5 variables. Stepwise estimation starts by selecting variables for inclusion in the regression model by selecting the best predictor of the dependent variable. Additional independent variables will be selected in terms of their incremental explanatory power they add to the regression model. By choosing this method, only significant variables are included. Under the Stepwise Regression method, we will choose model 2 because model 2 has the largest adjusted R² (0.236) (Table 5). This means that model 2 is able to explain the most variance in the dependent variable. Model 2 refers to Speed and Experience and Value. All the other variables were removed because they are not significant at the 0.05 level. Table 6 shows that the regression model with 2 variables is significant at the 0.05 level. This indicates that the two I-Café factors are related to Overall Satisfaction, namely: Speed and Experience and Value.

Table 4. Correlation Matrix between Overall Satisfaction and I-Café variables

	Overall Satisfaction	Experience and Value	Gaming Related	Business Related	Fundamentals	Speed
Overall Satisfaction	1.000	.278	.192	.092	.187	.399
Experience and Value	.278	1.000	.000	.000	.000	.000
Gaming Related	.192	.000	1.000	.000	.000	.000
Business Related	.092	.000	.000	1.000	.000	.000
Fundamentals	.187	.000	.000	.000	1.000	.000
Speed	.399	.000	.000	.000	.000	1.000

Table 5 Regression Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.399 ^a	.159	.144	.638
2	.486 ^b	.236	.209	.613

a. Predictors: (Constant), Speed

b. Predictors: (Constant), Speed, Experience and Value

c. Dependent Variable: Overall Satisfaction

Table 6 Significance of Regression Model**ANOVA^a**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.381	1	4.381	10.775	.002 ^a
	Residual	23.178	57	.407		
	Total	27.559	58			
2	Regression	6.512	2	3.256	8.663	.001 ^b
	Residual	21.048	56	.376		
	Total	27.559	58			

a. Predictors: (Constant), Speed

b. Predictors: (Constant), Speed, Experience and Value

c. Dependent Variable: Overall Satisfaction

Table 7 Regression Coefficients of I-Café Variables**Coefficients^a**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.797	.083		45.732	.000
	Speed	.270	.082	.399	3.283	.002
2	(Constant)	3.797	.080		47.568	.000
	Speed	.270	.079	.399	3.414	.001
	Experience and Value	.188	.079	.278	2.381	.021

a. Dependent Variable: Overall Satisfaction

Since the assumptions behind the regression variate were met, so we can proceed with the interpretation. Table 7 shows that Speed and Experience and Value are all significant at the 0.05 level. The best predictor of Overall Satisfaction is Speed. Experience and Value are significant but are insubstantial compared to Speed. We conclude that both variables explain Overall Satisfaction. Gamer Related, Business Related and Fundamentals do not relate to overall satisfaction.

4. Conclusions

I-Cafés' resources are limited, hence they need to concentrate on resources that would generate the greatest satisfaction. While improving all the operational factors would have a positive affect on satisfaction, the affects of these different elements differ significantly. I-Cafes should only focus on the operational factors that would lead to greatest satisfaction to avoid wasting resources on those that would not generate as much benefit.

I-Café users consider connection speed as the most important element of an I-Café. Price, comfortable atmosphere, personal space, availability of computers for use, friendly staff service and seating were all consider relatively important as opposed to the remaining operational factors. However, not all of these elements lead to a significant increase level of satisfaction. In other words, although the elements may be considered important, the improved provisioning of these elements may not significantly satisfy users.

The experience and value of the visit; price, comfortable atmosphere, type of customer, friendly staff service and seating are the second set of elements that indicate a moderate increase to satisfaction. This indicates that customers are price sensitive so charging a premium is not an effective strategy, but yet customers still want a premium experience.

The other operational factors; variety of games, variety of payment options, variety of service, variety of software, variety of food and drinks, personal space and availability of computers do not significantly improve overall satisfaction.

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A Collaborative Framework For Collaborative Commerce

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Abstract

This article proposes a collaborative framework for the process of collaborative commerce (c-commerce) through which prospective partners could employ and configure c-commerce technologies according to the needs of different stages to realize potential benefits promised by the next generation of enterprise application software. This framework details pre-conditions that lead prospective partners to establish a collaborative relationship, including structural, social-psychological, and technological factors. This framework also describes how collaboration in c-commerce is unfolded following a teamwork problem-solving model. Furthermore, the framework discusses a variety of possible outcomes resulting from an initiative of collaborative commerce. Those components of collaborative commerce are structured in the format of the input-process-output model.

1. Introduction

In the past few years, the business press has constantly reported successful stories of collaborative commerce (c-commerce) that companies in a variety of industries employed to realize potential benefits from the use of collaborative technologies. For example, Boeing improved its production productivity from 228 airplanes per year in 1992 to 620 expected in 2002 by using collaborative e-marketplace [9]. In order to build a new family of supersonic stealth fighter planes that it was bound to deliver in four years, Lockheed Martin Aeronautics Co. used collaborative technologies to link more than 80 suppliers located at 187 locations to design and build components of the Joint Strike Fighter [15]. A recent report on c-commerce [2] indicated that software for creating c-commerce would be the next stage of growth in the enterprise application software business. The report estimated that the size of the c-commerce market would grow from \$5.8 billion in 1999 to \$36.5 billion in 2004 (estimated by AMR and IDC). Another report [8] showed that about 60 percent of 356 survey respondents considered c-commerce as critically important to their businesses in the year of 2001 – 2002 and 78 percent of companies planned to implement c-commerce to improve supplier and customer interaction. As many firms start adopting c-commerce, issues surrounding c-commerce have intrigued researchers' interests. For example, Welty and Becerra-Fernandez [31] investigated the issue of managing trust and commitment in collaborative relationships. Kumar [16]

delineated the features of information and communication technologies for supporting c-commerce. Based on the type of inter-organizational relationship and the level of organizational computing, Chuang and Nakatani [5] propose a classification of c-commerce.

The majority of existing c-commerce literature was anecdotal, although sporadic research about c-commerce has been published. The focus of extant literature has been on reporting the benefits realized by those pioneers and on the architecture of information technology for c-commerce. C-commerce applications are generally described with what business processes c-commerce systems may support. For example, Bellini, Gravitt and Diana [2] classify the c-commerce market into three categories: supplier relationship management, knowledge management, and product lifecycle management.

Not much, if any, research has been done to examine the phenomenon from the perspective of collaborative process, let alone the interactivity of the process. Furthermore, even though it is indicated that the value proposition of c-commerce should be derived from the development of collaborative relationship [7], how c-commerce could be used to facilitate the development of such a relationship is not clear. Fou [10] defined c-commerce as "commercial relationships carried out over a collaborative framework to integrate enterprises' business processes, share customer relationships and manage knowledge across enterprise boundaries." [9, p. 1] Although the target of c-commerce might not be limited to the items listed by Fou, his definition indicates an important element in c-commerce: a collaborative framework through which prospective partners obtain mutual benefits and share common risks. Nevertheless, his definition raises a few interesting questions that are unanswered by the extant literature. For example, what is a collaborative framework for c-commerce? How could it facilitate the achievement of goals of c-commerce initiatives? How are c-commerce technologies used in such a framework? We believe answers to those questions are critical to understand the phenomenon of c-commerce. Furthermore, answers to those questions would provide guidance for determining and configuring the features of c-commerce applications and for sustaining collaborative relationships. Consequently, the objective of this article is aimed to answering those questions by proposing a collaborative framework for the process of c-commerce at the project level. By drawing research in organizational collaboration, organizational cooperation, group dynamics, and information systems,

we developed such a framework to address the above issues.

2. Literature Review

Even though c-commerce is an emerging business phenomenon, collaboration between trading partners / stakeholders has long been a research topic among researchers in the areas of business and public policy disciplines. In the field of marketing, for example, researchers examine the factors that affect the development of collaborative relationships between buyers and sellers [27], and the means to develop and sustain collaborative supply chain relationships [26]. Also, research in the field of social services has been done to investigate into how business, government, and stakeholders form collaborative alliance to generate constructive solutions to social problems [11]. However, only limited research studies have been conducted in c-commerce. With very few exceptions, such as Welty and Becerra-Fernandez [31], Kuma [16], and Chuang and Nakatani [5], existing studies are focused on two themes: (1) reporting successful anecdotes and potential benefits of adopting c-commerce (2) proposing IT infrastructures for building c-commerce. Examples of successful stories [9] [15] are available in companies in various industries, such as Boeing Co. and Lockheed Martin Aeronautics, Co., General Motors Corp., Juniper Networks Inc., and Toshiba Canada Office Corp. Alexander [1] gave a more general discussion about the benefits of c-commerce and barriers of deploying c-commerce from a practitioner's point of view.

The emphasis of IT infrastructure prevails in the extant literature of c-commerce. For example, Bellini, Gravitt and Diana [2] classify the c-commerce market into three categories of enterprise application software: supplier relationship management, knowledge management, and product lifecycle management. Fou [10] considers c-commerce as a continuum of application of enterprise application software and classifies the evolution of c-commerce into three stages: (1) web-enabled single-dimensional and single-process c-commerce, (2) B2B exchanges-based, single-dimensional and multiple-process c-commerce, and (3) Web service-based, multiple-dimensional and multiple-process c-commerce. Fou asserts that the ultimate aim of c-commerce is to maximize return on intellectual capital investment, improve business agility, and provide better quality of customer experience. In order to achieve the objective, Fou believes that the next stage of c-commerce must be built on Web services, and he proposes a Web service-based collaborative architecture that consists of four tiers: c-commerce vendors, web services, business rule engine, and multi-dimensional c-commerce enterprise web portal.

Derome [7] believes that c-commerce capabilities should be depicted from a functional standpoint and downplays the importance of state-of-the-art technologies in developing collaborative relationship. For example, according to him, e-mail is a c-commerce tool, as are

Electronic Data Interchange (EDI) and extensible Markup Language (XML). He segments the c-commerce capabilities into three categories: Free-form collaborative services, process collaboration layer, and the structured data exchange category. The IT environment, duration of collaboration, and goal of collaboration vary from category to category. Although Derome suggests a variety of technologies for each of the three categories, he emphasizes the importance of deriving value propositions from the development of a collaborative relationship.

Li and Williams [19] examined the impact of previously established transaction-focused application one the cooperative relationship and found that companies that had established a successful cooperative relationship at the transactional level by creating interfirm network (via proprietary or open systems) tended to develop new and collaborative partnership at the strategic level. Their studies show that further developed collaborative relationship could occur in the existing transactional application or a new application devoted to the new partnership.

As it is generally accepted that trust and commitment are the premises for establishing and developing a collaborative relationship, Welty and Becerra-Fernandez [31] presents a business interaction model in which interaction technology (i.e., collaborative commerce software) is used to develop and enforce the development of trust and commitment between cooperative partners. Welty and Becerra-Fernandez's article highlights an important element of sophisticated c-commerce: interaction between cooperative partners over four different phases of business transaction process. Besides, they assert that the difference between traditional enterprise resource planning systems and collaborative commerce lies in that the latter integrate customer satisfaction into business processes. In other words, it is customer satisfaction rather than the delivery of goods or the submission of payment that closes a business transaction loop. The importance of trust and commitment in c-commerce is also addressed by Chuang and Nakatani [5]. Chuang and Nakatani assert that existing inter-organizational relationship (IOR) and trust level among prospective collaborators might affect the establishment of a c-commerce. Different types of IOR and different levels of trust might dictate the structure and conduct of a c-commerce. Based on the combinations of types of inter-organizational relationships and the stages of organizational computing, Chuang and Nakatani [5] propose a classification of c-commerce applications.

As shown by the above review, research studies of c-commerce are rare. Reporting successful cases and IT infrastructure for c-commerce dominate the extant literature. Although the selection of appropriate IT infrastructures is critical to develop successful c-commerce, yet they are not sufficient. The decision over the choice of an IT infrastructure for c-commerce should be made taking into account factors surrounding collaboration per se. Those factors should be identified and organized as parameters of a collaborative framework

through which collaboration would grow, develop, and sustain.

3. Collaborative Framework For C-Commerce

To serve the purpose of the study, we believe that a collaborative framework for c-commerce should include the elements that explain why firms enter into IT-enabled inter-organizational relationship, the process that describes how collaboration is unfolded, and what is expected to produce from such a collaborative effort. Hence, the structure of the collaborative framework we proposed will be in the format of precondition, process, and outcomes. By integrating research in inter-organizational cooperation, inter-organizational collaboration, group dynamics, and information systems, we propose a collaborative framework as shown Figure 1. In the following paragraphs, we will discuss how those factors come together and affect each other.

3.1 Pre-conditions of C-Commerce

Although the practice of collaboration is part of human life and might be as old as the history of human being, due to the concern with anti-trust law, not until early 1980s was the necessity and conduct of inter-organizational collaboration gradually recognized and accepted [17]. Since then, issues in inter-organizational collaboration and relevant areas have caught researchers' attention and research has been reported, though a comprehensive theory is still not available [32]. Based on different theoretical perspectives (e.g., resource dependence or political perspectives), researchers in relevant areas have identified several factors that may facilitate the development of inter-organizational collaboration. Those factors are presumably applicable to c-commerce, which we consider a special case of inter-

organizational collaboration. In addition to those factors identified by research in inter-organizational collaboration, we also consider other factors unique to c-commerce. We classify those antecedents into three broad categories: structural, social-psychological, and technological.

3.1.1 Structural factors

Structural factors refer to those related to the structure of prospective partners in the industry or in the supply chain. It is generally accepted that high interdependence between organizations is an important antecedent to the development of an inter-organizational collaboration [20] [12] [27]. Nowadays, because of the complexity of business activities and high level of division of specialization, no one single company can solely assume all kinds of roles in the industry. As a result, an essential aspect of today's business activities is the coordination of activities performed by different companies. While interdependence is widely acknowledged as an important factor to the formation of a collaborative alliance, the definition of it in most research studies is vague. It is generally referred to task interdependence, which can be defined as the extent that tasks performed by one party are related to those performed by other parties. However, according to Tjosvold [28], task is one of many facets of interdependence and he proposes an integrated model of interdependence in organizations in which he differentiates objective interdependence from subjective interdependence. Objective interdependences include tasks, rewards, and assignments, while subjective interdependence means the link between goals expectation. The importance of interdependence is that the extent and the manner that prospective collaborators are interdependent of may affect how they collaborate and the performance of the alliance.

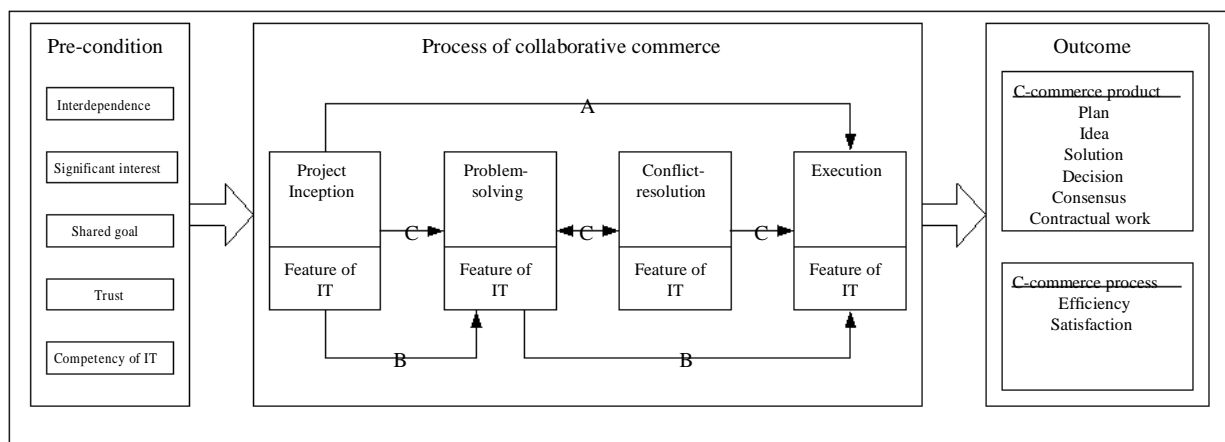


Figure 1. A collaborative framework for c-commerce

Another pre-condition of c-commerce is the significance of interest of the collaborative business in

question. Logsdon [20] argues that high stake and high interdependence are two premises to collaboration. She defines interest broadly, including long-term interest and

legitimacy status of an organization. In other words, she asserts that an institute would not engage in collaborative relationship with others because of short-term efficiency. Instead, just as Kanter indicates, "Successful partnerships manage the relationship, not just the deal." [13, p. 96], prospective collaborators will consider the significance of each transaction in the context of long-term perspective and decide whether to collaborate. In one study, Sriram, Krapfel, and Spekman [27] obtain similar results and their research shows that the importance of transaction (collaborative business) affects the propensity to collaborate through perceived buyer dependence and transaction costs.

3.1.2 Social-Psychological Factors

Structural factors such as task interdependence might warrant the necessity for collaboration, but they are not sufficient for organizations to collaborate. Social-psychological factors, such as mutual trust, might play an even more important role in the decision on collaborative relationship. Trust and commitment are generally considered as premises for establishing a collaborative relationship [25] [26]. Trust could be broadly defined as the belief that others will act or react in a predictable way [21]. Trust is important for the creation of collaborative partnership because it could reduce uncertainty and provide certain extent of assurance for managers' decisions. The level of trust one party has on the other party in a relationship might determine how strong the first party is committed to the relationship. Just like relationship between individuals, relationships between companies begin, grow and develop [14]. The level of trust and commitment grows following the development process of relationship between two parties. The level of trust might have impacts in three aspects of an alliance of c-commerce: First, it might affect the willingness of prospective collaborators to join the alliance. Second, the level of trust might determine the amount of resources (e.g., time and effort) collaborators would invest in the relationship. Third, the level of trust and commitment influence the interaction between collaborators. Impacts in those aspects will not only affect the outcome of c-commerce, but also influence sustainability of the alliance. For example, previous studies [19] indicate that those companies that had already developed routine applications between them are more likely to develop interfirm collaboration than those had not, because trust and commitment had been nurtured.

Another social-psychological pre-condition is shared goal expectation. As indicated previously, Tjosvold [28] classifies interdependence into broad categories: objective and subjective interdependence. By subjective interdependence, he means the link between goals expectation, which means that the goals of collaborative initiative expected to achieve by prospective collaborators must be related or shared. The importance of shared goal expectation in c-commerce initiatives is twofold: One is that shared goal expectation could help direct efforts from different parties toward the

same direction and the result would be a truly synergetic outcome. Second, shared goal expectation would confine conflicts, when arise, to the category: choice of means. According to Daft & Lengel [6], conflicts in organizations may occur in two different ways: one is conflict in ends and the other is conflict in means. Conflict in ends means that organizational units have different viewpoints regarding what goals or objective the organization should pursue, while conflict in means implies that organizational units share organizational goals but have different opinions regarding how to achieve the shared goal. In general, conflict in means could be resolved by providing more data to parties in questions. Thus, shared goal expectation is important in that it may affect the way collaborators interact in the process of c-commerce.

3.1.3 Technology Competency of Prospective Collaborators

Technologies underpinning c-commerce vary considerably. As Derome [7] indicates, c-commerce technologies may range from free-form interaction tools, such as email and secure chat, to structured data exchange, such as electronic data interchange (EDI) and XML. Although proprietary c-commerce package is available, it is generally accepted by practitioners that c-commerce technologies should be integrated with existing commerce systems, such as ERP and CRM. As a result, at least, there are two reasons that organizational competency of information technology is an important factor affecting the establishment of a c-commerce: First, as other studies [7] [24] show, a c-commerce system usually consists of many different technologies, each of which could be chosen from a wide range of technologies. Without a decent level of IT competency, a prospective collaborator might not be able to make informed decisions over the choice of proper technologies. Second, organizational IT competency, to certain extent, reflects the sophistication level of the company using commerce systems. Previous studies [19] show that developing routing applications between partners is an important step of developing interfirm collaboration.

3.2 Process of C-Commerce

At the project level of a collaborative alliance, the practice of a c-commerce is teamwork in nature. Although a c-commerce initiative is initiated, sponsored, sustained, and supported by participating organizations, implementation and on-going activities are carried out by a group of people representing their own organizations who electronically work together in order to achieve a specific objective, such as developing a new product, forecasting product demand, or improving customer services. From this point of view, the on-going process of c-commerce is a teamwork process. Depending on the nature and purpose of the collaborative alliance, the duration and the structuredness of collaboration may significantly vary. For example, Procter & Gamble, Co.

developed a Collaborative Planning, Forecasting, and Replenishment (CPFR) system with which it could receive input from its partnerships with retail customers to determine when, what, and how much to produce so it would be able to meet demands from its retailers [30]. Although the implementation of a system like this may take time, once it is in place, the planning and forecasting process is relatively structured and each session could be relatively short. In contrast, a c-commerce for developing new products might not be so structured as CPFR systems. For example, Lockheed Martin Aeronautics Co. used collaborative technologies to link more than 80 suppliers located at 187 locations to design and build components in order to build a new family of supersonic stealth fighter planes that it was expected to deliver in four years [15]. The c-commerce case in Lockheed Martin Aeronautics Co. is much more unstructured than the CPFR system in Procter & Gamble. As a result, the prescribed process of a collaborative commerce should take into account the possibility that different c-commerce scenarios could have different routes.

3.2.1 Paths of C-Commerce Process

Based on the above discussion, we borrowed McGrath's model of stages of group project activity [22] to describe the on-going process of c-commerce. According to McGrath, groups perform three different functions: production function, member-support function, and well-being function. Production function means that groups perform a variety of activities to generate results, which make contributions to their embedding systems (e.g., participating companies in a c-commerce). Groups also make contributions to their components (member-support function) and to themselves (well-being function). For a long-term c-commerce relationship, sustainability of the collaborative alliance obviously is an important objective (i.e., well-being function of the alliance). However, for the purpose of this study, the production function is the major process that we should focus on. Here, we detail the stages of production function and, when appropriate, illustrate those stages with real cases.

McGrath [22] proposes that the stages of group activities are the inception and acceptance of a project (goal choice), the resolution of technical issues (means choice), resolution of conflict (police choice), and the execution of the performance requirements of the project (goal attainment). In the first stage, the inception and acceptance of a project, members of the collaborative alliance recognize the opportunity or the need for collaboration. The purpose or goal of the particular project for the group is articulated in this stage. McGrath indicate that there are three routes through which groups acquire projects: a project proposed by one of members of the group, a project assigned by an outside agent, or a recurrent project of long standing for the group. It is the third route that most of c-commerce sessions acquire their projects. For example, a manufacturer may regularly use a Collaborative Planning, Forecasting, and

Replenishment (CPFR) system [30] with its retailers to forecast the demand for products. The second stage is the choice or design of a logically correct or best means for solution to achieve the articulated goal, when such a means is not readily available. In the context of c-commerce, the second stage could be extended to include general problem-solving issues, not just the choice of means. The third stage, the resolution of conflict of interests or of viewpoints, might be needed when members of the group possess different, or even conflicting, interests or viewpoints. Finally, the last stage is the execution of the project, carrying out the procedure for achieving the articulated goal.

McGrath claims that those stages should be "regarded as a logical template for potential project activities, rather than an endogenous set of inevitable developmental phases." [21, p. 29]. This statement suggests that the process of c-commerce is not a linear or rigid process. Instead, members of the collaborative alliance may "shift gear" from one stage to another, whenever the need arises or the situation warrants. As a result, there are several different paths through which one session of c-commerce may pass.

Execution path: When the activities required to achieve the articulated goal are available, the first stage of inception might directly lead to the last stage of execution (Path A in Figure 1). For a well-defined and recurrent c-commerce system, path A might be the most frequently visited path. Under such a circumstance, the execution stage would be the heart of the c-commerce because for a c-commerce system characterized by recurrent activities (e.g., forecasting demand for products), the inception and acceptance of the goal would gradually become a routine.

For example, IBM developed a c-commerce prototype system for a fictitious company selling power tools [22]. This system would allow the user (i.e., buyers or purchasing agents) to perform transactional activities, such as create requisition lists and issue an order (or reorder) using a requisition list, and non-transactional activities, such as contract negotiation and collaborative product design. Once the user logs into the system, the system will greet him/her with a welcome menu in which the projects that the user is participating are displayed (i.e., configuration of membership in different projects) and the user could choose the project that he/she intends to create a session and carry out the necessary activities to achieve his/her objective for that particular session. In most of the time, the user might be able to carry out his/her business by following the straightforward procedure and finish the session without a glitch.

Problem-solving path: In a c-commerce system designed to support a less structured business process, the procedure or activities for achieving the goal might not be readily available. In such a case, users of the c-commerce system will enter into the second stage, the problem-solving stage, in order to identify or agree upon a feasible procedure to achieve the goal. When the choice of the procedure or the means is made, the group could move

ahead to the last stage of execution. This is path B in Figure 1. McGrath [22] indicates, “[For] path B, sometimes the problem-solving activities of Stage II are the heart of the matter, and Stage IV is pro forma once the correct procedure or appropriate algorithms has been determined.” [21, p. 32]. In the context of c-commerce, although for path B, Stage IV is not completely a formality, Stage II could be the major part of the whole process. For example, in a project of joint product development, the problem-solving activities are essential for product conception and development, not just only for the choice of means to conduct the product development.

An example of the problem-solving path is that of the prototype system developed by IBM [22]. In addition to functions introduced above, the system features an awareness function. This function allows the customer service agents of the prototype to offer assistance and proactive help to customers by giving an immediate context of what page they are on, and how long they have been there. Whenever the customer requests for assistance, this system would open a window for communication and allow customer service agents to provide live help. In terms of the process of c-commerce, the customer and the customer service agent enter into the problem-solving stage.

Conflict-resolution path: On some occasions, members of the group may attempt to enter the execution or problem-solving stages and found that they might need to address the issue of difference in viewpoints or interests among them before they can identify or carry out the procedure. As a result, instead of entering into the execution stage, members of the group need to enter the conflict-resolution stage. When this occurs, the path the group travels is path C in Figure 1. Because the impact of unresolved conflicts of viewpoints or interest in the process and the result of group activities could be detrimental, the management of conflicts is very critical to the success of teamwork. Consequently, McGrath [22] claims that on certain occasions, the conflict-resolution stage might be the heart of the matter and Stage II or Stage IV could be a matter of formality or even trivial.

The prototype system developed by IBM [23] offers several functions, such as contract negotiation, with features of real-time and asynchronous collaboration. Those features could partially facilitate the resolution of conflict of viewpoints. For example, the feature of real-time collaboration introduced above for problem solving could be used to present and discuss issues in the process of negotiation. If and when issues cannot be resolved in real time, the feature of asynchronous communication could be used to create a “forum” equipped with necessary contents and functions to facilitate group processes. Several functions of group decision support systems (GDSS), such as brainstorming, voting, and ranking, could be added on the c-commerce systems and used to resolve conflicts of viewpoints.

The significance of specifying different paths in the process of c-commerce is twofold: One is recognizing the

need for coordinating activities performed by different organizations or their representatives in different stages. Second, features of technology required for supporting different coordination mechanisms or activities in different stages would be accordingly different.

3.2.2 Features of Collaborative Technologies

Different technologies that offer different capabilities could be adopted to implement c-commerce. For example, in a highly structured partnership, EDI might be sufficient. However, more sophisticated technology will be needed for a less structured project, like joint product conception, in which partners usually need technology that supports real-time interaction. In these two cases, one type of technology might be sufficient for supporting the whole process. However, as we discussed above, when a group of people work together, the path they may take could be quite different from another group of people or perhaps, even different from the path they take in another session. Consequently, we assert that passing along with different paths and different stages will need support with different technologies. Here, we borrow Derome’s classification of technologies (which he called Collaboration over Internet Protocol, CoIP) to discuss how collaborative technologies could be used to support different stages.

Derome [7] classifies c-commerce technologies capabilities into three categories: Free-form collaborative services, process collaboration layer, and the structured data exchange category. Those categories differ in delivery model, suitable environment, duration of c-commerce, expected goal, and applicable business functions.

Structured data exchange is most suitable for a stable environment in which the goal of c-commerce is to precisely and accurately transport data from one location to another. As a result, the less human intervention, the better. Furthermore, the data format, data sources, corporate relationships, and quality of data are all well defined. Explicit rules and standards are necessary for the definition, movement, and representation of data. Technologies for this category are fairly mature and are available from major software vendors. Furthermore, technologies for this category pave foundations for paths A, B, and C. However, they are particularly important for path A. For example, in a c-commerce system based on Collaborative Planning, Forecasting, and Replenishment (CPFR) standard, most of communication could be accomplished with structured data, even though technologies for free-form interaction might be needed occasionally for resolving the difference in forecasting between buyers and sellers.

Process collaboration provides less structured, yet more flexible solution to the alignment of processes between companies. Process collaboration enable partners to share information, synchronize activities and execute shared processes. Because this category requires the synchrony between partners’ business activities, it is

usually integrated with existing back-office systems. The integration to back-office systems and the process-oriented focus dictate the requirement of technologies for this category. The capabilities of technology for process collaboration include process modeling, workflow management, document management, graphical analytics, and content aggregation technology. Additionally, process-specific capabilities, such as planning and scheduling optimization technologies, CAD/CAM design capabilities, project management, might be needed. Since the focus of CoIP networks is not on data transportation, but on the support of business functions, systems in this category are usually more flexible and less structured. Also, systems in this category are not so isolated from human intervention as those in structured data exchange. Technologies in this category could be delivered either as a stand-alone network or an add-on to e-marketplace system. Early systems are mainly focused on joint product development or joint-production planning and scheduling. Combined with structured data exchange, technologies for process-oriented collaboration could be used to support path A and partially support path B.

The third segment of c-commerce technology capabilities is free-form CoIP services, which is the most flexible in that participation is not pre-defined in this type of environment. Instead, goals of collaboration, governance rules for interaction, and information access are all defined by participants. The primary function of this category is to augment structured data exchange or process collaboration by offering ask-and-responses conversation, initiating and managing discovery processes, and interactively creating plans, strategies, and partnerships. CoIP technologies widely range from online whiteboard technology, secure chat, file sharing, and analytical tools. Those free-form CoIP services could be available on subscription basis, ("snapped on") part of enterprise applications, or via a web browser free of charge. As the prototype developed by IBM [23] shows, technologies for free-form interaction could be used to in

Stage II and Stage III. In other words, those technologies could be employed to support paths A and B.

3.3 Outcomes of C-Commerce

Although a c-commerce could be a short-term establishment, most of them would be long-term agreement among collaborators and collaboration will be recurrent processes. For a long-term collaborative relationship, the outcome of the c-commerce is more than that resulting from one session of c-commerce. The sustainability of the collaborative alliance might be a desired result. While what factors affect the sustainability of a c-commerce needs further investigation, we postulate that the more satisfied with the process and the result of c-commerce the collaborators are, the more likely the alliance would sustain. Consequently, we consider two broad categories of the outcomes that should be measured for evaluating the performance of c-commerce: the product and the process of c-commerce.

Information sharing is one of major targets of c-commerce; however, many reports show that sharing information is one small portion of and limited value-added activity in c-commerce. In order to direct the target of c-commerce to high value activities, we make an attempt to conceptualize the product of c-commerce by employing task classification of McGrath's Task Circumplex, in which McGrath classifies the types of tasks into four broad categories: generating alternatives, choosing alternatives, negotiating issues, and executing works. Because the execution type is mostly about physical activities, such as performing psycho-motor tasks, we don't consider it here. Under each of the other three categories, McGrath further classifies into two subcategories, as shown in the second column in Table 1. In Table 1, we add a few c-commerce examples from Phillips and Meeker [24] to demonstrate the applicability of the classification.

Table 1. Products and examples of c-commerce (Source: Adapted from [22] and [24])

Category	Type	Definition	Examples in c-commerce
Generate	Planning tasks	Generating plans	Planning, scheduling and forecasting
	Creative tasks	Generating ideas	Product conception and development
Choose	Intellective tasks	Solving problem with a correct answer	Payment reconciliation, or complex pricing, route optimization
	Decision-making tasks	Dealing with tasks for which the preferred or agreed upon answer is the correct	Collaborative promotion planning, campaign management
Negotiate	Cognitive conflict tasks	Resolving conflicts of viewpoint (not of interests)	Resolving difference in forecasts of demand for products
	Mixed-motive tasks	Resolving conflicts of motive-interest	Contract negotiation and management

Each type of the products of c-commerce could be measured and evaluated in terms of objective dimensions that are appropriate for that type. However, because c-commerce generally involve more inter-personal and inter-organizational interaction than transactional commerce, stakeholders' satisfaction with the product might be, if not more important, as important as objective measurements. Those measurements are directly related to the product of one session of c-commerce. It is obvious that those dimensions of the result of c-commerce will have impact on stakeholders' assessment over whether the establishment of the c-commerce achieves its objectives and expected benefits.

Many c-commerce initiatives are intended to improve the efficiency of business processes. For example, shortening the lead-time of product delivery or product development cycle time. As a result, the efficiency of c-commerce process is an important factor for the survival of the c-commerce. With the same token as satisfaction with the product of c-commerce, the level of stakeholders' satisfaction with the c-commerce process is important for the retention of stakeholders in the c-commerce.

4. Conclusion

C-commerce creates a new form of commerce. Extant literature has focused on the development of IT infrastructure for c-commerce and reporting realized benefits in those companies adopting c-commerce. In this article, we proposed a collaborative framework that depicts the pre-condition, interactive process, and possible outcomes of collaborative commerce. Interdependence, significant interests, mutual trust, shared goal expectation, and sufficient IT competency are factors that lead companies to initiate and join the establishment of collaborative commerce. The proposed framework indicates that the collaborative process is an interactive process in which participants may "shift the gear" and take different paths when the situation warrants the necessity. It is our position that different technologies should be employed to support different stages and paths of c-commerce. Furthermore, we take the first step toward conceptualizing the product of c-commerce and briefly discussed the issue of sustainability of a c-commerce initiative.

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Learning in Cyberspace

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Abstract

This paper discusses research that has been conducted in relation to online learning websites. Initially, the current situation of Online Learning will be discussed. Results of the analysis of a number of Online Learning websites (such websites include both international and New Zealand websites) will then be discussed in depth. This paper will describe the basic requirements of Online Learning websites, and will provide the reader with website design principles, in order to assist in increasing the effectiveness of an Online Learning website. The benefits and drawbacks of the creation of, and use of an Online Learning environment will also be discussed. In the end of the paper, a few future trends of online learning will be indicated. This paper will provide the reader with a general overview of the current status of Online Learning.

1. Introduction

As one of the most significant technologies created during the last century, computer network has been changing people's lives dramatically. The way we live, we work, we entertain and even we think are likely changed by the spreading computer network. This paper is going to talk about another change made by computer network---the change on our way to learn.

The way in which our learning is conducted can be expected to be vastly different to that of our forbears. Such new technologies will have a dramatic impact on learning aspects such as where an individual learns, when they learn, and who will be assigned the role of the teacher. Recently, exponential growth of information becomes the driver for people to be a lifelong learner, continuously engaged in some form of learning activities. Therefore education becomes a lifelong process rather than being taken in a short period of time in the first twenty years of life.

In order to assist in the fulfillment of individuals new learning requirements, a new education strategy merged, that is online learning. Online Learning utilizes computing technologies to achieve educational goals. It provides people a much more flexible learning environment to learn what they want to learn with their own class schedule.

In order to harness the global trend towards Online learning, educational institutions and private corporations have and will continue to invest significant amounts of capital in online learning capabilities. It is estimated that the portion of online learning market devoted to technical

training alone will grow from \$1.7 billion in 2000 to about \$5.3 billion in 2003 [1].

Whether these investments could get satisfactory payoff?

How we can improve the learning process so that the benefits can be sustained?

In order to provide explanation for such questions, this paper will discuss the findings of research that was conducted on existing online learning programs. The key elements of the implementation of an Online Learning system will then be discussed, taking into consideration the principles on how an Online Learning site should be built and managed.

2. Research Background

2.1 What is Online Learning?

Before this paper provides further discussion of the Online Study undertaken, it is felt necessary to clearly define what is indicated by the term "Online Learning", and the relationship that it has with other learning networks.

Online learning refers to all learning strategies, which use Internet/Intranet as learning environment. Computerworld magazine defines it as online learning is the delivery of remote training over the Internet or a corporate Intranet via a Web browser. The program which implements online learning is called online learning system. The network supporting online learning is called online learning network (OLN), which is "a system that enables students learning via the Internet. OLN facilitates interaction of professor-to-students, student-to-professor and students-to-students communication via asynchronous learning tools, including anytime, anywhere learning or synchronous learning tools, i.e., real-time communication, or any combination of these two" [2].

A broader concept is online learning system (OLS), which includes learner, instructor, class, technological and system configuration, and management of OLN. Online learning systems can be mainly divided into two parts—synchronous and asynchronous online learning systems. Figure 1 shows a hierarchical relationship of different learning systems.

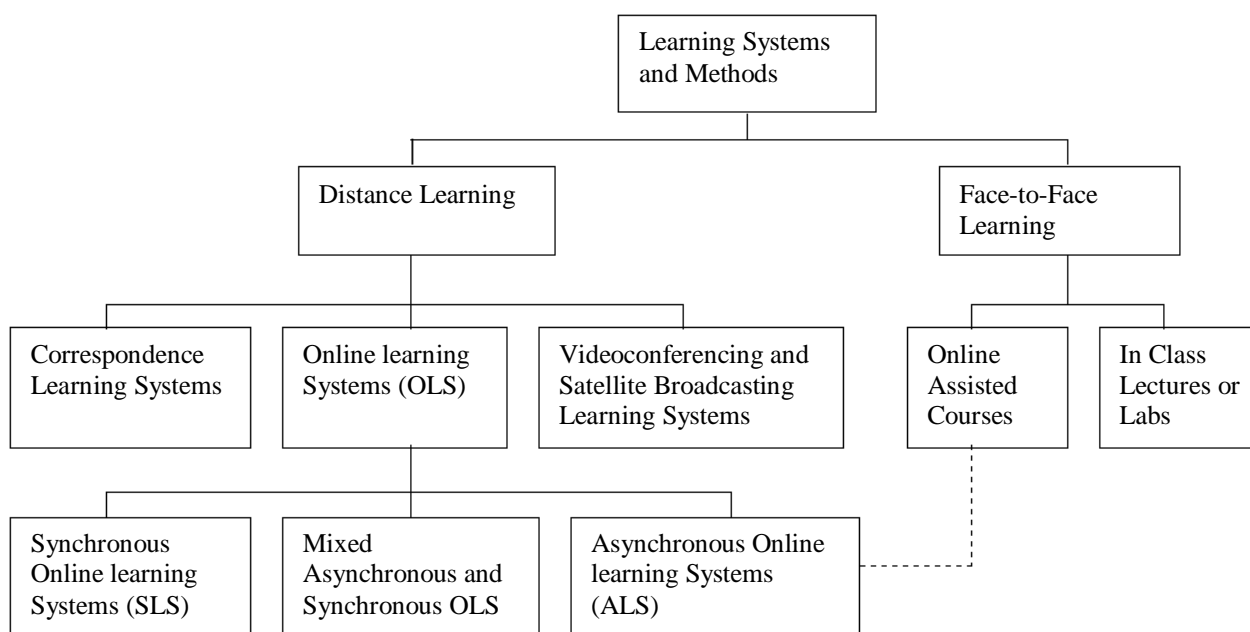


Figure 1: Different Learning Systems Hierarchy

2.2 History of Computers in Education

The popularity, the wide use of computer makes the merge of online learning. The use of computers during learning was first hypothesized approximately four decades ago. Such computer-based learning applications were referred to as computer-assisted instruction (CAI) or computer-based instruction (CBI). The main idea was that computers could provide individualized learning experiences, including interactive sequences consisting of problems or questions with appropriate feedback [3].

In the early stages of computer-assisted learning, the aforementioned idea was only used on some courseware within some specific course programs. Later, some CAI/CBI systems merged, like PLATO. Such integrated systems incorporated email and BBS functionality. Such functionality is currently widely utilized within Universities nowadays.

But the real bloom did not occur until the World Wide Web appeared in the early 1990. The Web makes it easier to create and access networked information. It also supports the collaboration of the major forms of learning interaction (email, chatting, threaded discussions, and conferencing). The form of computer assisted learning, that utilizes the Internet as its platform will now become the basis of this paper – referred to as “Online Learning”.

2.3. Infrastructure Required for Online Learning Networks

It is obvious that an online learning system heavily involves the use of computer networks. Different forms of OLS may be built using computer networks from large-scale public networks such as the Internet to small local networks (LANs). For most institutions and organizations, LAN is the basis for their learning systems. In general, such LANs will also be connected to public

networks, making differences in location transparent to individual users.

Connections to public networks are mainly dependent on moderns and existing telephone lines, whereas LAN connections are normally facilitated through the use of cable. School and college systems with many locations are likely to lease high-speed data communication lines using fiber optics or microwave transmission. Large corporations and government/military agencies utilize satellite technologies for data transmission and network communications. It is also possible (and increasingly common) for people to connect to public networks or LANs using wireless technologies.

Regardless of the underlying technologies of a network, a considerable technological infrastructure is always required, in order to develop, and support a given network. A network infrastructure is comprised of hardware, software and support personnel. It is thought that the hardware and software required to support an Online Learning system are no more complex than that required in a general-purpose computer.

With the rapid growth of computer industry and spreading use of computer in education, such infrastructures will not be a problem any longer. Nowadays, most countries are ready for adapting online learning as a new education strategy.

2.4 Literature Review

A number of studies have been conducted associated with online learning. Each study discusses the status of one given aspect of Online Learning. Studies performed include the following:

2.4.1 Online Professional Interactive Network: Virtual Professional Learning Communities for Teachers

Supported by different types of professional interactive network examples, this paper summarises the functions of professional learning networks, the way to achieve information for meeting the goals of working professionals and the reasons of using electronically mediated networks. Also it gives examples of teacher support networks in New Zealand and compares them with international counterparts.

2.4.2 Internet Use in Schools: Legal and Ethical Issues

Internet gives children and young people access to the same information as adults, which causes a series of legal and ethical problems. When schools decide to get Internet connection, it is very necessary to consider these issues and make the Internet exactly be used for educational purposes. This paper discusses these legal and ethical issues and gives suggestions for schools on how to use Internet to its best advantage.

2.4.3 Designing Web-Based Learning Environment

This paper discusses some questions and provides some resources as to how to design a website for an online learning program. It provides the procedure of website designing and implementation with the principles of online learning website design.

2.4.4 Toward a Value Framework for Online Learning Systems

This paper queries the student concerning the features of these systems that add value to their learning experience. A questionnaire is utilized for gathering student values associated with online learning systems and organization supporting these technologies. Results from the survey and a literature review are organized in a proposed value framework for online learning course effectiveness.

3. Web Site Analysis

The major research method in this paper is website analysis. In subsequent chapters, the research results are gotten from the analysis made in this chapter. After reviewing a number of Online Learning websites, it has become apparent that such sites should be categorized, and discussed independently. In the field of online learning, websites serve for the following multi-dimensional topics and sub-topics [4].

Higher Education

K-12

Corporate

Health Care

Informal Learning (Museums, Communities, Homes)

Government

Military Training

Professional Associations & Non-Profits

In this paper, three main segments of online learning websites will be discussed in detail, including their unique features and an example will be provided as to a website that facilitates the defined category of Online Learning applications.

3.1 Online Learning Applications

3.1.1 Higher Education – University of Auckland

It is apparent that online learning methods are most extensively facilitated within Colleges and Universities. Due to the wide availability of computers, and the provision of basic computing education, within the Tertiary Education sector, Online Education can be widely implemented within their course offerings.

Currently, Online Courses offered by Tertiary Institutions rely on a web-based database for the storage of course materials and information (such as lecture notes, student grades, hyperlinks).

A relevant example within this category is Cecil (www.cecil.edu). Cecil can be viewed as the University of Auckland's Online Learning System. Students have the ability to access course materials, and course related information, from anywhere. Cecil provides a majority of the previously discussed online learning functions (namely, group email, a discussion forum, course information, and file downloading). Cecil accommodates all courses that are offered by the University of Auckland. The degree of utilization of Cecil appears to differ between departments and papers. Cecil also allows for the checking of coursework marks, and online testing functionality. It helps greatly for providing high quality education.

3.1.2 K-12 Education – The Global Lab (<http://global.terc.edu>)

For K-12 schools, online learning websites' major function is to provide an online library system. With the help of these online libraries, searches for books, journals, and other relevant sources of information become much easier. This indicates that schools are no longer constrained by the information contained within their limited number of textbooks, and library books.

Another popular application incorporated into Online Learning Systems within K-12 Schools, is the facilitation of collaborative projects. Collaborative projects may be implemented solely within one class, or spanning a number of schools. Students utilize the network to collect relevant information, and prepare documents in small-sized groups. A majority of such projects also require interaction with students at different schools (via email).

Other functions of OLS at this level include: linking to the outside world; storing curriculum resources and providing interaction.

An example of an implementation of an Online Learning System in Middle Schools is the Global Lab. The Global Lab is a large-scale science project that

involves in excess of 100 schools internationally. Students within participating schools must agree to collect, and analyze data that relates to some aspect of their local environment. Such analysis results are then placed on the Global Site website, in order to allow for the determination of global trends in each given aspect.

3.1.3 Corporations – Cisco Network Academy (<http://www.cisco.com/edu/academies>)

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3.2 NZ Online Learning Websites

A large number of OLN's serve the purpose of the provision of additional resources for teachers, as well as allowing for the exchange of information, and utilization of new technologies. Like other countries, online learning has been developing fast in recent years. New Zealand Learning Network can be considered to be a relevant example of New Zealand online learning websites.

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4. Results

4.1 Unique Features of Online Learning

Unlike any other training form, online learning promises to provide a single experience that accommodates the three distinct learning styles of auditory learners, visual learners, and kinesthetic learners [5]. By the advent and development of online learning more efficient training is provided to a globally dispersed audience. As Web-based training becomes a standard, publishing and distribution costs have been reduced.

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Additionally, synchronous online learning is self-paced. Advanced learners are allowed to speed through or skip instruction as needed.

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4.3.5 Structure and Management of the Learning Environment

A Web-based learning environment should be a flexible learning environment. A good management structure should include clear and explicit information on the assessment tasks, as well as just in time feedback on their assignments.

4.4 Benefits of Online Learning

By combining the new technology of the Internet with new thinking of how people learning, online learning brings a new era to traditional education. Some of the most outstanding benefits have been indicated [7].

4.4.1 Online Learning Lowers Costs

Despite appearances, online learning is often the most cost-effective way to deliver instruction (training) or information. It cuts travel expenses, reduces training time, and eliminates costs [8]. The elimination of costs associated with instructor's salaries, meeting room rentals, and student travel, lodging, and other infrastructures. When deployment is based on a sound business case, the significant startup investment can be quickly recovered through delivery savings.

4.4.2 Online Learning Enhances Business Responsiveness

Online learning can reach an unlimited number of people virtually simultaneously. This can be critical when business practice and capabilities are rapidly changing.

4.4.3 Messages are Consistent or Customized, Depending on Need

All can get the same content, presented in the same way. Meanwhile the programs can also be customized for different learning needs or different groups of people.

4.4.4 Content is More Timely and Dependable

Because it's web-based, online learning can be updated instantaneously, making the information more accurate and useful for a longer period of time.

4.4.5 Learning is 24/7

People can access online learning anywhere and any time. It's "just in time – any time" approach makes an organization's learning operations truly global.

4.4.6 No User "Ramp-Up" Time

With so many millions of people already on the Internet and comfortable with browser technology, learning to access online learning is quickly becoming a non-issue.

4.4.7 Universality

Online learning is Web-enabled and takes advantage of the universal Internet protocols and browsers. Concern over differences in platforms and operating systems is rapidly fading. Everyone on the Web can receive virtually the same material in the same format.

4.4.8 Builds Community

The Web enables people to build enduring communities of practice where they can come together to share knowledge and insight long after a training program ends. This can be a tremendous motivator for organizational learning.

4.4.9 Scalability

Online learning solutions are highly scalable. Programs can move from 10 participants to 100 or even 100,000 participants with little effort or incremental cost (as long as the infrastructure is in place).

4.4.10 Leverages the Corporate Investment in the Web

Executives are increasingly looking for ways to leverage their huge investment in corporate intranets. Online learning is emerging as one of those applications.

4.4.11 Provides an Increasingly Valuable Customer Service

Although not internally focused, a business e-commerce effort can be enhanced through the effective and engaging use of online learning that helps customers derive increased benefit from the site.

4.5 Drawbacks of Online Learning

Despite its benefits, online learning is still in its nascent stages. It does have limitations.

4.5.1 Technology Issues

This include whether the existing technology infrastructure can accomplish the training goals, whether additional tech expenditures can be accepted, and whether compatibility of all software and hardware can be achieved. For learners, these issues include commonly technophobia, unavailability of required technologies and inability of grasping the computer techniques.

4.5.2 Reduced Social and Cultural Interaction

The impersonality, over-dependence of computer techniques, suppression of communication mechanisms such as body language, and elimination of face-to-face communication are part of the potential disadvantage brought by the advances in communications technologies.

4.6 Summary

The pros and cons of online learning vary depending on their business goals, target audience and organizational infrastructure and culture. But it is apparent that online learning is rapidly growing as form of training delivery and it is clear that benefits to online learning will guarantee it a position in the overall learning strategies.

5. Future Trends

Online learning is the most rapid growing learning form in recent years. There was an evolution that technology-enabled learning and distance education changed to online learning. By now, more and more people agree that online learning is here to stay. So we need to examine some trends of this new learning strategy.

5.1 Online Learning as a Business Strategy

For smart companies, it's no longer a question of if, but when to use online learning. These organizations see online learning as a strategic solution that must be deployed to all employees. Enterprises consider online learning as a guarantee to increase sales effectiveness, improve organizational competency, and build rich customer relationships. Consequently, online learning will continue to be a part of organizational infrastructure, similar to email packages and other product suites used to increase staff productivity.

5.2 Blended Learning

This trend involves blended learning programs, designed to integrate online learning with traditional training methods to increase overall effectiveness. A single delivery method is no longer sufficient to handle new training needs. The construction of true blended learning programs pushes learning into a new age. Blended learning preserves the necessary consideration of how people learn while offers options for learning and can still produce measurable savings promised by online learning.

5.3 Moving from Discrete to Integrated Learning

There is an increased desire for a seamless transition from one learning activity to another. Rather than stand-alone learning activities, the trend is towards the integration of these activities. The trend is looking for seamless transitions from live group activities to individual exercises, from self-paced learning activities to synchronous instruction, from activities in smaller groups to activities in a larger learning community.

5.4 Online Learning Beyond the Corporation

Early adopters of online learning consisted mainly of corporations, which were trying to enhance face-to-face meetings, demonstrations, training classes, and lectures. Nowadays, government agencies, colleges, universities, and non-profit organizations are now followers. These organizations are using online learning to address their learning and communication needs, as well as expand their business opportunities.

6. Conclusion

Rapidly expanding network technologies increase the possibilities of online learning. It is, however, difficult to predict what technology will be the dominant driving force in online education delivery in the future. It is expected that, in this new century, tremendous advances in computers and networks will have dramatic effect of altering individuals' lives and the learning experience as well.

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Learning in Cyberspace

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Abstract

This paper discusses research that has been conducted in relation to online learning websites. Initially, the current situation of Online Learning will be discussed. Results of the analysis of a number of Online Learning websites (such websites include both international and New Zealand websites) will then be discussed in depth. This paper will describe the basic requirements of Online Learning websites, and will provide the reader with website design principles, in order to assist in increasing the effectiveness of an Online Learning website. The benefits and drawbacks of the creation of, and use of an Online Learning environment will also be discussed. In the end of the paper, a few future trends of online learning will be indicated. This paper will provide the reader with a general overview of the current status of Online Learning.

1. Introduction

As one of the most significant technologies created during the last century, computer network has been changing people's lives dramatically. The way we live, we work, we entertain and even we think are likely changed by the spreading computer network. This paper is going to talk about another change made by computer network---the change on our way to learn.

The way in which our learning is conducted can be expected to be vastly different to that of our forbears. Such new technologies will have a dramatic impact on learning aspects such as where an individual learns, when they learn, and who will be assigned the role of the teacher. Recently, exponential growth of information becomes the driver for people to be a lifelong learner, continuously engaged in some form of learning activities. Therefore education becomes a lifelong process rather than being taken in a short period of time in the first twenty years of life.

In order to assist in the fulfillment of individuals new learning requirements, a new education strategy merged, that is online learning. Online Learning utilizes computing technologies to achieve educational goals. It provides people a much more flexible learning environment to learn what they want to learn with their own class schedule.

In order to harness the global trend towards Online learning, educational institutions and private corporations have and will continue to invest significant amounts of capital in online learning capabilities. It is estimated that the portion of online learning market devoted to technical

training alone will grow from \$1.7 billion in 2000 to about \$5.3 billion in 2003 [1].

Whether these investments could get satisfactory payoff?

How we can improve the learning process so that the benefits can be sustained?

In order to provide explanation for such questions, this paper will discuss the findings of research that was conducted on existing online learning programs. The key elements of the implementation of an Online Learning system will then be discussed, taking into consideration the principles on how an Online Learning site should be built and managed.

2. Research Background

2.1 What is Online Learning?

Before this paper provides further discussion of the Online Study undertaken, it is felt necessary to clearly define what is indicated by the term "Online Learning", and the relationship that it has with other learning networks.

Online learning refers to all learning strategies, which use Internet/Intranet as learning environment. Computerworld magazine defines it as online learning is the delivery of remote training over the Internet or a corporate Intranet via a Web browser. The program which implements online learning is called online learning system. The network supporting online learning is called online learning network (OLN), which is "a system that enables students learning via the Internet. OLN facilitates interaction of professor-to-students, student-to-professor and students-to-students communication via asynchronous learning tools, including anytime, anywhere learning or synchronous learning tools, i.e., real-time communication, or any combination of these two" [2].

A broader concept is online learning system (OLS), which includes learner, instructor, class, technological and system configuration, and management of OLN. Online learning systems can be mainly divided into two parts—synchronous and asynchronous online learning systems. Figure 1 shows a hierarchical relationship of different learning systems.

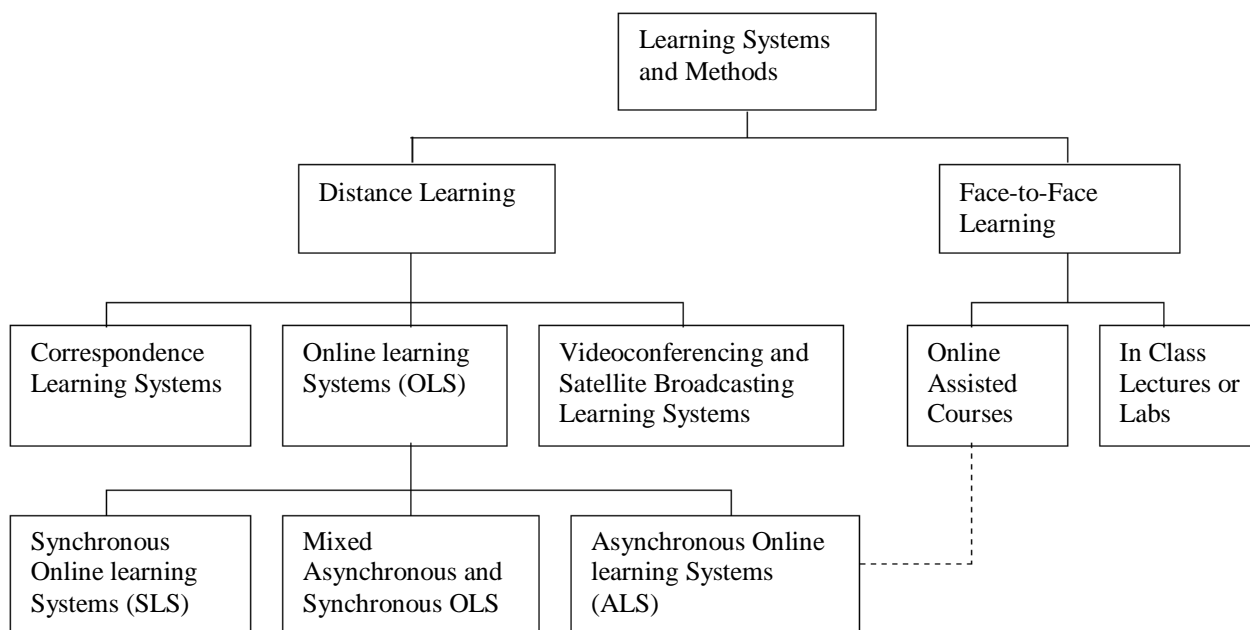


Figure 1: Different Learning Systems Hierarchy

2.2 History of Computers in Education

The popularity, the wide use of computer makes the merge of online learning. The use of computers during learning was first hypothesized approximately four decades ago. Such computer-based learning applications were referred to as computer-assisted instruction (CAI) or computer-based instruction (CBI). The main idea was that computers could provide individualized learning experiences, including interactive sequences consisting of problems or questions with appropriate feedback [3].

In the early stages of computer-assisted learning, the aforementioned idea was only used on some courseware within some specific course programs. Later, some CAI/CBI systems merged, like PLATO. Such integrated systems incorporated email and BBS functionality. Such functionality is currently widely utilized within Universities nowadays.

But the real bloom did not occur until the World Wide Web appeared in the early 1990. The Web makes it easier to create and access networked information. It also supports the collaboration of the major forms of learning interaction (email, chatting, threaded discussions, and conferencing). The form of computer assisted learning, that utilizes the Internet as its platform will now become the basis of this paper – referred to as “Online Learning”.

2.3. Infrastructure Required for Online Learning Networks

It is obvious that an online learning system heavily involves the use of computer networks. Different forms of OLS may be built using computer networks from large-scale public networks such as the Internet to small local networks (LANs). For most institutions and organizations, LAN is the basis for their learning systems. In general, such LANs will also be connected to public

networks, making differences in location transparent to individual users.

Connections to public networks are mainly dependent on moderns and existing telephone lines, whereas LAN connections are normally facilitated through the use of cable. School and college systems with many locations are likely to lease high-speed data communication lines using fiber optics or microwave transmission. Large corporations and government/military agencies utilize satellite technologies for data transmission and network communications. It is also possible (and increasingly common) for people to connect to public networks or LANs using wireless technologies.

Regardless of the underlying technologies of a network, a considerable technological infrastructure is always required, in order to develop, and support a given network. A network infrastructure is comprised of hardware, software and support personnel. It is thought that the hardware and software required to support an Online Learning system are no more complex than that required in a general-purpose computer.

With the rapid growth of computer industry and spreading use of computer in education, such infrastructures will not be a problem any longer. Nowadays, most countries are ready for adapting online learning as a new education strategy.

2.4 Literature Review

A number of studies have been conducted associated with online learning. Each study discusses the status of one given aspect of Online Learning. Studies performed include the following:

2.4.1 Online Professional Interactive Network: Virtual Professional Learning Communities for Teachers

Supported by different types of professional interactive network examples, this paper summarises the functions of professional learning networks, the way to achieve information for meeting the goals of working professionals and the reasons of using electronically mediated networks. Also it gives examples of teacher support networks in New Zealand and compares them with international counterparts.

2.4.2 Internet Use in Schools: Legal and Ethical Issues

Internet gives children and young people access to the same information as adults, which causes a series of legal and ethical problems. When schools decide to get Internet connection, it is very necessary to consider these issues and make the Internet exactly be used for educational purposes. This paper discusses these legal and ethical issues and gives suggestions for schools on how to use Internet to its best advantage.

2.4.3 Designing Web-Based Learning Environment

This paper discusses some questions and provides some resources as to how to design a website for an online learning program. It provides the procedure of website designing and implementation with the principles of online learning website design.

2.4.4 Toward a Value Framework for Online Learning Systems

This paper queries the student concerning the features of these systems that add value to their learning experience. A questionnaire is utilized for gathering student values associated with online learning systems and organization supporting these technologies. Results from the survey and a literature review are organized in a proposed value framework for online learning course effectiveness.

3. Web Site Analysis

The major research method in this paper is website analysis. In subsequent chapters, the research results are gotten from the analysis made in this chapter. After reviewing a number of Online Learning websites, it has become apparent that such sites should be categorized, and discussed independently. In the field of online learning, websites serve for the following multi-dimensional topics and sub-topics [4].

Higher Education

K-12

Corporate

Health Care

Informal Learning (Museums, Communities, Homes)

Government

Military Training

Professional Associations & Non-Profits

In this paper, three main segments of online learning websites will be discussed in detail, including their unique features and an example will be provided as to a website that facilitates the defined category of Online Learning applications.

3.1 Online Learning Applications

3.1.1 Higher Education – University of Auckland

It is apparent that online learning methods are most extensively facilitated within Colleges and Universities. Due to the wide availability of computers, and the provision of basic computing education, within the Tertiary Education sector, Online Education can be widely implemented within their course offerings.

Currently, Online Courses offered by Tertiary Institutions rely on a web-based database for the storage of course materials and information (such as lecture notes, student grades, hyperlinks).

A relevant example within this category is Cecil (www.cecil.edu). Cecil can be viewed as the University of Auckland's Online Learning System. Students have the ability to access course materials, and course related information, from anywhere. Cecil provides a majority of the previously discussed online learning functions (namely, group email, a discussion forum, course information, and file downloading). Cecil accommodates all courses that are offered by the University of Auckland. The degree of utilization of Cecil appears to differ between departments and papers. Cecil also allows for the checking of coursework marks, and online testing functionality. It helps greatly for providing high quality education.

3.1.2 K-12 Education – The Global Lab (<http://global.terc.edu>)

For K-12 schools, online learning websites' major function is to provide an online library system. With the help of these online libraries, searches for books, journals, and other relevant sources of information become much easier. This indicates that schools are no longer constrained by the information contained within their limited number of textbooks, and library books.

Another popular application incorporated into Online Learning Systems within K-12 Schools, is the facilitation of collaborative projects. Collaborative projects may be implemented solely within one class, or spanning a number of schools. Students utilize the network to collect relevant information, and prepare documents in small-sized groups. A majority of such projects also require interaction with students at different schools (via email).

Other functions of OLS at this level include: linking to the outside world; storing curriculum resources and providing interaction.

An example of an implementation of an Online Learning System in Middle Schools is the Global Lab. The Global Lab is a large-scale science project that

involves in excess of 100 schools internationally. Students within participating schools must agree to collect, and analyze data that relates to some aspect of their local environment. Such analysis results are then placed on the Global Site website, in order to allow for the determination of global trends in each given aspect.

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A Web-based learning environment should be a flexible learning environment. A good management structure should include clear and explicit information on the assessment tasks, as well as just in time feedback on their assignments.

4.4 Benefits of Online Learning

By combining the new technology of the Internet with new thinking of how people learning, online learning brings a new era to traditional education. Some of the most outstanding benefits have been indicated [7].

4.4.1 Online Learning Lowers Costs

Despite appearances, online learning is often the most cost-effective way to deliver instruction (training) or information. It cuts travel expenses, reduces training time, and eliminates costs [8]. The elimination of costs associated with instructor's salaries, meeting room rentals, and student travel, lodging, and other infrastructures. When deployment is based on a sound business case, the significant startup investment can be quickly recovered through delivery savings.

4.4.2 Online Learning Enhances Business Responsiveness

Online learning can reach an unlimited number of people virtually simultaneously. This can be critical when business practice and capabilities are rapidly changing.

4.4.3 Messages are Consistent or Customized, Depending on Need

All can get the same content, presented in the same way. Meanwhile the programs can also be customized for different learning needs or different groups of people.

4.4.4 Content is More Timely and Dependable

Because it's web-based, online learning can be updated instantaneously, making the information more accurate and useful for a longer period of time.

4.4.5 Learning is 24/7

People can access online learning anywhere and any time. It's "just in time – any time" approach makes an organization's learning operations truly global.

4.4.6 No User "Ramp-Up" Time

With so many millions of people already on the Internet and comfortable with browser technology, learning to access online learning is quickly becoming a non-issue.

4.4.7 Universality

Online learning is Web-enabled and takes advantage of the universal Internet protocols and browsers. Concern over differences in platforms and operating systems is rapidly fading. Everyone on the Web can receive virtually the same material in the same format.

4.4.8 Builds Community

The Web enables people to build enduring communities of practice where they can come together to share knowledge and insight long after a training program ends. This can be a tremendous motivator for organizational learning.

4.4.9 Scalability

Online learning solutions are highly scalable. Programs can move from 10 participants to 100 or even 100,000 participants with little effort or incremental cost (as long as the infrastructure is in place).

4.4.10 Leverages the Corporate Investment in the Web

Executives are increasingly looking for ways to leverage their huge investment in corporate intranets. Online learning is emerging as one of those applications.

4.4.11 Provides an Increasingly Valuable Customer Service

Although not internally focused, a business e-commerce effort can be enhanced through the effective and engaging use of online learning that helps customers derive increased benefit from the site.

4.5 Drawbacks of Online Learning

Despite its benefits, online learning is still in its nascent stages. It does have limitations.

4.5.1 Technology Issues

This include whether the existing technology infrastructure can accomplish the training goals, whether additional tech expenditures can be accepted, and whether compatibility of all software and hardware can be achieved. For learners, these issues include commonly technophobia, unavailability of required technologies and inability of grasping the computer techniques.

4.5.2 Reduced Social and Cultural Interaction

The impersonality, over-dependence of computer techniques, suppression of communication mechanisms such as body language, and elimination of face-to-face communication are part of the potential disadvantage brought by the advances in communications technologies.

4.6 Summary

The pros and cons of online learning vary depending on their business goals, target audience and organizational infrastructure and culture. But it is apparent that online learning is rapidly growing as form of training delivery and it is clear that benefits to online learning will guarantee it a position in the overall learning strategies.

5. Future Trends

Online learning is the most rapid growing learning form in recent years. There was an evolution that technology-enabled learning and distance education changed to online learning. By now, more and more people agree that online learning is here to stay. So we need to examine some trends of this new learning strategy.

5.1 Online Learning as a Business Strategy

For smart companies, it's no longer a question of if, but when to use online learning. These organizations see online learning as a strategic solution that must be deployed to all employees. Enterprises consider online learning as a guarantee to increase sales effectiveness, improve organizational competency, and build rich customer relationships. Consequently, online learning will continue to be a part of organizational infrastructure, similar to email packages and other product suites used to increase staff productivity.

5.2 Blended Learning

This trend involves blended learning programs, designed to integrate online learning with traditional training methods to increase overall effectiveness. A single delivery method is no longer sufficient to handle new training needs. The construction of true blended learning programs pushes learning into a new age. Blended learning preserves the necessary consideration of how people learn while offers options for learning and can still produce measurable savings promised by online learning.

5.3 Moving from Discrete to Integrated Learning

There is an increased desire for a seamless transition from one learning activity to another. Rather than stand-alone learning activities, the trend is towards the integration of these activities. The trend is looking for seamless transitions from live group activities to individual exercises, from self-paced learning activities to synchronous instruction, from activities in smaller groups to activities in a larger learning community.

5.4 Online Learning Beyond the Corporation

Early adopters of online learning consisted mainly of corporations, which were trying to enhance face-to-face meetings, demonstrations, training classes, and lectures. Nowadays, government agencies, colleges, universities, and non-profit organizations are now followers. These organizations are using online learning to address their learning and communication needs, as well as expand their business opportunities.

6. Conclusion

Rapidly expanding network technologies increase the possibilities of online learning. It is, however, difficult to predict what technology will be the dominant driving force in online education delivery in the future. It is expected that, in this new century, tremendous advances in computers and networks will have dramatic effect of altering individuals' lives and the learning experience as well.

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An Analysis of e-Mortgage Sites in New Zealand

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Abstract

The New Zealand mortgage market is undergoing tremendous change with more lenders, more offers, and more options available to the borrower to structure home loans to suit their needs. The rapid growth in use of the Internet by mortgage operations is both a consequence and a symptom of the rapid development of the mortgage market as well as of the underlying information and communication technology. Given the increasing number of online mortgage service providers and increasing advertising to promote awareness of their websites, it is important to evaluate the effectiveness of the Internet solutions. A multi-method approach (including website content analysis, two surveys, and interviews) was adopted for this study.

1. Introduction

As in so many other fields, the advent of the Internet has provided opportunities for doing old things in new ways. According to 2001 Census statistics, 1,368,204 dwellings were owned in the country, with 31% of dwellings owned with a mortgage. The mortgage broker who serves as the intermediary between the bank (mortgagor) and the customer (mortgagee) can play an important role in the daily lives of New Zealanders. A mortgage is typically a household's biggest expense. The Internet has already demonstrated its ability to be a critical competitive advantage for organisations that can provide better services for customers. With high Internet penetration in New Zealand and the local penchant for adopting new technologies, the possible market for e-mortgages is substantial. It is therefore worth studying the effectiveness and trends of Internet mortgage services in New Zealand.

The main objective of this research project was to evaluate the effectiveness of the mortgage provider and broker websites in New Zealand. The current situation and performance of all identified e-mortgage services were explored. Questions such as "Does e-mortgage provide a better service than the traditional way?" and "Will e-mortgage change the way New Zealanders arrange, and/or pay, their mortgages in the future?" were addressed.

A multi-methodological approach was used. Websites and other electronic communications were analysed, the institutions offering e-mortgages and brokering were interviewed, and potential and current clients were surveyed.

2. Study Methodology

Due to the exploratory character of this research, data collected using multiple methods and from multiple sources were considered necessary to add rigour to the study [10]. This suggestion was affirmed by Mingers [4] within the context of information systems research; he asserted that a multi-methodological approach by combining different research methods would produce more reliable and richer research results. A multiple-methods approach was therefore adopted to provide a more complete picture of the online mortgage industry. The research methods utilised and their primary purposes are as follows:

Content analysis, which focuses on the characteristics of the online mortgage services websites, was used to assess and rank site capabilities against the model proposed to serve as a benchmark.

Two *surveys* were used to investigate the industry's Internet usage and to obtain consumer perceptions about online mortgage services capabilities, respectively. One survey was targeted at online mortgage brokers, the other at customers.

Interviews were conducted to gain an in-depth understanding of online business operations from the perspective of the mortgage market players.

2.1 Content Analysis

Berger [1] described content analysis as a communication media research technique based on quantitative means, for example, counting the amount of the presence of identified elements used to measure the concept in the study. To conduct such an analysis, a predefined model is required to serve as a benchmark. Therefore, content analysis in this study consists of two steps. Tailored online mortgage site evaluation models were developed, followed by a process of systematic analysis of websites. Before starting with the content analysis and the survey, an online mortgage website evaluation model was initially developed to provide the fundamental background to the study.

Based on a literature review of items relevant to website evaluation, in particular to measurement of online financial operations [3] [5], and preliminary observations of the New Zealand online mortgage websites, standards for measuring the mortgage sites were established. The primary ideas of the model are the components in Hersey's e-commerce website evaluation model and the categories in the abstract site usability model [7]. Due to

the unique features of each industry some of the components and /or categories considered to be inappropriate were tailored to meet the requirements of the online mortgage services market. The same approach was adopted by Satitkit [8] and Chung [2], who developed the adjusted models for measuring travel industry websites and Internet banking services, respectively.

2.1.1 Evaluation Model Components

This general online mortgage website evaluation model has six dimensions used to measure the concept of an effective online mortgage website, with each dimension consisting of several elements. Due to differences in their types of business operations, the model for online mortgage lending evaluation varies slightly from the model for online mortgage broking websites. The online mortgage broking model is depicted in Figure 1. In general, the online mortgage site evaluation model consists of six categories. These categories are:

- ¾ Information
- ¾ Mortgage transactions
- ¾ Trust
- ¾ Ease of use
- ¾ Marketing and customer focus
- ¾ Non-functional requirements

Content analysis should be a multistage and systematic process [9]. This point is also illustrated by Neuendorf's flowchart [6] for the typical process of content analysis research. The description of the process employs three main steps, sampling, coding, and analysis.

2.1.2 Sample Identification

The mortgage sites came from various sources:

1) 35 mortgage lenders' sites were collected from two websites located at: <http://www.nzherald.co.nz/money/ratetables/html/mortgagerates.htm> and <http://www.interest.co.nz/mortgages.html>, respectively. The New Zealand Herald online edition was ranked as among the top twenty by Hitwise (at <http://www.hitwise.co.nz>), the industry leader in comparative website monitoring and analysis. Interest.co.nz serves as a guide for the best options of interest rates derived from almost all professional organisations in the money market, including both banks and other financial institutions.

2) 40 mortgage brokers' sites were identified via the NZSearch search engine (a well-known web directory in New Zealand), via the Yellow Pages online edition finance section (at www.yellowpages.co.nz), and from the first survey conducted at the preliminary stage of this study.

The list totalling 75 online mortgage service websites in New Zealand, all that could be identified, constitutes the sample population of this study.

2.1.3 Coding

All of the sample sites were evaluated by using the same coding scheme. Binary scores (0 or 1) were used to

record the appearance of the characteristics on the sites against the two predefined models. A score of 1 is assigned to the elements identified while looking at the websites. In contrast, a score of 0 reflects the absence of such an element. It should be noted that some elements, such as page loading speed, and page presentation could not be simply scored by establishing their occurrence. Attitudes to such elements differ from person to person, therefore judgment of these elements tend to be somewhat subjective. To attempt to limit the subjectivity rules in terms of a range or a list of acceptable requirements are defined. The elements with performance within the accepted range or meeting the requirements were judged as 1, otherwise they were scored as 0.

The major advantage of this coding is that it maintains objectivity. Each site was assessed three times in order to minimise or eliminate judgment variance. Microsoft Excel was used for coding, which took place on 20 March 2002.

2.2 Surveys

Two surveys were carried out in the study, targeting industry players and consumers respectively.

The first survey outlines Internet usage in the mortgage broking industry. Members of the New Zealand Mortgage Brokers Association (NZMBA) were selected as a representative sample. The survey was administrated via e-mail. A list of the email addresses was collected from the New Zealand Mortgage Brokers Association website located at <http://www.nzmba.co.nz>, section "locate a member." The emailing list there is arranged on an organisation basis. Some organisations such as Mortgage Link Ltd, which is a co-operative of selected 35 offices and 65 mortgage brokers throughout New Zealand, Mike Pero Mortgages and Mortgage Choice with a franchise model are deemed as one single organisation specified in the study. They and their members share the same site. The survey was distributed twice within a period of ten days due to the limited response of the first survey.

The second survey was a web-based survey. It was created and published using WebSurveyor Corporation's online survey software and hosting services. It is ranked highest by PC Magazine for ease of use in America and located at <http://www.websurveyor.com>. The online mortgage web survey was published at <http://websurveyor.net/wsb.dll/8390/online-mortgage-websurvey.htm> on 26 March 2002 for a period of three months. In addition, this site was posted online on 24 April 2002 through link at <http://www.propertyinvestor.co.nz/>, a Residential Property Investor Magazine in New Zealand. Other means such as university staff and postgraduate students mailing list and newsgroup sites in New Zealand were used for the site promotion.

2.2.1 Pilot Test

Prior to publishing the mortgage web survey online, a hard copy version of the questionnaire was pilot tested by seven people including lecturers and postgraduate students. They were chosen because they are mortgage

borrowers and/or experienced Internet users. Inappropriate expressions of items or scales were modified to make sense and be logical. A revised questionnaire was tested again to assure the reliability and validity of the survey. Due to the characteristics of a web survey's presentation, four staff and postgraduate students in the MSIS department of the University of Auckland tested the final online version of the online mortgage survey.

2.3 Interviews

Interviews were conducted to gain an in-depth understanding of online mortgage operations from a mortgage market player perspective. The main emphasis was on strategy issues of online mortgage solutions in the mortgage industry. Major players who use the Internet for doing online mortgage business and /or the top 15 sites, ranked as the most innovative online mortgage sites in website content analysis in this study were invited to participate. Three organisations agreed to participate in the study. They are as follows, in the order of our obtaining permission to conducting interviews.

Mortgagenet Investments Ltd www.mortgagenet.co.nz

Wizard Mortgage Corporation www.ewizard.net.nz

Cains Lockie Mortgage Banker www.emortgage.co.nz

3. Analysis

3.1 Survey Results

3.1.1 Industry Survey

The data in this survey were gathered from the mortgage broking industry survey emailed (except one which was required to sent by post) to the NZMBA members. There were 120 unique sites of which 110 took delivery of the email (i.e. 10 messages failed). Twenty-four responded via email; four dropped out for reasons of company voluntary liquidation, duplication, enquiry, and unwillingness to be involved. Therefore, the response rate of 18% resulted from 20 completed and returned valid questionnaires. Fifteen replies were collected via email, four via fax, and one by post. The three key findings from the industry survey are:

(1) There has been a rapid growth of Internet presence in the mortgage broking industry in New Zealand, accounting for 40% of those studied. Although the adoption of the online mortgage service lags by several years compared with other financial services, such as banking, the entire mortgage broking market has been experiencing an increase in online mortgage operations in recently years.

(2) The field of online mortgage broking in New Zealand is relatively new. The Internet is mainly used as an advertising and brand-building tool; the majority (87.5%) of the mortgage broking sites are information-based rather than providing transactional facilities.

(3) The effectiveness of the web operation is still a major concern. First, the current online mortgage broking

service is considered to be less effective, as the majority of mortgage brokers (70 percent) surveyed indicated feeling neutral on the degree to how satisfied they are with their web presence. Second, brokers have not been convinced an increased amount of business has been generated from an online service, therefore they are watching, waiting for market trends, and then planning, rather than making decisions in a rush. Third, the effectiveness of investment in time, cost, and effort versus returns is taken into account. Finally, a personal touch is considered to be critical in the mortgage business.

3.1.2 Consumer Survey

People in their 30s and 40s are more likely to use an online mortgage service to arrange their mortgages. 49 out of 65 respondents (75.4%) were aged from 30 to 49. Increasing educational levels have contributed to the ability of customers to accept the online services. Half (33 out of 65 or 50.8 %) of customers are property investors, followed by first home buyers, accounting for 26.2% (17 out of 65). This would be a useful guide for developing a mortgage website, particularly the content design, when considering the target audience.

Mortgage borrowers are still comfortable with traditional services to arrange their mortgages. Face-to-face is regarded as an essential component of a mortgage business. In addition, mortgage borrowers are more likely to make a mortgage application in a traditional way rather than taking an online application.

Customers primarily use mortgage websites as an information gathering medium and an educational tool. The majority of the respondents access mortgage websites for the purpose of information-related activities such as shopping for mortgage rates, making comparisons among mortgage options, and gaining market intelligence. This was reflected in comments made by the customers on desired future improvements, which mainly included a desire for more detailed information, more options for comparisons, more powerful functionality, and faster response. Interactive features received more attention among the site users. Facilities in the forms of a powerful mortgage calculator, enquiry email, and various e-forms such as comments, feedback and request forms gave customers a good sense of two-way interaction. The lower percentage of transactional facility usage may be attributed to the fact that they were not popular at this stage, as well as that the website itself was not fully geared for mortgage business transactions. The absence and or the lack of such facilities were also observed in the content analysis of the mortgage websites.

Timesaving, convenience and reduced cost are the major benefits experienced by the online mortgage customers. In fact, the Internet has already demonstrated its ability to have a powerful impact on changes in time, cost and service. The online mortgage service is simply one reflection.

Participants felt more strongly about the importance of certain elements. Like most e-business consumers, the mortgage consumers are concerned with security issues.

Safety of information storage and transaction was ranked as the biggest concern of the customers. Information attracts considerable attention from the customers. There is an increasing demand for more up-to-date, more accurate and more detailed information displayed on a mortgage website. It is interesting to note that online servicing and electronic advice on mortgage options were important to the customers this survey reached. This would imply an increased awareness of the benefits of using online transaction processing. Therefore, changes in the mortgage facilitation process are expected. Other important issues include response time, page loading speed, and interactive tools. In contrast, some issues related to site marketing such as site brand, site innovations, and site personalisation are not considered to be important factors for a mortgage website. The low importance of e-subscription as perceived by the customers was contrary to what the mortgage service providers thought.

Although there is tremendous room for more effective mortgage website operation in New Zealand, overall the customers were satisfied with the current online mortgage services and indicated a greater probability of future adoption of online mortgage services.

3.2 Content Analysis

Content analysis, used to evaluate the effectiveness of the online mortgage websites, is quantitative in nature. The content domain chosen for examination in the study is of the online mortgage websites in New Zealand. The sample includes thirty-five mortgage lender websites and forty mortgage broker websites. The content analysis process followed the Neuendorf [6] flowchart for the typical process of content analysis research. The websites surveyed were evaluated based on the benchmarking models developed. Two evaluation models in terms of mortgage lending sites and mortgage broking sites consist of six dimensions, namely information, mortgage transaction, trust, ease of use, marketing and customer focus and non-functional requirements, but they differ in a few elements.

3.2.1 Lender Site Content Analysis

According to <http://www.interest.co.nz>, which also has a link from <http://www.nzherald.co.nz/money/>, there were fifty-six institutions providing their mortgage rates and products through the observation conducted on 18 March 2002. These included eleven banks, four trustee companies, nine building societies, five insurance companies and twenty-seven finance companies respectively. Out of the 56 mortgage lenders, 35 were found to have an Internet presence, via the web directory at <http://www.nzsearch.co.nz> by entering key words such as institution name. This gives an Internet usage of 62.5% for the mortgage lending industry in New Zealand.

The average score of each site, or the average number of elements used by a selected mortgage lender site was 15.8 per website, less than 17, the 'pass' or 50% mark for

representing all the 34 elements required in the evaluation model. Therefore, this figure reflects a fact that the overall adoption of elements measured on mortgage lender sites was low.

Additionally, the average numbers of elements utilised per website for different kinds of organisations was calculated. They are 21.3 (213/10) for the banking sector, 15 (60/4) for trustee companies, 13.75 (55/4) for insurance companies, 13.5 (162/12) for finance companies, and 12.4 (63/5) for building societies respectively. These average scores provide for comparisons among the different types of mortgage lender organisations. Other than the banks, which have a higher adoption of the elements required in the mortgage lender evaluation model, the others have a low occurrence of the identified elements.

3.2.2 Element Score Analysis

The same method as described above was applied to the calculation and the presentation of scores gained by each element across the selected population of the mortgage lender sites. The elements with higher scores illustrate their importance and / or usage in developing mortgage lender websites. The dashed line shows the maximum value obtainable for an element. The sample population of 35 mortgage lender sites determines this maximum value.

The average score for all elements, or the average number of organisations using an element, was 16.3 (553/34). The averages for each element were also calculated across the six dimensions classified in the evaluation model. They are 32.3 (97/3) for the information dimension, 9.1 (91/10) for mortgage transactions, 18.7 (56/3) for trust issues, 18.75 (75/4) for ease of use, 12.0 (132/11) for the marketing and customer focus dimension, and 34 (102/3) for non-functional requirements. These average scores show that the elements adopted by the organisations vary significantly with respect to the different dimensions to which the elements belong. Non-functional requirements and information received the most attention by the lender organisations, accounting for 97.1% and 92.3%, respectively. In contrast, the usages of the capabilities in terms of marketing and customer focus and mortgage transaction were low, accounting for 34.3% and 25.7%, respectively.

3.2.3 Broker Site Content Analysis

The average score of each site, or the average number of elements used by a mortgage lender site, was 14.1 (564/40) per website, which was less than 17.5, the fiftieth percentile for all the elements required in the evaluation model. Therefore, this figure indicates that the adoption of the elements measured in the model was below what may be expected. The overall standard of the online mortgage service website design was relatively low; they provide limited facilities at the online mortgage sites. The result is consistent with the observation of the lender sites.

The average scores for each element, or the average number of the organisations that use a specific element was 16.1 (564/35). The averages for each element were also calculated across the six dimensions classified in the evaluation model. They are 30.2 (151/5) for the information dimension, 10.25 (82/8) for mortgage transactions, 12.75 (51/4) for trust issues, 10 (40/4) for ease of use, 12.73 (140/11) for marketing and customer focus dimension, and 33.3 (100/3) for non-functional requirements. These average scores show that the dimensional average scores varied considerably. The information and non-functional requirements dimensions were considered essential parts in mortgage broker website design, accounting for 75.5% and 83.3% respectively. In contrast, the remaining four dimensions have an unacceptable level of organisational adoptions, accounting for only 25.6%, 25%, 31.9%, and 31.8% respectively.

The interviewees represented small organisations that had been in the mortgage lending and/or broking business for between 3 to 6 years. They used a combination of DIY and outsourcing to develop and maintain the site. Having up to date information was considered to be essential by all of them.

What are the factors that contribute to a successful website? "It must be easy to use; it must be very clear, (clear with the content), nice straight letters, you know, clear like that (show me a white paper with black letters on it). It's going to be quick down loading, very quick down loading, easy to navigate, Yes, very easy to navigate, easy to use."

3.3 Interview Results

All three interviewees stressed that the business could not just be electronic, but would be one component of an overall strategy "I think it's an ideal way to transact mortgage business, um, there are a couple of blockages, people have to sign mortgage documents, and also people still like talking to people, so the human factor is still evident, I think the Internet is going to be a helpful strategy, it's a part of your strategy. Here, we are not totally to rely on the Internet, the Internet is an important channel, and also an important marketing mechanism, but it's integrated with all the other marketing." Another found "You have to have the face-to-face to support the Internet presence"

The Internet site was seen as a communication channel, one that could allow the broker to make the initial contact and allow people who were overseas to invest in property in New Zealand and to take up a mortgage to do so. "I've got clients living all around the world now - Sweden, Japan, the USA, the Philippines, France, England. I could have never got without the Internet, too hard to find them, I can find them, now they can find me which is nice." The development of a mailing list or similar strategy was also seen as the major selling point of their business, although each had their own unique way of promoting this. "I've got a database now, it's actually close to 5000 subscribers

I've built up, and it's taken me five years to build that database. But it's good target marketing because ... most are property investors, because that's whom my site is designed to attract."

4. Discussion and Conclusions

In general, the online mortgage service sites that scored in the high category are considered fairly good with respect to the design and implementation of the six dimensions identified in this study. On one hand, they are informational in nature; on the other hand, they have a sophisticated web presence, not only offering a wide range of capabilities such as online transactions, online tools, and e-marketing incentives, but also taking advantage of new IT technologies to enable an interface with site navigability and media richness. Most of the high scoring online mortgage provider web sites represent leading players in the mortgage market in New Zealand.

Both mortgage lender and mortgage broker organisations represented multiple strategic business considerations on their websites, covering six dimensions in this study. This is consistent with findings from the literature. However, the performance of each dimension differs quite significantly. Six dimensions surveyed in the content analysis comprised information, mortgage transaction, trust, ease of use, marketing and customer focus, and non-functional requirements. Figure 1 provides statistics on specific site characteristics (elements) for the Broker sites. Information and non-functional requirement were the most frequently implemented elements. Most sites did fairly well with in terms of page loading, the use of graphics and animation, and the content organisation and presentation. Websites examined did not make heavy use of the site for marketing and customer focused activities. Activities such as mortgage glossary, site personalisation and e-subscription, were used by few of the responding organisations. Only two of the mortgage lenders provide site customisation, and none of the mortgage broker organisation applied this function to their websites. On the mortgage transaction side, the performance was considerably poor. The online tools used to process a mortgage arrangement were provided by very few organisations. About 31.4% of the mortgage lender and 40% of the mortgage broker offer an online application. None of the online mortgage service providers offer online mortgage approval. When we consider ease of use, although the overall navigability of the sites was considered good with the use of navigation tools, location indicator, and internal and external links, other facilities such as site map, online help and search function appear at relatively few online mortgage service sites.

The results of the content analysis allow a comparison between lender sites and broker sites (Table 1). The mortgage lender sites outscore the mortgage broker sites in terms of the overall capabilities and performance of the online services provided satisfaction.

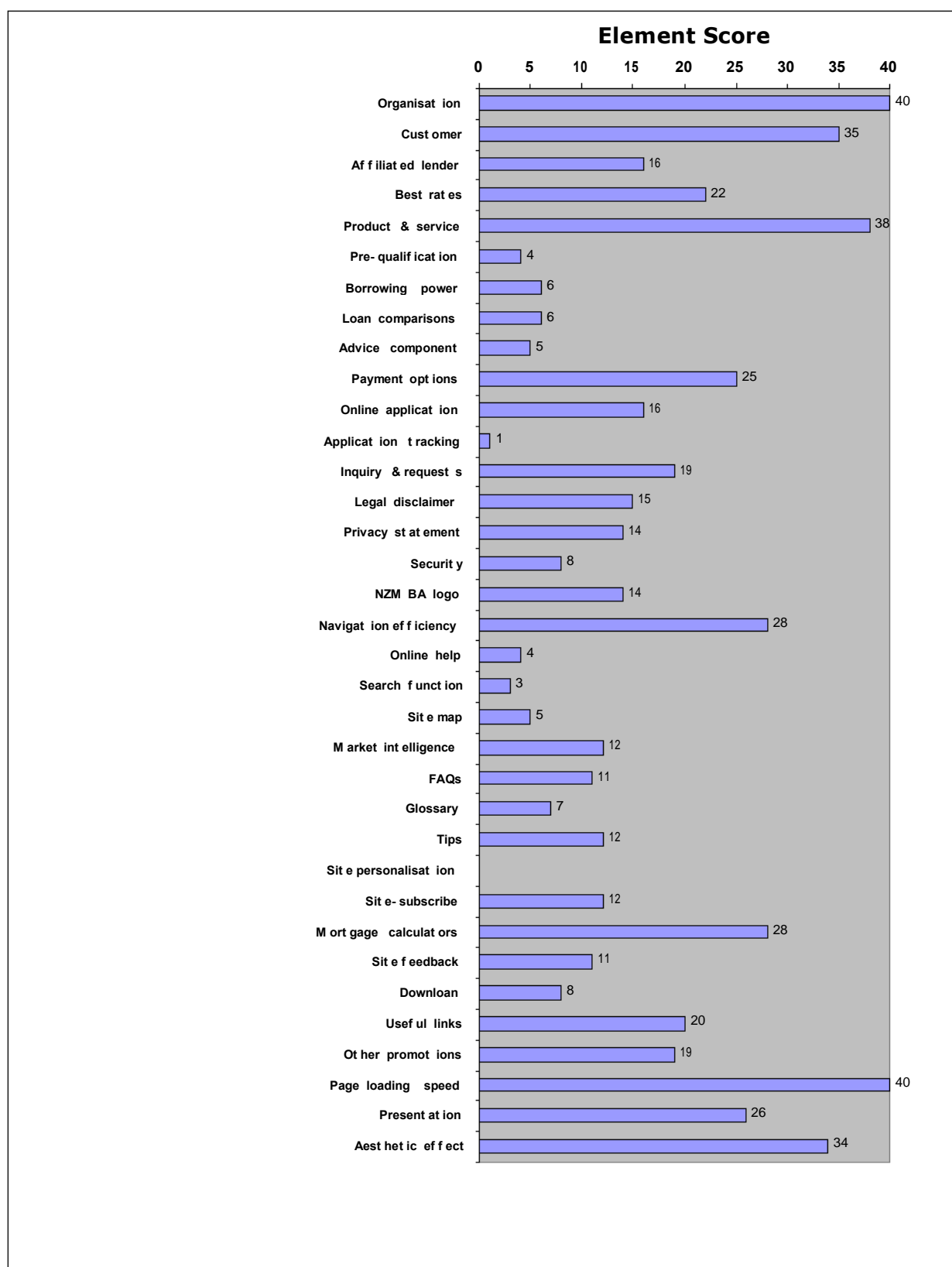


Figure 1: Scores for each element on mortgage broker sites

Table 1. Online mortgage websites score summary

	Lender Sites (Total 35)			Broker Sites (Total 40)		
Site Scores	Low (17 or lower)	Medium (18 to 24)	High (25 to 34)	Low (17 or lower)	Medium (18 to 24)	High (25 to 35)
Percentage	22 (62.9%)	9(25.7%)	4 (11.4%)	30 (75.0%)	7 (17.5 %)	3 (7.5%)
Summary	$\frac{3}{4}$ Most of the sites providing online mortgage services received low scores $\frac{3}{4}$ Bank sites dominated the high scores with 7 in the top 10 $\frac{3}{4}$ Three non-bank sites also were ranked in the top 10 $\frac{3}{4}$ Overall, online mortgage lending sites are of poor performance			$\frac{3}{4}$ Most of the broker sites received lower scores $\frac{3}{4}$ The sites ranked in the top 10 included the most visible mortgage broker sites and primarily those among the medium and leading players in the market $\frac{3}{4}$ Overall, online mortgage broking sites performed poorly		

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New Zealand Real Estate Agencies in e-Commerce Environment

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Abstract

1. Introduction

Recent research has been carried out investigating the integration of e-commerce in major industries such as travel agency [12], e-mortgages [6] and banking [9]. Most of this research indicated that e-commerce potentially plays a major role in the business process of these organisations. This paper examines real estate agencies in the same way, as e-commerce redefines how the intermediary between seller and buyer may operate. The impact, benefits and implication of Internet on real estate agency have been investigated in the literature review. This study seeks to explore current situation and performance of the online real estate agency website in New Zealand, and to determine crucial web elements for this industry and to propose a tailored model that will serve as a benchmark for evaluating online real estate agency websites in New Zealand.

2. Background

2.1 Electronic Commerce

Rapid development in information technology, such as the Internet, broadband communications, networking and digitalisation of households, creates new forms of collaboration between seller and buyer. Peffers [11] and Turban et al [14] identify such collaboration as electronic commerce (e-commerce). With growing globalisation and deregulation, competitive strategies such as differentiation and cost leadership start to lose their effect [2]. Firms must now take advantage of the new technology and expand theirs into the e-commerce environment, in order to compete.

2.2 Real Estate Agency

The role of real estate agency is to facilitate the property transaction between buyer and vendor. This includes aiding the buyer to buy the property, aiding the vendor in selling their property and advising both parties best interest. A broker, who has license that can legally convey property, heads the agency. Within the real estate agency there are several agents, they have a contractual relationship with the agency [3]. The roles of real estate agent involve acting for the buyer and vendor, and maintaining interpersonal interaction with them in different roles.

Typically, real estate sales usually involved five stages. There are listing, prospecting, servicing, negotiation and agreement, and closing as identified by Wofford and Clauretie [16] (cited in [1]). These stages are essential for a real estate transaction to occur.

2.3 Internet Penetration in NZ Real Estate Agencies

The two vital real estate websites in New Zealand are REINZ (<http://www.reinz.org.nz/>) and RealENZ (<http://www.realenz.co.nz/>). REINZ is the official website of the Real Estate Institute of New Zealand (REINZ). RealENZ is associated with REINZ, which is the official property directory of REINZ. RealENZ list all the properties from different real estate agencies that submit the properties to them.

A list of 467 real estate agencies based in Auckland District was obtained from the REINZ website on 31st October 2002. This list is believed to be exhaustive given the fact that all real estate agencies in New Zealand are required to register with REINZ. 73% of the 467 real estate agencies in Auckland have their email address included in their contact detail. This suggests that most real estate agencies have access to the Internet. 32% of the 467 real estate agencies include a website in their operations. However, only 21% of the real estate agencies with a website have their own domain and website content, while the majority of them provide content through REINZ website, implying that the penetration of websites in the real estate industry in Auckland is relatively weak.

2.4 Potential Property Buyer and Internet Real Estate Agency

This section attempts to understand the relationship between the consumer, the property buyer, and online real estate agency. To understand such a relationship, we begin by exploring the classical decision-making process. Classical decision-making consists of five stages, namely problem recognition, information search, evaluation of alternatives, purchase decision and post purchase behaviour. According to McGaughey and Mason [7], the Internet can successfully influence all the stages of the decision making process from stimulating problem recognition to supporting post purchase behaviour.

However, in the real estate industry, the Internet serves as a mechanism to enhance the information search stage of the decision making process. Littlefield [4] reported that a significant proportion of consumers tend to use the

Internet to enhance the information search phase of the home purchasing process. This is because one transaction in the real estate industry usually involves a large sum of money. Littlefield indicated that the Internet enables the consumer to purchase houses conveniently and efficiently through obtaining online real estate information. Such information includes information relevant to the property such as prices and features, and also information irrelevant to the property such as real estate agent information, demographic information of the areas. Thus, the information-intensive Internet has proven to be a very powerful tool for such an information-intensive and information-driven industry.

2.5 Impact of Internet on Real Estate Sales

The Internet has brought significant impact to the real estate. The impacts are translated in terms of changes in the real estate processes. According to Alberts and Townsend [1], the Internet affects all five stages in the real estate sales as mentioned previously. In the listing stage, the Internet allows vendors to list properties online through a real estate agency website. These properties are then available for a potential buyer to search and browse on the agency website, this is the prospecting stage.

In the servicing stage, technology such as 'virtual tour' eliminates the need for the buyer to view the house physically. Instead, the buyer is able to inspect the property with 360 degrees panoramic view throughout the property, using the Internet. The Internet also enhances the negotiation and agreement stage such as allowing the buyer to apply for a loan [6] or contact a lawyer online. The Internet could also give the real estate agent the ability to communicate with the buyer and vendor through e-mail, thus the agent could facilitate negotiation between vendor and buyer through e-mail. Unfortunately, the Internet is currently unable to close a transaction online. However, there are websites such as Property Transaction Network (<http://www.theptn.com>) that offers a secure environment in which to exchange documents privately between vendor, buyer and other parties involved in the transaction [1].

In general, the Internet enables firms to increase revenue through increased sales and reduced expenses by cutting administrative and operating expenses [5] [13]. It provides another alternative channel for real estate agencies to market their properties. Traditionally, agencies would incur expenses in marketing their properties through intensive distribution of property brochures, or other costly activities that would distinguish themselves from their competitors. However, with the use of the Internet, smaller agencies can afford to market their properties to a wide audience.

3. Study Methodology

Content analysis is employed to evaluate and analyse web site content in order to determine crucial elements for this industry as well, as determining their strategy. We

start by proposing a tailored website evaluation model for real estate agency websites. This involves gathering dimensions and elements of the website contents; and then evaluation of real estate agency websites with the tailored model. This requires selecting websites from the 151 found, coding to obtain data and conduct analysis on the data. The web sites selected all had to have their own site (rather than be a part of others e.g. Yellow Pages TM or RealENZ, or a branch of a parent site), and deal in residential property in the Auckland region. We reviewed all 31 that fitted these criteria to identify the crucial elements for this industry. Elements that are perceived to be important are noted down, while elements that are common in a number of websites will also be noted down. As indicated in the literature review, the real estate website serves to augment consumer information search phases, thus it is important to focus on the element that reinforce quality of information. Through this exercise, a handful of elements are identified.

Due to the nature of the real estate agency operation, some elements from Hersey's model (as cited in [15]) are deemed inappropriate and inapplicable. Such elements will be omitted. The following indicate the list of elements that will be omitted from the Hersey's model along with an explanation.

[Negotiation], [Order], [Payment] and [Delivery]: These elements are not applicable to real estate agency website because face-to-face negotiation is still required and essential. This is due to the fact that the nature of the transaction in the real estate industry, particularly in change of ownership, always involve large sum of money.

[After-sales] and [Community]: These elements are not applicable to the study mainly because they are usually supported through email communication. However, email communication does not constitute a website element. Therefore, these elements will be omitted from the study.

The selected elements from Hersey's model are shown in Table 1.

Table 1. Elements from Hersey's model

Search	Company	Customer	Product
Performance	Ease of Use	Aesthetic Effect	Innovation

3.1 The Tailored Model

The elements obtained from site observations will be used in conjunction with the selected elements in Hershey's model to form the tailored model. Eight categories are defined as crucial elements for capturing the elements of quality for the tailored model. These eight categories are shown in Table 2.

Table 2. Elements for the tailored model

Property Search Criteria	Property Information	Relevant Information	Organisation Information
Price range	Photo tour	Job opportunity	Agent
No. of bathrooms	Virtual tour	Featured home	Branch
No. of bedrooms	Rigorous	Open home	News
House type		Sponsorship	Contacts
Suburb		New information	About us
Region		Local/Community	
Sales type		Tips for seller	
		Tips for vendor	

Appearance	Ease of Use	Relevant Features	Trust
Innovative	Help with website	Property appraisal	Legal disclaimer
Aesthetic effect	Site search	e-subscription	Privacy statement
Presentation	Sitemap	Other language	Other
	Navigation	Feedback	
	Favourite property	Useful links	
		Cookie	
		Mortgage	
		Calculator	
		Sell property	
		Performance	

All the elements indicated above are relevant to the real estate industry. However, it is clear that transactions that occur in the real estate industry involve three parties, namely buyer, vendor and real estate agency. The real estate agency, thus, has to ensure itself to function efficiently to satisfy both the buyer and vendor market.

The second part of content analysis involves a series of simple processes that include selecting the sample for evaluating, coding and analysis. These processes are generalised from the Neuendorf's [8] flowchart for typical process of content analysis research. When the sample is obtained, the coding process begins by evaluating the pool of sample website with the tailored website evaluation model for real estate agency through the process of assigning binary of 1 (the element is present) or 0 (absent), which is then analysed. Of the sample of 31 real estate agency websites, only 26 websites were analysed, as the other 5 websites remained inaccessible throughout the coding period.

4. Results

Under the 'Property Search Criteria' dimension, very few sites provide search criteria for 'Sales Type', while half the sites provide search for 'No. of bathrooms'. However, the elements 'Region', 'Suburb', 'House Type', 'No. of Bedroom' and 'Price Range' are very common to most websites, (ranging from about 50%-70%) of the websites. This may suggest that the sites that have search features usually provide all these five elements together. Under the 'Property Information' dimension, only 34% of websites provide rigorous information on a particular property while 38% of websites use both 'Virtual tour' and 'Photo tour'. The 'Virtual Tour' capability usually provides 'Photo Tour'. Thus sites supporting any of these elements tend to have these two elements together. 58% of the websites provide the element 'Featured Home', making it the most common element in the 'Relevant Information' dimension. 'Tips for Vendor', 'Local/Community', 'New Information' and 'Market Report' all have the same proportion of websites using these elements at around 30%. The element with the lowest proportion is 'Sponsorship', with only 23% of websites providing it.

The most significant findings for Organisation Information dimension are that over 90% of the websites have the 'About Us' and 'Contact' elements, an indication that they are the basic elements for real estate agency website. 'News' and 'Branch Information' are the least used elements at websites, at about 38% and 46% respectively.

'Navigation' has the highest proportion with 80% of websites scoring such an element, which suggests that many websites identify the need for good navigation. However, under this section, a significant proportion of websites did not hold any one of the elements apart from 'Navigation'. 96% of websites scored on 'Presentation'. Only about 58% and 27% of the websites have the elements 'Aesthetic effect' and 'Innovative'. This suggests that real estate agency perceive 'Presentation' as more important than 'Innovation'. Good 'Presentation', in general, is cost-effective and easier to achieve than being 'Innovative'. The common elements in the 'Relevant Features' dimension are 'Performance' and 'Useful Links' with about 77% and 70% respectively of the websites having such elements. Elements such as 'List property', 'Cookie' and 'Property Appraisal' have the same proportion of websites at 19%. The proportions of websites that use elements in the 'Trust' dimension are relatively low, 35% for 'Legal Disclaimer' and 27% for 'Privacy Statement'.

The overall performance of each dimension from our web evaluation model of Auckland real estate agency websites is shown in Figure 1. It shows that most websites in our study focus on Property Search Criteria, Organisation Information and Appearance, while Ease of Use and Trust appeared to be two of the lowest. The scoring for each of the elements can be found in Appendix 1.

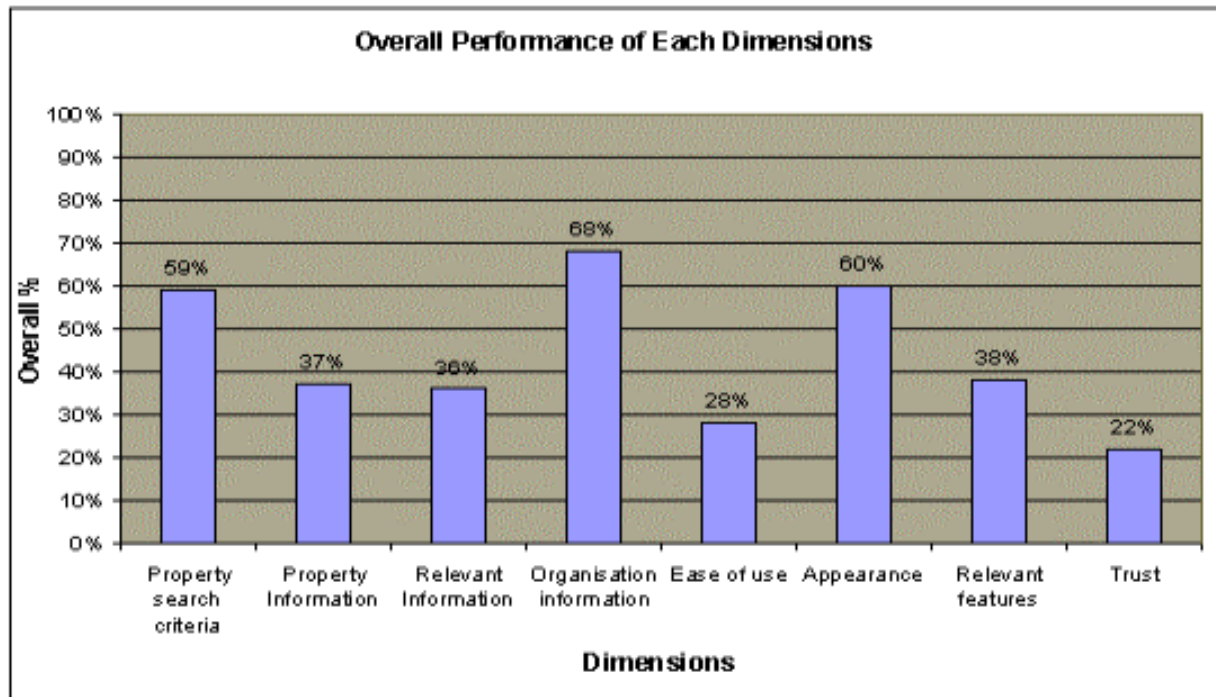


Fig. 1 Overall performance of each dimension

There has been a rapid growth of Internet presence in the mortgage broking industry in New Zealand, accounting for 40% of those studied. Although the adoption of the online mortgage service lags by several years compared with other financial services, such as banking, the entire mortgage broking market has been experiencing an increase in online mortgage operations in recent years.

5. Discussion

The elements found in New Zealand real estate agency websites reflect an informational basis. That is to say that none of the sites could facilitate or perform a transaction through the website. Most of the sites managed to provide a majority of the elements in the 'Property Search Criteria' dimension.

Features such as virtual tour require considerable resources to implement, which usually involve a process known as object modelling that can capture 360-degree panoramic views from a standing point. Although less than half the real estate websites in the study provide features such as virtual tour, the proportion of the websites that provide this feature do so via third party websites. Two major third parties that provide virtual tour primarily for real estate agencies in New Zealand are Open2view (<http://www.open2view.co.nz>) and Virtualtours (<http://Virtualtours.co.nz>). Agencies such as Bayleys or Harcourts are an example of real estate agency websites that optimise the use of such a feature.

Some of the elements in the 'Relevant Information' dimension require a significant amount of resource. It is unlikely that smaller real estate agency can support this. Thus, large international real estate agencies such as the Professionals and Bayleys benefit from this dimension by providing elements such as 'Market Report' and 'Sponsorship' those smaller real estate agencies might not provide. Large real estate agencies tend to have the resource to update their website regularly too. The smaller real estate agency websites that score well in this dimension tend to take advantage of the elements that require fewer resources. Sawyer Real Estate is among the list of small local-based real estate agency that has the same score as the majority of the large international real estate agencies by providing elements such as 'tips for buyer and vendor' and 'local information' that require less resources.

Once again, the websites that top these dimensions are mostly the large real estate agency or ones that operate internationally. The smaller agencies tend to under-perform in elements such as 'News'. The reason is that 'News', such as newsletter, maybe costly for smaller real estate firms to produce. Another reason why smaller real estate firm score less in this dimension is because smaller real estate agencies usually only have a single branch, thus they automatically miss out the score for element 'Branch Information'.

Over 80% of the websites in the study scored in the element 'Navigation'. This suggests that most websites grasp the importance of navigation to the user. The only websites that score over 60% of the elements in this

dimension are Barfoot and Thompson and Wrightson Ltd, both of which are large firms with considerable resources. The element 'Favourite Property' is also found mostly in large real estate agency websites.

The findings suggest that not most websites score high in this dimension, they include both large and small real estate firms. Good 'Presentation' proved to be common to most real estate websites. However, a large proportion missed out in element 'Innovative'. Once again, the proportions of websites that include 'Innovative' in their websites are mostly large real estate firms.

The top four websites that top this dimension are, again, large real estate firms. Most websites take advantage of the element 'Performance' and 'Useful links'. Others benefited from providing 'Mortgage Calculator' directly from their website, which is reasonably easy to implement. Interestingly, the websites that provide the 'List Property' feature for vendors are mostly moderate or small real estate firms. Likewise, only two websites provide 'Other language' capability suggesting that elements in this dimension do not require significant resources, and can be easily provided by small firms, even though websites that top this dimension are large companies.

The proportion of websites that have many of the elements in the 'Relevant Features' dimension is low. A number of the websites do not have the subscription feature. The elements in this dimension are usually associated with the subscription as this brings visitors back to the site. Thus, sites that do not have subscription feature tend to exclude such elements from their website.

5.1 Study Limitations and Future Research

The samples of websites used in the study are all based within the Auckland district, as defined in REINZ's website. Although, a majority of them are nationwide agencies, it does not necessarily give an accurate complete representation of New Zealand real estate agency websites.

The tailored web evaluation model generated from the study is subject to personal inference to some degree. The elements selected for the tailored model may hold different interpretations for different individuals. Thus, the coding process would have resulted in slightly different findings if performed by different individuals. It should also be noted that only one person did the coding, which is potentially error-prone. The tailored web evaluation model could be enhanced using a survey to capture user perception on the crucial elements for real estate agency websites. Likewise, an interview with some real estate professionals would aid to validate the model too.

This study only evaluates elements of real estate websites based on the tailored model, which indicates how

well the website captured these elements. However, it does not reveal how popular the websites are to consumers. The website could be evaluated based on user perception, such as the most frequently visited website and also determine certain aspects of the websites that tend to attract consumers i.e. good web elements versus good property. Research would determine whether there is a correlation between high web scores and the size of the firm or the number of years the agency has been operating. As all the websites in the study are based in the Auckland district, it might be useful to carry the study to other districts in New Zealand.

6. Conclusions

The web provides an opportunity for the real estate agency to move information to the potential buyer. For some buyers, the 'servicing' stage, i.e. open home, can be participated in 'cyberspace' as capabilities such as the 'virtual tour' are used by some agencies to the benefit of buyer, agency and purchaser. Websites can be so efficient that the first four stages in real estate sales could be performed without the physical contact with a real estate agent. Ultimately, the website presents a win-win situation for both the agency and the consumer of the agency's website, providing that the website utilises the appropriate web elements, such as the ones identified in the tailored model of this study. The agency, that stands to benefit from the website, can effectively cut costs through eliminating the traditional distribution of real estate brochures or magazines. In addition, the website provides added benefit to the agency as property information can be now accessed anywhere in the world by potential buyers [10]. This implies that the potential buyer can easily relocate himself or herself from one region to another through advanced property hunts.

However the potential property purchaser would need the knowledge and technology to search for properties. The purchaser would also lose the benefit of a quality relationship with the agent, one that is only possible through interpersonal contact.

It is evident that the websites provide immense convenience for the purchaser in this information-driven industry. This, in effect, may attract a pool of non-current purchasers to the website. The website is so convenient that it might attract the attention of potential consumers who have no intention to purchase a property to use the website. Ultimately, while browsing the website, the consumer might be tempted to purchase the perfect property that they have found or indeed to list their own property.

Appendix One – Elements scoring

CATEGORIES		Property Search Criteria		Property Information		Relevant Information					
Elements											
ALL PERSPECTIVES (Aggregated Elements)											
#	Websites										
1	http://www.barfoot.co.nz/	1	1	1	1	1	5	1	1	2	1
2	http://www.bayleys.co.nz/	1	1	1	1	1	6	1	1	1	5
3	http://www.bluecircle.co.nz/						0	0	1		4
4	http://www.century21nz.co.nz/	1	1	1	1		5	0		1	1
5	http://www.citysales.co.nz/						0	0		1	3
6	http://www.crockers.co.nz/	1	1	1	1	1	6	0	1		1
7	http://www.darrenstockman.co.nz/										
8	http://www.eastcity.co.nz/	1					1	0		1	3
9	http://www.realpeter.co.nz/						0	1	1		4
10	http://www.excellrealty.co.nz/index.php						0	0		1	3
11	http://www.firstnational.co.nz/	1	1	1	1	1	7	1	1		0
12	http://www.harcourts.co.nz/	1	1	1	1		5	1	1	1	5
13	http://www.harveys.co.nz/	1	1	1	1	1	6	1	1	1	1
14	http://www.curtis.co.nz/curtis/splash1.html										
15	http://www.knightfrank.co.nz/										
16	http://www.lochores.co.nz/	1		1	1	1	6		0		4
17	http://www.ljhooker.co.nz/	1	1	1	1	1	6		1	1	6
18	http://www.milfordrealestate.co.nz/			1	1		3	1	1	2	3
19	http://www.miltonrealty.co.nz/						0	1	1	2	1
20	http://www.pihaproperty.co.nz/						0	0	1		3
21	http://www.geocities.com/ponsonby_howick						0	0			2
22	http://www.premium-realestate.co.nz/	1		1			3	1	1	2	2
23	http://www.prestigerealty.co.nz/	1	1	1	1	1	6		1	1	0
24	http://www.professionals.co.nz/	1	1	1	1	1	6	1	1	1	7
25	http://www.apartment-realtor.to/										
26	http://www.propertyexchange.co.nz/										
27	http://www.raywhite.com/	1	1	1	1	1	6	1	1	2	4
28	http://www.richardsons.co.nz/	1	1	1	1	1	6		0		3
29	http://www.sawyer-realestate.co.nz/	1	1	1	1	1	6	1	1	2	5
30	http://www.waihekerealestate.co.nz/	1	1	1	1	1	6		0		1
31	http://www.wrightson.co.nz/	1	1	1	1	1	6		0	1	4

Appendix One – Elements Scoring (continued)

Organisation					Ease of Use				Appearance				Relevant Features							Trust							
1 1 1					3	1 1 1 1				4	1 1 1				3	1 1 1 1 1 1							6			0	24
1 1 1 1 1					5	1					1 1 1 1				3	1 1 1							2			0	25
1 1 1					3	1					1 1				1	1 1 1							2	1		1	12
1 1 1 1					4	1					1 1 1				2	1 1 1							2	1		1	16
1 1					2	1					1 1				1	1 1 1							2			0	9
1 1 1					3	1					1 1 1				2	1 1 1							3			0	16
1 1 1					2					0	1				1	1							1			0	8
1 1 1					3	1					1 1				1	1 1 1							2			0	12
1 1 1					3	1					1 1 1				2	1 1 1 1 1 1							3			0	12
1 1 1 1					4	1 1					2 1 1 1				3	1 1 1 1 1 1 1 1							7	1		1	25
1 1 1 1 1					5	1					1 1 1				2	1 1 1							2	1		1	24
1 1 1					3	1					1 1 1				2	1							1			0	17
1 1 1 1					4	1					1 1				1	1 1 1 1 1							4			0	20
1 1 1 1					4	1 1					2 1 1				2	1 1 1 1 1							5	1 1		2	28
1 1 1					3	1					1 1 1				2	1							1			0	15
1 1 1					3	1 1					2 1 1				2	1							1	1		2	13
1					1					0	1				1	1 1							3	1		1	9
1 1 1					3						0					1							1			0	6
1 1 1 1					4	1					1 1 1 1				3	1 1 1							3	1		1	19
1 1					2	1					1 1 1				2								0			0	12
1 1 1 1					4	1 1					2 1 1 1				3	1 1 1 1 1 1 1 1							8			0	31
1 1 1 1					4	1 1					2 1 1				2	1 1 1 1 1 1							6	1 1		2	28
1 1 1					3					0	1				1	1 1							3			0	16
1 1 1					3	1					1 1				1	1 1 1 1 1 1							5			0	23
1 1 1					2					0					0	1 1							2			0	11
1 1 1 1					4	1 1 1					3				1	1 1 1 1 1							4	1 1		2	24

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An Investigation of New Zealand Recruitment Agency Web Sites

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Abstract

Many recruiters use the web for job placements, to help organisations quickly reach the correct audience by posting available positions on the Internet and providing a way for candidates to submit resumes electronically. Recruitment agencies find this an efficient and effective way to establish a connection between employer (client organisation) and job seeker (candidate). It is a fast, flexible, inexpensive way to find potential organisations/candidates. Content analysis is used in this study to evaluate recruitment agency web sites. The online recruitment agencies web sites are categorised into two groups: IT specialists, and the more general recruitment agencies web sites covering a wide range of industries. We evaluate and compare the New Zealand web sites of seven IT specialist recruitment agencies and eleven general ones. The fundamental elements for a fully functional electronic evaluation model based on the Hersey model (as cited in [5]) were defined. The results showed that although the sites scored well on the Information and Trust dimensions, they performed relatively poorly in transaction capability and in providing promotional elements.

1. Introduction

The Internet has become a medium, a channel between two independent parties. In this study, they are the client organisations and job candidates. The Internet not only brings the potential for much more marketing opportunities for both entities, but also provides the way both could communicate with each other more efficiently and effectively. The Internet has a great impact on the process of the traditional recruitment industry evaluation, so a new business model is built, and the recruitment environment is changed as well. In addition, organisations and customers are facing potential opportunities and challenges.

The global economy is entering a slowdown stage; this phenomenon affects not only NZ economics but also the employment market. In this environment, people are not passively seeking jobs any more. They know in the world where everything is fast moving, employers and employees want to make quick decisions. Recruiting through the Internet allows them to do this. The Internet becomes an effective medium, providing a wealth of information in real time. Online job recruitment agencies provide a common ground for both client organisations and job seekers. As a result, candidates use it to attempt to

obtain new jobs. People are aware that online recruitment agencies web sites are an important and effective tool to both seek candidates and to place resumes that can match the job requirements of both parties.

2. Literature Review

This section will present a literature review on recruitment related topics. First, the Internet's influence on industry structure will be explored. Second the role of online recruitment agencies is described. Finally, web site evaluation models suitable for examining the effectiveness of recruitment web sites are reviewed. These include the infotainment model and usability evaluation model.

2.1 The Internet Influences Industry Structure

Strategy guru Michael Porter [3] states that the Internet's greatest impact has been to enable the reconfiguration of existing industries that had been constrained by high costs for communicating, gathering information, or accomplishing transactions. Particularly, for the online recruitment agencies, the Internet is used not only to connect the various activities and entities but to optimise its working in real time. In addition, the data the recruitment agencies can collect and maintain will be optimised and customised based on input not only from organisations and suppliers but also from customers. He also explains that the basic tool for understanding the influence of Internet on organisations is the value chain - the set of the activities through which a product or service is created and delivered to customers [3:74]. By enabling the new approaches to meet needs and perform functions, the Internet creates new substitutes. The use of the Internet also tends to expand the geographic market, bringing many more organisations into competition with one another.

2.2 The Role of Online Recruitment Agencies

The recruitment agency's job is to represent job seekers fairly to potential employers, and to explain in clear detail where the job seeker stands in the marketplace and the types of work one can expect to find, as well as the appropriate remuneration package. A good agency should be able to give you a timeframe for finding a job, as well as provide you with an idea of the type of organisations with whom you can expect to be deal.

Whitely [5] said that the advantages of the Internet on recruitment agencies are obvious. It is easy for everyone with a computer access. It is incredibly quick, and much cheaper than advertising in newspapers and magazines. He also predicted that in the future the standard way to apply for a job could be to send e-mail to an online recruitment agency and go through the whole interview and selection process over the Internet. However, David Fox, CIPS's recruitment database co-ordinator, says: "The Internet is not a replacement for traditional methods. It's an add-on."

From the job seeker's view, they can provide their resume to a number of locations much more quickly, and also can get up-to-the-minute information in terms of which jobs are available. Organisations are looking for people who are not necessarily located in their area or even in the country in which the organisation is operating.

Customers want a recruitment and selection system is not only fast, but also flexible, paperless, and inexpensive. At the same time, they want a system that can be tailored to their individual requirements, be customised to select for position-specific skills, and provide up-to-date, easily accessible candidate information. They want a system that would reliably produce high quality candidates and be fair and equitable to all applicants.

2.3 Web Site Evaluation Model

This section includes models for web site evaluation, particularly for online recruitment agencies.

2.3.1 Infotainment Model

The Infotainment model created by Chung and Paynter [1] is used to provide a framework in which business sectors should consider a strategy to attract revisits to a web site. The framework includes two main attributes on which to classify a web site, 'information' and 'interaction'. A two by two matrix develops it with the axes of degree of information and interaction. Chung and Paynter defined these four quadrants as passive, interaction-oriented, information-oriented and interactive-information. Based on the features of online recruitment agencies against the infotainment model, the recruitment agencies web site should fall into information-oriented quadrants, which is mainly associated with information rather than with interaction.

2.3.2 Usability Evaluation Model

There are many approaches have been proposed for web site effectiveness evaluation and design. Here, a general model for e-commerce evaluation and design developed by Ian Hersey (as cited in [5]) is introduced. The model consists of fourteen elements that respond to different aspects of an effective e-commerce web site. This model was designed for the usability of an entire e-commerce web site and served as a five point scale from the web site visitor perspective to assess and rank the site when designing and implementing an e-commerce web site.

Based on this model, Paynter et al. [2] proposed a usability evaluation model that measures web sites by three dimensions: effectiveness, efficiency and satisfaction. The model consist of four fundamental components to an e-commerce web site. These are information, transaction service, trust and non-functional requirements. Each component includes the number of elements that might vary based on a particular industry. Therefore, this model presents an abstraction level, ignoring the identification of each element. With this idea, the model can be regarded as a basic model to evaluate the usability of variable e-commerce industry sectors. This model can be applied to recruitment agencies web sites. Therefore, the elements for this particular industry can be defined for examining the web sites. The details are described in the next section.

3. Research Method

The research method mainly focuses on content analysis backed up with qualitative assessments of the individual sites. The aim to determine the characteristics of the online recruitment agencies services web site to assess and rank site capabilities against the model proposed to serve as a benchmark.

3.1 Content Analysis

Weber [4] defined content analysis as a research method that uses a set of procedures to make valid inference from text. Content analysis is a quantitative research method. In this project, content analysis consists of two main steps. An evaluation model for online recruitment agencies web site is developed, and then a systematic and objective procedure can be followed to evaluate the individual sites.

3.1.1 Online IT Recruitment Agencies Web site Evaluation Models

The main ideas for the recruitment model are derived from the combination of the components in Hersey's e-commerce web site evaluation model and the categories in the abstract site usability model [2]. Due to the recruitment agencies' unique features, some components and categories are not appropriate to meet the requirements of online recruitment web site services. Therefore, a model for online recruitment agencies was developed. Five dimensions are used to measure online recruitment agencies web sites. Each dimension consists of various elements. Although the model is specific to IT recruitment agencies, the model still can be used for other types of recruitment agencies web sites. The categories are: Information, Transaction Service, Trust, Non-Functional requirements and Promotion. These five categories are defined to effectively catch the elements of quality for each specific model.

The categories and the elements incorporated into each category will be discussed below in detail.

1.Information: Three are three elements are associated with this category, which are

³/₄Organisation information. The site provides the information on the organisation, including the organisational profile, history, team members, contact information and marketing plan and branch.

³/₄Customer information. Due to the unique feature of recruitment agencies, two kinds of customer are allowed to enter into the web site by registration and contract service. These are job seekers, local or overseas, and client organisations.

³/₄Vacancy. The site contains job vacancy (NZ and overseas) information. These last two categories are the “product” of the recruitment agency.

2.Transaction Service: This category is used to assess the industry-specific services offered on recruitment agencies web sites. The criteria components are:

³/₄Job search engine. The site has this function to help customers purposely and quickly search the job.

³/₄Candidate registration (profile detail). The site registers candidate information into the database

³/₄CV submission. The candidates apply a vacancy by CV submission

³/₄E-mail contact service. The candidates can also use the email to apply for a vacancy.

³/₄Contractor Login. The function allows candidates to view or edit their personal details in the database, or enter the employment database that is specially set up for registered candidates.

3.Trust:

³/₄Legal disclaimer. The site should provide the legal information such as organisation and position information

³/₄Privacy statement. The site makes sure that a customer privacy and personal information are protected

³/₄Security. The site ensures the security when personal data (CV) are stored and transmitted.

4.Non-Function Requirements:

³/₄Aesthetic effect. The site contains graphics or animations

³/₄Ease of use. The site provides effective navigation tool or site map to help customers use the site

³/₄Update frequency. As the feature of recruitment industry, the job market is constantly changing, up-to-date information is essential to customers.

³/₄Page loading speed. The page loads in less than 8 seconds.

³/₄Online help. The site provides additional information to candidates.

5.Promotion

³/₄CV and interview Tips. The site provides the CV format and interview guide.

³/₄Email Newsletter. The site provide current job marketing news and update organisational news

³/₄Link. The site can link to other relevant sites from which the customers can get other information, such immigration and NZ general

³/₄Online learning/training. The site offers online training, especially in the IT field.

³/₄Articles and case study. A range of subjects in articles and case studies is available.

³/₄Survey. The site offers an up-to-the-moment insight into salaries presently commanded in each market.

³/₄Feedback. The site can get feedback from customers about the site and recruitment information.

³/₄Job offers. When a vacancy is matched, the site can automatically inform candidates by e-mail.

The components and elements on effective recruitment web sites are summarised in Table 1.

Table 1: Model for online recruitment web site evaluation

Information	Organisation
	Customer
	Vacancy
Transaction Service	Job search engine
	Candidate profile registration
	Contractor login
	CV submission
	Vacancy submission
	E-mail contact service
Trust	Legal disclaimer
	Privacy statement
	Security
Non-Function Requirements	Aesthetic effect
	Ease of use
	Update frequency
	Page loading speed
	Online help
Promotion	CV and interview tips
	Newsletter
	Web site link
	Online learning/training
	Article and case study
	Survey
	Feedback
	Job offers

3.2 Sample Selection

The main industry recruitment magazine, the New Zealand Computer World (www.computerworld.co.nz), and the New Zealand Herald (www.nzherald.co.nz) were scanned to look for recruitment agencies. The electronic yellow pages (www.yellowpages.co.nz) was used as an additional source to search for other recruiters. Surprisingly few recruitment organisations were found. It

seems that in the last few years there have been structural changes in the industry. There were few, if any, indigenous recruitment agencies. The existing ones had been dissolved on the retirement of their principals or had been absorbed into multinationals.

4. Data Analysis and Key Findings

This section presents an overview of the data and its analysis, including identification of the specific web sites examined, how the scores were obtained and coded, how each site scored, and how each item scored across sites.

Seven IT specialist recruitment agencies web sites were included in this study. The names of agencies and their URLs are listed in Table 2.

Table 2: IT Recruitment agencies

No.	Recruitment Organisation	URL (http://)
1	Candle New Zealand Ltd	www.candle.co.nz
2	DeWinter International Ltd	www.dewinter.co.nz
3	Duncan & Ryan Associates Ltd	www.duncanryan.co.nz
4	I.T.@Work Recruitment Ltd	www.itwork.co.nz
5	Information Technology Recruitment	www.itec.co.nz
6	Sabre Systems Limited	www.sabrenz.co.nz
7	Sapphire Technologies	www.saphhirenz.com

Eleven general recruitment agencies web sites were included in this study (Table 3).

Table 3: General Recruitment agencies

No	Recruitment Organisation	URL (http://)
1	Crown Recruitment	www.crown.co.nz
2	CRS Recruitment (Auckland) Limited	www.crsrecruit.co.nz
3	Lawson Williams Consulting Group Limited	www.lawsonwilliams.co.nz
4	Madison Recruitment Management	www.madisonrec.co.nz
5	Martin Personnel Group	www.martinpersonnel.co.nz
6	Momentum Consulting Group	www.momentum.co.nz
7	OCG Consulting Limited	www.ocg.co.nz
8	OPAL Consulting Group	www.opal.co.nz
9	Robert Walters Associates	www.roberwalters.co.nz
10	Sheffield Limited	www.sheffield.co.nz
11	Spherion Recruitment Solutions	www.spherion.co.nz

4.1 Coding of Recruitment Agencies Web Sites

Binary scores were used to record the appearance of each element in the evaluation model on each site, including both IT specialist and general recruitment agencies (Table 4).

Table 4: Site scoring by element

	Information			Transaction Service					Trust			Non-Function Requirement					Promotion										
www.candle.co.nz	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
www.dewinter.co.nz	1	1	1	1	0	1	0	1	1	1	1	1	0	1	1	1	0	0	0	1	0	0	0	0	0	0	14
www.duncanryan.co.nz	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	0	0	0	1	18
www.itwork.co.nz	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	19	
www.itec.co.nz	1	1	1	0	0	0	0	1	0	1	1	1	0	0	0	1	0	1	0	0	0	1	0	0	0	10	
www.sabrenz.co.nz	1	1	1	0	1	1	0	1	0	1	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	10	
www.saphhirenz.com	1	1	1	1	0	0	0	1	0	1	1	1	0	0	1	1	0	0	0	1	0	0	0	0	1	12	
www.crown.co.nz	1	1	1	0	1	1	0	1	0	1	1	1	0	0	0	1	0	1	1	1	0	1	0	0	0	14	
www.crsrecruit.co.nz	1	1	1	0	0	1	0	1	0	1	1	1	1	1	0	1	0	0	0	1	0	1	0	0	0	13	
www.lawsonwilliams.co.nz	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	15	
www.madisonrec.co.nz	1	1	1	0	0	0	0	1	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	11	
www.martinpersonnel.co.nz	1	1	1	0	1	1	0	1	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	14	
www.momentum.co.nz	1	1	1	1	0	0	0	1	0	1	1	1	1	1	1	1	0	1	0	0	0	0	1	0	0	14	
www.ocg.co.nz	1	1	0	1	0	1	0	1	0	1	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	13	
www.opal.co.nz	1	1	0	1	0	0	0	1	0	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	1	11	
www.roberwalters.co.nz	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	0	0	1	1	0	0	19	
www.sheffield.co.nz	1	1	1	0	0	1	0	1	0	1	1	1	1	1	1	1	0	0	1	1	0	1	1	0	0	16	
www.spherion.co.nz	1	1	0	1	1	1	0	1	1	0	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	19	

4.2 Scores on Recruitment Agencies Web sites

Scores for IT specialist recruitment agencies and general recruitment agencies web sites are shown in Figures 1 and 2, respectively. The bars labelled with the data value indicate how many elements were present in each specific recruitment agency web site. The longer the bar, the higher the site score. The recruitment agency web sites with a higher score have incorporated a greater number of elements identified in the evaluation model for effective web site design. The maximum value obtainable is 25, which represents the 25 elements defined in the evaluation model for the recruitment agency web sites.

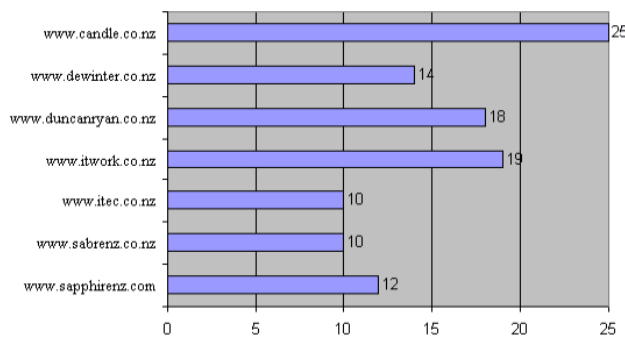


Figure 1: IT specialist recruitment site scores

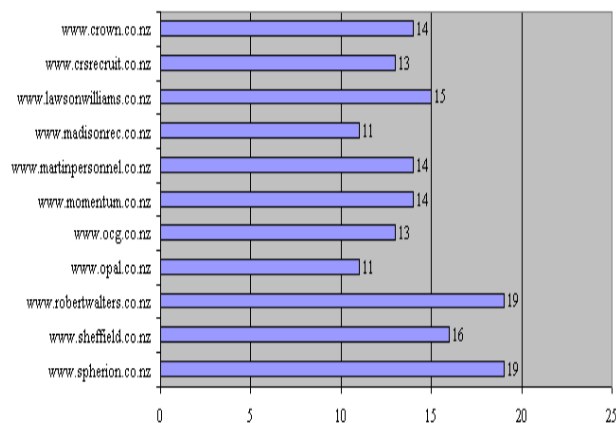


Figure 2: Generalist recruitment site scores

4.3 Site Score Analysis

The average number of elements by the seven IT specialist recruitment agencies was 15.4 (108/7) per site, more than 12.5, the 50% mark for representing all the elements identified in the evaluation model. The average number of the utilised elements per web site for the eleven general recruitment agencies web site was 14.5 (159/11). The two figures are not significantly different; they reflect that the overall adoption of elements measured on both IT specialist and general recruitment agencies was acceptable, but still of a moderate degree indicating low utilisation of the potential of the Internet for recruitment organisations.

4.4 Element Score on Recruitment Agencies Web Sites

The same method was applied to calculate the presentation of scores gained by each element across the recruitment agencies sites. Bars labelled with the data value indicated how many sites presented the specific element. The elements with higher scores reveal the importance accorded them by the agencies in designing their recruitment web sites. The selected sites (7 and 11 respectively) determine the maximum value.

4.5 Element Scores Analysis

Figures 3 and 4 indicate that there is wide variation across both categories of sites with respect to the use of the different elements of the model. Both categories paid relatively more attention to the information and trust categories. In contrast, the organisations did not pay much attention to transaction services and promotion.

4.6 Key Findings

Both the IT specialist and general recruitment agencies web sites received low and medium scores (Table 5). Overall, the findings show that the online recruitment agencies web sites are performing poorly, as measured by this model.

Table 5: Site classification as to effectiveness

Site Score	IT specialist sites (7)			General sites (11)		
	Low (0-13)	Medium (14-18)	High (19-25)	Low (0-13)	Medium (14-18)	High (19-25)
Count/ (Percent)	3 (42.9%)	2 (28.6%)	2 (28.6%)	4 (36.4%)	5 (45.5%)	2 (18.2%)

Table 6: Analysis of Dimensions

Type	Dimensions	Dimension Scores				
			Element			
	Information	21	3	7	7	100
	Transaction Service	24	6	4	7	57.1
	Trust	21	3	7	7	100
	Non-Function Requirement	21	5	4.2	7	60
	Promotion	21	8	2.6	7	37.1
	Information	30	3	10	11	90.9
	Transaction Service	33	6	5.5	11	50
	Trust	32	3	10.7	11	97.3
	Non-Function Requirement	40	5	8	11	72.7
	Promotion	24	8	3	11	27.3

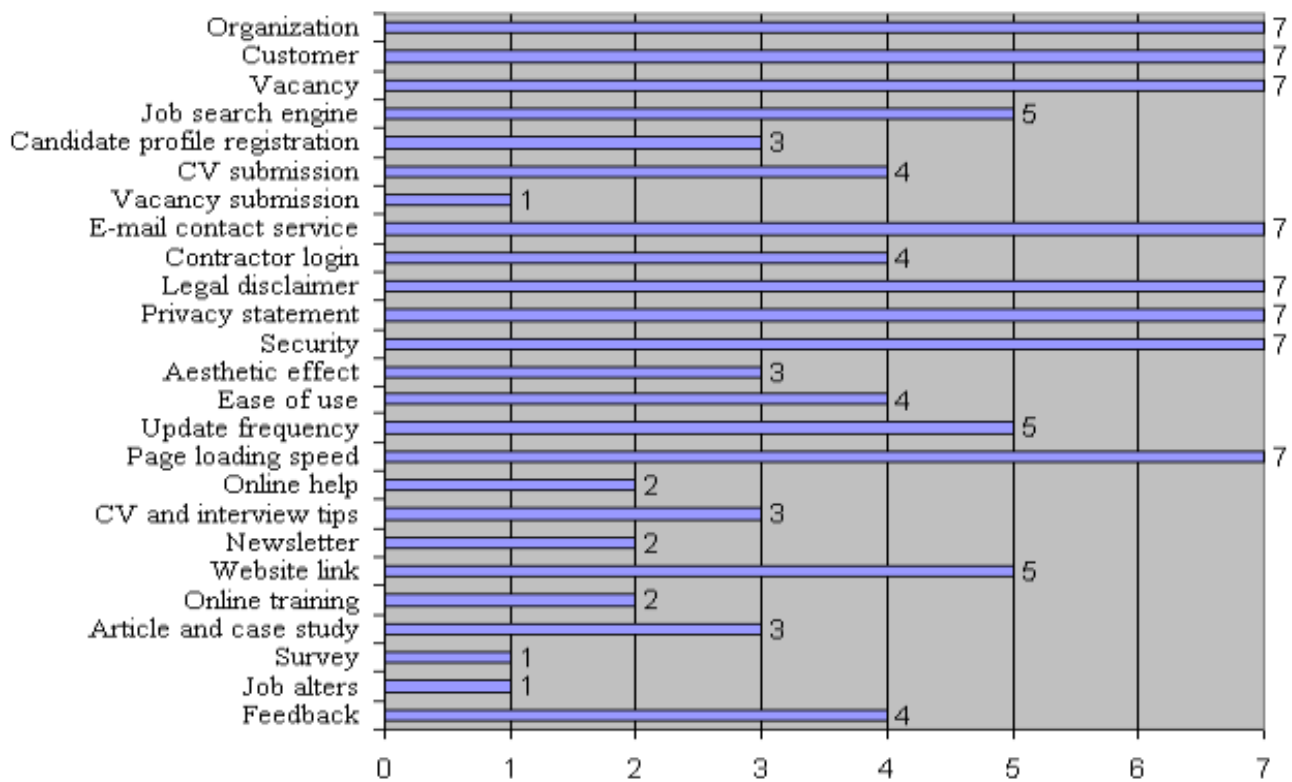


Figure 3: IT specialist recruitment element scores

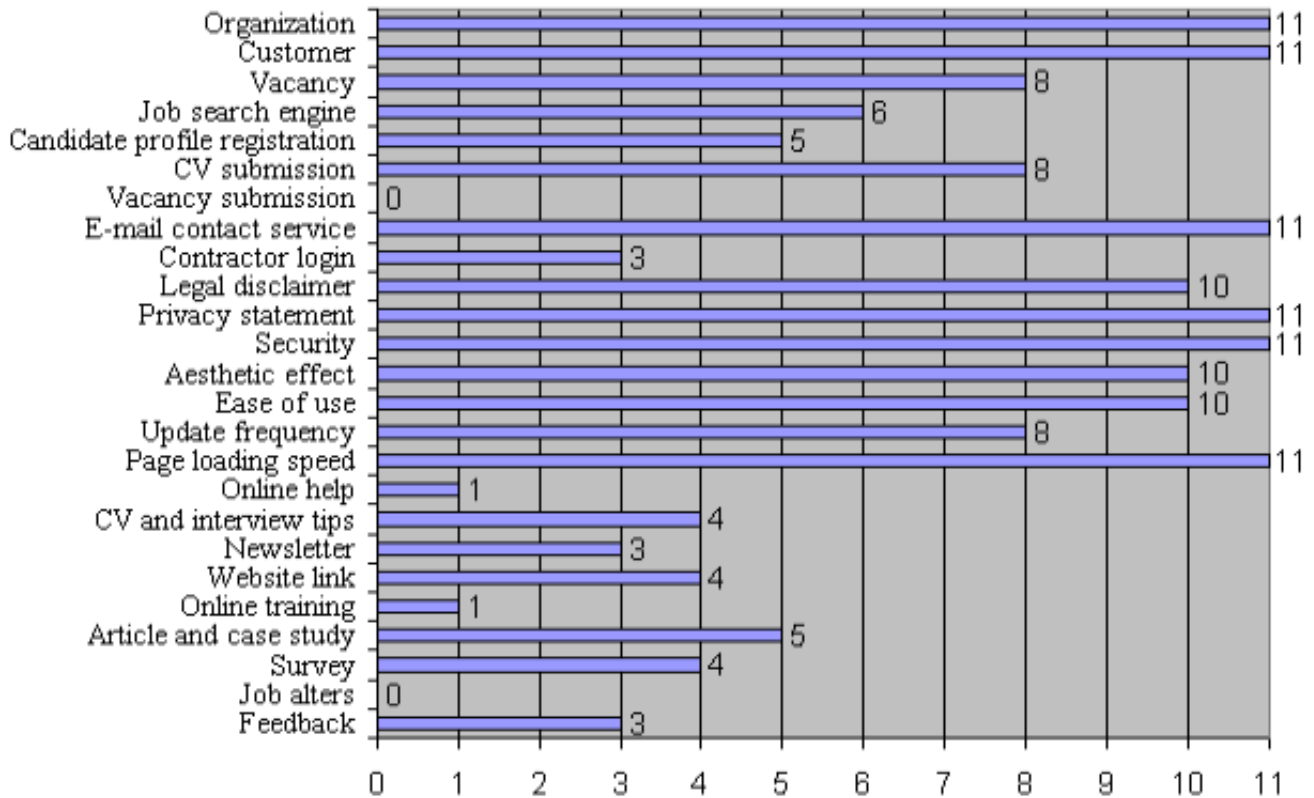


Figure 4: Generalist recruitment element scores

Both IT specialist and general recruitment agencies web sites contained elements of all five dimensions used in the study. However, the performance of each dimension varies significantly. Information and trust were the most frequently implemented elements. The findings indicate that the recruitment agencies web sites are informational rather than transactional. The recruitment agencies emphasise the information available at the site. It is also good to see that the trust dimension is considered as a high priority. This is a sound strategy as job seekers are highly concerned about the privacy of their applications. For instance, they might not want their current employer and colleagues to know that they are looking for jobs. In the same way, organisations might not want their employees to know that they are recruiting or if they are, what the remuneration packages might be. However, the lack of transaction service and promotion in both types web sites should be noted.

The requirements of candidates were considered in most recruitment agencies web site, such as job search, and candidate profile registration. Only one web site provided a function to allow client organisations to enter the candidate database. Most web sites have not realised that the web can provide more services for the organisations recruiting employees. The promotion dimension was implemented quite differently among all recruitment agencies web sites. For example, CV format and interview guide are offered by several sites. They are very attractive factors to candidates. The recruitment agency web sites with high scores tended to do well on the promotion dimension. Overall, the recruitment agency web sites did not provide many options for both candidates and client organisations.

5. Discussion

This section is divided into a discussion of the analysis of the web sites, and some recommendations for the organizations and their web site developers.

5.1 Recruitment Agencies Web Sites Assessment

As the online recruitment agency web sites play important roles in the organisation's business strategies, it is important to evaluate what has been achieved and what challenges are still to be faced. The previous section presented the findings based on content analysis. The evaluation results were based on the site scores and element scores across the IT specialist and general recruitment agencies web sites. The findings indicated the performance of both types of web site were similar.

When looking at the five dimensions - information, transaction services, trust, non-function requirements and promotion, both put the most attention on the information and trust. Sites did quite well on the organisation information and vacancies available, probably due to the fact that recruitment agencies are information-oriented. The organisations try to make a good and confidential impression based on the content of the information and the display of the conditions of the site. In contrast to that

achieved by the online recruitment agencies web sites to date, the challenges faced by the online recruitment services are severe. For example, the web sites evaluated did not make much use of transaction service nor for promotions.

Most recruitment web sites provide some services for job seekers, such as job search, candidate profile registration and login. As this key functionalities improve, the web sites become rich and effective, the candidates can get more value from them. However, the client organisations cannot do too many things by using the recruitment agencies, the reason probably is, the client organisations are more likely to have face-to-face communication with recruitment agencies. They are more passive entities. Only one recruitment agency web site examined offers a service to allow client organisations to enter the candidate database. This allows the clients to access candidates directly, and can seek more suitable people preventing the bias of recruitment agencies.

Performance in the promotion dimension varied significantly. Some sites did well with respect to this dimension, but some sites did little. The promotion dimension can attract the customers to visit the web site. For example, online training and learning, CV format and interview guide, newsletters and web sites link are very useful to candidates. By visiting the web sites that tend to have more promotional elements, the job seekers can get not only current job information but also future career advice. They are more likely to revisit and the agency retain their custom.

5.2 Recommendations

The focus is on the evaluation of online recruitment agencies web sites in New Zealand. The findings represented the recruitment agencies web sites as of poor performance. What should an effective recruitment agency web site contain? We should take into account the needs of the customers and the purpose of the web sites.

The customers want recruitment agency web sites with sufficient and timely information, confidential service and quick response. In order to interact effectively with the customers, the transaction services and promotion need to be enhanced on the recruitment agencies web sites. In addition, some elements, such as CV format, should become standard.

6. Conclusion

The focus of the study is on content analysis of online recruitment agency web sites. By examining the current achievement of these web sites, we may enhance our understanding of how to better develop an online recruitment agency web site. The evaluation of recruitment web sites in this study was based on a previously developed usability model featuring five major dimensions – information, transaction service, trust, non-function requirements, and promotion. Each dimension comprises different elements. The findings from scoring the sites and elements respectively indicate

that the online recruitment agency web sites studied do not perform in a uniform manner, and most are of poor presentation. Transaction services and promotion should be improved to enhance the effectiveness of the web site. However, the single evaluation method, and the small (although exhaustive) sample size may limit the generalisability of the study. The job recruitment industry's use of web sites for this purpose is in its infancy. A longitudinal study would provide a more comprehensive and thorough examination of the use of the Internet by this industry.

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E-Business Enabled Networks and Fourth Party Logistics (4PL) Providers :

An Overview

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Abstract

The Internet has been a key to optimizing the supply chain, enabling real-time data to be shared between supply chain partners, which usually connect together as an e-business network. Nowadays the focus is on building-in value added products/services, thereby enabling the network to differentiate itself from its competitors in a more sustainable manner. In this context, outsourcing has provided significant cost reductions for businesses, with the use of third party logistics providers (3PLs). This is today only a 'qualifying criterion' for most businesses, and no longer a competitive advantage. The creation of a fourth party logistics provider (4PL) aims at moving the client to a more competitive position, by analysing relevant business risk, and monitoring relevant KPI's, and applying these within a 4PL providers efficient alliance network.

1. Introduction

Supply Chain Management (SCM) may be viewed as "the art and science of creating and accentuating synergistic relationships among trading partners in supply and distribution channels with the common shared objective of delivering products and services to the 'right customer' in the 'right quantity' and at the 'right time'" [25]. Demand Chain Management (DCM) [23], provides another perspective where the locus of control is moved from the supplier to the customer. This move from a 'push' (supplier driven) to a 'pull' (customer driven) system allows customer initiated ordering to drive the entire supply chain. DCM aims first and foremost at meeting the needs of specific customer segments, rather than concentrating on internal optimization [28]. DCM also allows the single business unit to instigate new sets of efficient, co-ordinated, customer-related, data-sharing practices across its entire supply chain.

The World Wide Web and the Internet, combined with linked, innovative, integrated networks sharing digital information up-and-down the entire supply chain, provides the basis for the development of supply chains (SC), or demand chains (DC). Both supply chain management (SCM) and demand chain management (DCM) still have their place.

SCM is particularly useful in delivering longer product life-cycle items such as commodities, or complex products with long lead times such as aircraft

construction. Here, all links in the chain are compared to the desired overall total performance of the entire chain, and each individual link is separately optimized. Thus the overall performance of the entire chain may be improved [5].

The Internet has been a key to optimizing the supply chain. It has enabled real-time data to be shared between supply chain members (or partners). The supply chain members usually connect together as an e-business network. They share information freely with participating partners: obtaining real-time updates of production line product positions; planning schedules; stock requirements etc.; shipping to a schedule; paying electronically; and managing individual processes for the benefit of the entire supply chain. SCM is a continuously evolving process. New strategies, methods, systems, ideas, and the like continue to drive additional learning-curve effect efficiencies. Hence SCM is a pathway towards competitive advantage and sustainability [19], but they can only ever be as efficient as the sales forecast [18].

DCM is similar to SCM, but it is customer driven. Here the customer expresses a desire for a product, with a variation to the original standard product. The aim is produce this product variation and deliver it whilst meeting the customer's expectations. It appears best suited to shorter life-cycle products such as software, computers and the like. However, even traditional, complex SCM businesses, such as automotive industry companies like GM, are moving towards the DCM model.

The Internet has enabled the customer to acquire product knowledge from a global perspective, and to do so at a rapid rate. The knowledgeable customer has become the decision-maker, and the influence of the supplier is greatly reduced. The customer now manages the performance of the total supply chain [15], and decides what they want, when they want it, and why they want it.

The DCM model has conceptualized the introduction of dynamic pricing models, make-to-customer order systems, and new lead time policies [26]. Make-to-customer order systems have typically been termed 'customized' orders. DCM models are moving towards one-on-one customized orders where the individual customer gets a variation of the product that closely meets their needs and wants.

The next level of customization is the true one-on-one approach where the customer receives a product that fits their needs and wants exactly. This one-on-one relationship is termed 'customerization' [12]. Customerization requires skilful strategic positioning of the e-business [13]. Numerous other factors must be considered, including knowledge of the customer's culture [16]. For example, e-business research indicates Japanese customers prefer detailed descriptions and little graphics on e-business web sites, whilst USA and Korean customers prefer brief text and more extensive graphical presentations - yet all groups showed a preference for a grid layout when compared to a dynamic, curved layout. Where close similarities occur between countries, for example where USA and Korean customers preferred a more visual and less text based approach, one web site design may provide satisfactory, cross-cultural usability. The individual country customers are then segmented. This segmentation does not follow traditional lines based on demographics. It is based on technographics [10] [13] [30], where the country's customer profile is segmented based on their technological ability - how techno-savvy they are. User groups are profiled, and studied, with a view to providing 'customized' web interfaces that best meet their demands. Web site visitors are tracked, and customer specific interfaces are matched to the on-line information seeker's preferences. This immense task is most cost effective at the larger or 'portal' web site level. It requires: a programmer(s)/program analyst(s) and web master(s); a database driven web site(s); quality software, hardware and communications; specific tracking tools working in conjunction with internal business intelligence and knowledge management systems; appropriate supply chains and value adds; and a system that continuously updates.

Currently, under Internet communications protocol system IPv4, the on-line customer has no fixed address, there is no performance manageability due to routing and demand issues, and it is not really 'plug and play' [4]. Consequently, there is no direct way, other than 'cookies' and competitions, of tracking the number of visits a user makes to an e-business web site. We can, however, see where the user came from, how long they visit a page, where they go within the site (and the time they spend), and from where (and to) they exit. The user's mouse clicks can be tracked along with associated actions, and the time-interval between clicks. Thus some data collection (and subsequent analysis) is possible, especially if cookies can be deposited on the user's computer.

The new flexible, agile, demand chain driven/supply chain supported, dynamic e-businesses are also stretching out to build-in value added products, thereby enabling them to differentiate themselves from their competitors in a more sustainable manner. These e-businesses, being more agile, are more likely to survive against the lowest 'selling price' pursued by many on-line customers.

The entire e-business driven-supply chain is moving towards a new level of quantifiable information sharing and collaboration. To measure such intangible assets, the

'Cap Gemini Ernst and Young Centre for Business Innovation' has developed a 'Value Creation Index' (VCI) [6] [17]. The Index assesses (through regression and other advanced statistical tools) the non-financial value drivers. These drivers must be exploited in order of importance to maximize value. When applied to e-commerce businesses, strategic alliances, investments in innovation, and number of users are of high importance as drivers of market value. This in contrast to brand awareness, minutes per page, change in usage, and change in percentage reach, which do not display a statistical association with market value. The VCI model demonstrates that 90% of an e-commerce company's value is based on these intangible factors [6]. Thus e-business alliances should be established based on the firm's ability to: add value to customers; eliminate unnecessary and uneconomical complexity in creating value adding propositions; and consideration of the total customer experience [29].

Within the services arena the current, highly-competitive global business environment requires businesses to provide value to their business offerings [22]. For example: to remain agile, and compete effectively, IBM focuses on four drivers - globalization, value creation, the extended enterprise, and operational excellence. It has redefined its supply chain as 24 hours by 7 days access with immediate or same day delivery. This data centric corporation works with real-time information from smart data capture and analysis systems.

The 'services' industry has readily adopted the Internet based e-business environment. It has linked its supply chains to web interfaces, and has offered additional 'value-adds' to move its entire supply chain to more optimal positions. For example: the real estate industry, in addition to its property listings, offers financial calculators, mortgage and loan comparisons, on-line purchasing, and the like. Other service providers - including solicitors - have out-sourced non-core areas of their business like office typing and mail rooms. As such, these service providers have embraced an outsourcing model denoted as "Third Party Logistic (3PL) providers" [27].


This notion of outsourcing is taking on a new strategic dimension, which is the focus of this paper, and which will be further elaborated.

2. Third Party Logistics Providers

First Party Logistics (1PL) providers, prior to 1980, were traditional logistics suppliers. In the early 1990's Second Party Logistics (2PL) network players like TNT and UPS commenced global operations, and in the late 1990's Third Party Logistics (3PL) providers emerged with many unexpected players (for example: integrated IT suppliers; management consultants; financial services) entering the market. The development of 3PLs was primarily due to the emergence of technology - enabling information exchange and facilitating communication between businesses.

3PL providers offered the e-business significant benefits. They play a substantial role in supply chain optimization and integration initiatives, by taking over out sourced 'non core' business functions and reducing costs, consolidating activities, and improving efficiency of the supply chain. For the demand chain, the results are: reduction of asset intensity; restructuring of distribution systems triggered by restructuring of production structures; and reduction of labour costs by switching to a non-unionized labour force provided benefits. In addition, the supply side is driven by declining profit margins in basic services (like freight and transport), and the tight availability of capital outsourced items such as shipping. 3PL providers have the potential to add value to e-businesses by sharing resources between their customers, sometimes outsourcing certain activities to second or third tier providers, (who join the value adding process as complementary providers), with the greatest impact in containing logistics costs [20]. Thus both horizontal and vertical integration develops between these optimized 3PL service providers, and the e-business benefits [2].

Table 1: 3PLP Value Creation Table

Taxonomy of Value Creation by 3PL Providers				
				
Descript ion	Operation al efficiency	Integration of customer operations	Vertical or horizontal integration	Supply chain management & integration
Driver	Factor costs	Scale	1.Asset reduction 2.Scale 3.Factor costs	Development of customer business process
Skills	1.Operation 2.(IT)	1.Operations 2.IT	1.Operation s 2.IT 3.(Conceptu al)	1.Operations 2.IT 3.Conceptual
Example	Run warehouse efficiently	Share warehouse among several shippers	Outsourcing to lower tier providers	Cross-docking or other new concepts

Note:

1. Operations and IT are the basis of value creation
2. Skills - use conceptual logistics skills to improve supply chains
3. Conceptual skills - include knowledge of competitive advantage aspects

Table 1 encapsulates the four ways of adding value. Complexity and associated skills requirement increases from left to right. Vertical and horizontal integration often follows operational and resource sharing value creation. It is rare to find all three skill sets (operations, IT and conceptual) maximized to create value [2].

A major deficit of 3PLs has been the missing ingredients of continuous improvement, strategic supplier relationships, and responsiveness. This is due partially to

the nature of the 3PLs - as their specialisation was provided in a narrow range of services – as well as their historical roots of a very functional operations and logistics-provider background. These skills allow incremental improvements of both cost savings and benefits in sectors of the supply chain (primarily logistics and procurement)- where 3PLs were able to profitably manage these functions - however there is usually a lack of flow-on effect of overall benefit to the whole supply chain.

Today, with globalisation, and a highly competitive marketplace, the narrow service provisions of 3PLs are no longer providing a competitive advantage as these are the entry qualifications for all businesses. 3PLs are also struggling with the narrow profit margins, where providers compete by bidding for tenders – the lowest bid often winning the contract. This is coupled with customer demands for new and innovative solutions for their supply chain [8]. Improvements for 3PLs would be found in significant investment in IT, research and development, and high calibre management that would foster an environment of continuous improvement – yet 3PLs often do not have the financial resources to provide these value adding services.

At this time 3PLs usually do not have either:

- the necessary profit margins to develop new services that would add value for their clients
- nor the internal influence with their business partners to implement changes and improvements if they were developed, as these would be broader than current areas of service. This limitation is due to industry attitudes towards the function and place of out-source providers, as much as due to the self-defined specialisation of 3PLs. Thus 3PLs are confined to operational excellence in specific areas of the supply chain, and are usually unable to implement changes across the supply chain due to restricted access to information and managerial input.

However some current advantages for 3PLs are [9]:

- a highly fragmented and high growth market
- possibility for 3PLs with multiple customers to gain by providing technological and expertise advantages to their customers
- potential for further differentiation.

Some 3PLs are actively expanding their service provision to include procurement, inventory management and financial services [20]). The opportunities are extensive in the area of e-business, where integrated solutions and tools, along with collaborative supply chain management is the key to competitive advantage. Occasionally, a competent group of 3PL's have banded together to become a leading solution provider, closely linked to their customers. They often manage the transport and warehousing networks for a large group of second tier 3PL's. These leading solution providers are the precursor to the latest key players.

3. Strategic Sourcing

Dunn and Bradstreet [7], report large, sustainable cost reductions are achievable when spending is aggregated across business units (and regions), and suppliers are rationalized (with those remaining striving to find new ways of removing costs). This is very different from traditional procurement, which focused on squeezing cost reductions out of an existing set of suppliers. They believe strategic sourcing must incorporate:

- Integrated procurement and accounts payable systems so details and entire spending patterns can be monitored
- Detailed understanding of the amounts spent with each supplier (leading to an integrated position of accounts payable across the supply chain)
- Performance at both ends of the supply chain (as some suppliers are also customers, or alliance partners)
- Mass services as a commodity (one global price for major items, especially with a global provider)
- Risk management allowing consolidation of purchases with fewer, quality suppliers (collected, collated and evaluated information is the key to monitoring and assisting suppliers in this less flexible environment)

Isolated bodies including Deloitte, Ernst and Young, and others have been delivering similar services at an industry specific level for several years, working with specific telecommunications companies, software providers and the like.

Although outsourcing has provided significant cost reductions for businesses - especially at first - the use of 3PLs is now only a 'qualifying criteria' for most businesses, and no longer a competitive advantage. Outsourcing is a method for a company to refine its business to concentrate on core competencies, differentiate customer service and increase operational flexibility [1]. Further cost reductions are required for businesses to gain a competitive advantage and this is potentially found in managing the complete supply chain enabled by increased visibility of information - as seen in successful e-businesses.

4. Fourth Party Logistics Providers

4.1 Characteristics

A new model of logistics service providers is emerging. This model, termed a Fourth Party Logistics (4PL) provider, is shown in Figure 1. The 4PL provider aims to assume responsibility for the entire set of a client's supply chain processes, and to manage, coordinate and drive this 'set' in a highly efficient, and cost effective manner. This approach is no longer aimed at improving the supply chain for an individual company, rather to enhance the 'value-chain' across businesses [26], www.viewlocity.com.

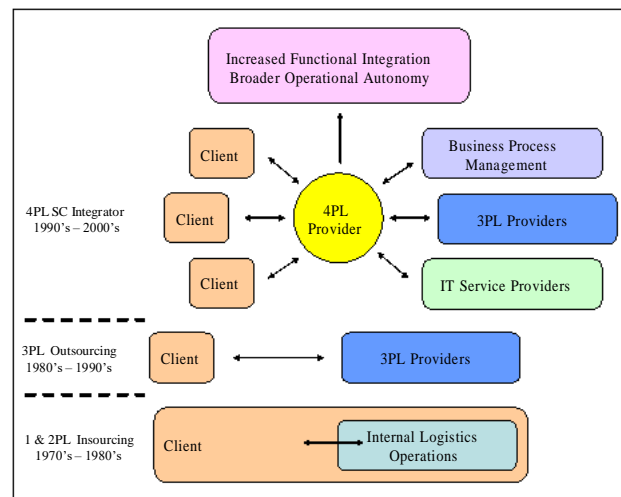


Figure 1: Evolution from 1 & 2PL to 4PL Models

A 4PL provider is a supply chain integrator that primarily provides technological capabilities to resolve a problem or opportunity for businesses [8]. The 4PL provider uses strategic sourcing to assemble and manage resources, capabilities, and technologies and assembles a conglomeration of other complimentary leading 3PL service providers for comprehensive supply chain solutions. It integrates these supply chain organisations into its 4PL structures, thereby creating unique new business models - tailor-made for the client's business or e-business, and its customer driven demand chain.

To be successful at the top of the supply chain, the 4PL provider must add value to its clients (e-businesses). It must deliver:

- Excellence in customer management, and do so in a manner that extracts maximum value. It must offer superior customer service, higher sales value, that focuses on delivering customer value and perceived value; operational excellence, that maximizes capital and human productivity; asset optimisation, that increases productivity and operational innovation; improved transparency and planning, thereby allowing visibility of forward orders across the supply chain; enhanced IT, network solutions and other business intelligence and knowledge management tools that allow lower transaction costs and world-class e-commerce solutions like e-procurement; and virtual inventory management with associated lower inventory costs.
- Corporate agility that maximizes the effectiveness of management by developing change management capabilities, teamwork, and alliance management with excellent people skills
- Strategic positioning that priorities and maximizes focus concerning relative market positioning and exploitation of the organization's capabilities within the

total supply chain, along with the related strategic choices of mode, geography, service and industry.

The success of a 4PL is dependent upon its ability to define top 3PL providers, enable technology providers to form alliances, and be extremely agile in all aspects of its operations. It has the added incentive to develop new cost reductions via leveraging integrated networks; exploring new ways to improve supply chain performance (for example, working with suppliers' external customers to improve and standardize their operations); aligning sourcing to strategic business unit needs (with CEO and CFO support); lead centrally but with local implementation (incorporating harmonious and skilled work teams); and provide excellent service to all its clients.

The 4PL provider may provide expert assistance to its alliance partners and create an extended enterprise. It must integrate ERP and gain/spend analysis data. Its IT systems must yield better information on spending and knowledge management (supplier performance knowledge, contract management, and the like).

4.2 Key Performance Indicators (KPI's)

To measure its success a 4PL must develop sets of key performance indicators (KPI). Measurable KPI's include:

- Availability of servers and applications
- Amount of work under backlog (tasks to complete eg help desk lists, IT/IS tasks)
- Utilization (database performance, resource allocation, personnel)
- Transactions per day (ordered by function, ease of payment, serviced level, responsiveness)
- Client customer satisfaction level with service
- Recovery time from disaster (business continuity metrics)
- Application functionality performance versus business requirements
- Number of problems per day
- Number of changes required per day
- Benefit realization
- Tracking and ordering (fill rates, on-time delivery, quality, rejections)
- Other (iitoolbox.com, haht.com, ncr.com and aeclever.com, 2003).

4.3 Risk Management

The 4PL must constantly assess risk. Risk-based management programs assess two key questions: what required assets are most at risk, and what constitutes risks to those assets? Risk is a relative term—an event or threat may be risky in one environment but not in another [3]. Therefore, a 4PL provider's risk management program will incorporate each strategic business unit's "worry radius" – where perceived risk and acceptable loss are defined. Effective risk management also requires determining the scope and value of assets. This cost must be considered against the estimated value of the assets

and the impact of their loss on operations and services[20].

There are numerous risk tools, risk guides, and risk services available on the Web. The 4PL's capital assets and digital assets management must be closely aligned with risk management developments. A typical progression of stages of risk management includes [14]:

- Risk identification
- Risk classification
- Risk assessment
- Risk analysis
- Risk management implementation

In addition to its KPI's, the 4PL must develop artificial intelligence methods, expert systems, knowledge management, business intelligence tools, profiles of itself, alliance partners, and its clients. The resulting tools and databases then provide evolving sources of information for analyzing potential risks.

Many decision-making and problem-solving tasks are too complex to be understood quantitatively, so 4PL's and others may succeed by using knowledge that is imprecise rather than precise. Any methodology or theory implementing "crisp" definitions such as classical set theory, arithmetic, and programming, may be "fuzzified" by generalizing the concept of a crisp set to a fuzzy set with blurred boundaries. Fuzzy logic allows these stratified sets to overlap (for example: an 85 kilogram man may be classified in both the "large" and "medium" categories, with varying degrees of belonging or membership to each group). Since fuzzy logic can handle approximate information in a systematic way, it is ideal for controlling nonlinear systems and for modelling complex systems where an inexact model exists or systems where ambiguity or vagueness is common. A typical fuzzy system consists of a rule base, membership functions, and an inference procedure. Thus the 4PL operation will generate perception-based decision analysis and decision support systems for risk analysis and management, uncertainty analysis, and new soft computing algorithms, making intelligent, semi-supervised use of large quantities of complex data to support its evaluation and management processes. When fuzzy logic and expert systems are applied to a customer's activities on an e-business web site, its database driven web site may be more responsive to the perceived demands of the user, thus enabling a faster, shorter path towards the customer's web site goals. Similar fuzzy logic processes may be applied across other areas of the supply chain. Thus performance against a 'business scorecard' can be established and monitored [24].

The next step for the 4PL provider is to use this business intelligence and determine the effect of changes on business effectiveness, competitive advantage, sustainability, and ROI.

5. Conclusion

The creation of a 4PL provider aims at moving the client to a more competitive position, at least until other

organisations either re-establish their competitive positions by copying such a system, or developing new innovative solutions. Analysing relevant business risk, and monitoring relevant KPI's, and applying these within 4PL provider's efficient alliance network may allow the 4PL to develop new, highly-efficient processes with added benefits to the client. These processes should increase the overall ROI of the system, and should benefit the client, the 4PL, its supply chain alliance partners, and most importantly, the client or customer.

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The Formation Processes of an R&D Network: A Case Study

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Abstract

Because of fundamental changes in the competitive environment the amount of resources and knowledge needed in R&D activities has become overwhelming for a single organisation. Thus there is a strong need to perform R&D activities effectively in networks. This study increases the understanding about research and development networks by presenting an empirically grounded process model of formation processes of R&D networks. The model has three main elements; the initial conditions, the network webber and the cycle of sub-processes through which the formation proceeds. The process model highlights the importance of a single actor – the network webber – both in triggering the formation process and in managing the process. Moreover, the model suggests a view of the process that is cyclical – the sub-processes of enabling the network, joining, assuring continuity, formal structuring, learning and developing commitment – do not follow each other in a certain order.

1 Background of the Study

Nowadays both companies and research & training institutes share a strong need to perform research and development activities effectively in networks of many actors. There are several reasons that explain why the change from internal R&D activities to R&D networks has taken place. Firstly, fundamental changes in the competitive environment have resulted in a situation where the amount of resources and knowledge needed in R&D activities has become overwhelming for a single organisation. Technological fragmentation, the increased cost and importance of knowledge, developed information and transportation technology and positive previous experiences of co-operation are among the reasons that have increased the feasibility of external R&D activities [22]. Even in large multinational companies networks have replaced the traditionally market based and vertically integrated structures with more dynamic R&D networks.

Secondly, different companies and research & training institutes lack different resources or knowledge. Thus there is a need to form networks of actors with complementary resources and knowledge. Therefore, R&D networks often include different types of actors; competitors, suppliers, customer companies, research and training institutes, which perform R&D activities jointly [9]. Through intensive co-operation with research and training institutions companies can keep up with new technologies and the advancement of science. Companies gain an indirect contact with the international scientific

community, which provides them insights in latest basic research and an access pool of technically and scientific

sophisticated personnel [22]. Reciprocally R&D institutions receive vital external funding from companies as well as from national funding agencies. A network formation can even be a prerequisite for such external funding [12].

Thirdly, performing R&D activities in networks can also produce extra value for the participants. Formation of dense networks of contacts improves innovative capacity and fosters economic growth [22]. The result of this tendency is that the source of innovation is no longer a single actor or an inventor, but a network of interrelated actors. According to Easton [7, p.24] “inventions and innovations occur in networks not within but between firms”. This being the case, there is a great need for knowledge about how to manage an R&D network effectively, so that each actor in the network creates and receives value.

The question of managing in networks (see eg. [21]) can be approached from two different angles. A strong research tradition in strategic networks or strategic nets (e.g. [16][11][21]) endorses and accepts the idea of a single actor influencing the structure of the network and the positions of the companies within the network. From this perspective a network can be initialised (e.g. [4][3, p. 176]) or managed by single operating actor. In other words, one company can manage, in addition to its own actions, also the actions and reactions of all the other actors in the network.

A contradictory view is suggested by the Network Approach (see e.g. [7][8][13]). The approach argues that networks as such cannot be managed nor designed by a single individual or even by a single company. The argument is that networking is essentially acting, interacting and reacting and an actor cannot dictate the reactions of other actors in the network [8]. A company within network must accept that the outcome of networking is a synthesised result of all companies involved in network. The outcome of any action by a single actor is seldom restricted to actors’ original aims. Håkansson & Ford [8] claim that although a company may initiate change in the network, the achievement of the change is still dependent on approval and actions of others. Thus the actors within network have to adapt their goals to the goals of other actors in the network continuously [8].

When looking at the two above mentioned approaches on network management together, there is a major contradiction between them. The contradiction of networks’ inherent characteristics of being self-evolving

and unmanaged and on the other hand, the possibility to manage R&D networks forms the starting point of this research. Our research focuses on the early stages of network development, in other words on the formation of R&D networks. The model generated in this study relates strongly on strategic network literature and previous research on R&D network formation (e.g.[4][3]).

2 Purpose of the study

This study increases the understanding about managed formation processes of R&D networks. Thus we focus on engineered formation processes [4] and develop an empirically grounded process model of engineered formation of an R&D network. We build the model in three sections. The first part of the model describes the *initial conditions* of the engineered formation process. The second part discusses the role of a single actor, i.e. *a network webber* in managing the network formation process. The final part of the model describes the *activities* performed during an engineered formation process of R&D network..

In the following sections we first describe the method through which the empirical grounding of the model has been taken place. The empirical data is gathered from a members of a research and development network in Finland. Thereafter, we present the empirically grounded model of engineered R&D network formation and discuss each of the three parts of the model more thoroughly. The paper concludes with a discussion of the merits and demerits of the model that pave ways to further research.

3 A Case Study of Network formation

We conducted a longitudinal single-case study to provide data for the empirical grounding of the R&D network formation model. The existing research on R&D network formation is mostly retrospective. Therefore, we chose to conduct the data collection as a follow-up study, enabling us to analyse the whole formation process real-time.

The case is an engineered formation process of a R&D network. The focal network designs and develops mobile, context aware mobile multimedia services to end-consumer environment. The networks is financed from two main sources. The most remarkable stakeholder is the National Technology Agency of Finland, TEKES. The rest of the funding comes from the private companies that have joined the network. The network consists of technology companies, software companies, content providers, City of Oulu, local retailers (small ones through their joint non-profit organization), and research groups from the University of Oulu as seen in Figure 1. Each actor group is connected directly to the research groups and indirectly to other actors via the research groups. The dash line rectangle around the research groups points out the border between research and business consortium in the network.

The formation process of the network begun early 2002 among the researchers at the University of Oulu. The network can be roughly divided into two consortiums. The research consortium consists of researchers from faculties of Technology, Economics and Business Administration, and Education. The business consortium includes local, international and global companies. Thus the actors that form the focal network are versatile and heterogeneous both on their capabilities and their needs.

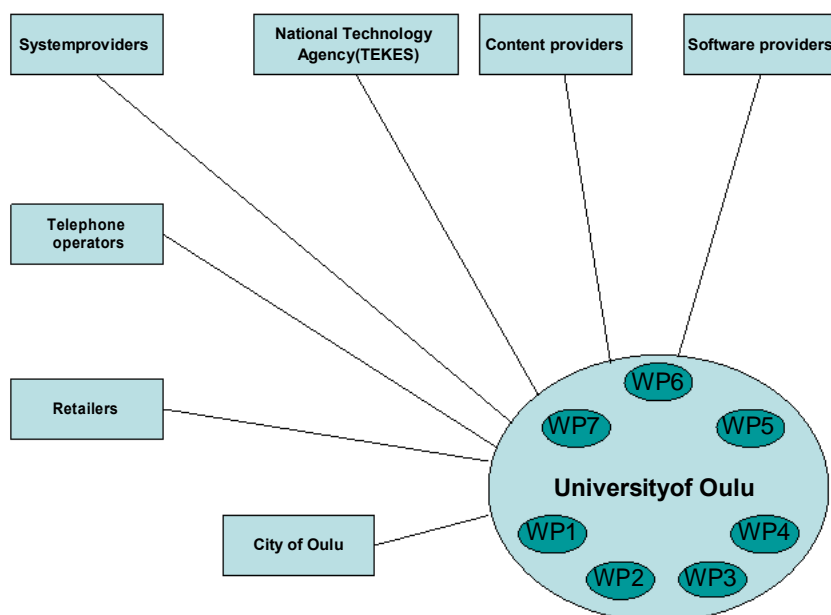


Figure 1. The overview of the case network

Gathered data consists of various types of information from the case network. Data were gathered through several personal focused interviews (see [20]) from different actors within the network under formation. The reason for utilising interview as a method for data gathering was the possibility to direct the focus of discussion during the interview. By interviewing it is possible to reveal the motives behind the actions of the interviewee. Focused interviews offer several advantages compared to other interviewing methods [20]. The interviewees can be selected among those that are knowledgeable of the issues under research attention. Secondly, the researchers have the opportunity to guide the structure of the situation with the use of theme lists. Focused interviews enhance the possibility to react to the responses of the interviewee and probe more deeply into interesting issues.

We selected four companies and two research groups to be interviewed on the basis of their membership in the network and the importance of their role in the network. The seven individuals interviewed were important contact persons of their company or research group, namely a CEO of a software company, a sales director of a software company, a sales manager of a global hardware provider, a CEO of a non-profit organisation representing the local retailers, a research director responsible of the whole research project (later referred to as PhD Timothy), and two research directors from different research groups (PhD Ann, PhD Philip), representing different scientific approaches and orientations. All interviews (in total 265 minutes) were tape recorded and transcribed producing in total 58 sheets.

In addition to the interview data we gathered empirical data through participation observations, as both authors took part in several official and unofficial meetings that took place between the members of the network. We also had access to all written material produced during the network formation, such as project plan, e-mails, PowerPoint slides, status reports, minutes of meetings, and press releases.

The nature of follow-ups study obscured the time span of data gathering for this study. The majority of data were gathered during 9 months, from August 2002 until the end of April 2003. Having said this, we have to admit that some important events took place a few weeks later and we have included them into the empirical data as well. We feel that, to restrict the data gathering tightly to certain dates would not have been the best solution in this case. The development of a network is never-ending continuous process and that is why any restriction to the dynamic process is always an artificial one. The ending of network formation or any other phase in network

development can not be stated exactly, hence the data gathering has to be flexible. This way the rich data enabled us to form a comprehensive picture of the initial conditions, formation processes, and the role of a single actor managing the network formation activities.

4 The Process Model of Engineered R&D Network Formation

Before introducing the model of R&D network formation, it is essential to discuss the approach this study applies when it refers to a process. Process refers to a sequence of events or activities, which describe the development over time [24]. In this study process is considered through a teleological perspective as we see the process of forming a network as a purposeful cooperation of the actors (see [24][25]). Applied in the focal case, a teleology process sees the network as a purposeful and adaptive entity, which has a jointly preferred end state towards which it reaches. The network thus pursues such actions that move it closer to the end state, which in this case is the formation of R&D network to produce an innovation. However, the process is seen as a multiple streams of activities, not as a continuous stream of sequences or phases. In addition, the network's recourses and environment may limit the process. This is why the outcome of the process is not known in advance, because the actions of the actors may also change the goal.

As pictured in Figure 2, the process model of engineered R&D network formation depicts the three main elements in R&D network formation; *the initial conditions* of the R&D network under formation process, *the role of the network webber*, and *the cycle of sub-processes*. The initial conditions, i.e. shared interest of the actors, interdependence among the actor, and the existence of a network webber influence each other as well as the network formation. The role of network webber is emphasised - the reason for doing this will be explained later in the paper.

The cycle of sub-processes contains six intertwined series of activities that take place during the network formation: enabling network formation, joining, assuring continuity, formal structuring, learning, and developing commitment. Together the sub-processes form the network formation process. Each sub-process is affected by the initial conditions and each sub-process may also influences other sub-processes. The intensity of a certain sub-process as a part the network formation process can vary from low to high. The higher the intensity, the more important the sub-process is.

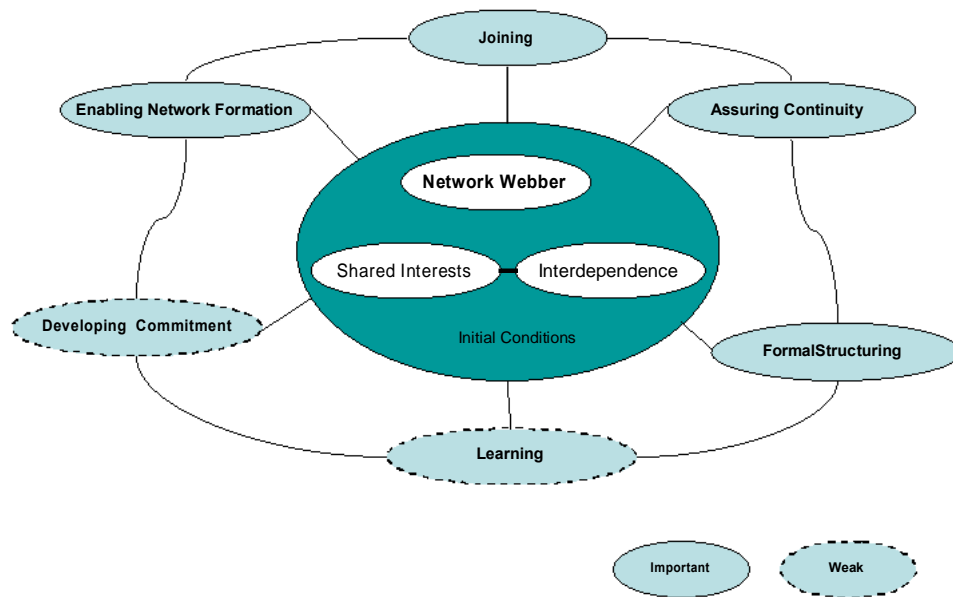


Figure 2. The Process model of engineered R&D network formation

The existing research (e.g. [4]) suggests that the sub-processes or stages of the network formation follow each other like steps in a staircase. We argue that this is not the case. Based on the empirical grounding, we are able to show that some of the sub-processes can take place at the same time, over a long time period and sometimes the process may return to previous sub-process forming loops within the process. Thus we suggest that there is no clear order of appearance in the sub-processes, they may take place simultaneously and partially, as well as that the network actors may repeat the sub-processes during the formation process. In the following sections each of the elements of the model will be discussed more thoroughly also in the light of the empirical data.

4.1 The Initial Conditions

According to existing literature on co-operative R&D processes (e.g. [4]) the network formation process is dominated by three sets of initial conditions. First initial condition is the actors' perception of interdependence caused by variety forms of change in the surrounding environment (e.g. [26][23]). Second initial condition is the existence and recognition of joint interests among the potential members of the network. Thirdly, the intervention of single energetic actor, which we call the network webber may trigger the formation process of R&D network.

4.1.1 Interdependence

Interdependence as initializing condition refers to the needs and willingness of single actors to perform R&D

activities with other members forming the potential network. Existing research (e.g. [4][24]) has also shown that companies tend to respond to their perceptions of interdependence by collaboration. The level of interdependence may of course vary significantly depending on the company. It is relevant to consider the level of interdependence, because the more the actors perceive their environment and the changes in the surrounding environment similarly the more willing they are to co-operate. If the changes of surrounding environment are not perceived the same way, the initialisation of network formation requires external influence typically provided by network webber.

In the case network, there are significant differences among the actors of the network. This diversity is related to the heterogeneity of the actors and their perceptions of their environment. Thus the incentive to join the network and the source of interdependency varies among the different type of actors. Small software companies seek marketing related benefits from co-operation. The companies have limited marketing resources and they expect to gain public relations benefits by operating jointly in nationally funded research and development network that attracts the public interests. University's research groups and technology companies' interests lie in the latest knowledge that the research project can provide. In addition, university research groups lack funding, and research networks are a way to attract outside funding, both from companies and from governmental sources. E.g. the National Agency of Technology (TEKES) requires co-operation with business life from any university research project for it to receive

funding. Research groups may also receive technological resources from companies. Scarcity of R&D resources combines both corporations and university research groups. University research groups can gain access to business context via technology companies. On the other hand, the companies need research groups to provide rigorous scientific research, which for the small companies is not possible because of the lack of resources. The following quotations illustrate how the actors perceive interdependence in their case.

PhD Timothy: *"Nowadays the persons that are responsible for R&D in certain companies receive so many project proposals...the change has been radical, if we compare to the past decade... they can compare and select only the ones they perceive interesting"*

PhD Ann: *"In fact we have... studied this area theoretically before this project and this is a quite logical extension to that. On the other hand, the mobility and mobile applications in our field are coming into the focus, but it is still quite shallow... which provokes severe criticism from a researcher. In a sense we have looking for this type of project earlier."*

In the focal case, the level of perceived interdependency was relatively low. Our view is that the reasons for this were the heterogeneity of the actors (e.g. high technology companies vs. small local retailers, international vs. local companies) as well as the task of the network, which is difficult to understand for the local retailers lacking the basic skills and knowledge in mobile systems. Our conclusion is that the level of interdependency was not high enough to alone initialise the formation of the network, but it was high enough to get the actors interested in the potential co-operation, once the opportunity was offered to them.

4.1.2 Shared Interest

The initialisation of R&D network requires also interest similarity between actors. The actors with pre-existing relationships, common industry origin, similarities with organisation structures and positive previous experiences in co-operation in R&D activities tend to recognise the interest similarities more effectively than the ones lacking similar experiences. The actors should be able to identify significant shared interest to initialise the network formation [4].

CEO of a Software Company: *"Actually we joined the project for the sake of interest. We like to be in a project, which in a certain way investigates the development of this business from customer's and service provider's perspective. Naturally, because we belong to this distribution chain we are interested to hear how the other members of the chain operate and what kind of expectations they have."*

4.1.3 Network webber

Third initialing condition in R&D network formation is the influence of the network webber. Network webber refers to a single actor in network, which proactively identifies even weak interdependencies and interest similarities among other potential members and

communicates these findings to the actors persuading them to join the network, in other words to perform the R&D activities jointly. It is very common that a central organisation or a central firm takes the role of the network webber (e.g.[18][5][14]) Also individuals or groups of individuals (e.g. [15], which potential actors find legitimate, justified and neutral initiators (e.g. [3]) can act as network webbers.

The network webber operates in a structure hole (e.g.[1]) combining relevant potential actors to form the network but also restricting irrelevant actors outside the network. The role of the network webber extends to also the later sequences of network formation, as the collaboration initiator may also possess an assuring role among network actors [3, p.177].

In the focal case, the heterogeneity of actors affected the relatively low level of interdependence joint perception of the surrounding environment. Thus an outsider was needed to point out the potential actors that they shared common needs and that they may expect certain benefits from co-operation. In other words, a legitimate network webber was needed to trigger the formation process. In the case, it was very clear that the research director, PhD Timothy took the role of the network webber, as the following quotation illustrates.

PhD Mary: *"Without a doubt - Timothy has been guiding the formation of this project and research consortium."*

The other network actors may perceive the strong position and influence of network webber as a threat towards themselves and the fulfilment of their own interests. Any change within network is always a result of joint acceptance among actors involved. (e.g.[13]) and therefore the actions of the network webber have to be accepted by the other actors in the network. A network provides almost endless possibilities of combining actor's resources. However, any innovation is created among those actors who perceive a useful combination and seize it. The network webber perceives opportunity and shares the notion with other actors, which seize the opportunity. The actors in the network accept the required change, as long as they perceive that the benefits from the change are mutual ones. Therefore, as long as the network webber acts benefit the joint goal of the network, the role is accepted. The role may also be perceived as an opportunistic behaviour, which would not be accepted by the other actors in the network.

In the focal case, the actions of the network webber were considered as a positive and the other actors accepted them. The network webber also allowed the other actors right to make decisions concerning their own preferred line of action, and then tried to fit and adjust these decisions into actions that guide the network towards its common goal, also shared by the network webber.

PhD Timothy: *"As a Responsible Director I have to make the final decision. Naturally we seek consensus and we have a conclave of research directors in which we discuss the decisions, but somebody has to take the final responsibility. Thus you receive the power to make*

decisions.”

PhD Timothy: *“We have had series of Research Group Directors’ meetings and everybody have had a possibility to contemplate also independently. Naturally the technical framework, which we have created, defines in a sense what can be done, but outside that, it has been their responsibility and in their interests to define what they want to do.”*

4.2 The Cycle of Sub-processes

The third element of the R&D network formation model is the cycle of sub-processes, which describes the activities undertaken during the formation process. The cycle consists of several series of activities: *enabling network formation, acquiring actors, formal structuring, assuring continuity, learning and developing commitment.*

4.2.1 Enabling network formation

By enabling network formation we refer to such activities that aim to develop the fundamentals of co-operative action. Through enabling network formation the potential network actors create a consensus of network domain. (e.g. [4][3]) The network domain consist number of mutual definitions among actors about performance expectations, goals, participants of the network and scope of co-operation. Prior positive experiences between actors and trust tend to lighten these activities. [6][10]

The effect of the network webber (i.e. PhD Timothy) was significant in the case that we analysed, since he took care of more than one task in enabling the network formation. The network webber was the main source of the original idea of forming the R&D network. Therefore his first role was to act as a representative of a R&D network, which did not exist at the time. The network webber set up all the meetings and discussions, chaired the occasions and communicated the basic goals of the network, the performance expectations, and the scope of co-operation as he planned them in his mind. During the first discussion with the potential actors the goals, expectations and the scope of co-operation were negotiated and the voice of the actors willing to joint in the network was incorporated to the original idea, as illustrated in the following.

PhD Mary: *“I would say that our goals remained quite the same, like they were at the beginning. Of course the restrictions related to the project, like the resources, timetables etc. had to be taken into account.”*

Some of the other actors counted on the network webber to enable the formation of the network and only wanted to react if the webber approached them. Some even considered the task of reaching a consensus over the basic elements of the network as a task solely for the network webber. These actors felt that it was not important for them to influence the basic premises of the research co-operation, since they were willing to accept them anyway.

PhD Ann: *“...of course I have maybe wanted to be a little bit ... or wished more just to follow from the*

background, than to be very proactive during the early phase, because the procedures follow more or less TEKES procedures, which define the rules or the game which relate more to the know-how of the Faculty of Technology than of ours.”

CEO of a retailers’ non-profit organisation: *“Entrepreneurs from different lines of business, like retailers, restaurants, service providers etc have been involved. They have provided pointers, but more like in basic issues of doing business.”*

PhD Mary: *“But maybe there is that MTeam (PhD Timothy’s research group) has already gone quite a long way, they have done a lot of work outside the project. We cannot influence that much what they present as their project.”*

However, there were many meetings where the University research groups had to discuss their goals and expectation related to the network, since there was a need to produce a common research plan to be presented to potential company actors as well as other funding agencies. The research plan included most of the definitions that the company actors as well as the funding agency accepted and therefore they perceived the network attractive and joined in. However, the research plan was deliberately left on a rather general level when addressing the co-operation of the company actors. This resulted in a situation that once the research plan had been presented to the funding agency and accepted by it, the network started to negotiate with each of the company members their specific role in the network. Thus the time span during which the network formation enabling actions were performed was rather long.

4.2.2 Joining

The sub-process of joining includes all the actions that the actors in potential network perform to seek and persuade other potential actors to join the network as well as the actions of actors wishing to join in. The sub-process consists of several activities of attracting new potential actors, selecting suitable actors among all the potential ones and restricting improper actors outside [4][3, p.177] The task in selecting potential members is not to find the best possible individual actors, but find the ones that perform best together. As Lundgren [19, p. 211] puts it, the challenge is to create policies that foster technological evolution on whole rather than of the parts. It is not difficult to find companies, research organisations or university research groups that are capable of performing R&D functions. The key is to find such actors that have the ability to joint decision-making concerning the task and goals of the network [3, p. 177][4].

In the focal case, the network webber made direct contacts to each and every actor that joined the network. However, the network webber was neither the only nor necessarily the first to take a contact. The actors joined to the network via three alternative routes. Firstly, network webber evaluated group of potential actors and contacted them directly offering them the possibility to join in. Secondly, actors willing to join in the network contacted

the network webber directly, since they had heard rumours about the project. Thirdly, some members of the network knew or found out about other potential members and contacted them directly. After the first contact, potential member was put into contact with the network webber. Also actors interested in the network contacted network members, which directed the potential ones to the network webber.

The webber was the main decision maker who accepted actors as members, if the actor itself was willing to join in. Thus the network webber had two roles during the sub-process of joining. The webber both persuaded potential members to join in and dissolved relationships with some actors willing to participate but not considered suitable. Although many of the network members took part in acquiring new members, only the network webber had the role of restricting actors.

PhD Ann: *"Timothy contacted Eric (another research director) and he knew us based on previous projects and he like knows what our research group does."*

Sales Manager of a hardware producer: *"Our co-operation started when PhD Timothy contacted us to discuss the opportunities our WLAN solutions would offer. We discussed and reached a successful agreement that enhanced the start of the co-operation."*

CEO of a Software company: *"Well, the joining the project was really an accident... I heard that there was a new professorship at the university... and I thought that since it was related our line of business I will contact him and ask if we he could share his views with us. He then told me that there is one project that is starting and it would be an opportunity for co-operation. The professor then asked me to contact PhD Timothy and we agreed that I will continue the discussion with him."*

PhD Timothy: *"In a way, Company X operated as a bridge to Company Y."*

Although the influence of the network webber in the focal case was considerable in acquiring the actors, there were also cases where the webber did not succeed. Some actors that were contacted by the webber and asked to join in refused to invest resources in the co-operation. There were also some environmental constraints restricting the acquisition of new members. A local department store was actively involved in enabling the formation of the network. However, the store did not join in the network since the local manager of the store had to get approval from the head office of the chain, which unexpectedly forbid the store manager from joining in. There were also other similar situations where the real decisions-makers were not local. Since the network webber could not get into contact with the decision-makers, the company did not consider joining the network useful for them and thus refused the invitation.

PhD Timothy: *"We even had a group from Organisation Z that developed a certain technology, but it did not lead to... And then the connection to Z became weaker and weaker. I wouldn't say that it broke down, but... At the moment it seems that the Organisation Z will not join the project. I am sure they will not."*

4.2.3 Assuring continuity

The sub-process of assuring continuity in the network formation process refers to all actions directed towards creating and communicating perception of the future benefits that the co-operation will offer as a reward for the investments of resources. Thus the members should share positive expectations of the co-operation in order to continue investing time and money into it ([3, p.177][4]). One essential element in the positive expectations is trust between the members of the network. Trust is gained through preventing opportunism either by sanctioning it in the contract [4], referring to a partner's reputation of being trustworthy [10], or referring to the history of successful past co-operation between the members [2]. The actors within network under formation may not have a history of co-operation and therefore the signs and conditions that raise the reliance on each other are vital for the network's future success [4]. The willingness to adapt and continuity of actor policies and priorities communicate credibility in joint operations [3, p. 178].

In the focal case, the most important precondition of continuity was the acceptance of the major funding organisation, TEKES. However, the acceptance is always based on the funding that other network actors, in this case the private companies and the city of Oulu provide for the network. Thus to assure major funding, the companies had to perceive that the network had a good chance of being accepted by TEKES, as all the funding from it is competitive and there is a large number of projects than do not receive funding.

In addition, in spite of the uncertainty of major funding the University research groups prepared for the project by investing their resources and setting up the infrastructure needed for the network. Thus the network webber was able to show concrete results of the network already during its formation. This way the University was perceived by the potential members of the network as a reliable research partner, that probably would also during the project deliver what it promises.

PhD Ann: *"Well of course the financial issues, as usual. Also, I think that everybody has pondered if and when we will reach the point of not understanding each other. This kind of multidisciplinary is always a possibility, but it is also a threat, since we have to respect the fundamentals of each discipline any way. We think that we know what the other work group is doing, but we cannot fully understand it, because it is a different discipline."*

4.2.4 Formal structuring

The last activity, which possesses a strong effect status in our model, is formal structuring. Formal structuring refers to actions designed to create structures that enhance co-operation, decision-making, communication, and learning [4]. Formal structure may consist of written or verbal agreements (e.g. a research agreement, a project plan) between actors, decision-making procedures or joint decision making organs. Formal structures can also include procedures through which conflict situations are resolved and exits from the network are accepted.

In the focal case the level of formal structuring was relatively low. During the nine months period that we followed the formation process intensively, the companies did not sign any agreements. However, the research groups needed to write a research plan and a project plan to apply for funding from TEKES. The documents also included plan of the formal structuring, namely designs for the steering groups, operative steering groups, project meetings, meetings of research directors, documentation procedures etc. All the companies that had orally agreed to join in and finance the network were listed in the documents, although they had not signed anything. Thus a high level of mutual trust was present and the members did not expect to meet any opportunistic behaviour from other members.

CEO of retailers' non-profit organisation: *"We have not made a written contract at the beginning... we have an oral agreement which divides our responsibilities between MTeam and our organisation. However, we have discussed our co-operation and ways of working together among our board members and internal committees."*

Since the network formation process took a long time, and there were no pressures to contribute financially until the national funding organisation accepted the application the companies could rely on oral agreements. After the acceptance from TEKES arrived during summer of 2003, all the involved actors had to agree on the terms of the research agreement and sign it officially. This process was still going on in the autumn of 2003. However, the plans to organise the project management that already appeared in the application documents were immediately put into practise once the funding was accepted. The steering group was set up (one member from each member) and in the first meeting, chairpersons were elected as well as individuals in other management groups.

As far as the research groups are concerned, their work became formally structured much earlier. Research directors meeting was the location where the groups co-ordinated their plans and efforts in the network.

PhD Timothy: *"In the research directors' meetings we have discussed work packages and the funding application as a whole. This means that everything that we have agreed on should be in the funding application and in the contents of the work packages. To the best of my knowledge, there were no discussions outside the meetings. It has progressed during the meetings."*

In the following sections we will discuss two of the sub-processes, learning and developing commitment that remained less important in our case example.

4.2.5 Learning

A company has to have an ability to learn from other actors if it wants to receive its share of the benefits that the co-operation in the R&D network brings. Inability to learn and adapt may even endanger the continuity of co-operation and lead to a dissolution of the joint activities [4][2]. The nature of any network is stable but, not static [7], meaning that even existing networks change, but the change is rarely quick and radical. Since the actors

joining an evolving network face a high level of change, e.g. new members joining in and thus changing the network, the need to adapt is also high. Thus the inability to adapt may easily lead to re-evaluation of the position of the actor in network. The level of interdependence and shared interest as initial conditions of network formation also affect the actors' abilities to adapt and learn from other each other. The actors perceiving high levels of interdependence and similar interest tend to be more capable of learning than actors that have joined the network solely because of network webber's efforts.

The network actors' learning in the focal case was not extensive. We suggest that during the formation process, the co-operation between the members of the network did not reach such an intensive and concrete level that would enhance learning from each other. However, in the relationships between software companies and the research group that PhD Timothy is responsible of, we could find clear indications of learning, since they had reached a concrete level of co-operation already during the network formation phase.

Sales director of a software company: *"For us the co-operation has already given a chance to exchange knowledge on technology. We have received feedback concerning the bugs in our software and some new ideas for further development of the software."*

CEO of a software company: *"Indeed we have received some pointers and thoughts concerning the direction to which the services are planned to develop. Through that we have learned new visions for the future."*

4.2.6 Developing commitment

The last activity of the activity cycle is labelled as developing commitment. Commitment development includes all actions to increase the awareness of single actor about their significance as a member of R&D network under formation. Through increasing awareness among actors each individual actor notices the importance of other partners as well as their own significance in R&D network. Successful collaboration starts feeding itself. Through establishment of a common ground between actors over time and fulfilling the commitments it is also possible to increase the scope and duration of co-operation [3]. This can lead to a positively reinforcing circle, where the attitudinal commitment leads to behavioural commitment and when the goals of the behaviour are achieved, this enforces the attitudinal commitment.

Communication is an important antecedent to enhancing commitment. All the important events in the network, such as goals achieved, delays or obstacles in action, overcoming the obstacles should be openly communicated to the members since this increases the members' reliance in co-operation. Open communication increases commitment and investments into the co-operation. [17]

In the focal case, the actors showed various levels of commitment. The research groups became committed to the network even before the first company members

agreed to join in. The commitment lead to finding new and extended possibilities for co-operation, as the following quotation reveals.

PhD Mary: *"It really has led to something concrete. We were preparing an EU-project, to which our department and two other departments, which are members of the network had prepared a separate application each. Thus we combined the applications. Because, based on this network, we knew that the research groups address the issue a bit alike."*

The company actors' commitment was more in an attitudinal level, since most of the companies did not have to perform any concrete tasks before signing the research agreement. However, there were also such companies, e.g. software producers, who also acted upon their commitment and invested human resources even before the funding decision was announced. These were also the ones that showed signs of learning as discussed above.

Discussion

This research has put forward an empirically grounded model of engineered R&D network formation process. The model has three elements: the initial conditions, the network webber and the cycle of sub-processes. The model offers two contributions to existing knowledge on R&D network formation. The first contribution concerns the strong role of a single actor, the network webber, in managing the network formation process. The second contribution concerns the nature of the formation process – it is a cyclical process.

The role of a single actor - *the network webber* - emerged from the data as highly influential and more extensive than research has indicated so far. The network webber not only initiates the formation of R&D network but also affects all the sub-processes of R&D network formation. The network webber triggers the engineered formation process when the initial conditions are not strong enough to trigger the process. However, the role of the network webber does not end here. The study shows clearly that the network webber was very active during the most important sub-processes through which the network became existent. The network webber enabled the network formation by pointing out to the potential members that they share interests and that those interests could be served in co-operation. During the acquiring actors sub-process, the network webber attracted, approved and disapproved potential members. The network webber was also a main assurance for continuity, since based on previous experiences he enjoyed a reputation of being reliable and was able to orchestrate the compiling of the research and project plans, which earned the major funding for the network. Also, during the formal structuring, the network webber acted as a major designer of the organisation, which actualised itself once the funding application was accepted. Besides being a major actor in the most important sub-processes, the network webber also was active in providing opportunities for learning and the development of commitment.

The suggested model presents six sub-processes, namely enabling network formation, joining, assuring continuity, formal structuring, learning and developing commitment, through which the formation process proceeds. We argue that the network formation activities do not follow a predetermined path as suggested by existing research. On the contrary, the model presented in this paper suggests that the activities appear in cyclical structure. Based on the empirical grounding, there is no clear order of appearance in the sub-processes and they may take place both simultaneously and partially. Moreover, the members of the network may repeat the sub-processes during the formation process. For example, actor acquiring was a sub-process that was ongoing throughout the duration of the formation process.

As any research, this also involves restrictions that pave ways to further research. Our focus was on the engineered network formation process and therefore it is natural the role of the network webber is strong. R&D networks can also evolve without a strong network webber, if the initial conditions are strong enough. However, we do not know how often the networks start without the triggering actions of network webber.

The empirical grounding of the model was based on a case study on a network formation, which included members from both academia and business life. Although we can assume that whenever the task of the network involves developing new technologies, the network includes research organisations that are government funded, there are also R&D networks that consist of private companies only. Even if the private company networks would receive government funding, we expect that in cases where the role of a network webber is held by a private company or representatives of one, that alone influences the process. In the focal case, the network webber was considered as a neutral actor, who acted upon the behalf of the whole network and not only behalf of his or his organisation's interest. This of course, had an effect on the formation process. However, it is logical to assume that the sub-processes would be much the same, although the outcome of e.g. joining would be different. Thus it would bring us new knowledge to compare the formation processes of different kinds of R&D networks, to see in what was they differ, if at all.

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The Analysis of Critical Factors of E-Learning System for E-Business[†]

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Abstract

Many factors such as barriers, reasons, vendor consideration, success factors and challenges play important roles in implementing electronic-learning systems for e-business. In this paper, a questionnaire is used to collect respondents' attitudes toward those factors, and the result is analyzed.

The result of chi-square test indicates that the respondents who have e-learning systems in their organizations are mostly from industries, and for those who have not tend to emphasize more on "cost and unawareness" which scored under 0.4 (i.e. low internal consistency) in reliability. However, the variance of the respondents' attitudes toward the remaining six factors is not large.

Keywords: e-Learning, e-Business, barriers, reasons for implementation, vendor consideration, success factors, challenge factors.

1. Introduction[†]

Problems may be encountered when implementing e-Learning systems for e-business; however if barriers are known in advance, problems are easier to be solved. In addition, reasons for implementation from different stakeholders setup directions to be followed for e-Learning systems. If the expectation of an e-Learning system is known, corporations can be more confident setting up corresponding strategies (see Figure 1) and implementation can be started. Furthermore, suitable vendors can supply satisfactory e-Learning solutions to corporations. Suitable vendors which provide contents, technologies and services help shorten the implementation time, and guarantee a successful e-Learning system for e-business. Success and challenge factors are collected from related articles which suggest actions to be taken for a better implementation.

In sum, it is recommended to analyze the situation of the corporation as well as plan the expectations for e-Learning systems for e-business. Suitable vendors shall be chosen, and lastly success and challenge factors serve as references for their e-Learning systems.

2. Purpose

B2B e-Learning systems facilitate enterprises' (i.e. business-to-business) learning mechanisms via the Internet. Some research reports the factors of their implementations. However, the relationships among the responses toward these factors and whether respondents have e-Learning systems in their organizations are seldom observed. Why do corporations need to understand all these critical factors clearly? Because by doing so, corporations save time and avoid spending money on unnecessary places. If corporations know exactly what different stakeholders feel toward these items, the results will be valuable.

This research investigates implementation factors, and provides practical advices. It analyzes the collected data which is from the survey of "critical factors of an e-Learning system for e-business", and tests such as chi-square test, factor analysis and t-test are used to verify whether there are significant differences in respondents who have e-Learning systems in their organizations, and those who have not. Lastly, the differences and new findings are emphasized.

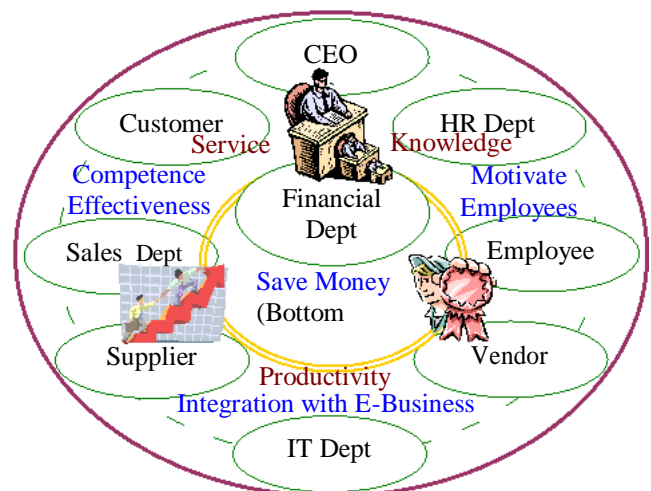


Figure 1 Strategy and Stakeholders

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3. Methodology

The research methodology consists of “select critical factors”, “questionnaire design”, “chi-square test”, “factor analysis”, “t-test” and “conclusions” (see Figure 2). The critical factors which collected from the related literatures (see Table 1) are categorized into barriers for e-Learning, reasons for implementation, vendor consideration, success and challenge. A questionnaire which includes nine demographic questions and thirty-eight questions of critical factors is thus designed.

Chi-square test, factor analysis and t-test are conducted to examine if there are significant differences among the responses toward these factors and whether the respondents have e-Learning systems in their organizations. Lastly, the results will be well examined and feedback to the survey for advanced research.

3.1 Designing Questionnaire

Three different types of questionnaires that are web-based, e-mail and hardcopy are provided. The majority of the respondents prefer the web-based questionnaire. The questionnaire consists of six sections. Section 1 identifies the demographic information of the respondents. Questions include gender, age, career, department, position and education. Section 2 focuses on the attitudes of respondents toward the identified “four barriers”. Section 3 emphasizes their attitudes toward “reasons for implementation”.

Section 4 focuses on “vendor consideration”. Section 5 weights their viewpoints toward “success factors”, and lastly section 6 examines the attitudes toward “challenge factors”. These factors are measured using Likert-type scale which ranges from 5 to 1 with the following equivalence, “5”: “strongly agree”; “4”: “agree”; “3”: “neutral”; “2”: “disagree”; “1”: “strongly disagree”.

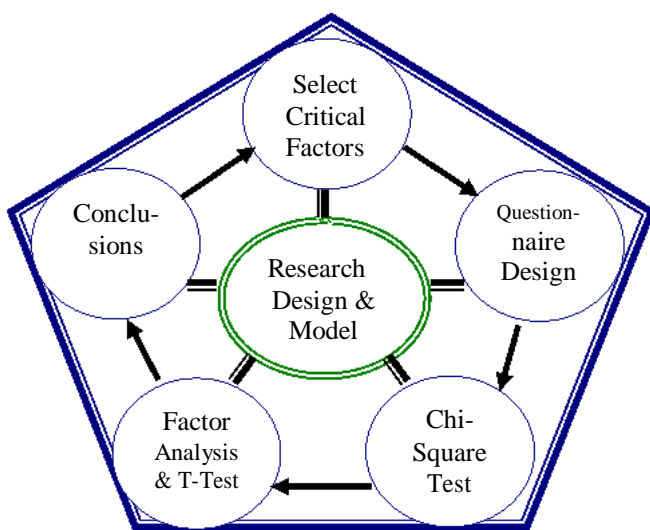


Figure 2 Research Methodology

Table 1 Factors Selected from Related Literatures

Factors / Findings	Source
Ä Barriers	
® Budgetary considerations.	SRI [18]
® Immaturity of learning object technologies.	Consulting Business Intelligence
® Lack of awareness.	
® Cost versus value.	Forum Corp.
® Quality of learning content.	[9]
® Internal resistance to using technology instead of face-to-face learning.	
Ç Reasons	
® Stay nimble and innovative.	Lance Dublin and Jay Cross [14]
® Increase customer satisfaction.	
® Stomp the competition.	
® Cut costs.	
® Satisfy the IT department.	
® Improve my skills.	
® Earn more money.	
É Vendor Consideration	
® Content, Technology and Service.	Digital Think [4]
® Experience.	Rosenberg
® Cost.	[15]
Ë Success	
® Executive stakeholders.	Cisco [2]
® Be the learner.	
® Marketing is your friend.	
® Virtual project teams.	
® Measure everything.	
® Include peer interaction.	David Price & Patrick von Schlag [3]
® Provide mentoring.	
® Offer performance feedback.	
Ö Challenge	
® The first seven items as described in Section 3.2 – Challenge Factors.	Digital Think [4]
® Perceived difficulty of using such a system.	Forum Corp. [9]

3.2 List of Factors under Investigation

In this survey, five main items are observed, and each of them contains sub-items. They are listed below:

Factors of Four Barriers [9] [18]

- B1 Cost too high
- B2 Technology Immaturity
- B3 Solution Immaturity
- B4 Unawareness

Factors of Reasons for Implementation [14]

- R1 Increase Competence
- R2 Stay Innovative
- R3 Support 24 x 7 Training
- R4 Reduce Training Time
- R5 New Training Technology
- R6 Reduce Training Cost
- R7 Increase Revenue
- R8 Decrease Time Spending on Selling
- R9 Flexible Learning
- R10 Win-Win Situation
- R11 Customer On-Line Learning
- R12 Enhance Customer Satisfaction

Factors of Vendor Consideration [4] [15]

- V1 Content
- V2 Technology Integration
- V3 Service Quality
- V4 Implementation Experience
- V5 Implementation Cost
- V6 Reputation

Success Factors [2] [3]

- S1 Organizational Support
- S2 Virtual Project Teams
- S3 Measure everything
- S4 Include Independent Learners
- S5 Include Peer Interaction
- S6 Provide Mentoring
- S7 Offer Performance Feedback
- S8 Marketing

Challenge Factors [4] [9]

- C1 Correct Target Setup
- C2 LMS Configuration
- C3 Tutors and SMEs Integration
- C4 Content Creation
- C5 Multiple Modes of Learning
- C6 Back-End Systems Integration
- C7 Web Infrastructure
- C8 Online Access Capability Training

3.3 Conceptual Model

A qualitative phase of this research is conducted to identify possible factors leading to the implementation of an e-Learning system for e-Business [1]. Related literatures on e-Learning systems for e-Business are also reviewed in order to select the factors of interest. Figure 3 depicts the conceptual model of the six factors naming, “Barriers”, “reasons”, “vendor consideration”, “success” and “challenge” and “implementation”.

4. Analysis Methods

Information on the attitudes toward critical factors of e-Learning systems for e-business is gathered through survey. Four types of analysis algorithms are used for different factors. Percentage analysis is used for demographic information, and chi-square test examines the relationships among different demographic data as well as whether the respondents have e-Learning systems in their organizations. Factor analysis extracts new factors from those five critical items. New factors are verified using Cronbach’s alpha test to measure the reliabilities. T-test examines the differences among the extracted factors and whether the respondents have e-Learning systems in their organizations.

Excel 2002 and SPSS10.0 are used to compute those results. Detailed explanation and diagrams are provided and discussed in the following sections. Chi-square test contains the row and column variables of the test. Factor analysis and Cronbach’s alpha test are explained in Section 4.2 and 4.3. T-test contains one diagram of the test and grouping variables.

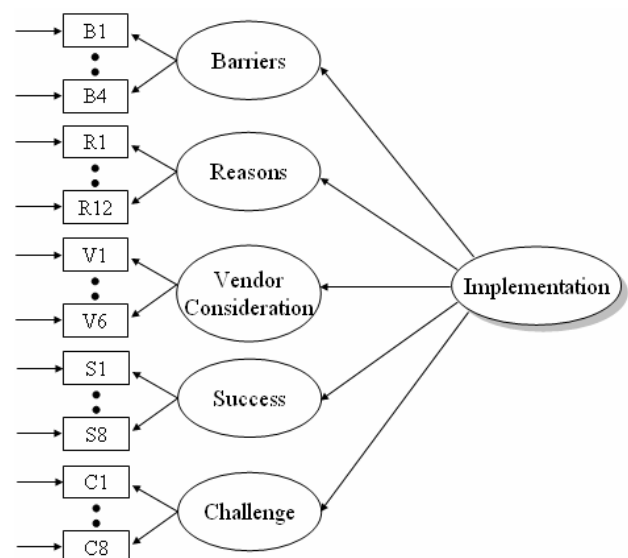


Figure 3 Proposed Models of Factors of Implementing E-Learning Systems for e-Business

4.1 Chi-Square Test

Figure 4 depicts the variables of chi-square test. The relationships among gender, working field, department, role, experience and whether the respondents have e-Learning systems in their organizations are carefully examined.

Gender consists of female and male. Field contains students and the respondents from industries. Department is divided into two groups: Non-IT and IT departments. Role consists of the respondents' experiences on implementation of e-Learning systems. Lastly, experience includes those who have or have not experiences of using e-Learning systems.

4.2 Factor Analysis

According to Foster [12], factor analysis is a technique or a family of techniques which aim to simplify complex sets of data by analyzing the correlations between them. A component or a factor explains the variance in the inter-correlation matrix, and the amount of variance explained is called the eigenvalue.

A factor loading is the correlation of a variable with a factor. If a loading is higher or equal to 0.3, it is frequently taken as meaningful when interpreting a factor. In this paper, principal components analysis is recommended as the method for reducing the number of variables. In order to obtain an orthogonal simple structure rotation, varimax method is used.

4.3 Cronbach's Alpha Test

According to Foster [12], reliability refers to the consistency of the results on different items in a test. Cronbach's alpha is one of the standard ways to express the reliability of a test. The value can be obtained by using SPSS10.0. A reliability coefficient of 0.8 or higher is considered as "acceptable" in most social science applications. The value should not be lower than 0.7. However, tests of personality often have much lower values, partly because personality is a broader construct.

4.4 T-Test

Figure 5 depicts the test and grouping variables of t-test. The differences among "Cost and Unawareness" and "Immaturity" in barriers factor, "Training Effectiveness" and "New Revenues" under reasons for implementation, "Vendor Consideration", "Success", "Challenge" and whether the respondents have e-Learning systems in their organizations are carefully examined.

5. Demographic Information

The survey was conducted from May 13th to May 27th, 2003. There is a total number of 142 respondents, including 56 females (39.44%) and 86 males (60.56%) respectively (Figure 6), agreed to participate in this research. Most of them were from Hsin-Chu Industrial

Science Park and National Chiao Tung University.

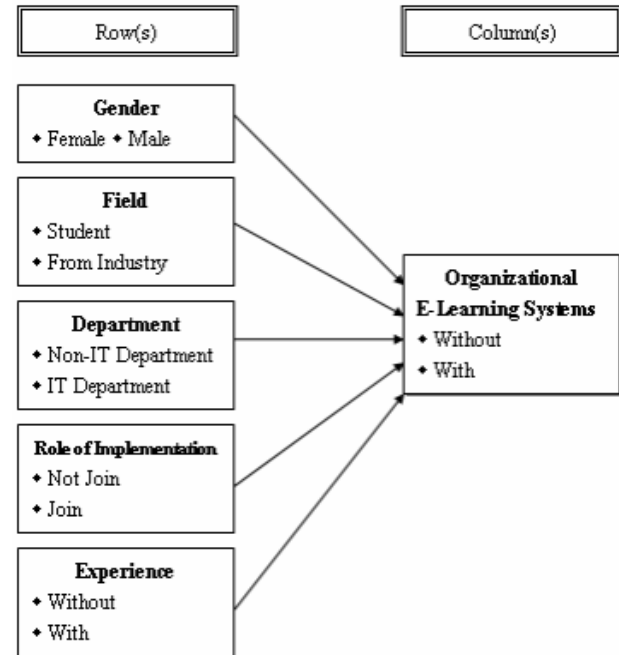


Figure 4 Variables of Chi-Square Test

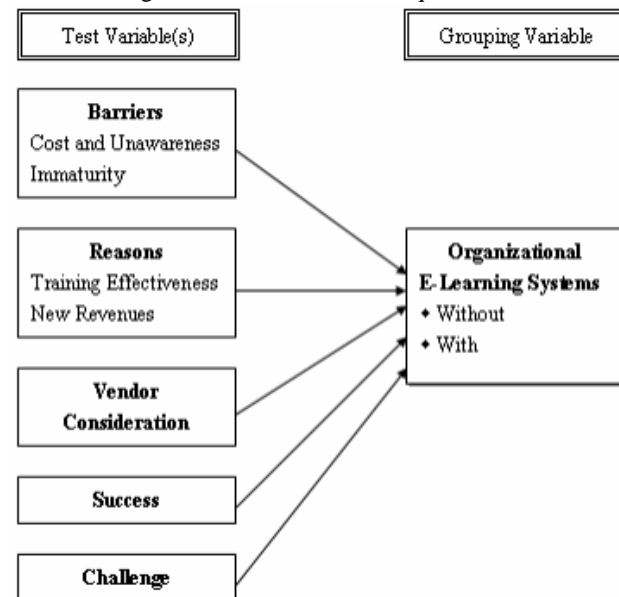


Figure 5 Test and Grouping Variables of T-Test

From figure 7, it clearly illustrates that 29.58% of the respondents were students, and 23.24% of the respondents came from the information technology industries, 16.20% were from electrical and electronics, and 15.4% were from military, government and academic. After the analysis of the departments' bar chart as shown in Figure 8, it is found that 21.13% of the respondents were from the departments of information technology, 11.27% were from management, 10.56% were from technical support, 8.45% were from research & design. 53.52% of the respondents have no e-Learning systems in their organizations (Figure 9). The respondents who have no experiences of implementing e-Learning systems accumulate 72.54% whereas the ones who have account for 27.46% (Figure 10). Lastly, Figure 11 illustrates their experiences of using

e-Learning systems.

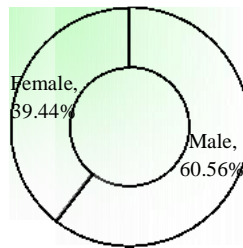


Figure 6 Gender

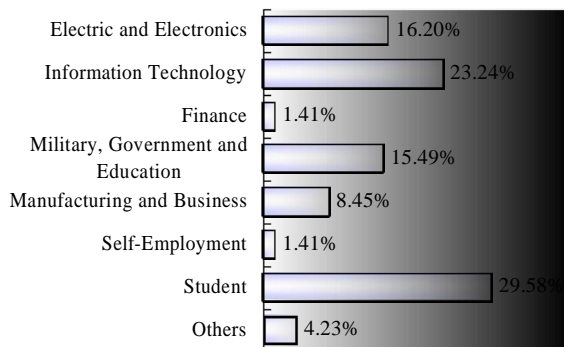


Figure 7 Industry

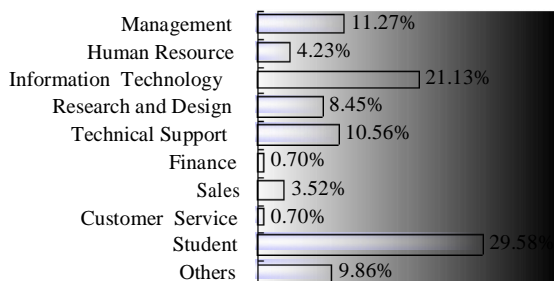


Figure 8 Department

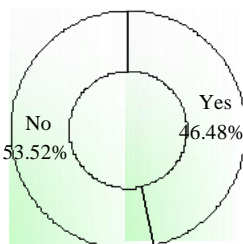


Figure 9 E-Learning Systems Implemented in Organizations

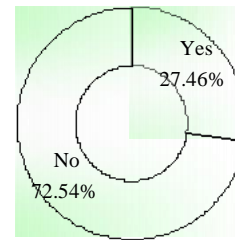


Figure 10 Joining the Implementations of E-Learning Systems

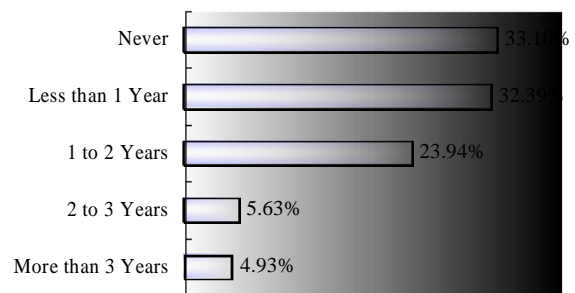


Figure 11 Experiences of Using E-Learning Systems

6. Chi-Square Test on Demographic Items

The chi-square test was conducted to test whether there were significant differences among different demographic data as well as whether the respondents have e-Learning systems in their organizations.

Gender

The chi-square value is 1.087 (df=1, n=142) and the p-value is .297 ($p > 0.05$) which means that there is no significant difference. Thus we concluded that whether the respondents have e-Learning systems in their organizations do not have significant difference in gender.

Working Field

The relationship between the respondents' fields and whether they have e-Learning systems in their organizations is shown in Table 2 (Note: WO/EL = Without Organizational E-Learning Systems; CW / EL = with Organizational E-Learning Systems). The chi-square value is 5.78 (df=1, n=142) and the p-value is .016 ($p < 0.05$) which means that there is a significant difference. When comparing the percentages of the two working field groups in Table 2, the percentage of the respondents who are students and have e-Learning systems in their organizations (19.7%) are smaller than those who are from industries (80.3%). It is obvious that the majority of the respondents who have e-Learning systems in their organizations are from industries rather than students. Figure 11 depicts the line chart of field * organizational e-Learning systems.

Table 2 Field * Organizational E-Learning Systems Cross Tabulation

Field	WO/ EL	W/ EL	Total
Students	29 (38.2%)	13 (19.7%)	42 (29.6%)
From Industries	47 (61.8%)	53 (80.3%)	100 (70.4%)
Total	76 (100.0%)	66 (100.0%)	142 (100.0%)
Chi-Square Value	$X^2=5.78$ $df=1$ $n=142$		

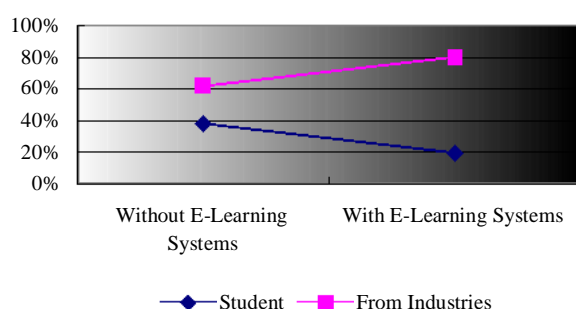


Figure 12 Field * Organizational E-Learning Systems

Department

The chi-square value is 2.642 ($df=1$, $n=142$) and the p-value is .104 ($p>0.05$) which means that there is no significant difference. Thus we conclude that whether the respondents have e-Learning systems in their organizations do not have significant difference in non-IT or IT departments.

Role in Implementation of E-Learning System

The relationship between the respondents' roles in implementations of e-Learning systems and whether they have e-Learning systems in their organizations is shown in Table 3. The chi-square value is 20.033 ($df=1$, $n=142$) and the p-value is .000 ($p<0.001$) which means that there is a significant difference. In order to find out which role group has more respondents, the percentages of the two role groups in Table 3 are compared. When comparing the respondents who have no e-Learning systems in their organizations, it is clear that the respondents who have no experiences of implementing e-Learning systems accumulate greater percentage (88.2%) than those who have (11.8%). However, if comparing the respondents who have e-Learning systems in their organizations, the percentages of respondents who have no experiences of implementing e-Learning systems (54.5%) and who have (45.5%) are very close. Therefore, we conclude that most of the respondents who have no e-Learning systems in their organizations also have no experiences of implementing e-Learning systems. Figure 13 depicts the

line chart of role * organizational e-Learning systems.

Experiences on Using e-Learning Systems

The relationship among the respondents' experiences on using e-Learning systems and whether they have e-Learning systems in their organizations is shown in Table 4. The chi-square value is 24.506 ($df=1$, $n=142$) and the p-value is .000 ($p<0.001$) which means that there is a significant difference. In order to figure out which experience group has more respondents among those who have e-Learning systems in their organizations, the percentages of the two experience groups are compared. It is obvious that the respondents with experiences show greater percentage (87.9%) than those who do not (12.1%). Thus we conclude that the majority of the respondents who have e-Learning systems in their organizations also have experiences of using e-Learning systems. Figure 14 depicts the line chart of experience * organizational e-Learning systems.

After the analysis of the chi-square test, we conclude that only working field, role and experience have significant differences between the respondents who have no e-Learning systems in their organizations and those who have. The respondents who have e-Learning systems in their organizations are mostly from industries and have experiences of using e-Learning systems. However, the majority of the respondents who have no e-Learning systems in their organizations also have no experiences of implementing e-Learning systems.

Table 3 Role * Organizational E-Learning Systems Cross Tabulation

Role	WO/ EL	W/ EL	Total
Not Join	67 (88.2%)	36 (54.5%)	103 (72.5%)
Join	9 (11.8%)	30 (45.5%)	39 (27.5%)
Total	76 (100.0%)	66 (100.0%)	142 (100.0%)
Chi-Square Value	$X^2=20.033$ $df=1$ $n=142$		

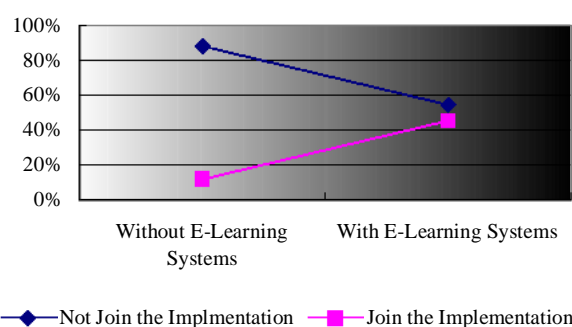


Figure 13 Role * Organizational E-Learning Systems

Table 4 Experiences * Organizational E-Learning Systems Cross Tabulation

Experience	WO/ EL	W/ EL	Total
Have no Experience	39 (51.3%)	8 (12.1%)	47 (33.1%)
Have Experience	37 (48.7%)	58 (87.9%)	95 (66.9%)
Total	76 (100.0%)	66 (100.0%)	142 (100.0%)
Chi-Square Value	X ² =24.506 df=1 n=142		

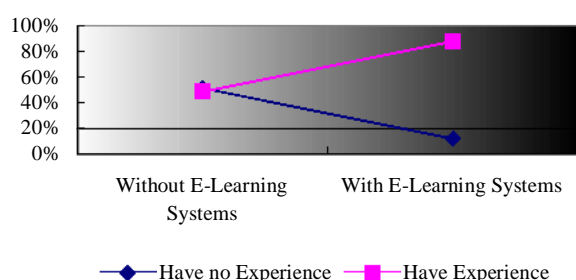


Figure 14 Experiences * Organizational E-Learning Systems

7. Factor Analysis & Cronbach's Alpha Test

The following sections explain the results of factor analysis and Cronbach's alpha test, which are carefully calculated using SPSS version 10.0. It uses the extraction method of principal components and varimax rotation. Additional information regarding the results is also described, such as factor loadings, eigenvalues, percentages of variance and Cronbach's alpha values.

Every factor is labeled a new name which reflects the characteristics of the items it contains. Items are ordered according to their factor loadings (from highest to lowest) and grouped according to factors. However, if the difference between the item's highest and second highest factor loadings is less than 0.15, the item is eliminated.

7.1 Analysis of Four Barriers

The factors analysis result of barriers indicates that there are two factors with eigenvalues greater than 1.0. A two-factor solution is suggested after examining the results (see Table 5).

Component one is labeled "Cost and Unawareness" and accounted for 33.372% of the variance. It includes "cost too high" and "unawareness". The reliability (internal consistency) is 0.3702. Component two is labeled "Immaturity" and accounted for 30.031% of the variance. It includes "technology immaturity" and "solution immaturity". The reliability is 0.3848.

Table 5 Factor Analysis of Barriers

Item		Component & Factor Loading	
		1: Cost and Unawareness	2: Immaturity
B1	Cost too High	.811	-5.373E-02
B4	Unawareness	.682	.141
B2	Technology Immaturity	-9.541E-02	.900
B3	Solution Immaturity	.451	.606
Eigenvalue		1.335	1.201
% of Variance		33.372%	30.031%
Cronbach's Alpha		0.3702	0.3848

Note. Boldface indicates highest factor loadings.

Table 6 Factor Analysis of Reasons

Item		Component & Factor Loading	
		1: Training Effectiveness	2: New Revenue
R3	Provide 24 x 7 Full time Training	.834	6.830E-02
R5	New Training Technology	.830	.164
R9	Flexible Learning	.793	.289
R11	Customer On-Line Learning	.782	.132
R4	Reduce Training Time	.757	.228
R1	Increase Competence	.738	.385
R6	Reduce Training Cost	.547	.378
R10	Win-Win Situation	.538	.431
R8	Decrease Time Spending on Selling	-7.382E-02	.886
R7	Increase Revenue	.248	.672
R2	Stay Innovative	.464	.550
R12	Enhance Customer Satisfaction	.428	.507
Eigenvalue		4.796	2.457
% of Variance		39.964%	20.477%
Cronbach's Alpha		0.9033	0.5678

Note. Boldface indicates highest factor loadings.

Δ indicates the difference between two factor

loadings is less than 0.15.

7.2 Analysis of Reasons for Implementation

The factor analysis result of reasons indicates that there are two factors with eigenvalues greater than 1.0. A two-factor solution is suggested after examining the results (see Table 6).

Component one is labeled “Training Effectiveness” and accounted for 39.964% of the variance. It includes all the sub-items about training. The reliability is 0.9033. Component two is labeled “New Revenues” and accounted for 20.477% of the variance. It includes “decrease time spending on selling” and “increase revenue”. The reliability is 0.5678.

7.3 Analysis of Vendor Consideration

The factor analysis result of vendor consideration indicates that there is one factor with eigenvalue greater than 1.0. A one-factor solution is suggested after examining the results (see Table 7).

Component one is labeled “Vendor Consideration” and accounted for 62.289% of the variance. It contains all the items in vendor consideration. The reliability is 0.8658.

7.4 Analysis of Success Factors

The factor analysis result of success indicates that there is one factor with eigenvalue greater than 1.0. A one-factor solution is suggested after examining the results (see Table 8).

Component one is labeled “Success” and accounted for 65.314% of the variance. It contains all the items in success. The reliability is 0.9227.

7.5 Analysis of Challenge Factors

The factor analysis result of challenge indicates that there is one factor with eigenvalue greater than 1.0. A one-factor solution is suggested after examining the results (see Table 9).

Component one is labeled “Challenge” and accounted for 66.420% of the variance. It contains all the items in challenge. The reliability is 0.9274.

Table 7 Factor Analysis of Vendor Consideration

Component 1: Vendor Consideration		Factor Loading
V3	Service Quality	.911
V2	Technology Integration	.892
V4	Implementation Experience	.875
V1	Content	.840
V5	Implementation Cost	.723
V6	Reputation	.344
Eigenvalue		3.737
% of Variance		62.289%
Cronbach's Alpha		0.8658

Note. Boldface indicates highest factor loadings.

Table 8 Factor Analysis of Success Factors

Component 1: Success Factors		Factor Loading
S6	Provide Mentoring	.863
S5	Include Peer Interaction	.837
S1	Organizational Support	.829
S7	Offer Performance Feedback	.820
S3	Measure Everything	.816
S4	Include Independent Learners	.810
S2	Virtual Project Teams	.793
S8	Marketing	.685
Eigenvalue		5.225
% of Variance		65.314%
Cronbach's Alpha		0.9227

Note. Boldface indicates highest factor loadings.

Table 9 Factor Analysis of Challenge Factors

Component 1: Challenge Factors		Factor Loading
C3	Tutors and SMEs Integration	.849
C2	LMS Configuration	.837
C6	Back-End Systems Integration	.821
C4	Content Creation	.816
C7	Web Infrastructure	.814
C8	Online Access Capability	.812
	Training	
C1	Correct Target Setup	.774
C5	Multiple Modes of Learning	.796
Eigenvalue		5.314
% of Variance		66.420%
Cronbach's Alpha		0.9274

Note. Boldface indicates highest factor loadings.

8. T-Test of Seven Extracted Factors

T-test is conducted to examine whether there are significant differences between the above seven factors and whether the respondents have e-Learning systems in their organizations. The seven factors are “Cost and Unawareness” and “Immaturity” under barriers, “Training Effectiveness” and “New Revenues” under reasons for implementation, “Vendor Consideration”, “Success” and “Challenge”.

8.1 Barriers

The t-test result of “Cost and Unawareness” ($t=-2.147$; $p<0.05$) from t-test shows significant differences between the respondents who have no e-Learning systems in their organizations and those who have. However, the result of “Immaturity” ($t=-.773$; $p>0.05$) from t-test does not have significant difference. The mean value of “Cost and Unawareness” from the respondents who have no e-Learning systems in their organizations is 6.8158; while from those who have is 6.2879. It is obvious that the respondents who have no e-Learning systems in their organizations emphasize more on “Cost and

Unawareness” than those who have (see Table 10).

Table 10 Group Statistics of Cost and Unawareness

Group	Mean	t-value	p-value
Without Organizational E-Learning Systems	6.8158	-2.147	0.034
With Organizational E-Learning Systems	6.2879		

8.2 Reasons for Implementation

The t-test results of both “Training Effectiveness” ($t=-.162$; $p>0.05$) and “New Revenues” ($t=.987$; $p>0.05$) do not show significant differences between the respondents who have no e-Learning systems in their organizations and those who have.

8.3 Vendor Consideration

The t-test result of “Vendor Consideration” ($t=-1.009$; $p>0.05$) does not have significant differences between the respondents who have no e-Learning systems in their organizations and those who have.

8.4 Success

The t-test result of “Success” ($t=-.683$; $p>0.05$) does not have significant differences between the respondents who have no e-Learning systems in their organizations and those who have.

8.5 Challenges

The t-test result of “Challenge” ($t=-.964$; $p>0.05$) from t-test does not have significant differences between the respondents who have no e-Learning systems in their organizations and those who have.

At the end, we conclude that only “Cost and Unawareness” have significant differences between the respondents who have no e-Learning systems in their organizations and those who have. Furthermore, the respondents who have no e-Learning systems in their organizations obviously consider it more important than those who have. On the contrast, regardless the respondents who have e-Learning systems in their organizations or not, they do not significantly differ in the attitudes toward other remaining factors.

9. Conclusion

9.1 New Findings

The following represents the new findings of this investigation. They are gathered from the results of chi-square test, factor analysis and t-test.

Results of Chi-Square Test

The results of chi-square test indicate that the majority of the respondents who have e-Learning systems in their organizations are mainly from industries. Most of the

respondents who have not e-Learning systems in their organizations also have not experiences of implementing e-Learning systems.

Results of Factor Analysis

From the results of factor analysis, only the two factors in barriers have reliabilities lower than 0.4 which indicates low internal consistencies. However, the other five factors have reliabilities higher than 0.7 which represents high internal consistencies.

Results of T-Test

When examining the results of t-test, the respondents who have not e-Learning systems in their organizations emphasize more on “Cost and Unawareness” than those who have. However, whether the respondents have e-Learning systems in their organizations, they do not have significant different attitudes toward the other six factors which are “Immaturity”, “Training Effectiveness”, “New Revenues”, “Vendor Consideration”, “Success” and “Challenge”.

9.2 Contributions

The following represents the seven contributions of this investigation. They are approaches and considerations, advantages and disadvantages of e-Learning systems for e-Business, elementary concepts and understanding, useful information, examples of benefits, where corporations stand and references from other e-Learning stakeholders

Basic Approaches and Considerations

There are some basic approaches and considerations proposed to help the corporations who are just getting started with the implementations of e-Learning systems for e-Business.

Advantages and Disadvantages of E-Learning Systems for E-Business

It advises the decision makers what the advantages and disadvantages are. They shall balance from the situations they choose, and avoid the failures from other people’s experiences. Different stakeholders shall know their own responsibilities and jobs.

Elementary Concepts and Understanding

The elementary concepts and understanding about the implementations of e-Learning systems are introduced. It also gives a good e-Learning guide and roadmap. No matter the reader is a beginner or an expert, this paper can enrich his / her e-Learning knowledge.

Useful Information

All the analytical results in the study provide useful information on how the respondents rate on all the critical

factors proposed. The information leads corporations to have a successful e-Learning system for e-Business.

Ö Benefits

If corporations know respondents' attitudes toward the barriers, barriers are easier to be solved. By knowing the reasons for implementation, corporations can propose a sound e-Learning project. The results of vendor consideration can aid to choose an appropriate one. The rates of success and challenge factors undoubtedly give strong evidences for a better e-Learning system.

Ü Where Corporations Stand

With a clear understanding of these results, corporations know where they stand. Furthermore, they can setup corresponding strategies and objectives which lead them to a smooth implementation of e-Learning system for e-Business.

á References from other Stakeholders

The vendors of e-Learning solutions can figure out what end-users emphasize the most when choosing suitable vendors. Different stakeholders shall consider all the perspectives. By doing so, they can understand what others feel toward a better implementation of e-Learning systems for e-Business.

9.3 Limitations

There are five points of limitations must be acknowledged. All of them are listed and explained in the following. They are time, manpower, demographic, response rate, validity, flexibility and reliability limitations.

Á Time and Manpower Limitation

Due to the limited time and manpower, there are still spaces for further investigation.

Ç Demographic Limitation

Most of the respondents came from Hsin Chu Science Park and National Chiao Tung University, so the results are limited to these areas.

É Response Rate and Validity

As people tend to dislike questionnaires, thus a low sample size is gathered. Furthermore, the conditions under which the questionnaires are finished cannot be controlled.

Ñ Flexibility

Questionnaires are less flexible and therefore required more preliminary thought and preparation for their structures and contents.

Ö Reliabilities of "Cost and Unawareness" & Immaturity"

They are both under 0.4 which mean that their internal consistencies are low. Therefore, in the future study, new test items shall be developed.

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Model and Algorithm for Sea Cargo Mix Problem

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Abstract

In this paper, we study a sea cargo mix problem that occurs in the context of container shipment planning and revenue analysis in ocean carriers. We describe structure and characteristics of the cargo mix problem, and formulate as a Multi-Dimension Multiple Knapsack Problem (MDMKP). In particular, the MDMKP is an optimization model that maximizes the total profit in several periods, subject to the limited shipping capacity and the limited number of empty containers in the origin port, etc. Algorithm is proposed to obtain the near optimal solution for the problem. Numerical experiments demonstrate the efficiency of the algorithm.

Track area: SCM & e-logistics/ Operations Planning & Control.

Keywords: sea cargo mix, container shipping industry, MDMKP.

1. Introduction and Problem Description

In the recent economic environment, it is often the case that profits can only be maintained or increased by improving efficiency and cutting costs. This is particularly proverbial in the shipping industry, where it has been seen that the competition is very intensive among container carriers, thus alliances and partnerships are resulting for cost effective services in recent years. In this scenario, effective planning methods are important not only for strategic but also operating tasks, covering their entire transportation business (see [2][4][13][18][19]). Sea cargo mix planning is an important part of the operations of container shipping lines. This paper addresses the problem of sea cargo mix planning for containerized cargoes, to achieve the most profitable, time definite and cost-effective services in a competitive ocean container

shipping market.

Shipping industry has started utilizing internet B2B exchanges, a marketplace where many buyer and sellers post buy and sell bids to make trades at dynamically determined market prices. Both shipping lines and shippers are moving towards e-logistics in all dealings. All documents can be received electronically, captured and processed directly into the e-logistics system seamlessly. Online booking request is made available 24 hours a day. Within the e-booking, shipper has to select the cargo from the commodity list provided, specify the size and type of container, and enter port of receipt or delivery on the latest departure and arrival date. For examples, Maersk-Sealand, Hanjin, APL and Hyundai are among the carriers offering such service (see their websites for details). Maersk-Sealand uses digital certificate to prove one's identity and enable access to protected area to make booking online faster and safer. The shipper suggests the most appropriate vessel sailing from global schedule system displayed on screen and finally save all information. The shipper's request will then be transmitted to the local Maersk-Sealand office, where confirmation of requirement together with the booking reference number will be sent back to the shipper.

For many containerized cargo carriers, the majority of their bookings are under long-term contracts with shippers. Such long-term agreements help carriers support requests for the large amounts of capital required to run their businesses. These long-term contracts are typically for one to three years. For some carriers, annual contracts all date to the same time of year and may cause a flurry of activity to re-negotiate terms and solidify the next year's business. Regardless of timing, these contracts form a significant part of the revenue stream for a container carrier and negotiating the right prices and terms can be a major contributor to overall profitability. In practice, booking requests are often made less than 14 days before the freight becomes available for shipment, in which case

the carrier may delay moving the freight if insufficient capacity is available. For example, the shipper may request a booking on a voyage that departs 9 days into the future, but if that voyage is already too fully booked, then the carrier may offer to transport the freight on a voyage that departs a week later, thus 16 days into the future. The shipper may then accept the booking offer, or decline the booking offer and request a booking with another carrier. Also, often shippers' cancel previously made bookings. It also happens that freight scheduled to depart on a voyage does not arrive at the port in time for the voyage. Approximately 30% of booked freight ends up not transported as originally booked. The booking control decision maker at the carrier has to decide, whenever a shipper requests a booking, what booking to offer the shipper. For example, the carrier may offer the shipper a booking on the voyage 9 days into the future, or on a voyage scheduled to depart a week later. The decision maker should take into account the revenue specified in the contract with the shipper, the probability of the shipper declining the booking offer, as well as uncertain future booking requests, cancellations and no-shows.

In practical situation, less-than-container-load (LCL) cargo orders come through telephone, email or website from established customers (these usually have their own shipping department), freight forwarders who act for customers or some new customers. Full-container-load (FCL) cargo orders are usually from big firms such as many electronics manufacturing companies. These big customers usually let the carrier know approximately the number of containers they will ship over the next three or four weeks (need to check if this practice still is in place). Agreement is loose and not legally binding.

The carrier will have the following priorities:

- 1) High paying FCL cargo (e.g., electronics)
- 2) Medium paying
- 3) Low paying (e.g., gypsum board)

If times are good and demand exceeds container space, the shipping company will rollover those low paying cargo (i.e. not ship on schedule but postpone shipment to a later date). Under the contract, customers cannot sue the shipping company. If times are bad, the shipping company will look for low-paying cargo to fill the vessel rather than ship empties.

FCL cargo usually has no weight/volume specification because customers always pack to the fullest. Because maximum weight of 20-foot and 40-foot container are 18 MT and 40MT, respectively, so if cargo is volume cargo, you can pick in something like 40 cu meters and yet the cargo weighs less 20 tons. For weight cargo (e.g., steel), 20 tons is easily reached when the container is 1/3 full. You just cannot pack in anymore (legal requirement). Most LCL cargo tends to be volume cargo and the shipping company prefers that because they charge by weight or volume. The shipping company takes all orders but those they can't ship, they will inform the customers after the ship sails.

Sea cargo mix problem arises when a liner operator wants to select cargoes in order to maximize his revenue for some particular trips. Optimal cargo mix technique

needs data from the online booking system and container tracking system to provide current status and location of container inventory as well as details of all costs associated with shipments. Historical data is gathered or built up over time to permit forecasting of container flows and inventory levels. From demands, bookings, available capacity and average contributions, it mathematically determines an optimal target contribution to determine whether to accept or reject a proposed booking, or to suggest a surcharge or alternate product or service at a higher/lower price. The result would be used to adjust contribution calculations to favor certain types of freight on certain routes and discourage others.

Each type of cargo has different volume/ weight characteristic, different freight rate and generates different revenue. For example, the tradeoff in FCL and LCL cargo mix is important operational issue for liner operators. Shipping companies offer customers priority, time-bound forwarding for LCL and FCL shipments with fast transits, reliable schedules and competitive price. A FCL of electronics pays higher than a FCL of gypsum board. Furthermore, if the inbound vessel is full, and if this is not balanced by a full outbound, then there is the need to ship empties necessitated by the need to re-position the empties for use by the destination port. This too has to be taken into account in the optimal revenue analysis. The repositioning of empty containers is one of the single largest expenses for most container carriers. Regarding container demand and supply it minimizes empty repositioning costs and maximize vessels utilization and it lead to a pro-active pricing mechanism for improved revenues and reduced costs. In order to optimally use vessels optimally matched where possible according to customer requirements to minimize empty repositioning costs. This takes into account excess empties and will result in optimal utilization of vessels while total transportation costs (for both full and empty containers) are reduced and trade imbalances will be compensated. Many different models have been proposed in the literature to obtain an optimal container repositioning planning. However, most of them did not consider it with transportation of laden containers and revenue management (see [1][3][9]).

In our work, we abstract the FCL and LCL cargo and the empty container as different type of cargo. Further more, in the model proposed in our paper, we consider more detailed information concerned with each type of cargo. Such information include the weight, volume, shipment price and shipment due date requirement, etc.

To our knowledge, up until now, there is no any description and formulation for the multi-period sea cargo mix problem in the literature. Single period sea cargo mix problem is proposed by [5] and it is formulated as linear programming model by [10], when all cargoes are separable for shipment. Literature on related mathematical programming models and algorithms see related Sections.

The rest of the paper is organized as follows. In Section 2, the multi-period sea cargo mix problem is formulated as the Multi-Dimension Multiple Knapsack Problem (MDMKP). Section 3 presents algorithm for the

model. The heuristic algorithm with effective gradient and its modified algorithm are given in this section. We demonstrate the algorithm with effective gradient by a simple example in this section, followed in Section 4 by numerical experiments of the algorithm with a wide range of problem instances. Section 5 concludes the paper.

2. Mathematical Formulation

There are several technical constraints relative to how a ship should be loaded. The obvious constraints are that cargo weight and volume should not exceed the ship's capacity. The operational objective is to select the loading parameters in order to maximize some profit criterion subject to the mathematical expression of the weight/volume constraints. If the freight rates are known and the operator can refuse or delay to carry cargoes, then the multi-period sea cargo mix problem can be formulated as MDMKP. The objective of the problem is to maximize a weighted sum of the quantities transported. The relative coefficients for the cargoes might reflect their unit profits.

In this section, we develop a mathematical model for the problem under consideration. For the ease of our discussion, we consider that one time period represents one day or one week and we use the term t to represent the t th time period.

In order to present the mathematical formulation of the model for a given planning time horizon, we introduce some notation:

Index Sets

\tilde{T} set of time periods $\{1, 2, \dots, t, \dots, T\}$

\tilde{J} set of ports $\{1, 2, \dots, j, \dots, J\}$

\tilde{K}_t set of all cargoes received in period t , i.e.,

$$\tilde{K}_t = \{1, 2, \dots, k, \dots, K_t\}$$

Parameters

r_{tkdj_k} per volume revenue of cargo k which is received in period t and shipped to port j_k in period d

c_{tkdj_k} per volume cost of cargo k which is received in period t and shipped to port j_k in period d

h_{tk} per volume inventory cost of cargo k which is received in period t and delayed to carry in next period

τ_k due date of cargo k

E_t total volume of available empty containers at origin port in period t

V_{tj} total available volume capacity of shipment to port j in period t

W_{tj} maximum allowable weight capacity of shipment to port j in period t

$v_{tk\tau_k j_k}$ volume of cargo k received in period t ready for shipment to port j_k before its due date τ_k

$w_{tk\tau_k j_k}$ weight of cargo k received in period t ready for shipment to port j_k before its due date τ_k

Decision Variables

x_{tkdj_k} binary variable, i.e., $x_{tkdj_k} = 1$, if cargo k is received in period t and is ready for shipment to port j_k in period d before its due date τ_k , 0, otherwise.

In this paper, we assume that there are one origin port and J destination ports. All cargoes are received at origin port in a certain period of time horizon T . The shipping company decide which cargoes carry in the current period and which cargoes are delay to carry in the other period within their due date and which cargoes are refused to carry in the time horizon T .

Let $\bar{r}_{tkdj_k} = r_{tkdj_k} - c_{tkdj_k} - (d - t)h_{tk}$, $\forall t \in \tilde{T}$, $k \in \tilde{K}_t$, $j_k \in \tilde{J}$, $t \leq d \leq \tau_k$, our multi-period sea cargo mix problem can then be formulated as follows:

$$(M1): \text{Maximize } z = \sum_{t=1}^T \sum_{k \in \tilde{K}_t} \sum_{d=t}^{\tau_k} v_{tk\tau_k j_k} \bar{r}_{tkdj_k} x_{tkdj_k} \quad (1)$$

subject to

$$\sum_{t=1}^d \sum_{\substack{k \in \tilde{K}_t \\ \tau_k \geq d}} v_{tk\tau_k j_k} x_{tkdj_k} \leq E_d \quad \forall d \in \tilde{T} \quad (2)$$

$$\sum_{t=1}^d \sum_{\substack{k \in \tilde{K}_t \\ \tau_k \geq d \\ j_k = j}} v_{tk\tau_k j_k} x_{tkdj_k} \leq V_{dj} \quad \forall d \in \tilde{T}, j \in \tilde{J} \quad (3)$$

$$\sum_{t=1}^d \sum_{\substack{k \in \tilde{K}_t \\ \tau_k \geq d \\ j_k = j}} w_{tk\tau_k j_k} x_{tkdj_k} \leq W_{dj} \quad \forall d \in \tilde{T}, j \in \tilde{J} \quad (4)$$

$$\sum_{d=t}^{\tau_k} x_{tkdj_k} \leq 1 \quad \forall t \in \tilde{T}, k \in \tilde{K}_t \quad (5)$$

$$x_{tkdj_k} \in \{0,1\} \quad \forall t \in \tilde{T}, k \in \tilde{K}_t, j_k \in \tilde{J} \quad (6)$$

The objective function (1) maximizes the total profit in the time horizon T . Constraints (2) ensure that the demand for empty containers at origin port is less than the number of available empty containers at origin port in each period. Constraints (3) ensure that the total volume of cargoes which will be carried to port j in period d is less than the total available volume capacity of shipment to port j in period d . Constraints (4) ensure that the total weight of cargoes which will be carried to port j in period d is less than the total available weight capacity of shipment to port j in period d . Constraints (5)

impose that each cargo may be carried in a certain period before their due date or be refused to carry in the time horizon T . Constraints (6) assure that each cargo can be either accepted at its total quantity or be turned down.

We may notice that the inequality sign in (5) is replaced by equality, if all received cargoes have to be carried in the time horizon T . In this case, the MDMKP (M1) may have not feasible solution, because the total available capacity of shipment may be less than the amount of demands in the time horizon T . On the other hand, MDMKP (M1) always has the optimal solution, because it has a trivial feasible solution $x_{tkdj_k} = 0$, for all $t \in \tilde{T}$, $k \in \tilde{K}_t$, $d \in \{t+1, L, \tau\}_k$, and its LP relaxation optimal value is an upper bound of its optimal value.

3. Heuristic Algorithm for MDMKP

The 0-1 or binary integer programming is an integer programming whose all decision variables are 0-1 values. An important class of binary integer programming problems is the Knapsack Problem (KP). The Single Knapsack Problem (SKP) is one kind of KP where only one knapsack needs to be filled and each item may be chosen at most once; If the items should be chosen from disjoint classes and exactly one item from each class, we get the Multiple-Choice Knapsack Problem (MCKP); The Multiple Knapsack Problem (MKP) is also a kind of KP where several knapsacks are to be packed simultaneously. The more general kind of KP is the Multi-Dimensional Knapsack Problem (MDKP), also known as Multi-Constrained Knapsack Problem, where there are more than one limited resources, i.e. the resources are multi-dimensional for the knapsack. And the MDMKP is the combination of MDKP and MKP. All Knapsack problems belong to the *NP-hard* family (see [6]), therefore it is impossible that polynomial time algorithms can be devised for them.

There are different algorithms for solving variants of KPs (see [14][15][16][17][11]). Generally, there are two methods of finding their solutions: one is a method for finding exact solutions and the other is heuristic. Finding exact solutions is NP hard. Using the branch and bound with linear programming technique, Kolesar ([9]), Shih ([20]), Nauss ([12]) and Khan ([7]) presented exact algorithms for KP, MDKP, MCKP and MDPK respectively. A greedy approach has been proposed by Khan et al ([7]), Martello and Toh ([11]) and Toyoda ([21]) to find near optimal solutions of KPs.

3.1 Heuristic Algorithm with Effective Gradient

MDMKP (M1) is different with all kinds of KPs mentioned in the literature and it needs to develop efficient algorithms for it. In this section, we give an efficient heuristic algorithm with the effective gradient for it.

Let $\bar{v}_{tkdj_k} = v_{tk\tau_k j_k} / V_{dj_k}$, $\bar{w}_{tkdj_k} = w_{tk\tau_k j_k} / W_{dj_k}$, then we can rewritten (M1) as follows

$$(M2): \text{Maximize } z = \sum_{t=1}^T \sum_{k \in K_t} \sum_{d=t}^{\tau_k} v_{tk\tau_k j_k} \bar{r}_{tkdj_k} x_{tkdj_k} \quad (7)$$

subject to

$$\sum_{t=1}^d \sum_{\substack{k \in \tilde{K}_t \\ \tau_k \geq d}} v_{tk\tau_k j_k} x_{tkdj_k} \leq E_d \quad \forall d \in \tilde{T} \quad (8)$$

$$\sum_{t=1}^d \sum_{\substack{k \in \tilde{K}_t \\ \tau_k \geq d \\ j_k = j}} \bar{v}_{tkdj_k} x_{tkdj_k} \leq 1 \quad \forall d \in \tilde{T}, j \in \tilde{J} \quad (9)$$

$$\sum_{t=1}^d \sum_{\substack{k \in \tilde{K}_t \\ \tau_k \geq d \\ j_k = j}} \bar{w}_{tkdj_k} x_{tkdj_k} \leq 1 \quad \forall d \in \tilde{T}, j \in \tilde{J} \quad (10)$$

$$\sum_{d=t}^{\tau_k} x_{tkdj_k} \leq 1 \quad \forall t \in \tilde{T}, k \in \tilde{K}_t \quad (11)$$

$$x_{tkdj_k} \in \{0,1\} \quad \forall d \in \tilde{T}, k \in \tilde{K}_t, j \in \tilde{J}_k \quad (12)$$

When each of the candidate items (i.e. cargoes) involves only one limited resource, it is easy to pick up more profitable items. When there exists more than one limited resource in the candidate items, it is difficult to evaluate the amount of limited resources used. Toyoda (see [21]) introduced the concept of penalty vector, which results in a single index based on the many limited resources. Toyoda's heuristic for MDKP starts with no items, and adds one item at a time iteratively as long as the solution is feasible. At any iteration, the heuristic picks the item which provides the maximum value per unit of aggregate resource or the effective gradient among the not-yet-picked items. Computational experiments show that this heuristic provides very good near optimal solutions to the MDKP using very short computation time, and it can be applied to large problem instances, such as problems with more than a thousand variables (see [21]).

In this section, we propose a heuristic algorithm HAEG to provide a near-optimal solution to MDMKP (M2) by means of concepts such as penalty vector and effective gradient in [21].

The heuristic algorithm for MDMKP can be presented as follows.

Algorithm HAEG

Step 1: Initialization.

Step 1.1: Let $K_U \leftarrow \emptyset$, where K_U is the set of accepted items.

Step 1.2: Assign all items to $K_D = K - K_U$, where K_D is the set of items not in K_U and $K = \{k : k \in \tilde{K}_t, t \in \tilde{T}\}$.

Step 1.3: Let $A_U^{dj} \leftarrow (0, 0)$, where A_U^{dj} is the total quantity vector of accepted items shipping to

port j in period d .

Step 1.4: Let the objective value be zero, i.e., $z \leftarrow 0$.

Step 1.5: Let $x_{tkdj_k} \leftarrow 0$, for

$$\forall t \in \tilde{T} \quad k \in \tilde{K}_t \quad d \in \{t+1, \tau_k\}$$

Step 2: Let $K_C \leftarrow \{k : k \in K_D, \exists d \leq \tau_k$

$$s.t. (\bar{v}_{tkdj_k}, \bar{w}_{tkdj_k}) \leq (1,1) - A_U^{dj_k},$$

$$v_{tk\tau_k j_k} \leq E_d - \sum_{\substack{k \in K_U \\ \tau_k \geq d}} v_{tk\tau_k j_k} \},$$

where K_C is the set of candidate items.

Step 3: Check K_C . If K_C is empty, the procedure terminates. Otherwise, proceed to the next step.

Step 4: Let $\bar{K}_C = \{(k, d) : k \in K_D,$

$$(\bar{v}_{tkdj_k}, \bar{w}_{tkdj_k}) \leq (1,1) - A_U^{dj_k},$$

$$v_{tk\tau_k j_k} \leq E_d - \sum_{\substack{k \in K_U \\ \tau_k \geq d}} v_{tk\tau_k j_k} \}.$$

Compute effective gradients for the items in K_C as follows.

Step 4.1: If $A_U^{dj_k}$ is a zero vector, then we set

$$G_{kd} \leftarrow \frac{\sqrt{2} v_{tk\tau_k j_k} \bar{r}_{tkdj_k}}{\bar{v}_{tkdj_k} + \bar{w}_{tkdj_k}}, \text{ for } (k,d) \in \bar{K}_C$$

Step 4.2: Otherwise, we set

$$G_{kd} \leftarrow \frac{v_{tk\tau_k j_k} \bar{r}_{tkdj_k} \sqrt{(\sum_{k' \in K_U^d} \bar{v}_{tk'dj_{k'}})^2 + (\sum_{k' \in K_U^d} \bar{w}_{tk'dj_{k'}})^2}}{\bar{v}_{tkdj_k} \sum_{k' \in K_U^d} \bar{v}_{tk'dj_{k'}} + \bar{w}_{tkdj_k} \sum_{k' \in K_U^d} \bar{w}_{tk'dj_{k'}}},$$

for $(k,d) \in \bar{K}_C$, where

$$K_U^d = \{k' : k' \in K_U, x_{tk'dj_{k'}} = 1\}.$$

Step 5: Find that item k whose effective gradient is the largest in a period, i.e.,

$$G_{kd} \leftarrow \max\{G_{k'd} : (k',d) \in \bar{K}_C\}$$

Step 6: Accept k . Let $K_U \leftarrow K_U + \{k\}$,

$$A_U^{dj_k} \leftarrow A_U^{dj_k} + (\bar{v}_{tkdj_k}, \bar{w}_{tkdj_k})$$

$$z \leftarrow z + v_{tk\tau_k j_k} \bar{r}_{tkdj_k}, K_D \leftarrow K_D - \{k\},$$

$$x_{tkdj_k} \leftarrow 1. \text{ Then, goto step 2.}$$

We may notice that the solution of HAEG is a feasible solution of MDMKP (M2) and the objective function value is a lower bound of the optimal solution value of it. The numerical experiments in Section 4 show that the solution of HAEG is very close to the optimal solution of MDMKP (M2).

3.2 A Simple Example

$$\text{Let } \hat{r}_{tkdj_k} = v_{tkdj_k} \bar{r}_{tkdj_k}, \tilde{T} = \{1, 2\}, \tilde{J} = \{1, 2\},$$

$$\tilde{K}_1 = \{1, 2, 3, 4, 5\} \quad \tilde{K}_2 = \{6, 7\}; \quad j_k = 1, \text{ for}$$

$$k = 1, 3, 5, 6; \quad j_k = 2, \text{ for } k = 2, 4, 7; \quad \tau_1 = 1 \quad \tau_k = 2,$$

$$\text{for } 2 \leq k \leq 7; (E_1, E_2) = (40, 32),$$

$$k = (V_{12}, V_{22}) = (13, 21) \quad (V_{11}, V_{21}) = (39, 30),$$

$$k = (W_{11}, W_{21}) = (35, 25) \quad (W_{12}, W_{22}) = (12, 38)$$

$$(w_{1111}, w_{1321}, w_{1521}, w_{2621}) = (10.13, 5, 9)$$

$$(w_{1222}, w_{1422}, w_{2722}) = (13.12, 8)$$

$$(\hat{r}_{1111}, \hat{r}_{1311}, \hat{r}_{1511}) = (340, 660, 60),$$

$$(\hat{r}_{1212}, \hat{r}_{1412}) = (182, 77),$$

$$(\hat{r}_{1321}, \hat{r}_{1521}, \hat{r}_{2621}) = (506, 70, 170),$$

$$(\hat{r}_{1222}, \hat{r}_{1422}, \hat{r}_{2722}) = (70, 231, 200).$$

We solve it by the heuristic algorithm with effective gradient HAEG given in Section 3.1. the procedure is briefly given as follows.

$$\text{Since } \bar{v}_{tkdj_k} = v_{tk\tau_k j_k} / V_{dj_k}, \bar{w}_{tkdj_k} = w_{tk\tau_k j_k} / W_{dj_k},$$

we have

$$(\bar{v}_{1111}, \bar{v}_{1311}, \bar{v}_{1511}) = (0.4359, 0.5641, 0.1282)$$

$$(\bar{v}_{1222}, \bar{v}_{1422}, \bar{v}_{2722}) = (0.3333, 0.5238, 0.8095)$$

$$(\bar{w}_{1111}, \bar{w}_{1311}, \bar{w}_{1511}) = (0.2857, 0.3714, 0.1429)$$

$$(\bar{w}_{1212}, \bar{w}_{1412}) = (1.0833, 1)$$

$$(\bar{w}_{1222}, \bar{w}_{1422}, \bar{w}_{2722}) = (0.3421, 0.3158, 0.2105)$$

$$(\bar{v}_{1212}, \bar{v}_{1412}) = (0.5385, 0.8462)$$

$$(\bar{v}_{1321}, \bar{v}_{1521}, \bar{v}_{2621}) = (0.7333, 0.1667, 0.3333)$$

$$(\bar{w}_{1321}, \bar{w}_{1521}, \bar{w}_{2621}) = (0.52, 0.2, 0.36)$$

Step 1. Let $K_U \leftarrow \emptyset$, all items be assigned to

$$K_D = K - K_U, z \leftarrow 0, A_U^{dj_k} \leftarrow (0, 0),$$

$$x_{tkdj_k} \leftarrow 0 \quad \forall t \in \tilde{T}, k \in \tilde{K}_t \quad \forall j_k \in \tilde{J}_k.$$

Step 2. Let $K_C \leftarrow \{k : k \in K_D, \exists d \leq \tau_k$

$$s.t. (\bar{v}_{tkdj_k}, \bar{w}_{tkdj_k}) \leq (1,1) - A_U^{dj_k},$$

$$v_{tk\tau_k j_k} \leq E_d - \sum_{\substack{k \in K_U \\ \tau_k \geq d}} v_{tk\tau_k j_k} \}.$$

Step 3. Since $K_C \neq \emptyset$, proceed to the next step.

Step 4. Since $A_U^{dj_k} = (0, 0)$, the effective gradients are calculated by formula:

$$G_{kd} = \frac{\hat{r}_{tkdj_k} \sqrt{2}}{\bar{v}_{tkdj_k} + \bar{w}_{tkdj_k}}, \text{ for } (k,d) \in \bar{K}_C,$$

$$\text{we have } G_{11} = 666.33, G_{31} = 997.7,$$

$$G_{51} = 313.04, G_{32} = 666.33, G_{52} = 269.99,$$

$$G_{62} = 346.75, G_{41} = 58.98, G_{22} = 146.56$$

$$G_{42} = 389.09, G_{72} = 277.28.$$

Step 5. The largest effective gradient is $G_{31} = 997.7$.

Step 6. Accept item 3. Let $K_U \leftarrow K_U + \{3\}$,

$$A_U^{11} \leftarrow A_U^{11} + (\bar{v}_{1311}, \bar{w}_{1311}) \quad z \leftarrow z + \bar{r}_{1311},$$

$K_D \leftarrow K_D - \{3\}$, $x_{1311} \leftarrow 1$. Then, go to step 2.

After it is repeated several times, K_C becomes empty and we obtain the final solution:

$$z = 1471, x_{1111} = x_{1311} = x_{1521} = x_{2621} = x_{222} = 1,$$

$$x_{1511} = x_{1321} = x_{1212} = x_{1412} = x_{2222} = x_{2722} = 0.$$

This solution is the same as the optimal one obtained by perfect enumeration.

3.3 Modified Heuristic Algorithm

In this section, we modify the effective gradient G_{ij} which introduced in Section 3.1 to increase accuracy of the heuristic algorithm.

Algorithm MHA

Step 1: Initialization.

Step 1.1: Let $l \leftarrow 0$, $\hat{z} \leftarrow 0$, $\hat{x}_{tkdj_k} \leftarrow 0$,

$$\forall t \in \tilde{T}, k \in \tilde{K}_t, t \leq d \leq \tau_k.$$

Step 1.2: Let $K_U \leftarrow \emptyset$, where K_U is the set of accepted items.

Step 1.3: Assign all items to $K_D = K - K_U$, where

K_D is the set of items not in K_U and

$$K = \{k : k \in \tilde{K}_t, t \in \tilde{T}\}.$$

Step 1.4: Let $A_U^{dj} \leftarrow (0, 0)$, where A_U^{dj} is the total quantity vector of accepted items shipping to port j in period d .

Step 1.5: Let the objective value be zero, i.e., $z \leftarrow 0$.

Step 1.6: Let $x_{tkdj_k} \leftarrow 0 \forall t \in \tilde{T}, k \in \tilde{K}_t$,

$$t \leq d \leq \tau_k.$$

Step 2: Let $K_C \leftarrow \{k : k \in K_D, \exists d \leq \tau_k$

$$s.t. (\bar{v}_{tkdj_k}, \bar{w}_{tkdj_k}) \leq (1, 1) - A_U^{dj_k},$$

$$v_{tk\tau_k j_k} \leq E_d - \sum_{\substack{k \in K_U \\ \tau_{k'} \geq d}} v_{tk'\tau_{k'} j_k}\},$$

where K_C is the set of candidate items.

Step 3: Check K_C . If K_C is empty, goto **step 7**.

Otherwise, proceed to the next step.

Step 4: Let $\bar{K}_C = \{(k, d) : k \in K_C, (\bar{v}_{tkdj_k}, \bar{w}_{tkdj_k})$

$$\leq (1, 1) - A_U^{dj_k}, v_{tk\tau_k j_k} \leq E_d - \sum_{\substack{k \in K_U \\ \tau_{k'} \geq d}} v_{tk'\tau_{k'} j_k}\}.$$

Compute effective gradients for the items in K_C as follows.

Step 4.1: If $A_U^{dj_k}$ is a zero vector, then we set

$$G_{kd} \leftarrow \frac{\sqrt{2} v_{tk\tau_k j_k} \bar{r}_{tkdj_k}}{\bar{v}_{tkdj_k} + \bar{w}_{tkdj_k}}, \text{ for } (k, d) \in \bar{K}_C$$

Step 4.2: Otherwise, let

$K_U^d = \{k' : k' \in K_U, x_{tk'dj_{k'}} = 1\}$, for $l = 0, 1, 2$ we set

$$G_{kd} \leftarrow \max\left(\frac{v_{tk\tau_k j_k} \bar{r}_{tkdj_k} \sqrt{\left(\sum_{k' \in K_U^d} \bar{v}_{tk'dj_{k'}}\right)^2 + \left(\sum_{k' \in K_U^d} \bar{w}_{tk'dj_{k'}}\right)^2}}{\bar{v}_{tkdj_k} \sum_{k' \in K_U^d} \bar{v}_{tk'dj_{k'}} + \bar{w}_{tkdj_k} \sum_{k' \in K_U^d} \bar{w}_{tk'dj_{k'}}}, \right. \\ \left. - \alpha \max\left(\sum_{k' \in K_U^d} \bar{v}_{tk'dj_{k'}}, \sum_{k' \in K_U^d} \bar{w}_{tk'dj_{k'}}\right), 0\right)$$

for $(k, d) \in \bar{K}_C$, where $\alpha = 0, 0.2, 0.9$ respectively, for $l = 0, 1, 2$

for $l = 3$, we set

$$G_{kd} \leftarrow \max\left(\frac{v_{tk\tau_k j_k} \bar{r}_{tkdj_k} \sqrt{\left(\sum_{k' \in K_U^d} \bar{v}_{tk'dj_{k'}}\right)^2 + \left(\sum_{k' \in K_U^d} \bar{w}_{tk'dj_{k'}}\right)^2}}{\bar{v}_{tkdj_k} \sum_{k' \in K_U^d} \bar{v}_{tk'dj_{k'}} + \bar{w}_{tkdj_k} \sum_{k' \in K_U^d} \bar{w}_{tk'dj_{k'}}}, \right. \\ \left. - \left(\max\left(\sum_{k' \in K_U^d} \bar{v}_{tk'dj_{k'}}, \sum_{k' \in K_U^d} \bar{w}_{tk'dj_{k'}}\right)\right)^2, 0\right)$$

for $(k, d) \in \bar{K}_C$; we set

$$G_{kd} \leftarrow \frac{\sqrt{\alpha} v_{tk\tau_k j_k} \bar{r}_{tkdj_k}}{\bar{v}_{tkdj_k} + \bar{w}_{tkdj_k}}, \text{ for } (k, d) \in \bar{K}_C, \text{ where}$$

$\alpha = 0.125, 0.25, 2, 1.2, 1$ respectively, for $l = 4, 5, 6, 7, 8$.

Step 5: Find that item k whose effective gradient is the largest in a period, i.e.,

$$G_{kd} = \max\{G_{k'd'} : (k', d') \in \bar{K}_C\}$$

Step 6: Accept k . Let $K_U \leftarrow K_U + \{k\}$,

$$A_U^{dj_k} \leftarrow A_U^{dj_k} + (\bar{v}_{tkdj_k}, \bar{w}_{tkdj_k}) \quad z \leftarrow z + v_{tk\tau_k j_k} \bar{r}_{tkdj_k},$$

$K_D \leftarrow K_D - \{k\}$, $x_{tkdj_k} \leftarrow 1$. Then, goto **step 2**.

Step 7: If $z > \hat{z}$, then $\hat{z} \leftarrow z$, $\hat{x}_{tkdj_k} \leftarrow x_{tkdj_k}$,

$$\text{for } t \in \tilde{T}, k \in \tilde{K}_t, d \in \{t + 1, \dots, \tau_k\}$$

Step 8: If $l = 8$, then the procedure terminates.

Otherwise, let $l \leftarrow l + 1$, goto **step 1.1**.

From the steps of the modified heuristic algorithm, the solution of MHA is closer to the optimal solution than HAEG, because we take the maximum value among

solutions given by nine methods including the method used in HAEG. We may easily notice that the computation time of MHA is more than four times of HAEG.

4. Numerical Experiments

In this section, we implement the modified heuristic algorithm MHA and give comparisons among heuristic solutions and optimal solutions or LP optimal solutions (as the up bound of optimal solutions). The algorithm has been coded in C++ and run under Windows 2000 Professional using a notebook computer (Pentium IV with 1794MHz and 256MB in RAM). CPU times were obtained through the C++ function clock(). To conduct our experiments we used randomly generated instances. For simplicity of implementation, we assumed that destination port j_k of each cargo k is decided by:

$j_k = j$, if $\text{floor}(K/J) \times (j-1) \leq j_k < \text{floor}(K/J) \times j$,
for $j = 1, 2, \dots, J-1$;

$j_k = J$, if $\text{floor}(K/J) \times (J-1) < j_k \leq J$.

For each set of parameters J , T and K , we generated

10 random MDMKP instances. We tested heuristic solutions and optimal solutions or LP optimal solutions on all 10 instances, and tabulated the average relative gap and average computation time. In table 1, the relative gap between heuristic solution and optimal solution g_O is computed as

$$\frac{\text{total profit of optimal solution} - \text{total profit of heuristic solution}}{\text{total profit of optimal solution}} \times 100\%$$

In table 1 and table 2, the relative gap between heuristic solution and LP relaxation optimal solution g_L is computed as

$$\frac{\text{total profit of LP relaxation optimal solution} - \text{total profit of heuristic solution}}{\text{total profit of LP relaxation optimal solution}} \times 100\%$$

Table 1. Results for small test problems

T	J	K	Number of variables	Number of constraints	Instances tested	Average relative gap (%)	
						g_O	g_L
2	2	37	74	84	10	1.62	2.82
2	2	57	114	124	10	1.27	2.65
3	4	27	81	108	10	2.31	3.29
4	8	23	92	160	10	2.85	9.41

Table 2. Results for Medium Scale problems

T	J	K	Number of variables	Number of constraints	Instances tested	Average relative gap g_L (%)	Average CPU time (sec)	
							Heuristic	LP
2	2	271	542	552	10	5.79	0.54	5.02
4	8	800	3200	3268	10	6.18	26.43	1167.53
4	40	500	2000	2324	10	7.79	46.32	298.79
5	70	700	3500	4205	10	8.74	110.23	1982.67
5	9	900	4500	4595	10	7.65	41.58	2139.04
5	30	990	4950	5255	10	8.41	160.23	2531.45

Table 3. Computation Time for Large Scale Problems

T	J	K	Number of variables	Number of constraints	Instances tested	Average CPU time (sec)
5	70	1200	6000	6705	10	367.02
3	4	4000	12000	12027	10	273.46
6	7	2500	15000	15090	10	158.85
4	4	5500	22000	22036	10	503.49
5	10	5000	25000	25105	10	1310.34
6	8	4500	27000	27102	10	631.82

Table 1 shows the results obtained for a set of small test problems. Test problems 1-2 have 2 periods, 2

destination ports and 74, 114 items (cargoes) respectively; test problem 3 have 3 periods, 4

destination ports and 27 items; test problem 4 have 4 periods, 8 destination ports and 23 items. For comparison, the optimal solution has been computed using CPLEX 8.0. As can be seen from table 1, the obtained results seem to be encouraging. The gap between the optimal solution and the heuristic solution is small and the computation time is very short. Table 2 shows the results obtained for a set of medium scale problems. Table 3 gives the computation times for a set of large scale problem. It show that the computation time of the heuristic algorithm is very short even for very large scale problems with tens of thousands of decision variables.

We believe that heuristic algorithm will be a very good candidate for solving MDMKP in time critical or real-time applications such as sea cargo mix problems where a near optimal solution is acceptable, and fast computation is more important than guaranteeing optimal value.

5. Conclusions

We formulated the multi-period sea cargo mix problem as the MDMKP model and presented an effective heuristic algorithm for it.

The heuristic algorithm gives fast and near optimal solution for the multi-period sea cargo mix problem. We presented experimental results to evaluate the algorithm by a wide range of problem instances. The heuristic algorithm is a very effective for time critical operations level decisions where a near optimal solution is acceptable, and fast computation is more important than guaranteeing optimal value.

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Online Product Promotion & Trial Effectiveness

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Abstract

With the rapid growth of the Internet and the subsequent emergence of Electronic Commerce, the importance of product promotion in electronic marketplaces has come into sharper focus in marketing theory and practice. One way to acquire customers and promote the products is to initiate a trial of the company's product. Traditional product sampling is been extremely costly and many firms tend to sell and promote their products via their own website or through other web sites. The concept of Online Product Promotion & Trial emerged as an alternative to the traditional product promotion methods. This study examined the effectiveness of Online Product Promotion & Trial industry in New Zealand. In particular, this study investigates how well Freesamples Ltd web site is performing and how New Zealand consumers react to the idea Online Product Promotion & Trial. The results show consumer satisfaction and willingness to participate towards Online Product Promotion & Trial is high, and most New Zealand organisations are willing to promote their products by giving out free samples through the Internet depending on the cost and budget. Recommendations for this industry in New Zealand and future research directions are also presented.

1. Introduction

Online Product Promotion & Trial is the new wave in promoting products and offering consumers free products to trial through the use of a web site. Surveys estimate that there are 605.6 million people using the Internet throughout the world [5]. Due to the rapid rise of the Internet as a vital channel of communications, the consumer perception of product promotion is changing. The Internet makes it easier for organisations to initiate promotions anytime.

Consumer behaviour about the marketing messages and how they respond to those messages have changed since the Internet has given them power to ignore messages they do not want to see and to find the ones they want. Marketing organisations can truly measure how many people view their messages since in traditional marketing promotions (for example, television advertisement) measurement of how many people have viewed their messages are unattainable. Consumers are not passively letting marketing messages pass by them, rather they proactively choose the messages they want to receive. One of the best ways to reel in consumers is with

promotional offers [3]. Companies can choose to do promotional offers online, offline or both.

No prior research exists on the online product promotion and trial industry in New Zealand. In this research, we focus on the online product promotional aspects that include free product trials for consumers. The objectives of this project are to explore the need of Online Product Promotion & Trial in New Zealand and to investigate the effectiveness of Online Product Promotion & Trial from the perspectives of consumer and company (client).

2. Literature Review

There is no doubt that Information Technology is fundamentally changing the way people communicate and do business, and is changing the choices consumers can make. Electronic Commerce opens up new opportunities to develop new products and services, create new networks and relationships, exploit new markets and to reduce the cost of doing business. The emergence of Electronic Commerce presents new opportunities for New Zealand businesses, including potentially larger markets in which to sell goods and services, and improved communication with customers and suppliers. A survey by Statistics New Zealand [12] reveals that 79% of New Zealand businesses regularly use the Internet and 79% of New Zealand businesses regularly use email for communication. 36% of New Zealand businesses operates a website while total sales generated through the Internet are estimated to be \$523 million in the year ended June 2001 [12]. The Internet was mostly used as a means of communicating with customers and suppliers, as most firms use their website to provide information about their business.

The Internet is the primary driving technology behind electronic commerce and gives marketers unprecedented capabilities. Due to the low entry barriers of the Internet such as low set up cost and easy to maintain information websites, businesses can bypass physical intermediaries and bring goods and services directly to consumers. The Internet is fast becoming part of everyday life for many New Zealanders. AC Neilson Media Research [10] showed that in December 2002, three quarters of New Zealanders aged 10 onwards (2,469,000 people) have access to the Internet.

Promotion encompasses all the various ways an organisation undertakes to communicate its products and to persuade target customers to buy them [7]. One way to acquire customers is to initiate a trial of the company's

product. Traditional product sampling has been extremely costly. Carmody [3] states that the waste factor associated with most product sampling programs is astounding; traditional marketers focus on the “direct” marketing program ends up more like a shotgun approach hitting only 2 percent of the targeted consumers. The Internet helps to solve the waste problem through consumer self-selection. Benitez [2] also says that the ultimate goal of online promotions is to get consumers to come back to the website again and again, to purchase more items and tell their friends about the website. Benitez posits that convenience is the main reason why online sweepstakes, contests and sampling are more effective than in-store, fill out a card or mail out sampling, because consumers do not need to leave their home to enter. Bannan [1] described online product sampling as “consumers go to the website, browse among a smattering of samples and choose products, which are mailed to their homes”. There are a number of advantages for companies to promote products via online free samples. Consumers are attracted to the free sites because there is no cost for them; thus they come to the site specifically to learn about and sample new products, so the companies do not pester consumers who are not interested. Companies can also select certain groups of consumers to whom they want to make the samples available based on their demographic information and product preferences provided on the consumer registration form (for example, they can limit sampling to female consumers). 62 percent of Internet users say filling out online surveys that offer incentives is worth the hassle and admitted to going online specifically to hunt for special offers or contests [11].

As with any giveaway, there are disadvantages for businesses tempted to try online free sample offers. Some consumers surf the Internet looking for as many free samples as possible and often take samples out of the hands of targeted consumers. Another disadvantage of online free samples offers is it is limited to people who know how to use a computer and have access to the Internet.

While there are disadvantages of the Internet promotion, there are still many advantages that marketers can trigger. Based on theories developed by Carmody [3], Table 1 summarizes the specific pros and cons of online promotion.

2.1 Examples of Online Free Samples sites

There are a number of websites offering free samples and free products. All free samples or free products sites have their own unique look and feel, since they rely heavily on offers and links.

Freesamples.com, launched in March 1999, is financed by Witt Capital and other institutional investors. The aim of Freesamples.com is to connect qualified consumers with marketers. Users of Freesamples.com can select up to four free samples at a time, which are shipped directly from the company’s fulfillment centre. The best feature of Freesamples.com is that users can get all of the samples requested within a week. This is an important

distinction between other online sample sites as it takes a long time to deliver the samples to consumers. After the users receive the free samples, Freesamples.com will email the users with follow up questions about the product by offering cash rewards for every response. The clients companies of Freesamples.com can then obtain information and feedbacks about their products

Table 1: Overview of Online Promotions Pros and Cons

Pros of Online Promotions	Cons of Online Promotion
Costs: <i>Cheaper than traditional / offline promotions</i>	Contact: <i>no face-to-face contact with customers</i>
Permission-based: <i>Consumers determine their own level of involvement and manage their own profiles</i>	Histories: <i>no research/case histories</i>
New: <i>Constantly changing with new technology, new ideas</i>	Risk: <i>Larger risk of technology failures</i>
Technology: <i>Allows for further innovations</i>	Reach: <i>Cannot reach audience that don’t have Internet access</i>
Research: <i>Can get feedback and response (both qualitative and quantitative)</i>	Customer Service: <i>Higher degree of customer services needed.</i>
Speed: <i>Faster for create, launch and manage an online promotion</i>	
Control: <i>Higher degree of control</i>	
Environmental: <i>Less paper and other waster on non-interested consumers</i>	
Follow-up marketing: <i>Using email is a fast and effective way to do follow-up marketing when consumers given permission</i>	
Mobility: <i>Consumers can participate from virtually anywhere</i>	
Ongoing: <i>Easier to keep consumers coming back to participate in daily programs</i>	

. While there are other free sample sites on the Internet, few engage in the kind of lengthy information gathering used by Freesamples.com [8]. Freesamples.com is not just a sample distribution system; they are focused on real research data.

Other similar sites include easy-freebies.com and StartSampling.com.

3. Case Background - Freesamples Ltd

Freesamples Ltd. is a New Zealand based company that offers consumers free product trial and helps companies promote product online. Its website (<http://www.freesamples.co.nz>) was launched in April 2000. The primary objective of the company is to promote consumer products and services online to New Zealand residents by offering respondents free products and services through the website. The opportunity to use the Internet as a cheap communication method to promote products and services through one-to-one communication with consumers stimulated Freesamples directors to start up this business. Freesamples offers a convenient way for consumers to pre-trial the products or services and give valuable feedback to improve the product. Freesamples also offers clients a cost effective way to promote their products and services online, research consumers preferences for products and services and distribute free samples. At December 2002 there were approximately 35,000 New Zealanders registered with www.freesamples.co.nz. Products and services listed on the Freesamples site are on behalf of the manufacturers and consumers need to register before they can receive any of the products at no cost. There are times that consumers might need to fill in a survey before they can get free samples. Once consumers have selected the products or services they wish to trial for free and answer the pre-trial research questions; free samples are either posted, couriered to consumers or alternatively, consumers can collect the free samples from retail outlets. After the free samples have been delivered to consumers, they are invited to participate in post-trial research survey and give feedback about the products they received. Freesamples only contact their members via email when there are free samples on board and will invite them to get free samples.

4. Methodology

This study collects responses through interviews, questionnaires and observation. Electronic questionnaires are becoming more common, replacing mail questionnaires. As this study is related to an online application, electronic questionnaire is the best way to learn about the consumers. The advantages of online questionnaires include being able to collect large numbers of survey results in a short amount of time at a low cost. It is important to understand the organisations' perspectives for this study. Two surveys utilising electronic questionnaires were run and two interviews were conducted to test the uptake and effectiveness of Internet trailing. The first electronic survey is targeted at consumers who are a member of Freesamples Ltd. The second survey is targeted at marketing organisations or organisations with a marketing department in New Zealand. The first interview was conducted to capture information about the operations of Freesamples with a director. The second interview was conducted with a marketing organisation. All interviews conducted in this

study are in face-to-face format to capture ideas from organisations and Freesamples Ltd. This helps us to explore and understand complex issues about Online Product Promotion & Trial and company's operations. Following the surveys and interviews, analyses were made to test the four research questions.

4.1 Web site Analysis

While web site content development teams has focused on the necessary components of effective website design, content is much harder to measure. In this study, web site content analysis will be carried out to measure the effectiveness of Freesamples Ltd's web site. This study will follow Myer's [9] guidelines for web site content analysis: audience analysis and web site goals, appropriateness of content, familiarity, skimming & readability and matching delivery with goals.

5. Results

5.1 Content Analysis: Freesamples Ltd Website

5.1.1 Audience Analysis

The first step in web site content analysis is to understand audience demographics and psychographics. In order to capture the audience demographics and psychographics of Freesamples Ltd, a questionnaire was distributed by Freesamples Ltd to its members in March 2003. 4961 registered members answered this survey. The survey was posted in Freesamples website as a requirement for registration to be a member from March 2003.

5.1.2 Web Site Goal

The ultimate goal of Freesamples Ltd is to help clients to promote products and taking research while offering consumers free product trial via the Internet. The goal of Freesamples website is to provide a cost-effective and convenient product promotion medium that benefits both organisations and consumers. It is important to align the web site content goals with the organisation's goal. Freesamples matches the web site goals with the organisation goals.

5.1.3 Appropriateness of Freesamples Web site Content

Appropriateness of web site content is defined as "knowing what content is appropriate for your audience and what content is appropriate for organisation to publish" [9]. Freesamples Ltd has taken both factors into account when they started to re-design their web site to suit audience needs. Freesamples Ltd carried out a research of their members in March 2003 to capture their demographics and psychographics.

5.1.4 Technical Aspects of Freesamples Web site Design

The Freesamples.co.nz web site is categorised as having: Easy Navigation, Excellent Access Performance, Error-free and no dead-links, and Provides password retrieval services.

5.1.5 Written Content

The Freesamples site presents information about the company, samples available and information regarding technical problems. The web site content is updated when there are free samples available or any changes to the website. The site is easy to read and when members login they do not need to enter their personal information again. The web site content is also appropriately tied in to the samples offered. It gives brief introduction of the samples and how this site works. The goal of Freesamples web site is to distribute free samples for consumers and conduct market research for organisations. The web site persuades the audience to participate by telling them there is no cost to them. The goal of the Freesamples web site clearly aligns with its company goal.

5.2 Results of the Consumer Survey

There were 204 responses from the electronic consumer survey. The consumer survey link was available at the Freesamples web for a period of 45 days. The electronic consumer survey was placed at www.informis.co.nz. Visitors to Freesamples could click on the link and be seamlessly taken to the exact survey url. 74% of the total respondents completed the entire survey. As there is no real concept of response rate for Internet surveys; the total of 204 consumer responses represents 3.4% of the 35000 Freesamples members.

The exposure of the industry web sites to New Zealanders is one factor that can be used to gauge the consumer awareness of Online Product Promotion & Trial opportunities. Figure 1 shows that a large group of respondents (cited 66% of total respondents) were not aware of any online product promotion & trial opportunities before they became a member of Freesamples, while 28% of respondents were aware of these opportunities. Only a small percentage of respondents (6%) were unsure about their awareness of online product promotion & trial opportunities.

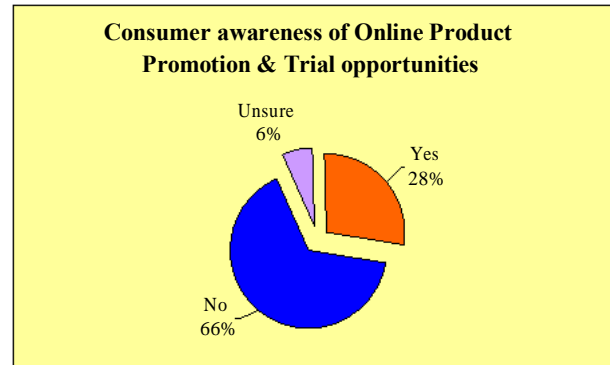


Figure 1: Consumer awareness of Online Product Promotion & Trial Opportunities

Consumer preference to receive free samples has also gathered from this survey, specifically for permission based sampling and sampling without permission. A high percentage (70%) of consumers are willing to accept free samples without their permission while about 30% of consumers would reject them. A high percentage (72%) of surveyed members have received free samples from Freesamples Ltd in the past. This result corresponds to the distribution information held by the company, confirming that the survey sample was representative. Over half of surveyed members (52%) have received more than one free sample from Freesamples Ltd in the past and 25% of them received more than five samples. The results show that large majority of consumers are willing to participate in the online product trial through the use of Freesamples web site.

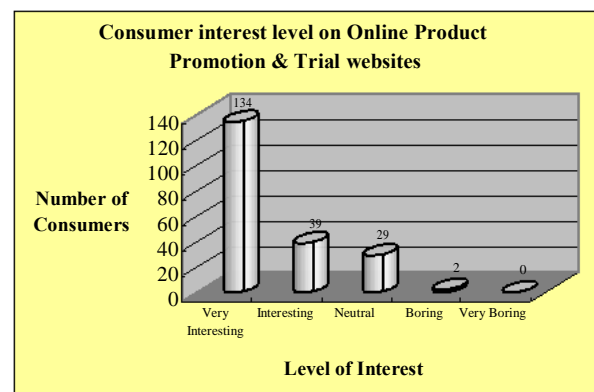


Figure 2: Consumer interest level on online product promotion & trial web sites

Three main factors were investigated to analyse the effectiveness of Freesamples web site from the consumer perspective. The three main factors were consumer opinions of the interest level, usability level and usefulness of the Freesamples web site. Figure 2 shows a large majority of respondents considered that Freesamples web site is very interesting. Only 2 respondents thought that such a web site was boring. A question on usability of the Freesamples web site was asked and the results showed that large numbers of participants in this study claimed that such web site are very simple to use, while a

very small number of participants in this study claimed that it is complicated (Figure 3). A simple and usable web site allows consumers to find their way around the site without difficulties and finding what they are after successfully.

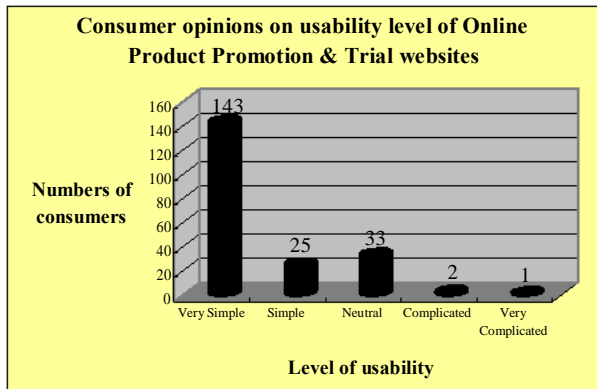


Figure 3: Consumer Opinions on Usability level of Online Product Promotion & Trial Web sites

The third factor is usefulness of Freesamples web site. When a web site provides useful functions or information on the product or company, consumers will usually return. Most respondents rated Freesample's website as very useful, and notably, no respondent rated it not useful or not useful at all. A small number of votes were cast as neutral. Figure 4 is the distribution of these ratings.

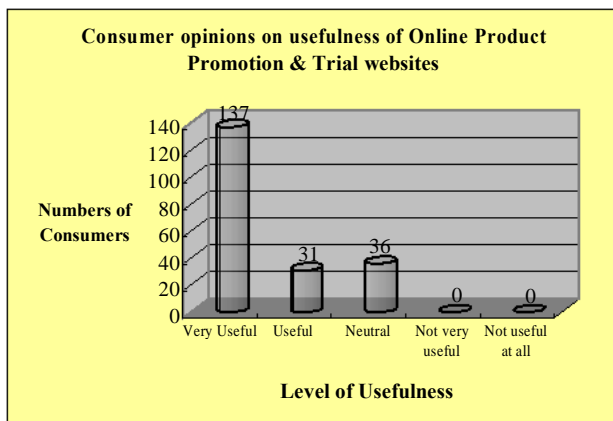


Figure 4: Consumer Opinions on usefulness of Online Product Promotion & Trial web sites

From the consumer survey, one question was asked to find out how often did participants visit Freesamples web site. 37% of the respondents visit Freesamples web site only when notified there are new samples available and 32% of the respondents visit Freesamples web site occasionally. Only a small percentage (5%) of respondents visit Freesamples web site on an everyday basis (Figure 5).

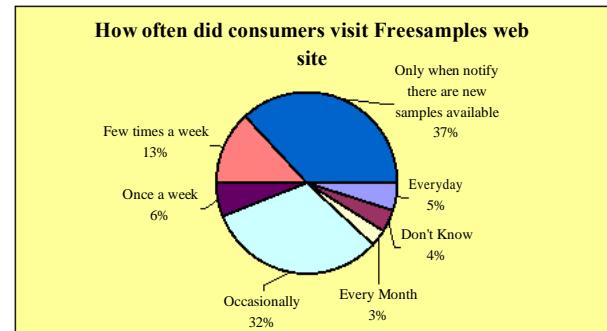


Figure 5: How often did consumers visit Freesamples website?

Another pleasing result is that most respondents are either very satisfied or satisfied with Freesamples service (Figure 6). Although a number of respondents stated they are dissatisfied with Freesamples service, a high percentage (98%) of the total respondents claimed that they would go back to Freesamples web site in the future, while only 2% of the total respondents who are not unsure what they will do given the circumstances. No respondent claimed that they would not go back to Freesamples web site in the future.

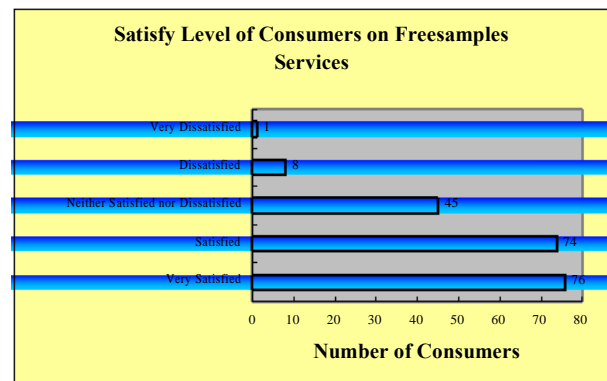


Figure 6: Satisfy Level of Consumers on Freesamples Services

Consumer comments of how Freesamples could improve the quality of service provide were collated. Most consumers desired Freesamples to provide greater variety of samples, including more interesting samples and to increase the number of available samples. A number of consumers suggested that Freesamples should notify members when new samples are launched, deliver the samples faster, give description of samples and change the samples more often to improve their quality of service. This result reflects how Freesamples can increase consumer satisfaction and encourage potential consumers to visit their web site. Another question explored general comments about Online Product Promotion & Trial web sites. Some suggested that more promotion of such web sites is needed and the concept of Online Product Promotion & Trial is a great way for consumers to trial the products before purchase. Some respondents desired more of such web sites.

It is noted that demographics of this sample are very similar to those found by the member survey of Freesamples. It is almost impossible to know how this sample might differ from the total user population; however, the sample population demographics clearly matches with the members' survey demographics so we can say that this sample is representative sample of Freesamples members.

5.3 Organisation Survey Results

The organisation survey is targeted at or organisations that might be expected to promote products by giving out free samples. The organisation survey was sent to 50 marketing organisations in New Zealand, most of the businesses were in Auckland. The 50 marketing organisations were selected randomly from the electronic yellow pages in the beauty & health and food categories and to past clients of Freesamples Ltd. Out of the 50 surveys, 2 of them were received from marketing managers who had been contacted personally and 3 of them were distributed electronically. The remaining responses were received from the postal survey. Out of 10 returned postal surveys, only 8 were completed adequately. There were a total of 15 surveys returned achieving a response rate of 30%. As a rule of thumb, a 30 percent response rate is considered acceptable [4]. The response rate of the organisations survey was acceptable in this study. The possible reason that a majority of all surveyed organisations did not respond could be due to timing constraints, or having little interest in the subject area covered in the survey.

Most organisations that responded to the survey had been operating for a number of years. Another way to determine the exposure of the online product promotion and trial concept to organisations is to verify that organisations understand the meaning of this concept. Over half of the surveyed organisations (54%) claimed that they do not understand what Online Product Promotion & Trial means, while 31% of all surveyed organisations stated they are not sure about the meaning. Only 15% of all surveyed organisations claimed that they understand the concept.

The organisations were asked about the recently used methods to promote their products. The result showed that most of the responding organisations used newspaper or magazines advertising. A number used direct mail and/or mailed out free to promote their products. The data clearly shows that most of the surveyed organisations used traditional promotion methods instead of an online promotion method. 11 of the 13 organisations used more than one promotion method.

Only two of the 13 responding organisations were familiar with Freesamples Ltd and only 31% of surveyed organisations are familiar with free product trials. However, 7 (54%) of surveyed organisations would be willing to promote their products and offer free samples online, 2 (15%) would not, while 4 (31%) were unsure. As Online Product Promotion & Trial is a new concept, the

benefits of Online Product Promotion & Trial are not known by many organisations. 7 (54%) of the surveyed organisations are aware of the benefits of Online Product Promotion & Trial method, while one was not sure.

3 (23%) of surveyed organisations say they would determine this based on the cost.

6. Discussion

Willingness of consumers to participate is important for the companies that offer online product trial as it affects their survivability. The majority of survey respondents say they are willing to participate in online product trial promotion. Most consumers are willing to go back to Freesamples web site and get more than one free sample. This shows the revisit rate of such web sites is high.

It is interesting to find out that most New Zealand consumers prefer permission based marketing messages but some of them still accept marketing messages without permission. Permission based marketing allow consumers to be in control of how much and how often they want to hear from marketers. Unlike traditional sampling programs, free product sampling sites capture customers who are actively looking for a particular product or experiences. Consumers do not get unwanted samples that are of little or interest to them. Traditional sampling methods without gaining permission from consumers include letterbox drops, or giving out free samples in shopping malls or supermarkets.

The willingness of New Zealand organisations to participate in online product promotion will affect the survivability of the Online Product Promotion & Trial industry in New Zealand. At present, it is fair to surmise that not many organisations understand the meaning of Online Product Promotion & Trial. Even though most of the organisations were not familiar with Freesamples Ltd in particular and free product trial promotion methods in general, most would be willing to promote their products and offer free samples online in the future. That an increasing number of companies would prefer to advertise or promote products through the use of websites reflects the increasing trend of Internet usage in New Zealand.

The head of a medium sized marketing agency in Auckland was interviewed. He stated that 50% of their clients are willing to promote their products through the use of web sites. Most of their clients have their own web sites and most of them use both traditional promotional methods such as print advertising and direct mail to customers as well as using Internet to promote their products. Most New Zealand organisations are not aware of the benefits of online product promotion and offering free samples online. They tend to use traditional product promotional methods rather than online product promotion methods. Some the organisations use both traditional promotional methods such as print advertising, direct mail to customers, magazines, event sampling as well as using the Internet to promote their products. New Zealand organisations tend to use more than one promotion methods.

It is rare that organisations use only pure Online Product Promotion & Trial method to promote their products. Some marketing managers believe that some people use the Internet to just get free samples without purchasing after trying. By giving out free samples through the web site, some organisations consider that their conversion to sales is minimal. According to Freesamples Director, it is difficult to get organisations to appreciate the value and power of online product promotion and trial. Generally organisations prefer traditional methods; that is through the use of magazines, television advertisement without getting responses and feedbacks from consumers and any idea of effectiveness of the promotion cannot be measured.

However, there are promotional advantages offered by online product promotion and trials. Online sampling sites offer advantages for both consumers and organisations. Convenience is the main reason considered by consumers why online sampling is more effective than other traditional sampling methods. Consumers also appreciate permission-based marketing where they do not get messages foisted on them. Organisations can enjoy a cost effective way to distribute free samples because samples are only given away to people requesting them. Consumer feedback can be collected and organisations can carry out pre and post trial research. Moreover, organisations can also promote their brand and their distribution chain / retail outlets by using them as the collection points for free samples.

Achieving consumer satisfaction is important for online product promotion and trial companies as it is related to consumer retention. It is obvious that if consumer retention is high, they are more likely to re-visit the website. Apparently, most consumers are either very satisfied or satisfied with the service offered by Freesamples. Generally, consumers appreciate web sites that refrain from 'hard selling'. Freesamples gives them an opportunity to trial the product before buying. Consumers like to try the products before buying, especially expensive products such as cosmetics.

Approximately 150 promotion and trial campaigns have been launched successfully in the Freesamples site. According to Freesamples statistics, about 20% of their clients have repeat campaigns. Consumers stated that most of the free samples sites are based in United States or United Kingdom and they are hoping there will be more free samples sites launched in New Zealand.

6.2 Limitations of this Research and Future Research Directions

There are several limitations in this research. Survey respondents might not answer the surveys correctly. Some people give inaccurate information because they are motivated by the need for privacy and some people might honestly not remember the answers to such questions as "How often did you visit Freesamples website?" The consumer survey respondents are self-selected. The survey might be misleading because it has attracted specific audience or people with particular motivation. On

the other hand, this is exactly the target market of Freesamples Ltd. It should be noted that the consumer surveys are only distributed to members of Freesamples.

Future research can focus on how other factors such as gender, age and income level of respondents can affect consumer satisfaction and consumer willingness to participate in Online Product Promotion & Trial. For instance, the relative importance of the different drivers in consumer participation is worth investigating. Another dimension of future research in this topic deals with the measurement issues of effectiveness of Online Product Promotion & Trial campaigns. In this research, we measure this by the repeat samples campaign rate to Freesamples and the repeat samples requested by individual consumers. It is important to go beyond just the repeat campaigns by organisations and the repeat samples requested by consumers; effectiveness of the past campaigns should be also measure by the actual product sales before and after the product trial.

6.3 Recommendations

Privacy concerns may make consumers unwilling to give out information and technologies such as privacy programs allow consumers to prevent data from being collected. Currently, Freesamples did not provide a privacy statement in their web site. Some consumers may realise the value of their information and demand a premium for it [6]. Using consumer information to create substantial value for the consumer can solve these problems; for example, letting consumers know Freesamples will offer more samples to suit their interests. As consumers recognise the value of giving up information they will be more likely to share their information.

Promotion of Freesamples Ltd is all through "word of mouth". It is suggested that Freesamples needs to advertise to consumers to grow the membership as well as client companies. Statistics shows that 41% of web users find new sites through search engines and online shoppers are three times more likely to use search engines than advertisements to find what they want on the web [10]. Freesamples can register in popular New Zealand search engines such as Xtra MSN, Yahoo NZ, and Nzooom.

7. Conclusions

There are enormous opportunities for businesses and consumers to participate in online product promotion due to the explosive growth of the Internet. The concept of Online Product Promotion & Trial has emerged as an alternative to the traditional product promotion methods. This study provides a better insight into both existing and potential members of Freesamples Ltd by examining the Freesamples Ltd member database. Most of the Freesamples members are in the mid to high-socio economic groups.

Our results suggest that the willingness of consumers and organisations to participate in Online Product Promotion and Trial are potentially high. Most New

Zealand consumers are very satisfied with services offered by Freesamples and they show interest to participate in the online product trial. The satisfied and loyal consumer database will increase the likelihood of return visits to Freesamples.

On the other hand, our results indicate that the concept of Online Product Promotion & Trial is not clearly understood by many organisations in New Zealand. Many organisations are not aware of the benefits the Online Product Promotion & Trial. However, it is shown from the results of this study that most organisations are interested in participating in Online Product Promotion & Trial depending on the cost and budget.

The benefits of Online Product Promotion & Trial include convenience for consumers, cost effective and efficient sampling method for organisations, carry out market research for organisations, provides one-to-one and permission based marketing.

We cannot prove that Online Product Promotion & Trial method can replace the traditional promotional method as surveyed organisations tend to use traditional methods or a mix of both methods rather than online promotion methods. The results of previous Online Product Promotion & Trial promotions launched in New Zealand were a success. This is determined by the strong consumer satisfaction level of Freesamples services and the willingness of consumers and organisations to use Online Product Promotion & Trial.

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Application for SMS in Mobile Commerce (A Study on Building Mortgage for Bank)

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Abstract

The financing field of Taiwan facing a violent variation in the recent years, a series of financing revolution and of lifting the ban of laws and decrees has brought forth a turning point of the existence for the line of finance. Only the financing unit may properly use the high-tech data, can an effective benefit be obtained, especially, the merger between financing units as well as crisscross sales, that reduce unnecessary expenditures of overhead for traders, and that transfer the saving cost and manpower into the product service corresponding with the demand of customer's design to enhance the clients satisfaction and loyalty.

In the year of Internet, CRM is the lifeblood to maintain the resource of customers for enterprises in the future; if an excellent relationship can be established with the customer, it shall be won their loyalties. The mobile communication with unlimited time and space, such a characteristic may develop the customer service into a maximum extent and let the users obtain the service easily.

A mobile bank cooperated by each bank to promote the value-added service may provide with an intelligent mobile-phone system for transfers, inquiries, and payment. Through the cellular phone, it can be directly to contact with the bank to proceed with the balance inquiry, checking the particulars of transaction and the payment and transfers, as if it has a potable, private, confidential, and secure ATM.

Research and development of the application with respect to the news flash provided by mobile bank, and taking the banking house loan as a topic to combine with wireless Internet tech, dealers and housing demanders are establishing a "Housing Loan Based upon the Protocol of Wireless Application", of which the specific researching content is comprised of wireless transmission protocol, instant order to buy a house on-line, transacting the trade on-line, and integrating the system of house loan on-line.

In conclusion, look forward to provide more conveniences of instant order to purchase a house through the substantial practice, and provide the service to transact the trade on-line to decrease enterprise's time and manpower's cost, combining with new high-tech development to enhance the service quality and competitiveness of the enterprise.

1. Introduction

The financing field of Taiwan facing a violent variation in the recent years, a series of financing revolution and of lifting the ban of laws and decrees has brought forth a turning point of the existence for the line of finance. Only the financing unit may properly use the Information, can an effective benefit be obtained, and that transfer the saving cost and manpower into the product service corresponding with the demand of customer's design to enhance the clients satisfaction and loyalty. [1]

The service quality is the hinge to determine if the financing service on-line is successful, so it has further to analysis it to enhance the industrial competitiveness with the relative contending superiority. The boundary of the network media in the future will be increasingly blurred, hence, developing the mechanism of various trading platform shall be the key-point for the future. The relevant dealer engaged in e-commerce has to orient toward easy use and compatibilities with the past habit for future development.

Following with the rise of e-commerce, the role acted by the bank of the cash-flow network becomes increasingly important, in which the network bank has to consider the issues of the enterprise demand. There is a obviously positive influence that the useful property for customer's perception to the innovating service versus the relationship for enterprise's client to an intimating extent. Provide an empirical research for mobile banks to reconsider their orientations, the function of which is not only a promoting web page of the substantial bank, but also a vital part of the e-commerce.

In the era of Internet, CRM is the lifeblood to maintain the resource of customers for enterprises in the future; if an excellent relationship can be established with the customer, it shall be won their loyalties. They are enthusiastically combining with communication dealers to provide an integral service recently, and helping the bank to provide more diversities and conveniences for clients.

In terms of the financing service, the promoted range may provide with a SMS of the payment in each current business for the bank and mobile bank, coordinated with the program of industrial automation advocated by the finance bureau of the Ministry of Finance and the Executive Yuan, reached to the target of a safe network, ensured the issues of consumer's privilege and verification in financing system, and controlled and administrated the trading risk by network.

Targeting at mobile communicating industries, a derivative issue caused by the competitions between that telecom operators acted as the communicating portal and that bankers held the status of transaction and liquidation in the e-commerce payment. The optimum model is to integrate most of telecom operators, banks and account-clearance centers, forming a MCSP (Mobile Commerce Service Provider) to provide the open and diverse mobile-commerce for traders and banks.

In conclusion, look forward to provide more conveniences of instant order to purchase a building through the substantial practice, and provide the service to transact the trade on-line to decrease enterprise's time and manpower's cost, combining with new high-tech development to enhance the service quality and competitiveness of the enterprise.

2. Related Works

In a score and half years, the social wealth is rapidly accumulated due to the incessant changes of industry and commerce, in which the level of nationals' income has substantially been increased as well as the money-managing movements are frequently operated in investment for various ranks in the society.

The operation of conventional bank is personally transacting the business through the banking staff, substantial shop-front, and counters, etc. The banking business is acting an important role in the cash-flow system of the service operation.

2.1 Information Technology Impacts on Banks

The financing environment of Taiwan in recent years has been transformed into liberalization and internationalization, which results in banking business getting more drastic competitions as well as the business of traditional bank becoming more and more difficult in operation. The banking business shall apply the characteristic of the network market to enhance the self-substantiality responding to environmental challenge and using the wisdom system to analysis the client behavior and the new benefit excavated by correlative data.

In the financial business, from ATM to unmanned bank as well as the network bank, the customer service is unceasingly enhanced by marketing conception of the network personalization. Only proceed with the one-to-one contact constantly with the consumer, can consumers' various demands and preferences be mastered further to provide individual service and client's satisfaction; the computerized "Call Center" may duly resolve customer's complains and telephoned promotion.

The large-scale mainframe may correctly record and transact the daily trading data; ATM is allowed the customer to engage in basic transaction during the off-duty; e-disbursement system can facilitate the customer having more payment modes besides the cash, check, and credit card; Internet is even expanded the trading range, with which clients may transfer his account, remit money, order

on line, and purchase insurances.

The financing units use the Information that many risks, hackers, or viruses will simultaneously be invaded, but it is only a small part among the multitudinous risks. A qualitative change will be produced by the data application to the floating risks. Only reduce the risk in the process of policy-decision, can the correct content be enhanced, and will the integral efficacy be increased in applications.[4]

Security Hole in WAP Legacy Stack:

1. At WAP gateway switching the WTLS to TLS, there is a loophole in safety due to the data is temporarily unencrypted.
2. It is incapable of reaching to a end-to-end security.

2.2 Mobile Banking Services

The tidal wave of Internet is still on its upward surge in recent years, how to reap profits and to enhance CRM's efficiency in the promotional operating movements is the most imperative and important target of the perspective for each enterprise.

Mobile Internet and Internet are blessed by network, communication and Information, achieving e-commerce to be developed prosperously, and subverting behavioral pattern of the traditional commerce. In the Internet world, despite the B2B, B2C, or multiple operating models, the network-foam is approved that genuine market value is based on the sufficient combination of the profitable business model and networking effect.

With the mobile communicating techniques getting mature day-by-day, the mobile commerce becomes another newly prosperous industry after the e-commerce. The development of mobile commerce, however, still not grows substantially as expectation to date. From the viewpoint of the practice to explore accepted behaviors of the consumer to mobile commerce is because the value of Information is derived from user's practicability.

Wireless communicating development has been changed the communicating model; by means of wireless communicating device. the needful data can be secured when we communicate with others from time to time [5] [10] [11] [12]. The network of marketing operation is not only provided with the promotion, advertisement, correct labor service, assisting merchandise confirmation, and orientation for Enterprise's runner, but also needed to seek out a distributing channel for consumers.

STK is a group of the mandate to develop the value-added business, as well as a small-scale programming languish software, solidifying in the SIM card to receive and send the data of GSM's SMS. SIM may use its own application software.

Mobile banking system of the STK at present time is mutually cooperated by each telecommunicating dealer and the financing unit, or by overseas dealer; all of the STK they established is adopted the One-to-One model, and its systematic frame is shown as Figure 1

Systematic Frame shown in Figure 1 specifies briefly process as follows:

¾ Users first must have the mobile phone with the STK

functions, simultaneously, apply the SIM card with the function of mobile bank to the telecommunicating dealer or the financing unit.

- ³/₄ Through the pre-recorded Applet in SIM card, users may browse and choose the financing service items of mobile phone to enter the necessary trading data.
- ³/₄ Through a dedicated line, the mobile banking system will be obtained the data by TCP/IP with interfaces, formatted by mainframe and transmitted the data to mainframe.
- ³/₄ After the disposition of mainframe either by this bank or by other banks, the trading result will fax back to the mobile banking system as a result to follow the original route fax back to users.



Figure 1. STK Mobile Banking Systematic Frame

The WAP mobile bank so far cooperated by domestic telecom operators and financing unit, and the functions of each components [13] and the process of integral transaction is specified as follows [14] [15]:

- ³/₄ Users use the WAP function of the mobile phone to connect with Internet access, entering the WAP website of the financing unit.
- ³/₄ The trading service content in WAP website of the financing units is using WML form through HTTP protocol being transmitted to WAP gateway.
- ³/₄ Received the WML, WAP gateway r uses WML encoder to shift it into binary code. If the WML received contains Script, use the WML script compiler to transfer it into executable code, and then transmit it to user's WAP mobile phone trough the GSM network by WSP (wireless session protocol) /WTP (wireless transaction protocol).
- ³/₄ Users browse and choose the financing service item at WAP website, and key in the necessary trading data through the key of mobile phone; the WAP web gateway then will transmit the trading data to web server of the financing unit.
- ³/₄ By CGI program or other techniques, the transaction server obtains the trading data from web server, and processes the operations of transferring the form of trading data and record with its transaction process modules, then, by mainframe connected with the interface to transmit the formed data to mainframe.

After the disposition of mainframe either by this bank or by other banks, the trading result will fax back to the mobile banking system as a result to follow the original route fax back to users.

In accordance with knowledge, Master Card, a heavyweight-financing unit, and its subordinate unit---Europe International, as well as the mobile phone

makers, intelligent card makers, and the application software company proceed with a strategic alliance. They present a wireless payment mechanism that users may use the WAP mobile phone to start up the SET [16] payment operation at the WAP-end of proxy server and remote wallet server, with which the existed Internet network trader and the payment gateway may continuously use this system. The payment mechanism, according to developing status of the market, identifies users' ID including:

- ³/₄ Dual-slot phone with full size chip Card : Use the intelligent card at once to identify the status and to provide the functions of basic code, certificates, and ciphers, which are necessary in the process of transaction.
- ³/₄ Multi-application SIM : Integrate the functions of basic code, certificates, and ciphers, into the SIM Card of mobile phone; it can be directly identifying users' ID in transaction, no need to insert the additional intelligence-card.
- ³/₄ ID-Password: Use the code name (e.g. MSISDN) and the code to identify user's ID, no need to provide the intelligent car; its security level is poor, not but that it is direct, convenient, and available to all.

STK (SIM Toolkit), the full-name read as "Subscriber Identity Module Application Toolkit", cooperates with SIM card maker through mobile phone company, recording or infilling the value-added servicing software into the microprocessor on user's ID card, select the value-added service he wants from the menu on the phone directly.

Only the banking business keeps continuously introducing the new service, can the predicament be settled, in which the wireless Internet and mobile commerce is a direction that banks, and that also is a successful operating model and key factor.

3. The Framework of the SMS Service

Domestic private-telecommunicating dealers recently are promoting in droves the service of wireless online, cellular phone with camera, and PDA, etc. Although it can be using the encrypted algorithms to protect the message transmitted, the operation ability and electric power of the cellular phone instead is only suitable for the symmetric-key algorithm of Symmetric-key to achieve the confidentiality and security rather than the complex and public one.

Hence, researching on the application development of the wireless Internet shall take the banking building loan as a subject to combine with the network technique of wireless Internet, traders, and building demanders to set up the "Housing Loan System Based on Wireless Application Protocol". With regard to its contents, it is comprised of wireless communication protocol, buying building with an instant order online, trading process online, and integration of housing-loan system.

In conclusion, look forward to providing more conveniences of the instant order to purchase a building, transacting the trade on-line and the data service,

decreasing the time and manpower's cost, combining with new high-tech development to enhance the service quality and competitiveness.

3.1 Characteristics of the SMS Service

Short Message Service (SMS): The bank currently provides the service of account management with an integral money-administration, with which it can cope with the integrated issues of different financing products. So, taken XML as a common standard for data exchange, the integrating issue may be avoided while the system data are involved with different forms.

Take the XML as a standard word for account data, further to set up an account platform frame to integrate individual money-management. Take the XML as a standard for documented data form in favor of the data exchange and transmission, so that target of the data integration can be reached. Based on the frame of individual money-management to integrate the account, achieving the purpose of the administration of individual money-management, and centralizing the asset to manage from time to time, and to dispatch nimbly the fund to procure the maximum profit.

3.2 Security Mechanism of the SMS Service

Common system of the STK mobile bank according to the transmitting feature to divide the trading message into two sections; the one is intervened between mobile phone users and common Center, and the other between common Center and financial units. The projected safety control mechanism, through the encryption and password, produce symmetric-key diversification, which may prevent the SMS cent or the message in transmitting process from encountering any security threat.

Table 1 Security Control Processes for Trading Message

Message Unit	Transmitting Process of the Message
Mobile Phone Users	Step 1: Select the trading item through the menu. Step 2: Input the data through the mobile phone Step 3: Enter user's cipher for the account transaction
Common Center	Step 4: Accept message of mobile phone users to decrypt and verify the password, transferring the cipher, and then shifting the message form.
Financial Unit	Step 5: The message received from common center, the password will be engraved transaction will be processed. Step 6: Responding disposition to the message.
Common Center	Step 7: Respond to the message of financing unit, verify the engraved code, and transfer the message form.
Mobile Phone User	Sept 8: Message of the common center, through mobile phone, prompts the user to read the result Step 9: Users of mobile phone read result through menu.

The message's security control measures, processes, and steps in transaction are specified as Table 1. The trading message transmitted by mobile phone will be transferred through common center, and this message will be sent back pursuant to the user of mobile phone after the financing unit has processed the message.

These trading messages are marked with account number, amount, and ciphers, the integrity of sequence, identification of the resources, and privacies of the message and cipher.

Another message of the account announcement is specified the security control measures and steps. Discovering user's account having inward remittance (I/R), not sufficient funds (n.s.f.), and expiry of C/D, etc. the system of financing unit will send the noticing message to the user of mobile phone through common center.

These notifying messages are likely carrying with data of the account number, amount, and etc. Therefore, the strictness in the security control has to be deliberately considered to protect the integrity of users' financial account, the integrity of sequence, the resources identification, and the message privacies.

It may decrypt the sensitive data due to the important data in storage protected effectively. The code system is the Symmetric-Key, e.g. DES (Data Encryption Standard), which is often used in decrypting algorithms with a considerable volume, exceeding the capability of the traditional chips---CPU can be loaded---thus the ALU has to be used for auxiliary purpose. Algorithms of the symmetric key is simpler, as same as the SIM and WIM, as the mobile station also used it.

3.2 Benefits of the SMS Mobile Banking Service

Anticipating to use the mobile banking service, the consumer primarily want to have the services of inquiries and transfer; and they have a positive relationship to the "Service Attitude of the SMS" and the "Service of Practical Using SMS". A convenience is the most noticeable factor to affect consumer's attitude to the service attitude of the SMS.

Scholar Brown (1989) had divided the convenient attribute into five formations as time dimension, place dimension, acquisition dimension, use dimension, and execution dimension. Functional Formation Conveniences in Mobile Phone Service) The mobile phone with the service of SMS has the merit of these five conveniences, and its servicing function is consistent with consumer's demand.

The banks have mostly adopted the specialized commissioner system to promote enterprise's financing business since a long time; the customer's commissioner runs the whole show of client's problem resolved and client's relationship maintained. Whether client's commissioner may properly arrange his working contents, and bring the benefit into a full play has become an important issue in banking operation.

4. A Case of SMS Mobile Banking Service

Bank is an important chain linked within the financing mechanism, dominating the indirect finance to act as an intervening role in funds. The resource of the bank deposit is to absorb the public unused-fund loaning to the demander, creating a revolving credit as the primary operating target to form a capital circulation, which is to play a decisive role in the trading behaviors of economies.

Banking business is a service business; in order to procure the optimum benefit of economic scale, the product is normally having the identical quality, traditionally; it is a blurred distinction between the different banks, so the service's convenience and security becomes the major variable of bank's distinction.

A mobile bank cooperated by each bank to promote the value-added service may provide with an intelligent mobile-phone system for transfers, inquiries, and payment. Through the cellular phone, it can be directly to contact with the bank to proceed with the balance inquiry, checking the particulars of transaction and the payment and transfers, as if it has a potable, private, confidential, and secure ATM. SIM card to collocate with STK cellular phone shall be having a higher security in confidentialities and verifications. Users may have the STK function if they own the SIM card issued by mobile bank.

The Internet application may help the bank to enhance the competitive superiority [6]. By means of the hyper-link feature of Internet, different industries have formed a strategic alliance such as the telecommunications, network communications, computers, securities, and insurances. Emome, as "e" is digital; "mobile" is action; and "me" is in the life, signifies the electronic and the mobile. Personalization is collective title of the value-added service of the mobile phone provided by the China Telecommunication Company. Emome website is a wireless portal. In order to procure the best profits of economic scale, the added value may provide more services, which is one of the important promoting strategies for banking business.

4.1 Alternative Operating Modes

The credit given is a major system of the commercial bank. The loan procedure for traditionally existed building made by banks is comprised of: client's negotiation, conditions discussion, acceptance of the application, collaterals appraisalment, credits investigation, analysis, and audits, etc. Should it be consistent with the bank would sign the contract with them, the mortgage arrangement of the collateral, and then the fund will be deposited into debtor's account [7] by transfers.

Internet's development signifies a breakthrough in the realm of information; the data can be received in any time and locations through the voice and words to make the communicating reciprocation, with which the commercial opportunity brought is immeasurable.

Owing to the Internet frequently being used, the computer becomes an indispensable partner in daily living. The Process Step Drawing of the Building Loan mad with

the SMS of Mobile Phone as shown in Table 2.

Table 2. Process Schedule for Mobile Building Loan.

Step	Process Schedule for Operation Building Loan Cellular Phone
1	Consumers use cellular phone to inquire the building type he likes.
2	Consumers use the cellular phone to order the building, and inquire the possible loan conditions.
3	The bank inquires the credit data by integrated database. A. If the client is having an account at this bank, investigate the credit grade and financial status data, and review his credit degree. B. If he is not, then, notify online and wish the client might visit the counter for negotiation.
4	When consumers inquire the possible preferential interest rate, the system will instantly inspect: A. If there is the data of credit's degree, give the good customer a preferential interest rate in accordance with the credit degree B. If not, the interest shall be in accordance with the normal loan condition.
5	Consumers based on the preferential interest rate provided by banks place directly an application for building loan [confirm]
6	A. Clients have to visit the counter to seal and affirm the identification, and both parties sign the contract of building loan. B. Banks will provide the league accountant to ensure the privilege for both parties. C. Banks will provide the league insurance company because their premium is absolutely reasonable
7	After banks and clients signed the contract, the sum can be deposited into consumer's account within 2~3 working days.
8	Deduct the principal and interest by the contract signed by both parties in accordance with terms.
9	When the building loan is expired, the client may apply to postpone the loan
10	When the building loan is expired, the client would not be continuously this loan; system will automatically cancel the debts.
11	If the building loan is not expired, this building loan shall be transferred into receivables on demand when the client failed to pay the interest with the demand many a time
12	If it is unable to communicate online, invite the client to pay a visit to the counter for negotiation.

The mobile bank cooperated with the telecom operator promotes the STK mobile bank service, adopting the GSM mobile phone with STK function to proceed with the order, transfers, and payment, etc of the financing service all year round through the service of SMS in SMS mode with the

menu function displaying on the screen of cellular phone. The features of STK mobile bank are specified as follows: 1). Adopt the menu function displaying on the screen, easy learning, and easy use. 2). 3DES is added the protections of decryptions and multiple ciphers. 3). Expandable, allow to deal simultaneously with many a security companies, and differ from WAP.

Financial card issued by mobile bank & emome money-managing card issued by the China Telecommunication Cellular-phone's function of the mobile bank, regardless of the where and the when, can use the cellular phone to accomplish lightly the transfer, payment, and inquiries of personal account data. In order to coordinate with various money-managing demand requested by clients, this card is integrated the service with the financing card of the mobile bank, or emome money-managing card of the China Telecommunication.

Building load of the mobile SMS, through the emome money-managing card of the China Telecommunication, is provided the menu function with a rapid operating mode. Emome is provided with the following functions except the normal conversation used by mobile phone, mobile online, and SMS.

³/₄ Mobile Bank – Clients may register maximum six banking accounts to provide the balance check, instant transfer, and free transaction service projected by each bank.

³/₄ Mobile Payment – Joining the emome money managing system and selected the merchandise at the contracted store, the client only needs to advise the store dealer of the payment number of the mobile phone issued by the China Telecommunication, then, the e-bill will be sent to the cellular phone with the SMS mode for client's reconfirmation while the financial card is processed the consuming transfer, or the credit card is signed for payment.

³/₄ Mobile Securities Firm – Clients may register maximum three securities accounts to provide the functions of orders (included stock buying, stock selling, loan purchase, loan selling, stock loan indent, stock loan venture, cancel the inquiry commitment, today's bargain status, inquire the stock inventory, free inquiries), profiles settings, profiles inquiries, and warming price setting, etc.

³/₄ Mobile Building Loan – Clients may, through the inquiry of SMS, determine the functions of building loan with cellular phone, which provides with inquiry to various types of building, and to the services of loan conditions, preferential interest rate, confirming the order to apply the building loan, account deposit, deducting principal and interests each term, and applying loan postponed online, etc.

The memory capacity of SIM card of the cellular phone helped with STK tech may expand the normal 2K to 32K, recording many executing program directly on the card, so consumers through STK of the cellular phone to place an order, the SIM card of which has the programming design. Set up directly on the screen, select and input the trading data, and exempt from the repeat listen and input while the

cellular phone is used as a voice order, enhancing the operating convenience and having an apparent improvement in efficiency.

Operate and input directly in accordance with the menu on screen, with which the correction and flexibility is better than voice order. The message is transmitted by the mode of SMS, and the charge is calculated by calls instead of by time.

The screen will be displaying the service of SMS and the normal communication; when the former is used, the keystroke on cellular phone will progressively select the necessary trading function according to the menu on screen, inputting various trading data, and pressing the confirm key to transmit with the SMS.

4.2 An Application Example

Use the cellular phone to determine the building loan, and place an order to operate the functions through the inquiry of SMS; the illustrative process of the cellular phone is simplified as follows:

Individual Inquiry to Buy Building:

³/₄ Step 1 first select [購屋個案查詢] item

³/₄ Step 2 Select the existed building located at County or City, which is distinguished by letters of the alphabet, e.g. Taipei County or City is A; Taoyuan City is B. When the selective items are more than one page, "next" shall be selected.

³/₄ Step 3 "previous" or "next" shall be selected.

³/₄ Step 4 Select the existed building located at County or City, distinguished by letters of the alphabet, e.g. Taipei County or City is A; Taoyuan City is B.

³/₄ Step 5 Select the existed building located at County or City, which is distinguished by figures, e.g. Hsinyi District of Taipei City is A1; Peitou District is A5. When the selective items are more than one page, "previous" or "next" shall be selected.

³/₄ Step 6 The inquiry of individual particulars has to input the inquired housing code (e.g. 1; 2; 3;...), inputting 1 means the individual case of code No.A51, Peitou District of Taipei City, irregularly updated by banking control center.

³/₄ Step 7 Pressing the [confirmed] key, it will show the "transacting is proceeded, please wait for responds", waiting for the center to respond the particulars data to each case.

³/₄ Step 8 Center responds the particulars to each case with following data; A51 Yu-Chuan Villa with Hot Spring, including the sector of the area, unit price, certificate, public facilities, available loan, and building-age.

Inquiries of Preferential Interest Rate:

³/₄ Step 1 first select [優惠利率查詢] item

³/₄ Step 2 Input the ID number to audit if it is the good customer of the bank.

³/₄ Step 3 Clients input the amount of loan, e.g. 130000000 signifies 13 millions.

³/₄ Step 4 Clients input the term of the loan (by year), e.g.

20 means 20 years.

³/₄ Step 5 Pressing the [confirmed] key, it will show the “transacting is proceeded, please wait for responds”, waiting for the center to respond the particulars data to each case.

³/₄ Step 6 Center responds particulars of the individual case with the following data: Building loan amount: 13,000,000; term: 20 years; preferential interest rate: 5.7%.

Applying an order for building loan:

³/₄ Step 1 first select [申請房貸下單] item

³/₄ Step 2 Input the ID number to audit if it is the good customer of the bank.

³/₄ Step 3 Placing an order is client’s personal money management, so it has to input the personal cipher to audit if the client has the authorization.

³/₄ Step 4 Clients input the amount of loan, e.g. 130000000 means 13 millions

³/₄ Step 5 Clients input the term of the loan (by year), e.g. 20 means 20 years.

³/₄ Step 6 Clients input the account number, e.g. 518551123451 signifies 5185-51-12345-1

³/₄ Step 7 Pressing the [confirmed] key, it will show the “transacting is proceeded, please wait for responds”, waiting for the center to respond the particulars data to each case.

³/₄ Step 8 Center responds particulars of the individual case with the following data: Building loan amount: 13,000,000; term: 20 years; preferential interest rate: 5.7%、A/C : 5185-51-12345-1.

4.3 Integrating with the Data Warehouse

To hold each customer is not a simple thing. Client’s data may be collectible through questionnaires or telephoned investigation though, the diversity of information resource and the increase of data volume are undeniable. Will a smooth operating mode be maintained, the demand of each customer shall be comprehended, and it shall be increasingly difficult on the merchandise and service.

Targeting information and data, different analyzing tools will produce various simple and complex analyzing outcome. Generally speaking, the functions of data all have the analyzing tools such as query and reporting, producing different analyzing report (shown as Table 3). Front Tools Including mainly various tools of reporting forms, data analysis, data development, develop tools based on the Data Warehouse.

In the process of a bank loan to the consumer, it is more valuing the various conditions at the consumer himself, banks, and external environment, as well as the factor research, loan-authorized contract, loan’s amount, and the reimbursing capability, than valuing the other request or restriction in the contract therein. As to the credit-authorized contract, manifest that bank often request the clause, which is neither agreeable nor incapable of scrutinizing the content of the contract, e.g.

the currently practical operating situation of immoveable collateral loan, immoveable evaluation, loan percentage, overdue loan, and bad debts, etc.

Table 3. Process Credit Control via Data Warehouse.

Step	Process of the Data Disposition
1	Providing user’s interface with a high affinity, the single window will be used for handling and integrating the storage function, control, and management to set up and maintain entire Data Warehouse.
2	Use unitary platform to control all accessing data of the inventory on entire network, and allow the manager of the Data Warehouse to manage easily the establishing program of Data Warehouse.
3	In the selective process, produce and manage relevant inventory frame and the metadata will automatically produce another metadata; vital data shall not be affected the inventory frame by the personnel variation
4	Provide interface to connect with OS, and time the scheduling software at a specific timing to execute the program automatically.

The commercial analyzing personnel in bank are exclusively using the tools of online analysis and multi-dimensional analysis, with which they might have the capability to analysis the original data, and to drill to understand the correlation among the different parameters in data[8].

Such analyzing report are mostly belonged to the property of system mode, that functional manager in relevant department is normally in charge, and that general analyzing subject is building loan in different phase, and the interest rated, etc.

Data mining is also having the preceding characteristic, the main discrimination of which is the data mining targeting at mass data to analysis and locate the hidden patterns in data. [9] Data mining is substantially differ from the statistic analysis and the online analyzing techniques; the former is only available for analyzing the minority of the data correlation or the different subject in statistics, while the latter is adopted to analysis the report for normal Data Warehouse, aiming at the system mode and the data with lower correlation in analysis.

Credit-authorization is one of the principle businesses, the quality of which is thus related to bank’s existence and development, especially within recent years, domestic economy was influenced by global depressions, the ratio of overdue loan has yearly been on the rise, further to stress on the importance that risk of the credit authorization shall be properly processed and managed from time to time. Nevertheless, owing to consumers’ building loan having

the features of small amount and high cost as per unit, it will be accept or not, and reaching the target to win the identical credit amount by quantities. Hence, to avoid of drawbacks, it is essential to reduce the audit time, decrease the risk of credit authorization, and establish a set of assessing model and system to measure the credit authorization.

5. Conclusions and Future Works

Succeeded by the upsurge of the network bank and the e-commerce, the wireless Internet access and finance has been becoming a newly burgeoning tropic. Developing the mobile bank may provide another sales channel and a more convenient service. As far as the service time is concerned, the mobile bank is 24 hours a day, and 365 days a year in operation, having no restrictions of traditional branches or ATM geographic influence, nor confining the customer to this bank, of which the service range may be included all network participants. Use the mobile phone and wireless transmitting tech to develop e-commerce to go across into a new realm. Promoting the mobile commerce, the banking dealer shall spare no efforts and walk towards the direction of easy use and the compatibility with old users habit in development.

The greatest contribution made by STK tech is to have provided an exploitable environment for the SIM card in value-added business as simply using easy operating and developing platform. Users exploit the SIM card through the coordination of server, with which it may present diversely rich and splendid business. SIM card may accomplish a given mission and the data storage, but its processing ability is inferior to that of computers. However, because it belongs to microcomputer system, it can be stored in the wallet or mobile phone, so SIM card also has an extensive application space. As far as the world scope is concerned, the application of Japan and Europe has gotten higher as well as the intelligent car is widely and rapidly spread out in US.

Devoting to develop the SMS service of the mobile bank, banks may effectively reduce the ratio of clients transact the business on counter. The employee of the bank would have more time to complete the higher value-added business (e.g. money-management projected, financing products promoted, and financing business process improved, etc.), further to benefit and enhance the banking competitiveness.

STK tech allows us directly to use cellular phone to place an order on stock and enjoy the financing service, it is, indeed, satisfied with modern's demands on pursuits of fast speed and on convenience as well as an extremely high security. So the entire transaction process is being protected as the relevant data is encrypted, from which we may see that securities of the data in the transmitting process is considerably conscientious and careful.

The SMS service combined with STK, it will be becoming a path to allow the system dealer to enhance individual service. STK tech is mainly being applied to the realms of mobile bank, stock transaction, foreign exchange

buying/selling, and money-management, etc. Although its service for is unitary, a considerable demand is requested to the use. For STK, it is still having a given technical defect such as the high difficulties in development, non-unified technical norm, confined to processor's tech development, narrowly technical developing space, etc. So it is still waiting for our unceasingly endeavors.

6. Appendices



Figure A. Mobile Building Loan SMS Processes.

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Sensitivity Analysis for Economic Lot Size Problem

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Abstract

Many problems in production planning and supply chain optimization can be modeled as Economic Lot Size problem (ELS). This paper first demonstrates forward and backward algorithms for the economic lot size problem with backlogging, and then applies the two algorithms to analyze the sensitivities of setup cost and demand. The result for setup cost sensitivity is the same as the one described in [8] for economic lot size problem without backlogging. These analyses are especially useful for online or real-time applications which are common in current E-commerce.

1. Introduction

Many problems in production planning and supply chain optimization can be modeled as Economic Lot Size (ELS) problem. For example, if we consider the single product production scheduling problem at the manufacturer's site, and also consider the same product's inventory control problem at the retailer's site, then it is a typical ELS provided the production and inventory cost have linear relationship with the production and inventory units. ELS is a classical problem and first proposed in [10]. After Wagner and Whitin provided and solved the economic lot size model without backlogging by an $O(n^2)$ algorithm, considerable research efforts have been made to extend the basic model. Two important extensions are the consideration of backlogging, and the improvement of computational complexity. This paper re-interprets the algorithms given in [12] and [7], and applies the forward and backward algorithms for conducting sensitivity analysis on setup cost and demand.

2. Previous Works

Zangwill [11] considered the inventory backlogging in the basic economic lot size model, and proved that there is an optimal solution that the production and inventory at every period satisfy the exact requirements. In the same paper Zangwill also developed an $O(n^3)$ algorithm to solve the model. Zangwill [12] expressed the economic lot size problem with and without backlogging as a network that has one entry with the demand summations and multiple exits with the demand of every period. He also developed an efficient $O(n^2)$ algorithm for the model where the production cost is fixed. It is worthy to notice

that the cost functions of every period in the Zangwill's works can be linear or nonlinear and the value can be computed in constant time. Blackburn and Kunreuther [3] developed a forward algorithm for the case where the production, holding and backlogging cost functions are linear. Some breakthrough was made at the beginning of 1990's. Wagelmans et al. [9] reformulate Wagner-Whitin model into a new model without holding cost, and employ a geometric method to reduce the computational complexity. Furthermore Hoesel, Wagelmans and Moerman [7] proved that the economic lot size problem with backlogging can also be solved with the same computational complexity as $O(n \log n)$ using geometric methods. Federgruen and Tzur [5] [6] also develop an $O(n \log n)$ forward dynamic algorithm to determine the optimal last setup period and minimum cost sequentially for the ELS with and without backlogging. Aggarwal and Park [2] identify the connections of the known fast array searching techniques in Monge arrays with the ELS, and obtain the same results.

Based on the geometric interpretation of the ELS developed in [9], Hoesel and Wagelmans [8] studied the variation scopes of setup, production, holding costs and demand respectively such that the optimal production schedule remained unchanged. If the setup cost for every period is constant and the unit production cost is also fixed, Chand and Voros [4] prove that the total cost of holding and backlogging is a non-increasing convex function of the number of setups for the ELS with and without backlogging, and develop an $O(n^2)$ forward algorithm to compute the stability region of the setup cost.

3. The Notations

Mathematically, economic lot sizing model with backlogging is to satisfy the known demands in a planning horizon at a minimum cost by a single commodity. ELS with backlogging permits to produce later to satisfy the demand of a former period. The following notations will be used through this article:

N : the length of the planning horizon,

d_i : the demand in period $i \in \{1, \dots, N\}$,

p_i : the unit production cost in period $i \in \{1, \dots, N\}$,

f_i : the setup cost in period $i \in \{1, \dots, N\}$,

h_i : the unit inventory cost $i \in \{1, \dots, N\}$,

h_i^b : the unit backlogging cost $i \in \{1, \dots, N\}$,

$$d_{i,j} = \sum_{t \in I} d_t, 1 \leq i \leq j \leq N$$

$$h_{i,j}^{\square} = \sum_{t \in I} h_t^{\square}, 1 \leq i \leq j \leq N$$

$$h_{i,j}^{\square} = \sum_{t \in I} h_t^{\square}, 1 \leq i \leq j \leq N$$

F(i): the minimum cost from period 1 to the end of period i, the demands are satisfied by the productions in these periods. The inventory at the end of period is zero (such period is defined as regeneration period).

F'(i) : the minimum cost from period 1 to the end of period i, the demands are satisfied by the productions in these periods. Period i is a production period (Such period is defined as production period).

B(i): the minimum cost from the beginning of period i to the end of period N, the demands are satisfied by the productions in these periods. The inventory at the beginning of period is zero.

B'(i) : the minimum cost from the beginning of period i to the end of period N, the demands are satisfied by the productions in these periods. Period i is a production period.

4. Forward and Backward Algorithms

Zangwill [12] gave a two-step expression to demonstrate ELS with backlogging. Hoesel, Wagelmans and Moerman [7] reformulated the formulas into the ones that can be explained in a geometric approach. Based on both the preceding works, this article re-formulates the backward and forward dynamic expressions with the parameters within the studied period scope, keeps the formulas' geometric meaning, and subsequently applies them in the setup cost sensitivity analysis and total demand variation.

4.1 Backward Algorithm

In [12] and [7], the backward algorithm of ELS with backlogging can be expressed as the following equations:

$$B(s) = \min_{s \leq t \leq N} \{ p_t d_{s,t} + \sum_{s \leq t \leq N} h_t^{\square} d_{s,t} + B'(t) \} \quad (1)$$

$$B'(t) = \min_{t \leq u \leq N} \{ f_t + p_t d_{t,u} + \sum_{t \leq u \leq N} h_u^{\square} d_{t,u} + B(u) \} \quad (2)$$

and define $B(N+1) = 0$, $B'(N+1) = 0$.

Define $M(s, t) = \sum_{s \leq t \leq N} h_t^{\square} d_{s,t}$ and

$$M'(t, u) = \sum_{t \leq u \leq N} h_u^{\square} d_{t,u}$$

The following equalities hold:

$$M(s, t) = M(s, N) - M(t, N) - h_{t,N}^{\square} d_{s,t},$$

$$M'(t, u) = M'(t, N) - M'(u, N) - h_{u,N}^{\square} d_{t,u}.$$

So the equalities (1) and (2) can be re-written as:

$$\begin{aligned} B(s) &= \min_{s \leq t \leq N} \{ p_t d_{s,t} + M(s, N) - M(t, N) \\ &\quad - h_{t,N}^{\square} d_{s,t} + B'(t) \} \\ &= M(s, N) + \min_{s \leq t \leq N} \{ B'(t) - M(t, N) \\ &\quad - (p_t - h_{t,N}^{\square}) d_{s,t} - (p_t - h_{t,N}^{\square}) d_{s,N} \} \quad (3) \end{aligned}$$

$$\begin{aligned} B'(t) &= \min_{t \leq u \leq N} \{ f_t + p_t d_{t,u} + M'(t, N) \\ &\quad - M'(u, N) - h_{u,N}^{\square} d_{t,u} + B(u) \} \\ &= M'(t, N) + f_t + h_{t,N}^{\square} d_{t,N} \\ &\quad + \min_{t \leq u \leq N} \{ B(u) - M'(u, N) \\ &\quad - h_{u,N}^{\square} d_{t,u} - (p_t - h_{t,N}^{\square}) d_{t,u} \} \quad (4) \end{aligned}$$

The geometric meaning of equalities (3) and (4) can be explained as follows: The lines passing through $(0, B'(t) - M(t, N) - (p_t - h_{t,N}^{\square}) d_{t,N})$ with slopes $(p_t - h_{t,N}^{\square})$ construct the concave lower envelope, the $B(s)$ can be obtained by maintaining this concave lower envelope; the points of $(d_{t,N}, B(u) - M'(u, N) - h_{u,N}^{\square} d_{t,u})$ construct a convex lower envelope, $B'(t)$ can be obtained by searching the point that the line passing through with slope $p_t - h_{t,N}^{\square}$ is tangent to the envelope. (Please refer to [7] for detail).

4.2 Forward Algorithm

The forward algorithm can be expressed as the following formulas:

$$F(s) = \min_{0 \leq t \leq s} \{ p_t d_{t,s} + \sum_{t \leq s \leq N} h_t^{\square} d_{t,s} + F'(t) \} \quad (5)$$

$$F'(t) = \min_{0 \leq u \leq t} \{ f_t + p_t d_{u,t} + \sum_{u \leq t \leq N} h_u^{\square} d_{u,t} + F(u) \} \quad (6)$$

and define $F(0) = 0$, $F'(0) = 0$.

Similarly, define

$$m(t, s) = \sum_{t \leq s \leq N} h_s^{\square} d_{t,s}, \text{ and}$$

$$m'(u, t) = \sum_{u \leq t \leq N} h_t^{\square} d_{u,t}.$$

The following equalities hold:

$$m(t, s) = m(1, s) - m(1, t) - h_{1,t}^{\square} d_{t,s},$$

$$m'(u, t) \leq m'(1, t) \leq m'(1, u) \leq h_{u,t} d_{2,u}$$

Equalities (5) and (6) can be rewritten as following:

$$\begin{aligned} F(s) &= \min_{0 \leq t \leq s} \{ p_t d_{t,s} \leq m(1, s) \leq m(1, t) \\ &\quad \leq h_{1,t} d_{t,s} \leq F'(t) \} \\ &= m(1, s) \leq \min_{0 \leq t \leq s} \{ F'(t) \leq m(1, t) \leq \\ &\quad (p_t \leq h_{1,t}) d_{1,t} \leq (p_t \leq h_{1,t}) d_{1,s} \} \quad (7) \end{aligned}$$

$$\begin{aligned} F'(t) &= \min_{0 \leq u \leq t} \{ f_t \leq p_t d_{u,t} \leq m'(1, t) \\ &\quad \leq m'(1, u) \leq h_{u,t} d_{2,u} \leq F(u) \} \\ &= f_t \leq m'(1, t) \leq h_{1,t} d_{2,t} \leq \\ &\quad \min_{0 \leq u \leq t} \{ F(u) \leq m'(1, u) \leq h_{1,u} d_{2,u} \\ &\quad \leq (p_t \leq h_{1,t}) d_{u,t} \} \quad (8) \end{aligned}$$

The similar geometric meaning of equalities (7) and (8) can be explained as follows: The lines passing through $(0, F'(t) \leq m(1, t) \leq (p_t \leq h_{1,t}) d_{1,t})$ with slopes $(p_t \leq h_{1,t})$ construct the concave lower envelope, the $F(s)$ can be obtained by maintaining this concave lower envelope; the points of $(d_{1,u}, F(u) \leq m'(1, u) \leq h_{1,u} d_{2,u})$ construct a convex lower envelope, $F'(t)$ can be obtained by searching the point that the line passing through with slope $p_t \leq h_{1,t}$ is tangent to the envelope.

Now we have the backward and forward dynamic algorithms that are expressed with the parameters within the study periods.

5. Setup Cost Sensitivity Analysis

In this section, two scenarios will be considered: setup cost at a period is decreased, or increased by a variation of Δ . The objective is to get the variation scope of the Δ such that the production schedule remains unchanged.

Scenario 1: Setup cost is decreased from f_i to $f_i \leq \Delta$.

First suppose period i is a production period in the original problem and we will prove the following proposition.

Proposition 1: If Period i is a production period in ELS model with backlogging, then period i will still be a production period if its setup cost is decreased.

Proof: Suppose the optimal production schedule S_1 for the new problem does not include period i . The minimum cost of the new optimal production schedule will not be less than that one for the original problem which period i is a production period. This contradicts that S_1 is the

optimal production schedule. \square

Lemma 1: If period i is a production period in the final optimal production schedule, then

$$B(1) = F(N) = F'(i) + B'(i) \leq f \leq p d.$$

Proof: Suppose the final production schedule is:

$1 \leq i_1 \leq i_2 \leq \dots \leq i_j \leq i \leq i_r \leq \dots \leq i_k \leq N$. If we can prove that the production schedule before and after period i in this final schedule is the optimal production schedule for $F'(i)$ and $B'(i)$ respectively, we prove the lemma. This can be proved by contradiction.

Suppose there is a better production schedule $i_1', i_2', \dots, i_j', i$ other than i_1, i_2, \dots, i_j, i for $F'(i)$ which the total cost for $F'(i)$ is smaller, then obviously $i_1', i_2', \dots, i_j', i, i_r, \dots, i_k$ will be a better production schedule than $i_1, i_2, \dots, i_j, i, i_r, \dots, i_k$. This is a contradiction to our supposition. In similar way, we can prove i, i_r, \dots, i_k is the optimal production schedule for $B'(i)$.

Because $f_i \leq p d_i$ is counted twice together in $F'(i)$ and $B'(i)$, so we have $B(1) = F(N) = F'(i) + B'(i) \leq f \leq p d_i$.

It is obvious to have the following lemma directly from equalities (4) and (8):

Lemma 2: If in period i , the setup cost is decreased from f_i to $f_i \leq \Delta$ (period i might not be a production period), then

(1) From period 1 to $i-1$, $F'(\cdot)$ remains unchanged; $F'(i)$ decreases by Δ ;

(2) From period $i+1$ to N , $B'(\cdot)$ remains unchanged; $B'(i)$ decreases by Δ .

From Proposition 1 and preceding analysis, we can get the following conclusion:

Proposition 2: If period i is a production period in ELS with backlogging, and its setup cost is decreased from f_i to $f_i \leq \Delta$, and the production schedule remains unchanged, then the optimal cost decreases by Δ .

Now suppose period i is not a production period in the original problem. Suppose period i becomes a production period in the new problem for its setup cost decreases from f_i to $f_i \leq \Delta$, then the optimal cost is $F'(i) + B'(i) \leq f \leq p d_i \leq \Delta$, and this value should be at least less than the original minimum cost. So:

$$F'(i) + B'(i) \leq f \leq p d \leq F(1),$$

$$\text{then } \Delta > F'(i) + B'(i) \leq f \leq p d \leq F(1)$$

So if $\Delta \leq F'(i) + B'(i) \leq f \leq p d \leq F(1)$, then period i will not become a production period in the new problem. So Δ is bounded by $\min\{f_i, F'(i) + B'(i) \leq f \leq p d_i \leq F(1)\}$. So the following

conclusion can be obtained:

Proposition 3: If Period i is not a production period in ELS with backlogging, and its setup cost is decreased from f_i to $f_i \square \square$, the variation of \square is bounded by $\text{Min}\{f_i, F'(i) \square B(i) \square f_i \square p_i d_i \square F(1)\}$.

Scenario 2: Setup cost is increased from f_i to $f_i \square \square$.

Opposite to Proposition 1, it is obvious that if a period is not a production period in the final production schedule, it is impossible for it to become a production period if its setup cost is increased. Thus, the period is a production period in the final production schedule can be considered only.

The idea here is to compute the optimal minimum value for problem that period i is not a production period from period 1 to N , the obtained optimal value is the upper bound for the problem that the setup cost of period i is increased and period i remains a production period.

Mathematically, the optimal minimum cost can be expressed as:

$$G = \min_{1 \leq j \leq i \leq N} \{F'(j) \square g(j, t) \square B'(t)\}, \quad (9)$$

where

$$g(j, t) \square \min_{j \leq 1 \leq t} \{p_j d_{j \square 1} \square p_t d_{1 \square t \square 1} \square \sum_{\square \square j}^{1 \square} h_{\square} d_{\square \square 1 \square 1} \square \sum_{\square \square 1}^{t \square} h_{\square} d_{1 \square \square \square}\}$$

In order to get the value of $G(\cdot)$ in equality (9), first we prove the following lemma:

Lemma 3: If a period is not a production period in the final production schedule, and its setup cost is increased, this period will still not be a production period in the final production schedule, and the final production schedule and optimal cost will remain unchanged.

Proof: Similar to proposition 1, the first part is obvious. The second part is proved as follows:

Suppose setup cost at period i is $f_i \square \square_1$ and $f_i \square \square_2$ respectively, and period i is not a production period in the final production schedule for both problems with different setup cost. Because the optimal total cost will only count the setup costs of final production periods, holding and backlogging costs between the consecutive production periods, and the other parameter values except the setup cost at period i are the same for both problems, so a feasible solution for one problem is also feasible for the other one. This proves the lemma. \square

Lemma 3 will be used in the following idea to compute the value of $G(\cdot)$: Because of increasing setup cost, it is possible that a production period i will be out of the final production schedule. So there is a break value of setup cost that period i is a production period in the final production schedule if its setup cost is less than this value (Proposition 1), and period i is not a production period in the final production schedule if its setup cost is larger than this value (Lemma 3). Also from Lemma 3, if setup cost is

larger than the setup break point value, the optimal final cost is the same no matter how big the setup cost is. So period i in equality (9) can be got if a big enough setup cost is assigned to period i such that period i will not be a production period in the final optimal solution.

Now it is clear that we can get the value of G in $O(n \log n)$ if the setup cost for period i is assigned a big enough value so that the period i is not a production period in the final solution. Of course we can start to solve the problem from $B(i+1)$ or $F(i-1)$. Such big enough setup value for period i exists, for example the new setup cost is:

$$f_i \square \sum_{j \square 1}^N f_j \square d_{1, N} [N * \text{Max}(h_1^{\square}, h_2^{\square}, \dots, h_N^{\square}) \square$$

$$N * \text{Max}(h_1^{\square}, h_2^{\square}, \dots, h_N^{\square}) \square \text{Max}(p_1, p_2, \dots, p_N)$$

If production occurs at such a period, the cost will be more than that for setup at every period, carrying and backlogging the total demands from the beginning to the end, and producing at the most expensive unit cost. Any production schedule other than including this period will definitely be smaller.

After value of G is computed, the period i will remain the production period if $F(n) + \square \square G$. So the upper bound for the value of \square is $G - F(n)$. So the following result holds:

Proposition 4: The maximal allowable increase of f_i can be calculated in $O(n \log n)$ time.

6. Total Demand Variation Analysis

It is also obvious to get the following lemma from equalities (4) and (8):

Lemma 4: If in period i , the demand is changed from d_i to $d_i \square \square$ then

(1) From period 1 to $i-1$, $F'(\cdot)$ remains unchanged, $F'(i)$ changes by $\square p \square$;

(2) From period $i+1$ to N , $B'(\cdot)$ remains unchanged, $B'(i)$ changes by $\square p \square$.

Here, we will study how the variation of the total demand affects the original optimal production plan.

Suppose the $\square \square$ units are increased or decreased at period i . The objective is still to let the whole costs minimum. Such minimum value can be expressed mathematically as follows for the case the products are increased or decreased:

$$VI(\square) \square \min_{1 \leq i \leq N} \{F'(i) \square B'(i) \square f \square p_i d \square p_i \square\} \quad (10)$$

$$V(\square) \square \min_{1 \leq i \leq N} \{F'(i) \square B'(i) \square f \square p_i d \square p_i \square\} \quad (11)$$

Let us discuss (10) first. Define l_i is the line which passes through point $(0, F'(i) \square B'(i) \square f \square p_i d)$ with slope of p_i . So lines of $i (1 \leq i \leq N)$ construct a concave lower envelop for the parameter of \square . Because

the values of $F'(i) \square B'(i) \square f \square p_i d_i$ are the same for all production periods, so only the period with the lowest p_i can be in the concave lower envelop for all production periods. Define such period as period A. The line A has the minimum value of $F'(i) \square B'(i) \square f \square p_i d_i$ due to A is a production period.

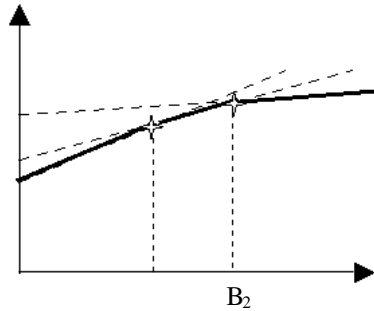


Figure 1

From Figure 1, we can see that if the increased \square is within $[0, B_1]$, which B_1 is the first break point of the concave lower envelop, then the production period A will produce the increased units; if the increased \square is not within $[0, B_1]$, then another period which is not a production period at the original optimal solution will produce the increased units, and therefore becomes a production period in the new solution.

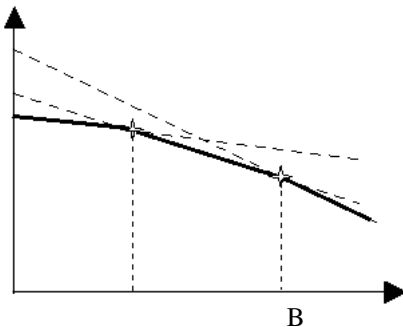


Figure 2

Same logic can applied for (11) except that i is the line which passes through point $(0, F'(i) \square B'(i) \square f \square p_i d_i)$ with slope of $\square p_i$; and only the period with the biggest p_i can be in the concave lower envelop for all production periods due to the line gradient is negative. Figure 2 describes this case.

In [7], it is proved that time complexity of constructing such a concave lower envelop in Figure 1 and 2 will be $O(n \log n)$. They also proposed that balanced tree such as 2-3 tree [1] is the efficient data structure for supporting such a procedure.

From the preceding analysis, we can draw the following result:

Proposition 5:

(1) If the solution remains the same, the increased total demand is produced at the period with least production cost; and the decreased total demand is extracted from the period with largest production cost.

(2) The maximum increased (decreased) total demand

variation is the value of B_1 which is described in Figure 1 (2).

(3) The value of B can be computed at time complexity of $O(n \log n)$.

7. Conclusion

This article describes the backward and forward algorithms for the economic lot size problem with backlogging, and subsequently applies the algorithms to analyze the two main parameters of the model: variation of period setup cost, and total demand variation. Although the computational complexity of the algorithm for determining the sensitivity range of setup cost and demand is $O(n \log n)$, the complexity of solving the problem itself is not augmented by sensitivity analysis since these two can be implemented concurrently. Such analysis is very useful for online or real time ELS planning or scheduling problems which are very common in today's e-commerce applications.

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A Behavioral Finance Analysis Using Learning Vector Quantization in Taiwan Stock Market Index Future

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Abstract

There are various types of trading behavior in the stock market. And the buying or selling activities in many investment strategies are influenced by numerous factors respectively, such as fundamental analysis, macroeconomic analysis, and news analysis. Consequently, various factors will reflect on market price. Random Walk in financial engineering is not the focus in this paper. Otherwise, the importance of the technique analysis about Taiwan Stock Index Futures will be emphasized in this research.

It is the intention of this paper to investigate the information content of Open, High, Low, Close prices in the previous trading day and relative higher and lower points in the prior period of the current trading day, as well as their prices in analyzing Taiwan Stock Index Future. The predictability of Learning Vector Quantization Network can clearly be seen from the empirical result.

Keywords : Neural Network, Learning Vector Quantization, Taiwan Stock Index Future

1. Introduction

From economic viewpoint, the prices of goods are determined by supply and demand. Buyers and sellers made their own trading decisions according to different view about the target goods. The price will rise if demand falls short of supply; On the contrary, if supply falls short of demand, price will decline. In other words, the price of goods is a common consensus for all participants about the value of goods itself. It is the same with financial commodities.

The prices of financial commodities are the trading results of buyers and sellers. Buyers and sellers made their own trading decision according to different trading rules, including fundamental analysis, macroeconomic analysis, and news analysis. Therefore, these factors have influence on determining stock prices as well. Figure 1 describes how these trading rules affect the stock prices continuously, such as fundamental factors, macroeconomic factors and etc. In this paper, we assumed that all factors are functions of time and will be continuous time relative data.

$$\text{Stock price} = \text{Real price} + \text{Effect price} \quad (1)$$

$$\text{Effect (fundamental)} = f_1(t) \quad (2)$$

$$\text{Effect(macroconomics)} = f_2(t) \quad (3)$$

Because of the restrictions on trading hours, the curve of market prices is discrete in time-axis. Therefore, it is impossible for market prices to reflect immediately the effect of all factors. After the market closing, all elements influencing market prices will be reflected on the Open prices in the next trading day. The non-cash-period represents expectation formation process.

For this reason, this research will focus on whether all factors between 13:45 and 08:45 (period T) from previous day will affect the Open price (point E) of next trading day. Furthermore, it is suspected that the sum of all factors will be the Open price of the next trading day.

$$\text{price}_{\text{Open}} = \sum_{e=1}^n \text{Effect}(e) = \sum_{e=1}^n f_e(T) \quad (4)$$

Open : open price

e : element influencing prices

n : number of elements

T : time period between two trading times

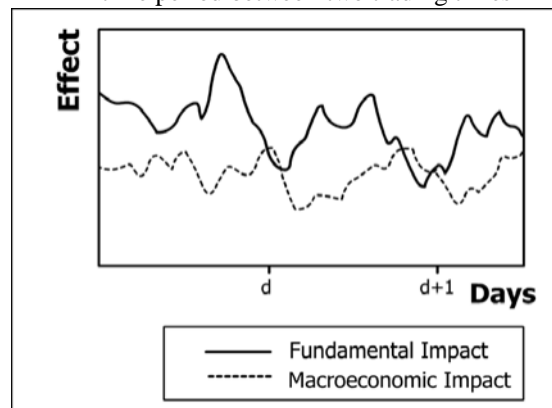


Figure 1. The factors influence the stock prices continuously, such as fundamental factors, macroeconomic factors and etc.

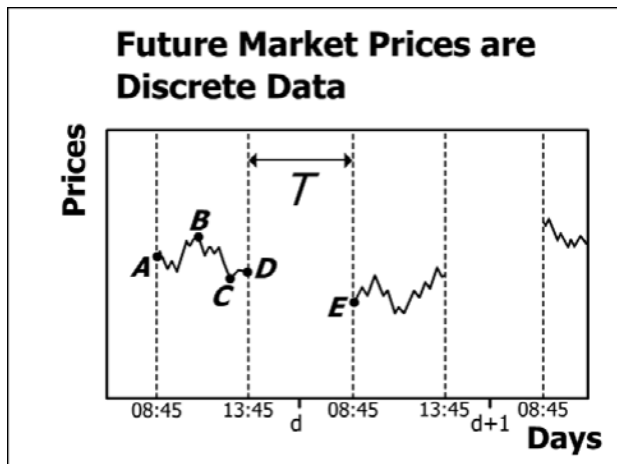


Figure 2. An illustration of the Open, High, Low, Close prices in the previous trading day as point A, B, C and D.

The relevance between the Open, High, Low, Close prices in the previous trading day, and relative higher and lower points in the prior period of the current trading day is discussed by using artificial Intelligence in this paper. The purpose is to make profits and to avoid risks by analyzing Taiwan Stock Index Future.

2. Literature

2.1 Literature Review

2.1.1 Literature in Stock Market Behavior

The overnight effect on the index future is discussed in this paper. Research on forecasting stock returns, such as Campbell and Shiller in 1988, and Bollerslev and Hodrick in 1992, have indicated that stock returns are predictable by using linear models.

Menkhoff (1998) indicated that changing order flows play an important part in determining market prices. Tian Shyue Lee and Nen Jing Chen [8] showed that the lead-lag relationship between the futures market during the non-cash-period and the cash market during its opening period does exist. The empirical results of the above research show that the prediction result of the model is better than random walk model. Therefore, this research is based on non random walk process.

2.1.2 Literature in Application of Artificial Intelligence.

Neural network has been widely applied in several financial areas, such as exchange rate prediction, bankruptcy forecasting and stock market prediction. For exchange rate prediction, Jingtao Yao and Chew Lim Tan [2] stated that a neural network model is applicable to the prediction of foreign exchange rates. For bankruptcy

forecasting, Moshe Leshno and Yishey Spector [5] stated that the prediction capabilities of neural network model in this bankruptcy case are clearly more accurate than other classical discriminate analysis model. For stock market prediction, Mary Malliaris and Linda Salchenberger [4] used neural network to forecast the S&P 100 implied volatility.

2.2 Candlestick Analysis

Open, High, Low and Close prices defined in candlestick analysis are used to be input factors in this research. Norbert M. Fiessa and Ronald MacDonald indicated that the difference between High and Low prices marks the intradaily trading range and measures volatility. The difference between the Open and the Close prices thus serves as a measure of the direction and the extent of intradaily trends. The academic survey on support and resistance levels by Curcio and Goodhart (1992), DeGrauwe and Decupere (1992) showed clearly that High and Low prices reveal information about shifts in the demand and supply structure. Therefore, Open, High, Low and Close prices are the inputs to the model in this research.

2.3 Learning Vector Quantization

Learning Vector Quantization of neural network is selected in this paper. Neural network is one part of Artificial Intelligence. It is an information-processing paradigm inspired by the way the densely interconnected, parallel structure of the mammalian brain processes information. The key element of the ANN paradigm to be differentiated from other methods of Artificial Intelligence is self-learning. Neural network is also well known for its ability to process nonlinear problem.

Ramazan Gençay[6] pointed out that strong evidence of non-linear predictability is found in the stock market returns by using the past buy and sell signals of moving average rules. Therefore, artificial neural network is applied in this paper to improve predictability of stock market and to raise the profitability.

Learning Vector Quantization is a competitive learning algorithm said to be a supervised version of the Self-Organising Map (SOM) algorithm by T. Kohonen[7].

Reference vectors are the weights of the connections leading from the input neurons to the output neurons. For each training sample, the reference vector that is closest to it is determined. Only the weights of the connections to this winner neuron are updated. The direction of the adaption depends on whether the class of the training sample and the class assigned to the reference vector identify or not. If the training sample is placed into the correct class, the reference vector is moved closer to the training sample; otherwise it is moved farther away. This

movement of the reference vector is controlled by a parameter called the learning rate [Christian Borgelt, 2000].

The algorithm of LVQ is listed as follows :

1. Initialize weights; initialize learning rate.
2. Do step 3-7 until stopping condition is true.
3. For each input vector X , repeat steps 4-5
4. Find node J so that $\|X - W_J\|$ is a minimum distance.
5. Update W_J according to follows :

 If X is classified to the correct class

$$W_J^{\text{new}} = W_J^{\text{old}} + \alpha(X - W_J^{\text{old}})$$

 If X is classified to the incorrect class

$$W_J^{\text{new}} = W_J^{\text{old}} - \alpha(X - W_J^{\text{old}})$$
6. Reduce learning rate.
7. Test stopping condition. It may be a fixed number of iterations or the learning rate reaching a sufficiently small value.

3. Architecture

3.1 The Research Process

First, data of Taiwan Stock Index Future is collected. The data of each trading day is processed as follows.

1. According to candlestick analysis, every Open, High, Low and Close prices are selected using daily minute ticks.
2. All apexes are found by the sign of multiple of two neighboring slopes, where these slopes are determined from each two neighboring points in daily minute ticks.

The input nodes of neural network model will be selected after completing the above steps. Then, the model will be trained with part of collected data. At last, there will be a performance validation with the rest of collected data. The research architecture is showed as Figure 3.

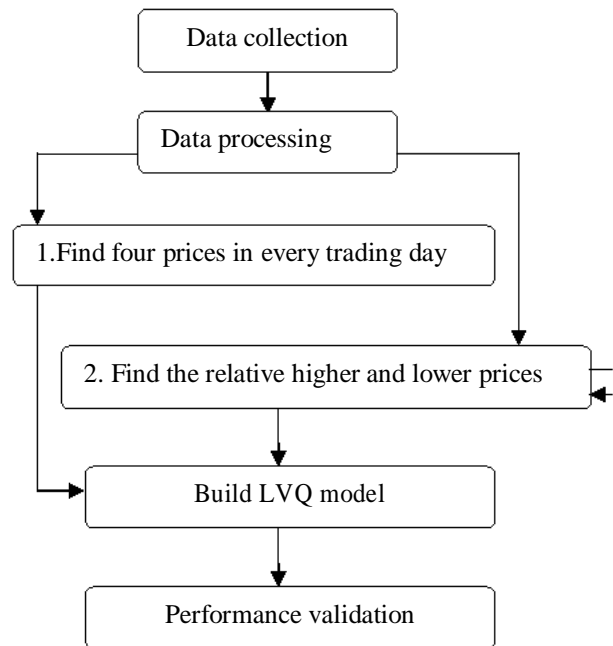


Figure 3. The research process of the study

3.2 The Neural Network Model

According to candlestick analysis mentioned in section 2.2, it is the belief that Open, High, Low and Close prices have a higher information content than other prices to extract featured prices of intraday trading. These four prices are used as input nodes in neural network model. The relative higher and lower points found after the opening of future market and stock market are also parts of the input nodes in neural network model. Hence, the Open, High, Low and Close prices in the prior period can be represented by these relative higher and lower points after future market and stock market opening. Based on fractal theory[3], pattern feature extraction is irrelevant to the length of period. Consequently, four prices in the previous trading day and four prices in the prior period after opening are considered as the factors to influence future prices. The input nodes and output nodes are listed as follows:

Table 1 Input nodes of neural Network model

1. True
2. False

Table2 Output nodes of neural Network model

1. The 1 st relative higher point after future opening
2. The 1 st relative lower point after future opening
3. The 2 nd relative higher point after future opening
4. The 2 nd relative lower point after future opening
5. The 1 st relative higher point after stock opening
6. The 1 st relative lower point after stock opening
7. The 2 nd relative higher point after stock opening
8. The 2 nd relative lower point after stock opening
9. Open price in the previous trading day
10. High price in the previous trading day
11. Low price in the previous trading day
12. Close price in the previous trading day

4. Experiment Result and Analysis

In this paper, the minute ticks of Taiwan Stock Index Future between 2001/04/13 and 2002/04/12 are used. Every minute price in one trading day is characterized as a record, totaling 204 records. 80% of records are taken as the training sample to build the neural network model. The remaining 20% records are tested for the accuracy of this model.

The first step is to process original data by computing the slope of every two neighboring points. The trend of stock market index could be determined by using the sign of slopes as formula (5).

$$m = \frac{p_2 - p_1}{t_2 - t_1} \quad (5)$$

m : slope
 t : time point
 p_t : future price at time t

By using the sign of the product of the two neighboring slopes, the apex is determined to be the relative higher point and lower point. The formula is listed as follows:

$$s = \text{sign}(m_t) * \text{sign}(m_{t+1}) \quad (6)$$

s : sign of product of two slopes

According to formula (5) and formula (6), relative higher and lower points can be found as Figure 4.

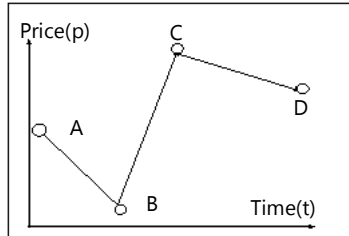


Figure 4. The relative higher and lower points

The slope of AB (m_t) is negative, and the slope of BC (m_{t+1}) is positive. So the product of m_t and m_{t+1} is negative. Because of a negative sign, point B is a relative higher and lower point.

This research takes relative higher and lower points and the four prices as the input nodes in this neural network model. The nodes are listed as Table 1 and Table 2. Nodes will be placed into True group if it is higher than or equal to the *higher price*, which is 0.5% higher than Open price calculated in formula (7), and the total number of True item will increase accordingly; otherwise, it will be placed into False group.

The formula to *higher price* is listed as follows:

$$h = O + 0.5\% * O \quad (7)$$

h : higher price

O : Open price

$$\begin{aligned} \text{If } H > h & \text{ then } T \\ \text{If } H < h & \text{ then } F \end{aligned} \quad (8)$$

H : High price

The ratio of success is the percentage of correct identification. The formula is listed as follows:

$$S = \frac{T}{T + F} \quad (9)$$

S : ratio of success
 T : the number of correct classification
 F : the number of incorrect classification

After data processing, Learning Vector Quantization is used to build a Neural Network model. The sequence of the input samples is randomly selected. This research also uses random weights and SOM (Self-Organizing Maps, SOM) to get the initial weights. After several runs, the representative results are listed in Table 3.

Table 3 Statistics of the experiment (iteration is 100)

experiment run	initial weights	learning rate	ratio of success
1	(W_1, W_2)	0.2	80%
2	(W_1, W_2)	0.2	35%
3	(W_1, W_2)	0.1	65%
4	(W_1, W_2)	0.1	37.5%
5	(W_1, W_2)	0.2	35%
6	(W_1, W_2)	0.2	30%
7	(W_1, W_2)	0.1	17.5%
8	(W_1, W_2)	0.1	27.5%

(W_1, W_2) are different initial weights in different runs of experiment.

$W_1 = \{w_{1i}, i = 1, 2, 3, \dots, 12\}$, $W_2 = \{w_{2i}, i = 1, 2, 3, \dots, 12\}$, (W_1, W_2) are showed as Figure 5:

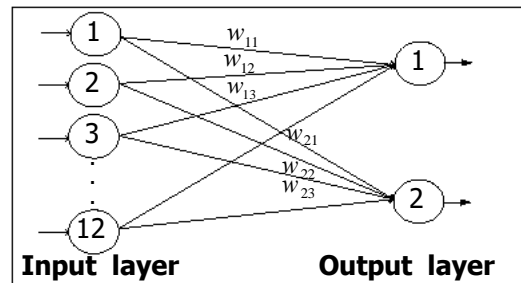


Figure 5. The structure of neural network model

Table 3 shows that the first four runs used random initial weights, and the last four runs used SOM initial weights. When using random initial weights, success rate

can achieve 80% with learning rate of 0.2 and iteration number of 100. Hence, it is obvious that selecting random initial weights is better than selecting SOM weights.

This research is the application of classification in Neural Network. In this paper, there are two analytic methods, including BPN (Back-Propagation Network) and LVQ (Learning Vector Quantization). Figure 6 shows the result of BPN training process in this experiment, and also shows the unstableness of BPN. On the contrary, LVQ is more stable instead. Figure 7 describes the increase on success rate and stability of LVQ. Therefore, Learning Vector Quantization is chosen in this paper.

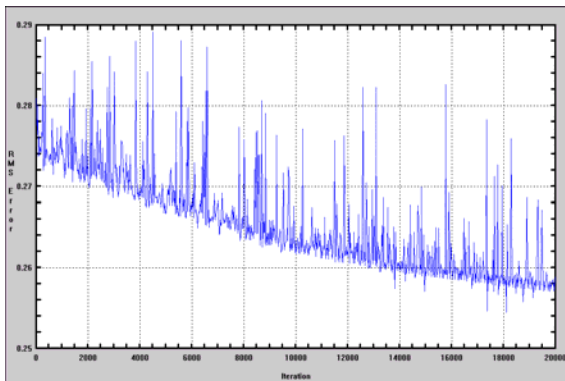


Figure 6. The result of BPN training process in this experiment, and also shows the unstableness of BPN

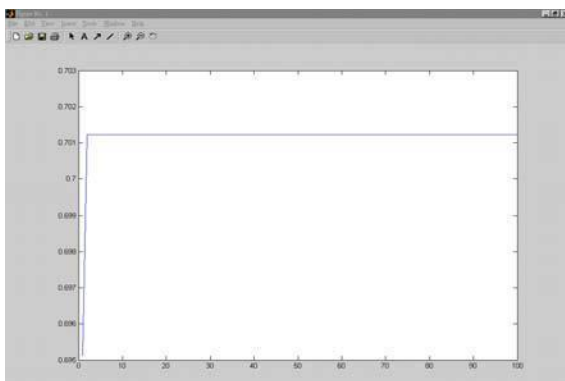


Figure 7. The increase on success rate and stability of LVQ

The relevance between the four prices in the previous trading day and the relative higher points and lower points in the prior period of current trading day is well analyzed using LVQ. The success rate of 80% represents the existence of behavior model, and disproved the unpredictableness of the stock market. In other words, this research emphasized analysis on behavior model. The phenomenon happened in the past can imply the occurrences of investment behavior in the future. This concept is a concept in behavioral science under conditional probability, not Random Walk Process stressed in financial engineering.

5. Conclusion

By using Learning Vector Quantization, this paper discussed about the gap of the market price between the two trading time. Furthermore, it showed that Open, High, Low, Close prices in the previous trading day and the relative higher and lower points are related to Taiwan Stock Index Future. The result can be applied to the strategy of arbitrage and speculation. As arbitrage between TAIMEX and SIMEX, arbitrageurs should have a short position on TAIMEX and have a long position on SIMEX or have a opposite position on SIMEX and TAIMEX. If the analysis on TAIMEX or SIMEX is correct, it is possible for investors to lower the trading cost of one. For example, Open price of TAIMEX is high, but the analysis shows that there will be a higher price in the trading hours. Arbitrageurs can offset the short position of TAIMEX, and repurchase the position back before closing. For arbitrageurs, this trading strategy can increase total profit by lowering the cost at the loss position. It can avoid the fluctuation of prices between the two trading times and make fixed profit.

Further research can focus on the application of Fuzzy system to judge amplitude of prices volatility and the application of trading volume to reflect momentum of buying and selling with the purpose to approve the accuracy of neural network model. In other words, it is intended to minimize the probability of loss and to increase profit.

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Development of Indexes for the Performance Evaluation of e-SCM

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Abstract

Web-based sharing of information across the supply chain can bring a host of advantages to the trading partners. lower cost, leaner inventories, and more efficient shipping are just the beginning. e-SCM is technology-enabled ability to concurrently manage high levels of complexity and multiple external relationships.

This study presents that the development of indexes for the performance evaluation of e-SCM should be given more priority by companies giving weights to each index. Deductive research is used for the development of evaluation items and AHP method for the development of weights of the items.

According to priority of each category - relationship between supplier and company, relationship between partner and company and relationship between customer and company- is as follows;

z Company driven type: relationship between customer and company, relationship between supplier and company, relationship between partner and company.

z Market portal type: relationship between supplier and company, relationship between customer and company, relationship between partner and company.

keywords : e-SCM, Relationship, Measure of Performance, AHP method

1. Introduction

Recent business environments of global firms are summarized by the globalization of competition, the advent of economic blocks represented in the European economic cooperation, the North American Free Trade Agreement, and the Pacific economic cooperation, and changes of competition advantage elements by developing of Information technology. International leading firms are taking a supply chain management (SCM) strategy in order to respond to these environment changes [6]. Furthermore, the development of digital technologies causes for leading firms to establish the Internet-based supply chain management (e-SCM) by changing business concept [3]. Therefore, the framework to evaluate whether the supply chains are operated well or not is requested.

As for the performance evaluation of an e-SCM, it is related deeply to business goal on all process of the chain --- growth, profitability, market share, and customer satisfaction [9]. Therefore, to evaluate the performance of a supply chain and to correspond to it could be a basis to secure competitive advantage of firms.

e-SCM is defined that to manage the flow of information, resources, and money on the supply chain, and to control all network between participants to achieve common goals using the Internet. This e-SCM is categorized into a company driven type and a market portal type. They have various differences. For the company driven type, the management flexibility is high and control on suppliers is

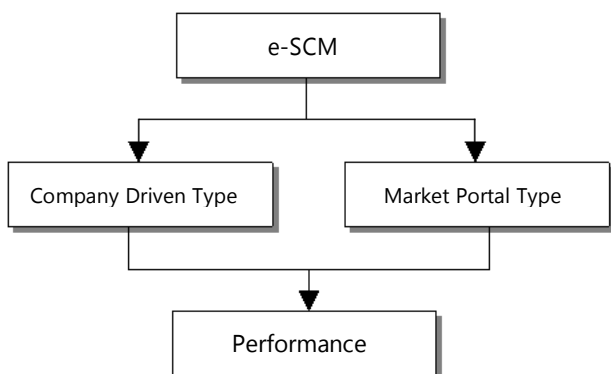
easy because the change of items is possible any time according to firms' own needs. Whereas, market portal type provides supplementary services such as purchasing guidance, payment guarantee, a risk management, a product delivery, payment, and storage. Besides, this type can provide more expanded services than the company driven type. However, it has a limit to provide the most suitable products that buyers want [5]. Therefore, this study finds weights of the performance evaluation items of the company driven type and the market portal type. And it suggests a guidance which items are more important, when the performance of firms is evaluated in both of the firms adopting company driven type and market portal type. Thus, the study provides the framework that can compare the performance before introduction of e-SCM with that after introduction of e-SCM

The research questions of this study are as follows:

- What is e-SCM and what kind of types are composed?
- What kinds of items are necessary to evaluate the performance of e-SCM? And what are weights of the performance of items in both of company driven type and market portal type?

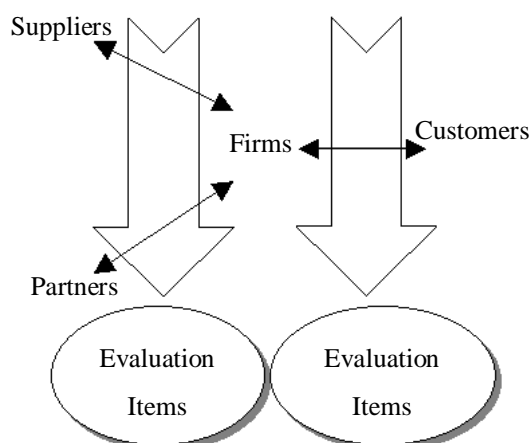
2. Research Model

The purpose of this study is to evaluate the performance of e-SCM, and to draw evaluation items and its weights depending on its types. The research model is shown in Figure 1.



<Figure 1> Research Model

The study tries to evaluate the process performance among the objects on the e-SCM based on the Internet as shown in Figure 2.



<Figure 2> Scope of Evaluation Items drawn for Performance

Performance will be evaluated by three categories. These categories are composed of (1) Performance on transaction process between suppliers and firms, (2) Performance between partners and firms excluding suppliers, (3) Performance on transaction process between customers and firms. From all of these categories, performance evaluation items will be extracted.

Although the operating method is different between Company Driven Type and Market Portal Type, the core concept -- process among suppliers, firms, partners, customers -- is the same, so the management items are regarded as the same. But, the quantity and quality of objects on the process is different, so these two types of performance evaluation items cannot have the same level of importance. So this study will pay different importance level by weighing differently according to types and items. The purpose of this process is to apply different evaluation weight according to respective types.

3. Research Methodology

This study uses the Analytic Hierarchy Process (AHP) as a research methodology. The analytic hierarchy was composed of the evaluation items that were extracted by previous studies and interviews with experts based on the framework for the development of evaluation items.

The AHP, which enables the user to determine the relative importance of criteria sets underlying their choice behaviors [1], is selected as the appropriate analysis tool. The AHP of Saaty [10]-is theory and reality-an often used to solve strategic decision problems [2] [4] [7] [10] [11]

According to Saaty's original proposal, a complex system is decomposed into subsystems and represented in the hierarchical form. The element at the highest level is called the goal. The elements at each level are the criteria (factors) of elements at the level below. The elements at the bottom level are called the

alternatives. In this way, AHP organizes the basic rationality of the priority setting process by breaking down a multi-element complex system into its smaller constituent parts called components (or levels). The process can be divided into three phases, which are structuring a system, comparing pair-wise and synthesizing priorities.

The principle of comparative judgment is setting up a matrix to carry out the pair-wise comparisons of the relative importance of the elements in a component with respect to the criteria, elements in a dominating component at a higher level in the hierarchy.

Let the relative importance of each evaluation items ($a_1, a_2, a_3, \dots, a_n$) is $w_1, w_2, w_3, \dots, w_n$, and the pair-wise comparison of a_{ij} or a_{ji} can be replaced like equation (1).

$$a_{ij} = w_i/w_j \quad a_{ji} = w_j/w_i \quad (1)$$

The entry a_{ij} measures the relative importance of the impact on the criterion from element i against that from element j . This matrix, denoted by A ($=[a_{ij}]$) in our notation, is called the pair-wise comparison matrix[See below equation (2)].

$$A = \begin{pmatrix} w_1/w_1 & w_1/w_2 & \dots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \dots & w_2/w_n \\ \dots & \dots & \dots & \dots \\ w_n/w_1 & w_n/w_2 & \dots & w_n/w_n \end{pmatrix} \quad (2)$$

It is straightforward to show that when A is consistent, the weight vector W , which gives the relative priorities of the elements, is identical to any one of the columns of A within a normalization factor. And when multiply

importance vector $W(w_1, w_2, w_3, \dots, w_n)$ by matrix A [equation (2)], equation (3) is extracted.

$$AW = nW \quad (3)$$

Since the relative importance of the elements depends only on the relative amplitudes of the components of the vector W , we may normalize W by requiring as shown on equation (4)

$$\sum W_i = 1 \quad (4)$$

In fact, the fuzzy nature of the comparison process dictates that inconsistency cannot be completely eliminated. It has been argued that even when A is not consistent, the weight vector W is still determined by the dominant eigenvector of A . The equality is reached only when the matrix is consistent. To measure the consistency of the matrix A , we define the Consistency Index (C.I.) as follows:

$$C.I. = (\lambda_{\max} - n) / (n-1) \quad (5)$$

When the consistency is perfect, $C.I.=0$, which means $\lambda_{\max}=n$. And when the consistency is low, $\lambda_{\max} > n$, so consistency index becomes high. In practice, we consider A is very consistent if the consistency index ratio is less than 0.1, which is the average consistency index of a random reciprocal matrix of the same dimension. And the consistency of A is acceptable if the ratio of C.I. is about 10% or less, we accept the estimate of W . Otherwise, we attempt to improve consistency [7] [10].

4. Conclusions

4.1 Results

This study divided the forms of e-SCM implemented in the Internet environment into

two types, such as the company driven type and the market portal type, and suggested evaluation items and their weights of each e-SCM type through previous studies and AHP technique.

The performance evaluation items of e-SCM were composed of the relationship between suppliers and firms, the relationship between partners and firms, the relationship between customers and firms. The detailed evaluation items of each were drawn. The analytic hierarchy was presented in Figure 3(see Appendices).

Program 'Expert Choice 9.5' was used for analysis. Results of the performance evaluation items satisfied non-consistency level 0.1 as Satty recommended. Firm driven type is 0.05, and Market portal type is 0.08, so Satty's standard was satisfied. To assign the importance of each evaluation item extracted by prior studies and interviews with experts, the related data were collected from the experts who had participated in the interview.

For the company driven type, the order of importance was calculated that the relationship between customers and firms is the first, the relationship between suppliers and firms, the second, and the relationship between partners and firms, the last. Among the sub-items of the relationship between customers and firms, the weight of customer service is the highest (Table 1 & Table 2 : See Appendices).

On the other hand, for the market portal type, the order of importance was calculated that the relationship between suppliers and firms is the first, the relationship between customers and firms, the second, and the relationship between partners and firms, the last. Among the sub-

items of the relationship between suppliers and firms, the weight of purchasing and procurement is the highest. In the company driven type, the importance of customers was highlighted because it is comparatively easy to manage relationship with suppliers by managing limited suppliers (Table 1 & Table 2 : See Appendices). For the market portal type, the relationship with supplier was emphasized since managing suppliers is relatively hard and on-line purchase was important.

4.2 Implications

It is natural to implement SCM on the Internet and make a performance using this tool. Many firms are using e-SCM in the developed countries, and Korea also recognizes the necessity of it and is using or implementing e-SCM. This study developed the evaluation items of the performance of e-SCM and established the evaluation framework to draw the weights of the items and performance evaluation method (Table 3 : See Appendices). Therefore, this effort contributes to evaluate each firm performance by providing evaluation criteria. Furthermore, this study provides a foundation of the study about e-SCM performance evaluation.

However, this study didn't provide the evaluation items subdivided according to industry and didn't verify the drawn evaluation items. The evaluation items of the performance presented in this study can be adopted as a general criterion. But the weight of each item could be different, and some items could be added or deleted according to firms. Therefore, it should be considered for the future study.

Appendices

Level 1	Level 2	Level 3	Level 4
The Evaluation Items of e-SCM Performance	The Relationship between Suppliers and Firms	Purchase and Procurement	EDI Program
			Investigation of estimate
			Negotiation of Transaction and Price
			On-line Purchase
		Inventory Management	On time Delivery Program
			Communication on Proper Inventory Level
		Order Process	Checking Credit of Suppliers
			Communication on the Order Procedure
		Production Scheduling	Coordinating Production Schedule of Suppliers
			Coordinating Production Schedule of Firms
		Relationship with Suppliers	Using On-line Catalogs
			Refunding and Dealing with Damaged Products
			Receiving and Managing Inquiries
			Providing the Order of Performance
	The Relationship between Partners and Firms	Delivery	Controlling Delivery
			Scheduling of Distributors
		Production Scheduling	Production Scheduling by Markets
			Production Scheduling by Other Firms
	The Relationship between Customers and Firms	Inventory Management	Notice of delayed delivery
			Communication related to Sold-Out
		Order Process	Providing Credit Information
			Providing Product Information
			Communication of Order Status
			Providing Performance of Total Order Cycle
			Communication Related to Sold-Out
			Communication Related to Refunding
		Customer Service	Dealing with Complaints
			Notifying Urgent Matters
			Providing Technical Services
			Selling on the Internet

<Figure 3> The analytic hierarchy of the evaluation items of e-SCM

<Table 1> Performance Evaluation Items' Weight (Firms Driven Types)

Customers (0.682)			Suppliers (0.235)			Partners (0.080)		
Customer Service 0.490	Dealing With Complaints	0.181	Order Process 0.089	Checking Credit of Supplier	0.066	Production Scheduling 0.058	Scheduling by Other Firms	0.034
	Notifying Urgent Matters	0.139						
	Providing Technical Services	0.089		Communication on the OP	0.023		Production Scheduling by Markets	0.024
	Selling on Internet	0.082						
Order Process 0.134	Communication Related to Sold-Out	0.049	Purchase and Procurement 0.058	EDI Program	0.031	Delivery 0.022	Scheduling of Distributors	0.018
	Providing Product Info.	0.031		On-line Purchase	0.010		Controlling Delivery	0.004
	Communication of Order Status	0.017		Negotiation of Transaction and Price	0.007			
	Communication Related to Refunding	0.017		Investigation of estimate	0.004			
	Providing Credit Information	0.013	Production Scheduling 0.051	Coordinating of Firms	0.032			
				Coordinating of Suppliers	0.019			
	Providing Performance of Total Order Cycle	0.006	Relationship with Vendor 0.023	Refunding and Dealing with Damaged Products	0.010			
Inventory Mgmt 0.061	Notice of delayed delivery	0.030		Receiving & Managing requires	0.006			
	Communication related to Sold-Out	0.030		Using On-line Catalogs	0.004			
			Inventory Mgmt 0.013	On time Delivery Program	0.010			
				Communication on Proper Inventory Level	0.003			

<Table 2> Performance Evaluation Items' Weight (Market Driven Types)

Suppliers (0.682)			Customers (0.222)			Partners (0.095)		
Purchase & Procurement 0.256	On-line Purchase	0.127	Customer Service 0.150	Selling on the Internet	0.055	Production Scheduling 0.066	Scheduling by Other Firms	0.054
	Negotiation of Transaction & Price	0.070		Notifying Urgent Matter	0.042		Scheduling by Markets	0.012
	Investigation of estimate	0.032		Providing Technical Services	0.031	Delivery 0.029	Controlling Delivery	0.020
	EDI Program	0.027		Dealing with Complaints	0.022		Scheduling of Distributors	0.010
Relationship with vendors 0.141	Using On-line catalogs	0.066	Inventory Mgt. 0.047	Communication related to Sold-Out	0.030			
	Refunding and Dealing with Damaged Products	0.046		Notice of Delayed delivery	0.017			
	Receiving & Managing Inquires	0.020	Order Process 0.025	Communication Related to Sold-Out	0.008			
	Providing Order of Performance	0.008		Communication Related to Refunding	0.006			
Production Scheduling 0.129	Coordinating of Firms	0.100		Communication of Order Status	0.004			
	Coordinating of Suppliers	0.029		Providing credit Information	0.003			
Order Process 0.084	Communication on the order Procedure	0.059		Providing Performance of Total Order Cycle	0.003			
	Checking Credit of Suppliers	0.026		Providing Product Info.	0.002			
Inventory Management 0.071	On time Delivery Program	0.058						
	Communication on Proper Inventory Level	0.013						

<Table 3> Performance Evaluation Method (Firms Driven Types)

1	2	Level 3	W	Evaluation Method
C U S T O M E R	Customer Service	Dealing With Complaints	0.181	Complaints process ratio (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%) Process time (1: very slow, 2: slow, 3: average, 4: fast, 5: very fast)
		Notifying Urgent Matters	0.139	Urgent matters delivery (1: not delivered, 2: delivered)
		Providing Tech. Services	0.089	Technical service providing (1: not delivered, 2: delivered)
		Selling on Internet	0.082	Internet use ratio per sold(1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
	Order Process	Comm. Rela. to Sold-Out	0.049	Notifying ratio per sold-out(1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
		Providing Product Info.	0.031	Providing price and product info. (1: Don't, 2: Do)
		Comm. of Order Status	0.017	Response ratio (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
		Comm. Rela. to Refunding	0.017	Refunding comm.(1: never, 2: seldom, 3: average, 4: often, 5: very often)
		Providing Credit Info.	0.013	Credit Info. Providing (1: Don't, 2: Do)
		Providing Performance of Total Order Cycle	0.006	Providing performance of total order cycle (1: Don't, 2: Do)
S U P P L I E R	Inventory Mgmt.	Notice of delayed delivery	0.030	Notifying ratio per delay (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
		Comm. related to Sold-Out	0.030	Communication (1:never, 2:seldom, 3:average, 4:often, 5:very often)
	Order Process	Supplier Credit Checking	0.066	Credit checking ratio (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
		Communication on the OP	0.023	Order checking possibility (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
	Purchase and Procurement	EDI Program	0.031	EDI Program (1: Don't have, 2: Have) Program use ratio per event(1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
		On-line Purchase	0.010	On-line catalog (1: Don't have, 2: Have) On-line catalog use ratio (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
		Negotiation of Transaction and Price	0.007	Average consuming time for negotiation (1: very slow, 2: slow, 3: average, 4: fast, 5: very fast)
		Investigation of estimate	0.004	Estimate checking ratio (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
	Production Schedule	Coordinating of Firms	0.032	Firms schedule change ratio per suppliers schedule changes (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
		Coordinating of Suppliers	0.019	Supplier production schedule change ratio per firms request (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
	Relationship with Vendor	Refunding and Dealing with Damaged Products	0.010	Process ratio per refunding and damaged products (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
		Managing requires	0.006	Process ratio per requests (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
		Using On-line Catalogs	0.004	On-line catalogs use ratio (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
	Inventory Mgmt.	On time Delivery Program	0.010	On time delivery coordination using program (1: Not possible, 2: Average, 3: Possible)
		Communication on Proper Inventory Level	0.003	Inventory level communication degree (1:never, 2:seldom, 3:average, 4:often, 5:very often)
P A R T N E R	Production Schedule	Scheduling by Other Firms	0.034	Firms schedule change ratio per partners schedule change (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
		Scheduling by Markets	0.024	Production schedule change ratio by market (1: 0%, 2: 25%, 3: 50%, 4: 75%, 5: 100%)
	Delivery	Scheduling of Distributors	0.018	Delivery scheduling coordination possibility (1: very difficult, 2: a little difficult, 3: average, 4: a little easy, 5: very easy)
		Controlling Delivery	0.004	Delivery controlling (1: never, 2: seldom, 3: average, 4: almost do, 5: strongly do)

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An Intelligent Information Management Environment for Mobile Commerce

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Abstract

This work proposes an intelligent information management environment for mobile commerce. The environment contains four modules, namely, interface manager, information repository, information analyzer, and information collector. The interface manager provides an intelligent interface for generating and collecting business information from the mobile device. The information repository contains the user-specific information and the meta-information of information sources. The information analyzer performs the tasks of user behavior analysis, quality of information service measurement, information repository management, cost evaluation, anytime information supporting, and information filtering. Finally, the information collector dispatches different information agents for collecting business information from different information sources.

1. Introduction

Mobile commerce (MC) provides the user best mediation to complete business activity and to receive valued-aided services through the wireless communication network [1][6][11]. The user can use mobile devices, such as, mobile phone, pocket personal computer, or personal digit assistant for obtaining services or merchandises. The service provider of MC tries to provide numerous functions to satisfy different requirements. However, they have not met the service requests since they still have some problems need to be solved. First, the portable and small display screen of the mobile device is not easily to display the transaction information clearly. It is not suitable for the small screen by using the dense hyperlinks in transaction process. Moreover, the limited processing capability of the mobile devices also obstructs the business information display. Second, the service providers of MC did not provide sufficient supporting information for the user to complete the business process. For example, they did not consider the communication cost and service charge of the user transaction [3]. Third, the service provider of MC did not use the user profiles for helping the business process. For example, they did not consider the geographical location and business behavior of the users [11]. Fourth, the service providers of MC did not personalize the transaction information based on the user interest. The large number of business information may increase the overloading of the user as well as the

processing capability of the mobile devices. Finally, the specific specifications of the mobile devices, the different system interface of the operation environment, and the different transmission protocol of the communication networks may also limit the information usability of the user.

This work proposes an intelligent information management environment for mobile commerce. The environment contains four modules, namely, interface manager, information repository, information analyzer, and information collector. The interface manager provides an intelligent interface for generating and collecting business information from the mobile device. It uses the mobile commerce markup language (MCML) for displaying the business information. The MCML provides the meta description script to support the information manager to optimize the appearance of the business information in different mobile devices and operation platforms. Moreover, the interface manager collects the transaction behavior logs of the users in the business process. The information repository contains two models, that is, the user model and information source model. The user model manages the user-specific information, such as, user behavior, user interest, and transaction history. The information source model records the response time, information quality, and up-to-date data of the information source. The information analyzer is the main component of the system to analyze the user behavior from the transaction behavior logs, measure the quality of information service, manage the information repository, evaluate the communication cost, support anytime information, and filters information based on the irrelevant and valueless information based on the interest and geographical location of the user. Finally, the information collector dispatches different information agents for collecting business information from different information sources.

2. System Architecture

The environment contains four modules, namely, interface manager, information repository, information analyzer, and information collector (Fig. 1). The interface manager provides an intelligent interface for generating and collecting business information from the mobile device. It uses the MCML for displaying the business information. The MCML provides the meta description script to support the information manager to

optimize the appearance of the business information in different mobile devices and operation platforms. Moreover, the interface manager collects the transaction behavior logs of the users in the business process.

The information repository contains two models, that is, the user model and information source model. The user model manages the user-specific information, such as, user behavior, user interest, and transaction history. The information source model records the response time, information quality, and up-to-date data of the information source.

The information analyzer is the main component of the system to analyze the user behavior from the transaction behavior logs, measure the quality of information service, manage the information repository, evaluate the communication cost, support anytime information, and filter information based on the irrelevant and valueless information based on the interest and geographical location of the user.

Finally, the information collector dispatches different information agents for collecting business information from different information sources.

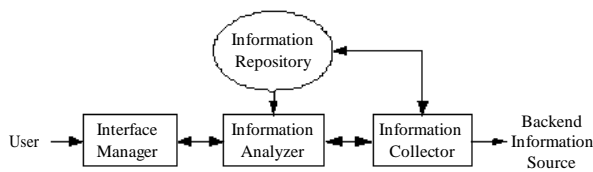


Fig. 1 System architecture

3. Interface Manager

The interface manager provides an intelligent interface for generating and collecting business information from the mobile device. Specifically, the interface manager uses a MCML for displaying the business information. The MCML is an information description language, which extends the Compact HTML (CHTML) [12] for mobile commerce. The MCML provides the meta description script to support the information manager to optimize the appearance of the business information in different mobile devices and operation platforms. Moreover, the MCML integrates the extensible markup language (XML) [13] and cascading style sheets (CSS) mobile profile [14] into the CHTML for enhancing the information display capability in small information appliance.

Furthermore, the interface manager collects the user transaction behaviors into transaction behavior logs. It collects the interaction message from the client and server-side. Each interaction message contains information regarding the interaction events and the message of interaction protocol. The interface manager uses the MCML and server logs to capture the user behaviors. The information analyzer then extracts the user information from the transaction information.

4. Information Repository

The information repository contains two models, that is, the user model and information source model. The user model manages the user-specific information, such as, user behavior, user interest, and transaction history. The user behavior records the transaction steps of the user for completing the business process. It uses the behavior network to represent the behaviors correlation of the user. Fig. 2 illustrates the topology of the behavior network. The square box is used to represent the business task, such as, browsing, searching, buying, and payment. The circular node is used to represent the name and frequency of the behavior with the interaction item. Moreover, the decorated link is used to represent the successive relations between behaviors and their frequency. The behavior network was updated after the user completed the business process. Notably, the behaviors use fuzzy relationship to represent the degree of relations. Fig. 3 and Table 1 exemplify the relations between transaction behaviors. The user interest records the favorite products and brand taste of the user. The transaction history records the user transaction information in mobile commerce. It uses cases to store the transaction history. Each case contains instances of the transaction time, geographical location, and product category.

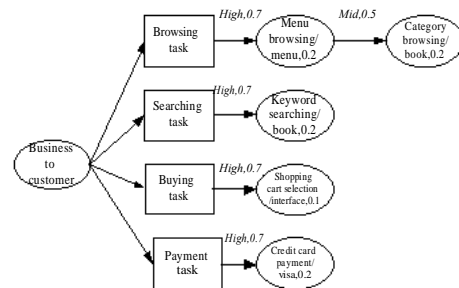


Fig. 2 Behavior network

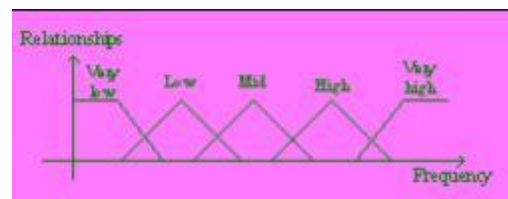


Fig. 3 Fuzzy partition of behavior relationship

Table 1 Example behavior relationships

Relationship	Menu browsing	Product browsing	Product selection	Shopping cart selection
Menu browsing		High, 0.7	Mid, 0.5	Very low, 0.1
Product browsing			High, 0.7	Low, 0.3
Product selection				High, 0.7

The information source model contains the service characteristics and quality of service information of the information source. The information source model records the response time, information quality, and up-to-date data of the information source. This information can support the information analyzer for providing the anytime service.

5. Information Analyzer

The information analyzer performs six tasks, including user behavior analysis, quality of information service measurement, information repository management, cost evaluation, anytime information supporting, and information filtering. The user behavior analysis uses the induction-based technique for mining the behavior relationships. It uses support vector machine [4] and k-means [2] to classify the user transaction behavior logs into different classes. It then uses the induction method [10] to find the behavior relationship of each class. The information analyzer uses the fuzzy behavior proximity (FBP) to update the behavior network of the user model.

$$FBP_{ij}(k+1) = FBP_{ij}(k) + a(|A_{ij}(k+1)| - |A_{ij}(k)|) \quad (1)$$

where i and j is the i th and j th behavior and i is the precedence of j , k is the k th business task, a is the learning rate, and $|A_{ij}(k)|$ is the frequency of the behavior j follow the behavior i . Moreover, the user behavior analysis also analyzes the interests and brand taste of the user based on the transaction information [9]. The interests record the domain habits, that is, the visited or used terminology, of the user. The term frequency, T , is used to calculate the frequency of the terminology.

$$T = T_i / n \quad (2)$$

where T_i represents the occurrence of the terminology i and n is the terminology number. Additionally, brand taste records the brands that are frequently occurrence in the transaction behavior. The brand test, B , is used to compute the frequency of the operations.

$$B = B_i / n \quad (3)$$

where B_i represents the occurrence of the brand i and n is the brand number of the transaction behavior.

The quality of information service (QoIS) measurement computes the quality of service in the network and information services. The network service measures the response time, connectivity, and reliability of the information source. The information service evaluates the availability, timeless, accuracy, and consistency of the business data.

The information repository management records the user behavior relationship, user interest and taste, and quality of service information into the user model and information source model in the information repository correspondingly. The information repository management records the up-to-date information of each information source for providing the anytime service. Moreover, the information analyzer also update the information repository based on the analyzed user

behaviors. The information analyzer then manages the transaction history of the users by case-based reasoning [8]. Fig. 4 illustrates the architecture of the case-based reasoning. The architecture contains three main modules, namely, the case library, case selector, and case evaluator. Basically, the case library contains instances of the transaction time, geographical location, and product category. The case library organizes the cases in the flat structure. Each case represents the data in the feature-value pair. The case selector selects the similar cases from the case library according to the transaction information. Moreover, the case evaluator compares the difference between the similar cases and transaction information. The case evaluator also abstracts the similar cases into prototype. Finally, the case evaluator then updates the case library by replace the similar cases into the prototype case.

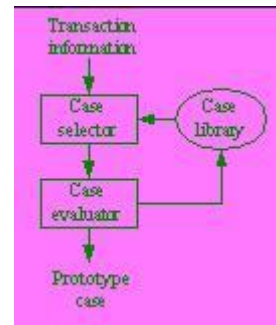


Fig. 4 Case-based reasoning

The cost evaluation predicts the transaction cost for the user by measuring the communication cost and service charge in the mobile commerce. It uses the information source model to predict the completion time of the business transaction from the service provider. It then computes the communication cost and service charge based on the QoIS measurement. This information may advise the user by considering cost and benefit before the transaction. The anytime information supporting also uses the QoIS measurement for providing the anytime information service for the user. The information source model may provide the anytime information when the QoIS was not good enough or the transaction data was time-invariant. The information filtering provides the personalized and location-based transaction information for the user. The information filtering filters out irrelevant and valueless information based on the interest and geographical location of the user. The information filtering then rearranges the information based on the user preference. These decorated transaction information were sent to the interface manager for displaying.

6. Information Analyzer

The information collector dispatches different information agents for collecting business information from different information sources, heterogeneous databank, or Internet-based information sources. The information agents were generated from the agent pattern

library that contains different agent components to do different tasks. The information collector instantiates and composites these patterns to construct different information agents. It retrieves, filters, synthesizes, and sends the most reliable data that the agent collected so far to the data analyzer. Fig. 5 shows the pattern of Connect_data_server in the pattern library.

```

Pattern name: Connect_data_server
Pattern task: Data server connection
Receiving: Data server location, database type
Production: Connection status
Context: N/A
Executor:
import java.rmi.*;
import java.sql.util.Vector;
public interface Connect_data_server extends Remote
{ void accept(Agent agent) throws RemoteException;
  Vector Connect() throws RemoteException,
    SQLException;
}
public interface Agent extends java.io.Serializable
{ void run();
}

```

Fig. 5 The Connect_data_server pattern

The information collector also dispatches the information agents to get the service information from the service brokers in web service environment [5][7]. The information agent collects the functionality and value-added service information of the information sources from the brokerages. Finally, the information collector collects and synthesizes the business information to the information analyzer.

7. Conclusions

This work proposes an intelligent information management environment for mobile commerce. The environment contains four modules, namely, interface manager, information repository, information analyzer, and information collector. The interface manager provides an intelligent interface for generating and collecting business information from the mobile device. It uses the MCML for displaying the business information. The MCML provides the meta description script to support the information manager to optimize the appearance of the business information in different mobile devices and operation platforms. Moreover, the interface manager collects the transaction behavior logs of the users in the business process. The information repository contains two models, that is, the user model and information source model. The user model manages the user-specific information, such as, user behavior, user interest, and transaction history. The information source model records the response time, information quality, and up-to-date data of the information source. The information analyzer is the main component of the system to analyze the user behavior from the transaction behavior

logs, measure the quality of information service, manage the information repository, evaluate the communication cost, support anytime information, and filters information based on the irrelevant and valueless information based on the interest and geographical location of the user.. Finally, the information collector dispatches different information agents for collecting business information from different information sources.

In summary, the proposed intelligent information management environment exhibits the following interesting features. First, the proposed system has an intelligent interface that supports different mobile devices to display the business information. Moreover, the MCML provides the XML-based meta description script with device-independent information for different mobile devices. Second, the information analyzer uses the user model to personalize the transaction information and to analyze the user behavior. Notably, the task of user behavior analysis and user model management was supported by the support vector machine and k-means. Third, the information analyzer uses the information source model for providing the cost evaluation and anytime supporting. The network and information service evaluation was supported by invoking the information quality measurement. The information analyzer manages the information source model by computing the QoS and recording the up-to-date data of the information source. Finally, the information agent was dispatched to collect the transaction data within business process. These agents were cooperated with each other to collect data from diverse databank and Internet-based information sources by using the agent communication languages (ACL). Moreover, the information agent can also be dispatched to collect information from the web-service-based environment.

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A MODEL OF CONSUMER BEHAVIOR IN ONLINE SHOPPING

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Track Area: Electronic Commerce Management

The development of Internet has brought enormous business opportunities and given new connotation to traditional commercial activities. E-commerce emerged as the times require. The business-to-consumer (B2C) is the most visible business of e-commerce. The so-called B2C is a commercial mode that starts from companies and ends at consumers. We often call B2C online shopping. With the inflation of Internet population, online shopping has been favored by more and more consumers. The benefits of online shopping are well known. The most common incentives for consumers to shop online are convenience, competitive pricing, greater access to information, complementarity of traditional stores and broader selections. Online shopping has broken through the restriction of space-time, changed the form and the way of transaction, and changed consumer concept and behavior.

As an online consumer, he/she has a dual identity, on one hand he/she is a shopper, he/she is a user of computer and Internet on the other hand. So the factors influencing online consumer should include information system, marketing and psychology. Since more and more companies swarm forward, the competition is becoming fiercer. To carry on the effective competition with “brick-and-mortar” stores and other online stores, there is urgent need for online stores to understand the factors that influence online consumer behavior, which motivates this

study.

There are some classic models or theories introduced to the research of online consumer behavior [3, 7, 9, 10]. Those theories include Technology Acceptance Model (TAM) [5], the Theory of Planned Behavior (TPB) [1] and flow theory [4].

TAM is the most widely used theoretical model for explaining end-user behavior of a system. In this model, perceived usefulness (PU) and perceived ease of use (PEOU) are the primary determinants of system usage. TAM has been successfully applied in the acceptance of Internet related technologies, such as e-mail, WWW and e-commerce. Using it as the basis for studying consumer acceptance of online stores is proven a highly reliable and valid approach.

Another model is developed based on flow theory [4]. Not of its original meaning, flow is used to describe a state of mind sometimes experienced by people who are deeply involved in some activity [8]. Flow has also been studied in the context of computer-mediated environments. Due to its valid results, flow has been recommended as a valuable metric of the online consumer experience. Many studies found that shopping enjoyment is an important predictor of online shopping.

Koufaris [7] has applied TAM and flow theory to online consumer behavior. He came to a conclusion that shopping enjoyment (considered in flow theory) and perceived

usefulness are important factors influencing consumers' intention to return. But the study had some limitations, i.e., subjects and missing of an important variable (e.g. planned purchases).

Chen [3] also had some findings of online consumer behavior with an extended technology acceptance perspective, by using TAM as the basic model. He indicated that compatibility, PU, and PEOU are the primary determinants of consumer attitude towards using virtual stores.

In social psychology, TPB is a well-established general theory. TPB shows the relationships between specific salient beliefs, given behavioral perceptions and subsequent actual behavior. Three types of beliefs will impact three constructs: behavioral beliefs that influence attitudes, normative beliefs that affect subjective norm, and control beliefs that shape perceived behavioral control.

Palvou [9] has studied the drive of e-commerce by using TPB. One of his important contributions was considering perceived behavioral control, trust, and perceived risk as determinants of B2C e-commerce adoption, drawing from TPB.

As to perceived risk, it's increased by two types of uncertainty in e-commerce. One is behavioral uncertainty, which arises because web retailers may behave in an opportunistic manner. Another is environmental uncertainty that occurs because of the unpredictable nature of the Internet technology that is

beyond the control of the consumer. Given the uncertain environment of EC, it is expected that perceived risk would lower consumers' intentions to shop online.

Palvou [10] pointed out perceived risk is a direct negative antecedent of intention to transact online and privacy and security perceptions indirectly reduce perceived risk and influence intentions to transact online. That perceived usefulness and perceived ease of use influence online usage intentions was validated again.

In our study, we attempt to provide both theoretical and empirical analyses to explain consumers' behavior in online shopping by applying TAM, TPB, flow theory and other relevant theory in an integrated theoretical framework. Based on these well-established theories, we retain PU and PEOU of TAM, shopping enjoyment, subjective norms of TPB, and perceived risk in the proposed model. And we add some factors that we consider important to develop a more comprehensive model. We think price advantage, perceived convenience and product involvement are important antecedents of PU and shopping enjoyment. Privacy perceptions and security perceptions of the consumer and after-sales service of the online stores will influence perceived risk of online shopping importantly. So we keep them as the antecedents of perceived risk. Figure 1 shows the proposed model, which incorporates the factors we mentioned above. The relationships in figure 1 can be stated in 15 hypotheses.

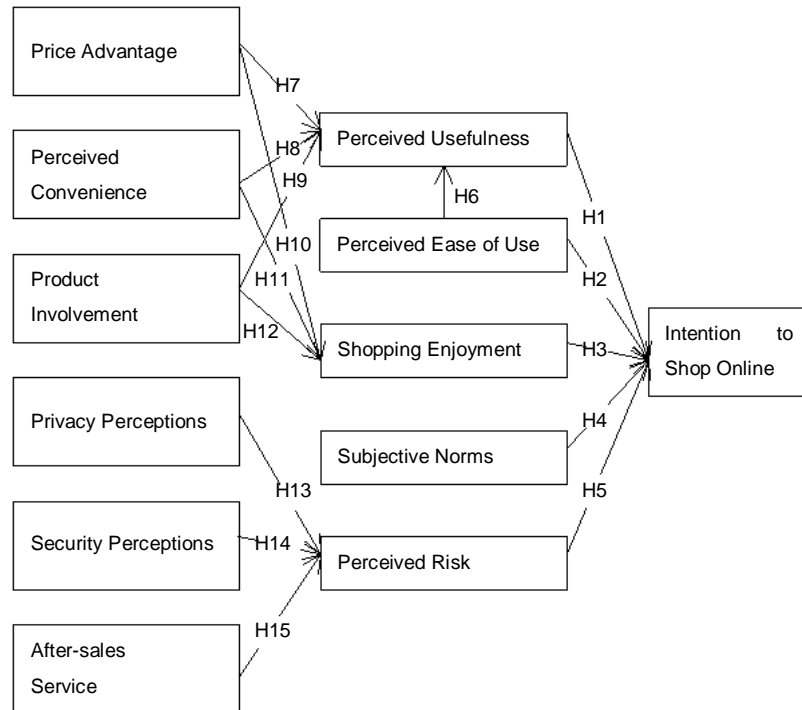


Figure 1 The Proposed Model

A questionnaire-based empirical study is used to test the proposed model. The questionnaire was completed by 183 subjects, including 125 university students and 58 office staffs. Their average age is 23.2 and 57.9% of them are males.

As shown in figure 1, there are 12 constructs in this model. To validate their internal consistency, we develop several items for each construct, which use 7-point scale. All constructs have acceptable internal consistency (Cronbach's alpha values, from 0.7579 to 0.9725).

The results of the regression analysis show that the model has an excellent fit and explains a large percentage of variance. To sum up, Hypothesis H1, H5, H6, H7, H8, H9, H12, H14 and H15 are supported by the survey.

From the results, some findings are drawn, which include:

1. The classic theories on IT and psychology are still valid in explaining online consumer behavior in the B2C e-commerce context.

2. Different from Koufaris's conclusion [7], shopping enjoyment cannot play an important role in our study.

3. Perceived usefulness and perceived risk are the primary determinants of intention to shop online. The former has positive impact and the latter negative.

4. The factors that influence perceived usefulness include perceived ease of use, price advantage, perceived convenience and product involvement.

5. Perceived risk is determined by security perceptions and after-sales service.

For managers of an online store, in order to entice consumers, it is useful to increase consumers' perceived usefulness of the store and reduce their perceived risk. To increase consumers' perceived usefulness, the store can put effort to the antecedents of it, such as offer more competitive price, make access and payment more convenient, and diversify products. To reduce perceived risk, the store can raise the level of security and after-sales service.

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Business-to-Consumer Electronic Commerce Success Factors in Thailand: The Website Merchant Perspectives

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Abstract

Electronic Commerce (E-Commerce) is considered a new channel of distribution that consumers can reach websites at anytime and from anywhere. In reality, however, consumers are not yet confident in on-line transactions. Several Thai website owners who operate business to consumer (B2C) e-commerce stated nine major success factors: government support, security and privacy, customer service, administrative support, online promotion, product uniqueness, logistics, product variety, and image creation. It is necessary that website merchants study various success factors, having impact on achieving business value of e-commerce investment and building customer trust which would then bring long-term profits to the organization.

Keywords: Electronic commerce, Business-to-consumer websites, Thailand

1. Introduction

The Internet, particularly the World Wide Web (WWW), has taken a greater role on business activities in the age of digital economy. This gave birth to an innovation called, "Electronic Commerce (E-Commerce)", a new way of doing business that helps the companies or individuals achieve their competitiveness. Businesses who invest in developing their own websites are able to expand their domestic and international markets while consumers can visit their shops with no time and space limitations.

Yet, e-commerce also poses a threat to businesses. That is, an increasing number of firms, who develop websites, have entered an "electronic market", a market with low barriers to entry. Furthermore, one of the important obstacles for the growth of e-commerce is the fact that most websites owners still lack true knowledge of conducting electronic business. They fail to consider key factors for the e-commerce and to convince stakeholders of significance of effective on-line transactions which could help the business to survive and bring customer trust and satisfaction.

At the same time, some customers hesitate to buy goods or services via the Internet because of security concerns. It is believed that on-line businesses will not be able to realize their success unless their customers have more confidence in the e-commerce. Moreover, Electronic commerce needs many management challenges to the firms to implement it successfully. Prior research on electronic commerce has mainly focused on the perspectives of consumers, frequently addressing issues such as benefits and barriers. Relatively little research has studied the electronic commerce management success factors by assessing from online website owners. Online website owners can have wider perspectives to determine the major issues affecting business success. The major objective of the study was to provide an online organization or other related organizations to concern about these issues and improve their business management via the Internet channel more efficiently. This article aims to present findings from the study of major factors for successful business to consumer (B2C) e-commerce from website merchants' perspectives. In other words, this article seeks to answer the following research question:

- What factors do online-companies anticipate from their implementation of business-to-consumers electronic commerce successfully?

2. Success factors for E-commerce

Electronic Commerce is frequently seen as an alternative channel of doing business enabling the owners or firms to be more competitive than traditional ones with retail stores. It helps suppliers to expand their channels of distribution to use

the Internet network. Many corporations, known as "Dot Com Companies", even use this channel to set up their business with low costs of investment. Additionally, consumers can reach the information they need with no time and space barriers, less expenses but more options. They also enjoy surfing through a variety of websites to search for goods and services [9]. However, success is not automatic on the Internet, the section below briefly noted the most commonly cited success factors.

Information technology infrastructure

Prior studies indicate that information technology infrastructure is one of the most important factors for doing effective on-line business [1,19]. This consists of network, and speed of the network. More than that, the World Wide Web (WWW), which is a part of the Internet and a channel of operating e-commerce, provides enormous sources of information for the users. Quality of information on the websites is still questionable for some groups of people. Many Internet users also experience information overload [2,13]. Furthermore, web applications, relating to data processing for executives and service providing to customers, such as the ERP, the CRM and sales support system are also vital.

Security and privacy

The next factors affecting the e-commerce are security and privacy. These have hindered on-line businesses from their success since consumers still lack confidence on security and privacy policy of the firms [8,12,16]. They are concerned about their safety, the misuse of their private information as well as the authentication of parties involved in the business [6].

Product issues

There are various product issues involved on-line transactions, for example, variety, uniqueness, and quality of products and services [2, 10]. They are significant to the clients' buying decision.

Marketing management

E-commerce needs good marketing efforts such as sales promotion and advertisement to introduce their websites to consumers [7,15]. Additionally, after sales service is necessary to maintain customer satisfaction. When clients are satisfied with the quality of the services, they are more likely to be loyal to products or services of that particular website. Despite the fact that the sellers and buyers do not actually meet and there is no proof of authentication, effective after sales service helps businesses sustain customer trust and satisfaction. Besides, good targeting and expansion to new markets are indispensable for the growth of e-businesses [7].

Logistics

Doing business via the Internet frequently involves the transport of goods to customers at distant locations or in foreign countries. Consequently, the entrepreneurs will have to consider the importance of packaging and transporting their products. Research indicates that B2C e-commerce will be more successful if the company can deliver the products in perfect shape and in a timely manner [2,10].

Management

Other websites management includes human resource management and organizational restructuring. Website owners will not fully benefit from e-commerce unless they have an appropriate structure to deal with the changing way of doing business. It is also necessary that their employees learn management know-how and how to give the best service to their clients. E-commerce owners might want to have business alliance in order to reduce their management costs [5]. In addition to this, websites have to be developed and updated regularly. The owner of each website will have to register for the "domain name". To use the right domain name could be very beneficial to the business. The domain name should not only relate to the brand of the product but also be easy to remember. Good management for the domain name registration and use of a recognizable domain name will help the business improve their image and to spread their brand's name [3].

Government support policy

An external factor that can promote the long-term growth of e-commerce is the favorable policy of the government to support online business and consumers protection. Government supports are among the most crucial forces affecting adoption of electronic commerce by consumers [19]. The government can greatly contribute to e-commerce by the implementation of such facilitating measures and regulations as legal infrastructure, consumer protection, taxation and other laws concerning e-commerce [14,17,11].

3. Research methodology

Data for the study was collected by means of a questionnaire to capture perceptions about these success factors. The questionnaire content was divided into two sections. The first section is about the success factor items, measured by a Likert's scale ranging from 1 = strongly disagree to 5 = strongly agree. The initial list of items was discussed with a number of experts, including faculty member, electronic commerce specialists, and managers in the field of Internet commerce to verify that each item represented the concept it was supposed to measure well. Items with which the experts did not agree were changed or eliminated to clarify wording. Two additional items were added: "apply push technology or marketing", and "real-time communication between buyer and seller".

The sampling frame was constructed based on the e-commerce websites provided by Electronic Commerce Resource Center in Thailand [4]. The 180 Thai websites constitute most of the population who actually do transactions with payment on the Internet. The respondents are persons who are the managers of the websites or marketing persons etc. Data was gathered by personal interview.

4. Demographic profile

A total of 143 website merchants responded to the survey, yielding a response rate of 79 %. As Table I shows, the majority of the respondents conducted electronic commerce over the Internet less than one year (about 50%). These electronic commerce websites were fairly small in size. Out of 143 respondents, 59 percent have invested less than 100,000 Baht in electronic commerce. On average, they had annual sales via the Internet channel ranging from 50,000 Baht to more than 5 million Baht.

Table I: Business-to-consumer website merchants' demographic profile

Characteristics	N	Percent[*]
Duration of E-commerce business		
≤ 1 year	71	50.35
> 1-2 years	50	35.46
> 2-3 years	13	9.22
> 3-4 years	6	4.26
> 4-5 years	1	0.71
Investment (Baht)		
≤ 100,000	83	59.28
100,001-300,000	27	19.28
300,001-500,000	7	5.0
500,001-700,000	1	0.72
700,001-1,000,000	3	2.14
> 1,000,000	19	13.58
Annual Sales (Baht)		
≤ 50,000	47	35.61
50,001 – 100,000	20	15.15
100,001 – 300,000	24	18.18
300,001 – 500,000	10	7.58
500,001 – 1,000,000	7	5.30
1,000,001 – 2,000,000	8	6.06
2,000,001 – 5,000,000	5	3.79
> 5,000,000	11	8.33

5. Findings

Exploratory factor analysis was used to examine the dimensionality of electronic commerce success. A principle component factor analysis with Varimax rotation was undertaken, and a nine-factor solution was found, which explained about 60 per cent of variation in the items (Table II). The tests suggested that the subsequent overall nine factors solution adequately accounted for the underlying structure of the data (Barlett's Test of Sphericity p-value=0.000, KMO measure of sampling adequacy = .740). Dimensions with Eigenvalues of 1 or above were retained and nine factors emerged. Table II indicates some items with an asterisk. These items can be dropped because they did not load above 0.5 on any factor.

The result showed that there are nine success dimensions. Most of the factors are meaningful sets of items. The first factor, named government support, focused on government supports in electronic commerce and consumer protection law. The second factor, security and privacy, included network security, payment security, and privacy protection. The third factor called customer service included online after sales service, responsive communication, and clear targeted customers. The next factor, called administrative support, consisted of application support system for management, qualify personnel, and business process redesigned to conducted business via the Internet more efficiently. Another two factors are online promotion and uniqueness of product factors, which included only one item in each dimension. One factor, named secure logistic, focused on reliable product delivered, secure product packaging. Probably, the ninth factor, product variety, dealt with the variety of product and content of the website. The final factor, image creation, included domain name setting, quality of product and push strategy to management online business.

Table II: Factor analysis for Business-to-Consumer Success Dimensions

Items	Loading for Factors								
	F1	F2	F3	F4	F5	F6	F7	F8	F9
Factor 1: Government support									
E-commerce tax law support	.878								
E-commerce law support	.841								
Consumer law protection support	.747								
Factor 2: Security and Privacy									
Security protection		.748							
Secure payment system		.697							
Privacy protection		.502							
Internet speed of consumer computer system*		.431							
Speed of the website network system*		.430							
Factor 3: Customer service									
Online after sale service			.786						
Having clear target customers			.536						
Realtime communication between seller and buyers			.502						
Provide certification authority*			.444						
Factor 4: Administrative support									
Application support systems for management				.680					
Qualified personnel				.660					
Business process redesign				.629					
Business alliance*				.423					
Factor 5: Online promotion									
Online domain name advertising					.877				
Online sale promotion*					.421				
Online purchasing support system*					.414				
Factor 6: Uniqueness of product									
Differentiated product for online sale						.763			
Search for new markets and customers*						.428			
Factor 7: Secure logistics									
Reliable product delivery							.809		
Secure product packaging							.552		
Cheaper price*							.464		
Factor 8: Product variety									
Variety of product provided								.910	
Website content								.500	
Factor 9: Image creation									
Easy domain name setting									.604
Product quality									-.564
Apply push technology or push marketing									.536
Eigenvalues	2.810	2.322	2.211	2.148	1.946	1.864	1.785	1.530	1.422
% of Variance	9.366	7.742	7.37	7.16	6.485	6.213	5.951	5.101	4.741
Cumulative % of Variance	9.36	17.10	24.47	31.63	38.12	44.33	50.28	55.38	60.13
Bartlett's Test of Sphericity = 1165.709 df = 435 Sig. = .000									
Kaiser-Meyer-Olkin Measure of Sample Adequacy = 0.740									

Note: * Items omitted because loading did not exceed 0.5

6. Conclusion and Implications

It can be concluded that nine factors have an effect on the B2C e-commerce, and this corresponds to past studies and can be generalized. For instance, government support is the most important indicator. Legal infrastructure and consumer protection factors are also significant and are widely discussed domestically and internationally, such as in health care, food and pharmaceutical businesses.

Next, the security and privacy factor includes the safe process for payment and privacy policy. This still discourages consumer confidence about e-commerce. Further, to conduct the online business more successfully, other important factors are to adjust business process to perform more efficiently, to provide information system applications to support management, and to have adequate knowledgeable personnel.

More than that, Thai website owners feel that traditional marketing efforts can be applied to on-line businesses. Continued advertisement of domain name, promotion, after sales services are helpful to build customer satisfaction. E-commerce needs to clearly specify their target groups and keep expanding their markets. Variety of products, good packaging and safe transport of products must also be considered as this type of business involves both domestic and foreign markets.

Furthermore, in this information age where people can reach websites anytime from several parts of the world, content on the web has to be always updated as this will help consumers to better decide to buy goods and services via the Internet. Would-be on-line businesspersons, thus, need to take into consideration the accuracy, relevancy, completeness of their products or services information. Besides, their websites should be designed for the ease of use while web content development and maintenance is also important.

This study makes a contribution that website merchants are also concerned about the factors that affect customers such as security and privacy, service and support, secure product delivery. Thailand's electronic business via the Internet channel will not succeed with long-term profits unless consumers accept it. To sustain the success of Thailand's electronic commerce, it is necessary to build customer confidence in consumer protection. They will have to be protected by the laws when they experience unfairness from the businesses and involving parties such as logistics companies, banks. The future success strongly needs the support from government sector integrated with the reliable management of website merchants in order to make consumers trust of the online system.

Moreover, this study suggests that electronic commerce implementation should not mindless hurry to a new technology without some extent of seriously management planning. Current and prospective online businesses need to merge excellent information technology, marketing and management efforts, for their moves towards business competitiveness. Limitations for this research are the fact that there are only a small number of companies conducting e-commerce with on-line payment. When there are increased numbers of on-line businesses, it could be possible to focus the study on one particular industry-export, tourism, on-line department stores or financial services-as well as to extend the framework of analysis to the Business-to-Business (B2B) e-commerce. Future research might have to use other variables to find out the result of these success factors, for example sales growth, return on investment, consumer loyalty.

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Internet banking benefits: a qualitative study among Thai Internet Banking Service Providers

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Abstract

Internet banking has become one of the new electronic service delivery channels that banks use in order to improve services they provide to their customers. Internet banking has allowed banks to offer information and services to customers at their convenience, and many Thai banks follow the worldwide trend to implement Internet banking. Information benefits are the major benefits for corporate customers, whereas transaction benefits seem to be less valuable because of concerns about security and reliability on the web. Banks do believe that Internet banking reduces operating costs and assists banks to interact with their customers more efficiently. Hence, when banks decide to use web technology to enhance customer interest and to develop customer relationships, they have to figure out how to create customer value and lower barriers of the web so that they can maintain long-term customer relationships and gain sustainable competitive advantage.

Keywords: Internet banking, web benefits, Thailand

1. Introduction

Today it is increasingly apparent that Internet innovation will become a critical service delivery channel in financial sectors. Internet banking, an example of technology and service innovation, is a web-based service innovation that allows bank customers to view their personal financial information and make online transactions via the World Wide Web. Banks are moving towards web-based service delivery – Internet banking – in order to provide better service to their customers [8,45,48]. From the banks' viewpoint, adoption of Internet banking will lead to cost reductions, improve customer service, and create long-term customer relationships.

Many banks have implemented Internet banking as a new electronic service channel, to offer their customers a variety of online services with more convenience for accessing information and making transactions [31,45]. Prior research indicates that web technology does provide information benefits to business [18,24,34,49]. Firms can provide information to communicate with their customers at several levels of information detail, and configure sites to allow them to drill down to the desired level. Information benefits can provide quality information, easier access to information, and information sharing [18,42]. Another benefit from web technology investment is a transaction benefit, which provides the firm ability to automate business functions via the web and provides service to customers with more responsiveness [18,35,39].

When banks decide to use Internet technology to enhance customer interests and to develop customer relationships, they have to follow up the results and evaluate whether this electronic channel actually creates business value and enhances long-term relationships with their customers, and finally provide competitive advantage to the banks [3,51]. Hence, the main purposes of this paper are to gather perceptions from Thai banks about using the web channel to offer services to their customers and how banks believe this channel provides benefits to their customers. In particular, this study is intended to illuminate how Thai banks achieve their goals to implement Internet banking service channels, which they expect to create competitive advantage, improving customer relationships and making long-term profit.

2. Literature review

In recent years, web technology has become an important tool for information search, and is considered to be a very useful information resource for customers and businesses [1]. Most companies use their web sites to publicize information about their companies. In addition, firms use web technology as a channel to provide information for commercial purposes. Firms can provide information about product specifications, price, and service delivery methods [18,42]. Further, firm websites can be used as the online promotional media for firm [31,40].

To obtain benefit from information provided via the web, firms must understand the nature of information, maintaining good quality to meet customer needs [6,11]. Prior research mentioned that one drawback of information provided via the web is the low quality of information; e.g., inaccuracy, irrelevance, out-of-date [11]. Information quality should focus on customer needs [4,10,32]. Once quality information is distributed to customers, they will perceive its quality, leading to trust in the information provided [16].

Quality information should be relevant, which means providing information related to customer needs and interests and which add value for customers [14]. Firms have to focus on relevant information which responds to customer needs and attract them to keep approaching the firm website as a quality information source [26]. The information benefit is more valuable to customers if websites owners provide accurate information [9,11,16]. Accuracy refers to “how well the information represents the phenomenon it purport to describe” [16, p. 216]. Finally, quality information has to be timely, which means that up-to-date or current of information must be provided [16, p. 216].

In addition, one of the major attractions in commercial use of the web is the ability to access information more responsively. If the firm website is easily accessible, customers can access information faster, encouraging them to continue connecting back to the firm website, so they can maintain access to firm information [9].

Moreover, information benefit should provide a selection of appropriate links or connections to other websites (site-to-site connectivity) that give more detailed information about related topics that are interesting for customers. The objective of the connectivity is to provide customers with all the information they want. Several recent studies on electronic commerce have noted that some features of websites related to these issues are critical to their business success. For instance, Lin and Arnett [37] suggested that a major factor for the success of a website is the design of information interfaces and navigation. Firms have to pay particular attention to creating flexible ways to disseminate information resources to their customers [34].

Online information sharing has been conceptualized in different ways. One of the popular issues mentioned by researchers is information sharing via a virtual community. Virtual communities can be used to attract customers and enhance their involvement with the firm [7,32,53]. Firms can now interact with customers on a global scale, in real-time, and using two-way interaction [24]. Information sharing among customers can help enhance customer service by increasing convenience, collecting service performance information for management decision support, and offering more customized products or extra services according to customer needs [22].

Business expands its traditional business processes by using the web as an electronic channel to link with its customers. Web technology adoption has influenced the transactional level in terms of convenience provided to customers. Well-implemented web technology consists of marketing tools designed to reach customers outside the firms and to support customers [36,51,52]. Prior research shows that businesses use the web to offer transactional benefits to customers through lower transaction costs, responsiveness of customer service, and service customization.

In doing business, both buyers and sellers try to minimize transaction costs. Customers perceive cost advantage if their service providers set price lower than others. Cost advantage leads to superior performance if service providers can provide an acceptable level of value with lower costs to their customers. One of the major contributions of the web is the reduction in transaction costs as buyers and sellers can contact each other directly. Service providers can gain operational benefits by reducing time, overhead costs in operation, and also eliminate service participants such as company service personnel [17].

In the financial services industry, the web is used as a means of payment or money transfer. This web-based payment process may be perceived as more convenient, and creates saving dimensions for customers. Prior empirical research about Internet banking reveals that time and cost are the key factors affecting Internet banking adoption of the bank. Many observers claim that Internet banking is a new channel that reduces time and cost to both customers and banks. In addition, Polatoglu and Ekin [45] found that cost and time saving dimensions are perceived as a larger benefit when customers use Internet banking services more often and for larger transactions.

To use web for commercial purposes also requires that the level of service provided to customers remain much the same as is provided from a sales force in traditional marketing [21,40]. The web is often used as a channel to communicate and provide support to customers in order to improve customer relations [15,31,40].

Firms have to communicate to their customers in order to provide them with more information on related products or services which they offer. Parasuraman et al. [43] found that information technology provides powerful tools to communicate with customers. In research on electronic services, Rust and Lemon [47] found that web technology provides situation-specific or personalized communication. For instance, customers can complain about a product or service in order to get their problem

solved or request for their specific needs and wants via multiple means (e.g. email, live chat, toll-free number or FAQ page), whereas the supplier or service provider can respond to customers more rapidly.

Customer service can improve by using web applications to identify and report problems more quickly, and allow more accurate diagnosis and faster responses to firm customers. Web applications such as customer relationship management (CRM) can gather data and analyze a customer database for specific customer needs and wants so that firms can have immediate feedback on services or products available as requested.

Kardaras and Papathanasslou [10] found that when banks provide service via the web for its corporate customers, customers demand many types of support from banks, such as after sales service support for customer training in using the Internet banking system.

Many companies have succeeded in using web-based business to implement innovative ideas by providing new services to their potential customers [34]. The new radical changes of services has led to superior offerings and provided significant economic benefits to their customers [55,40]. As mentioned before, the most commonly cited effective business use of the web is its value as an information source, offering accessibility, and sharing capabilities [18,31,32]. The power of the web in terms of information accessibility provides the firm an effective channel to respond to customer needs. This contribution allows service providers to gather customer information more quickly, conduct faster analysis, respond in shorter time, and customize services or products according to customer needs [18,31,34].

In addition, web technology empowers employee collaboration, information sharing, and knowledge integration which can create innovation faster. Rapid innovation offers even more opportunities to customize a specific service or product according to customer needs [23,25,28]. Service innovation is defined as “the process through which a firm undertakes changes in its philosophy, culture and operations and procedures to add value to the result of the service / product for the benefit of the customer” [29, p.54]. In the financial service sector, service innovation has become very important for service providers to keep ahead of the competition. Currently, corporate customer adoption of web-based service delivery showed that the web creates new opportunities for corporate customers and the bank to improve collaboration in product design and customization.

In recent years, an increasing number of businesses have recognized the benefits of establishing and maintaining relationships with their customers. Relationship building and management – relationship marketing – is frequently called a new marketing paradigm [19]. Relationship marketing has been conceptualized in different ways among academic researchers. For instance, Gronroos [19] defined relationship marketing as “marketing to establish, maintain, enhance and commercialize customer relationships so as the objectives of the parties are met. Gummeson [20] defined marketing relationship as relationships, network and interaction. He pointed out that the strength of the relationship can be enhanced through internal considerations or outside the organization. In other words, relationship marketing provides an approach that helps businesses to establish relationships with customers and other parties involved in the business process.

Berry and Parasuraman [2] proposed three levels of relationship in services marketing. At the initial level, service providers primarily use pricing incentives to encourage customers to use their services or products. For instance, a bank may offer lower loan interest rate to large corporation. Using price incentives essentially contributes little to building lasting relationships between customer and service provider.

Level two relationships go beyond pricing incentives. This level emphasizes personalized service delivery and the transformation of customers into clients that are served on an individual basis. Level two of the customer relationship is more according to customer needs and wants. It may include creation of long-term social relationships with customers, and it is more difficult for a new competitor to imitate than level one relationships. For instance, banking assigns account personnel to take care of specific customer accounts and visit the customer to build the business relationship and perhaps create social relationships with bank customers. Relationship building provides personalized service to customers, according to customer needs and wants [2,13].

Level three of customer relationships is to provide value-adding services to clients which may not be directly part of the specific service purchased in the transaction. Such services may not be available from elsewhere. Sometimes, the services are designed in the service system that helps clients to operate more efficiently, such as joint technical support assistance, or use of software provided by service provider which is not necessarily specific to the services bought from the service provider. Most higher relationships are about more value-adding services beyond the transaction involving what the customer buys from the bank. This level raises the clients’ costs to switch to other competitors and represents the greatest degree of competitive advantage and the most difficult for imitation. Such business value in relationships is difficult or expensive for customers to provide themselves and are not readily available elsewhere [2].

Corporate bank customers are mostly concerned about interaction, information exchange, and expect transaction-specific services from banks [50]. These two levels or natures of customer relationship are personalized service to clients, and business relationship value to clients. In other words, blending technology with customer needs is an important success factor in establishing and developing customer relationships [5,12,28,44,56].

In the financial services industry, Mulligan and Gordon [41] recently assert that web technology plays a major role in supporting relationships between customer and service provider by providing new standards of service delivery, allowing response more rapidly to customer needs and wants, and affording customers the opportunity to perform their business more efficiently. These things lead to improved customer relationships.

3. Research methodology

The qualitative research was conducted through a series of face-to-face interviews with Thai banks which offer Internet banking. Prior studies about information systems and electronic commerce have sometimes applied a qualitative approach in order to present better detail for exploring perspectives in the early stages of research, allowing the researcher to gain a better initial understanding of the problem, to identify facts, attitudes, and influence, and to provide knowledge [38,54]. The interviews were conducted with advance appointment. The list of guideline topics was developed from the literature, and occasionally supplemented by new issues that came up in the interviews.

In selecting appropriate respondents from the banks, the research used three criteria. First, Thai banks that are the leading Internet banking service providers were chosen as the target group. Secondly, banks where the researchers had sufficient connections to gain access were chosen. Those who have conducted research in Asia, where the tradition of business secrecy is very strong, will appreciate the necessity of such connections to obtain any useful information. Finally, the top level positions of bank managers who play the major roles in determining strategic direction of implementing Internet banking for corporate business groups were selected as interviewees. The interviews were conducted with a senior vice president of e-Commerce and e-Banking from the first two banks. For the third bank, the researcher has a good chance to interview three management positions. These three respondents are vice presidents of electronic channel management department, vice president of corporate business group, and division manager of corporate business marketing and products department. Therefore, total five top level executives from Thai banks were interviewed.

The in-depth interviews took about an hour for each respondent. All in-depth interviews were conducted in Thai language. A qualitative content analysis is used for paraphrasing the range of significant issues and categorized according to the concepts discussed above.

4. Results

Specific to Thai Internet banking service providers, all the respondents mentioned that Internet banking provides real-time financial information to their customers. Whenever customers want to view the statement, they can request it immediately via the Internet banking system, and do not have to wait until the end of each month to view the statement. The following statements illustrate this issue:

“It is very convenient to use Internet banking. It saves customers time and cost. Customers can check their account balance and request the statement at any time they want.”

“In the traditional system, customers have to wait until the end of each month to get financial statements. If customers want to request a statement during the month, they will get charged.”

“The only thing that customers will go to the bank for is to deposit cash or checks.”

Thai Internet banking service providers mentioned that Internet banking is the powerful channel for customers to access information. The following statements support this benefit:

“Customers are able to check their account balance and plan their cash management early in the morning.”

“Customers don’t have to wait until banks opened. They can check their account balance, fund transfer, and request for today and history statements during 9 am to 11 pm. Customers can have transaction services during closing hours of the bank or weekend.”

In addition, two Thai Internet banking service providers do provide links to other websites in order to motivate customers to visit the bank websites, e.g., they provide daily highlight news, and links to other financial information sources, such as the Stock Exchange of Thailand, and Bank of Thailand.

However, the accessibility through the network of Internet banking is sometimes quite slow because of the low speed of network infrastructure. Banks also realize that this is one of the usage barriers to customer adoption.

Unfortunately, the Thai Internet banking system hardly provides virtual space for their customers to share their experiences. One bank states that:

“To provide virtual space for customers needs additional investment on information technology. Currently, Internet banking systems require intensive investment of information technology, while customer adoption of Internet banking is not so high to cover the investment costs.”

However, two banks have realized that the value of interactions among customers, or even between the bank and customers, can create increased understanding of customers and adaptation of services offer to customer specific needs and wants. One respondent responds to this issue that:

“This is an interesting topic, we may consider providing the virtual space to our customers in the near future.”

Most of the respondents in our research also claimed that Internet banking becomes the cheaper service-delivery channel for financial transactions because it provides time and cost savings to customers. Two bank respondents' comments illustrate this point well:

“Internet banking provides customers with lower cost per transaction than traditional face-to-face or other service delivery channels.”

“I can say that Internet banking offers customers more convenience, customers save time and cost in making transactions via Internet banking system. I also believe that Internet banking is a win-win situation, both the bank and customers can reduce operating costs and increase profit in the long run.”

Thai Internet banking also provides online services, such as call centers and online help desks, that customers can use when they face problems. Thai banks provide training to their customers to try to add value for Internet banking customers in order to build trust. All the three banks provide service channel to their customers, as shown in the following statements:

“Internet banking provides a primary online help desk to customers or a call center for them to call the bank 24 hours. In case that customers want to talk to bank personnel they can contact the personnel in charge of the Internet banking system.”

“Our bank realizes that customer service and bank interaction with customers are important. Besides the current services for Internet customers, our bank plans to employ customer-oriented service by developing many applications such as customer relationship management (CRM) in the next year.”

Some Thai banks have developed applications according to the specific character of bank customers in order to handle the financial processes via the Internet banking system. Banks are willing to provide personalized service to corporate customers. For instance, Thai banks now implement a customized business-to-business (B2B) web based on invoice and payment processing – electronic bill presentation and payment (EBPP). This system is used to replace manual paper processes of the billing systems, which allows bank customers to interact with their customers via the bank website, e.g., bill presentation, invoice and payment handling. Bank corporate customers can download their accounts receivable system to the EBPP system of the bank and their customers can view the credit amount due via the bank website and make payment via the Internet banking system. This service allows customers to perform their traditional operations more effectively, and the capability to reduce operations costs. In addition, corporate customers and the bank also interact and exchange information with one another (e.g., using phone call or e-mail) in order to confirm whether the payments are paid.

Thai banks try to build long-term relationships with their existing and prospective customers in order to increase customer satisfaction. Banks get feedback from their customers that Internet banking provides new value to customers. Web technology provides tools or applications that can be used to interact with customers more efficiently. For instance, the call center is used as a response vehicle to communicate with customers or to provide customers with after-sales support, and to leverage sophisticated customer databases. Therefore, interactive communication and responsiveness of service and support via Internet banking are considered as important issues for building relationships to customers. Finally, customization of service according to customer needs and wants has potential to create customer relationships because it can reduce costs and generate revenue to customers.

In sum, in Thai Internet banking, many banks reveal that Internet banking is a powerful channel for banks to interact with customers faster. Internet banking enhances and improves bank and corporate customer relationships in terms of service responsiveness and service personalization. However, there are still few corporate customers adopting Internet banking because of many lack trust in web infrastructure. Many respondents point out that Thai customers still like to have personal interaction with the banks, they do not like to read but like someone to explain to them instead. They prefer face-to-face service and personal contact with the bank. These banks accept that major barriers to Internet banking adoption by corporate customers are trust in security of the web system and in the reliability of service delivered. Bank respondents mentioned that

banks have intensively invested in building security infrastructure to safeguard bank financial information systems via the Internet network systems. The following statement highlights concern about the security issue:

“Actually, many banks are concerned about the security systems. Banks never overlook security issues but take this issue as a major concern and invest a lot of money to protect the security system of the bank in order to enhance customers’ trust in banking service via the web channel.”

Moreover, banks also realize that many corporate customers are concerned about the reliability of making transactions via the Internet banking system, and also the documentation for transactions made via the web. However, banks have developed a system that allows customers to print out the transaction which is sent. The following statements illustrate how banks solve this point:

“Customers now can get the cyber receipt via the Internet banking.”

“If customers face a problem because of making a mistake via the Internet banking system, the bank can trace the record from log files. We keep customer history log files for five years.”

“From our past experience, when customers have problems, e.g., transferring money to the wrong account or any problem that needs the court to resolve the problem, we try to protect our guiltless customers and assist them to get their money back.”

5. Conclusion and limitation

Currently, banks perceive that web benefits do improve customer relationships with their corporate customers, but the web benefits do not seem to provide higher switching costs or higher customer loyalty through Internet banking channel. Thai banks realize that Internet banking provides information benefits to corporate customers. Customers are able to access their financial data in the more flexible way and on a real-time basis. In addition, Internet banking can reduce operating costs to both banks and corporate customers in the long run. Evaluating their corporate Internet banking customers, banks can judge that Internet banking assists them to develop and enhance customer relationships with their corporate customers in terms of providing service according to customer needs and wants with lower costs and service responsiveness. Furthermore, these banks are leaders in Thai Internet banking try to implement strategies that enable them to outperform other banks, such as developing web applications like CRM to gather and analyze customer information more efficiently.

Banks also believe that corporate accounts have greater potential for web applications because transaction amounts from corporate customers are bigger volume. Corporate customers are the main target group for Internet banking. They predict that the trend for corporate Internet banking customers will be continuous growth. The results show that implementing Internet banking helps to reduce operating costs, contributes to long-term relationships with their customers, and provides strategic benefit with higher profit to Thai Internet banking service providers.

On the other hand, while we have focused on the benefits in this discussion, Thai banks also face the barrier of customer trust in web-based service delivery via the web channel. Bank customers are concerned with the security and reliability of transactions via the web, which are the major barriers mentioned in many studies [33,46]. The results of in-depth interviews with bank respondents indicate that banks seem to understand their customers fairly well, at least realizing that security and reliability of web-based service are major customer concerns. They plan to invest in security infrastructure and web applications in order to build customer trust in Internet banking.

Finally, banks recognize that using web channels for commercial purposes will take some time for adaptation of management attitudes among corporate customers. Management has to be inclined toward a new technology adoption vision, and firms should have qualified staff to support management vision in order to enhance the growth of Internet banking. Thai Internet banking service providers believe that Internet banking will provide banks strategic benefits in terms of long-term profitability in the near future. Banks try to implement Internet banking by focusing on their specific groups of corporate customers in order to provide better service according to customer needs and wants.

The key limitation of this study was a small sample, because very few Thai banks offer Internet banking. Caution must be exercised regarding generalizability of the study. It does reflect the views banks currently offering Internet banking to corporate customers, but it may not necessarily reflect views of other banks as they begin to move online. More empirical work will be required to keep track of industry views about the issues developed in this paper, as later adopters may differ in their assessment from earlier adopters. In addition, clearly we need to get data from corporate customers themselves, especially those who have higher transaction volume with the banks. They are the main target market of Thai banks, and it will be important to determine how closely they share the banks’ vision. Future work may also need to investigate the impact of Internet banking on customer loyalty to the banks, i.e., look at the long-term customer response, not only immediate perceptions.

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Institutional Strategy And Multinationals' Entry Mode Choice

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Abstract

The ability of Multinational Corporations (MNCs) using different entry mode choices to strategically influence their environments has become an important concern in international business research. We adopt the concept of institutional strategy to explain patterns of MNCs' action that are directed toward managing the various institutional pressures. The institutional strategies vary with different multinational entry mode choices used by MNCs.

This study proposes that the MNCs using different entry mode choice adopt different institutional strategies to respond two primary institutional pressures---internal (parent) and external (host country). In order to provide a constructive alternative explanation for multinationals' entry mode choice in institutional perspectives, further empirical research and literature review is required.

Key terms: Multinational Corporations (MNCs), institutional strategies, entry mode choice, institutional theory

1. Introduction

Early studies in international business field have identified many determinants that influence the choice of an entry mode for a selected target market. The explanations of determinants draw from transaction-cost theory(Anderson & Gatignon, 1986; Erramilli & Rao, 1993), eclectic theory (Agarwal & Ramaswamy, 1991; Kim, Hwang & Burger, 1989), resource-based view(Chang, 1995) and Dunning's integrating perspective(1977, 1980, 1988). For all of these entry mode choices involve different level of resource commitments, MNC's initial choices of a specific mode are difficult to change without substantial loss of time and money(Root, 1987)Entry mode selection is a very important strategic decision(Agarwal & Ramaswamy, 1991). However, after MNC's selecting the entry mode choice, MNC must face two sources of isomorphic pressures: (1) host country institutional environment and (2) internal institutional environment or the parent organization(Davis, Desai and Francis, 2000) This paper focus on how MNC with different entry mode choices cope with these institutional pressure.

The ability of Multinational Corporations (MNCs) using different entry mode choices to strategically influence their environments has become an important concern in international business research. We adopt the concept of institutional strategy to explain patterns of MNCs' action that are directed toward managing the various institutional pressures(Lawrence, 1999). In order to gain the legitimacy in organizational field, membership rules and standards of practice remain acceptable response to institutional pressure. Institutional structures are conceptualized as pragmatically rules of membership and standards of practices. Organizations depend on these institutionalized rules and standards as guides to legitimate action within their organizational field(Hinings & Greenwood, 1988). The institutional strategies vary with different multinational entry mode choices used by MNCs.

2. International Entry Mode Choice

Of theoretical interest, there are four distinct international entry modes of wholly owned subsidiaries ,licensing, joint venturing and exporting. We simplify the entry mode choices because much of the international business literature emphasizes on these three distinct modes and suggests that each of these entry modes is consistent with resource commitment (Vernon, 1983) and a different level of control (Caves, 1982; Davis, Desai & Francis, 2000).Control indicate authority over operational and strategic decision making; resource commitment emphasize dedicated assets that cannot be redistributed to alternative uses without loss of value. Kim & Hwang(1991) suggest that wholly owned subsidiaries can be described as relatively high level of resource commitment and control, the opposite should be exporting. With respect to licensing agreement and joint venture, although the levels of resource commitment and control vary with the nature of the ownership split, their extent can be said to lie between that of wholly owned subsidiaries and exporting.

Prior clarifications for entry mode choice most draw from eclectic theory(Kim & Hwang, 1992), resource-based view(Chang, 1995), and transaction-cost economics(Erramili & Rao, 1993). Because so many factors may influence entry decision, the existing

frameworks are vague or contradictory for the patterns of entry mode choice. Our purpose is not to contest previous models, but to explore whether institutional relationships and strategies provides a constructive alternative explanation for multinationals' entry mode choice.

3. Institutional Theory and Institutional Strategy

3.1 Institutional Theory

Different from the traditional task environment perspective that focus on the role of competition, resource and markets, institutional theory emphasizes on the state and professional associations in an organization's institutional environment and their insightful influence in shaping the legitimacy and performance of an organization (DiMaggio and Powell, 1983; Scott, 1995; Zucker, 1987). Institutional theorist presume that organizations search for social approval and legitimacy (DiMaggio, 1988); the building of institutional relations assists the organization to mobilize cultural support for its activities and goals and to reveal its social validity and conformity with regulations, institutional rules and norms (Myer and Rowan, 1977).

Earlier institutional theorists highlighted the attribute of beliefs, rules, and myths as shared social reality and processes (Oliver, 1991). Prevailing theorists suggest that various institutions exert pressures on organization and result in appropriate and fundamentally meaningful organizational behavior (Zucker, 1983). Institutional theory could explicate the influence these pressures exert on organizations (Myer, Scott & Starng, 1987) and strategic behavior (Oliver, 1991). However, particular institutional context could determine an organization's appropriate behavior or activity (Davis, Desai, & Francis, 2000).

Institutional theory provides a rich, complex view of organizations. It emphasizes those normative pressures, sometimes coming from external sources, other times coming from within the organization itself, influence organizations. Under some conditions, these pressures lead organization to be guided by legitimacy. Adoption of legitimacy, leading to isomorphism with the institutional environment, increases the survival chances (Zucker, 1987).

Traditionally, institution theory focuses on the external institutions in influencing organizational behavior. The institutions contain public opinion, interest group, professions, regulatory structures, agencies and law (Oliver, 1991). Now the meaning of institutions has been extended to other business units in an organizational network (Kostova & Zaheer, 1999). According to this perspective, the parent organization's network will exert institutional pressure to its business units. The isomorphism mechanism will force business subunits to conform to parent organization's norms. However, the external and internal sources of pressure influence significantly on the entry-mode choice of MNC.

Isomorphic pressure institutionalizes MNC's structure and behavior. MNC's subsidiaries face simultaneous pressures to resemble other sub-units of the parent MNC, and to adapt to the institutional demands of host countries (Rosenzweig & Singh, 1991).

3.2 Institutional Strategy

According to Lawrence's perspective (1999), institutional strategy developed from institutional theory means patterns of action that are concerned with managing the institutional structures within which firms compete for resources. It focuses on organizations' strategic responses to institutional pressures and the active role of organizations concerned with constructing new institutions, and transforming existing institution to inspect institutional structure.

The conceptualization of institutional structures depends on an understanding of reality as socially constructed and enacted in discussion (DiMaggio & Powell, 1991). However, the key attribute of institutions is their pragmatic orientation: social actors draw on institutionalized knowledge as a resource in their routine life. At organizational level, organizations are driven to fit in the practices and procedures defined by current rationalized concepts of institutionalized in society and organizational work (Meyer and Rowan, 1977).

The concept of organizational fields plays a role of domain of meaning— fields of activity within which social structure and common languages develop. It also consists of sets of subject positions bound together by standards and institutionalized rules (DiMaggio & Powell, 1983; Bourdieu, 1993). To maintain legitimacy in an organizational field, an actor must conform to these institutionalized rules. Lawrence (1999) suggested that these practical rules help actors to respond two question: "Where can I go,?" and, "What can I do?". The first question relates to institutionalized boundaries issues, which limit the organizations' form of life into rules of memberships. The boundaries include culture, race, gender, profession or relationships. The second question asks what the coping skill within an organizational field. Standard of practice give norms, guidelines and legal prescriptions relating to how practices are to be carried out in some institutional setting (Clegg, 1989).

The importance of membership rules and practice standards in an organizational field doesn't imply that organizational action is determined by the rule. Rather, the basic relationship between social rules and action implies the possibility of change, as well as reproduction. Continual reproduction in social action determines the legitimacy of rules and practice. It implies that institutional rules are not fixed, but rather transformed by motivated actors (Clegg, 1989; Lawrence, 1999).

Institutional strategies are patterns of organizational action concerned with the transformation and formation of institution, the rules and standards that control those structures. Although all organizational strategy occurs within an institutional context, institutional strategy is distinguished by its orientation to that context. These

strategies emphasize more on transforming institutional standards and rules rather than gaining competitive advantage. Institutional strategies focus on managing existing institutional structures to establish a strategically favorable set of conditions. We adopt three types of institutional strategy: (1) membership strategies and (2) standardization strategies (Lawrence, 1999). (3) Hybrid strategies of membership and standardization; in this paper.

In response to normative pressures, which stem from professionalization, membership strategies rest on the power implicit in membership. Membership strategies include the definition of rules of membership and their meaning for an institutional community. An organization's capability to influence the membership rules of an organizational field is positively related to its control of institutional information and the degree to which it is perceived as a leading organization in the field (Lawrence, 1999). However, we proposed highly control entry mode of MNC will pursuit membership strategy to response normative pressure.

In response to coercive or mimetic pressures (DiMaggio & Powell, 1983), standardization strategies force other actors to conform to institutional standards. Standardization strategies emphasize the establishment of legal, technical or informal standards to define normality of a product, service or practice through regulation (Selznick, 1957; Montagna, 1990). An organization's incapability to influence the standards of practice in an organizational field is negatively related to its technical, legal, political and marketing expertise and the degree to which it is perceived as a leading organization in the field (Lawrence, 1999). However, we proposed low control entry mode of MNC will pursuit standardization strategy to response coercive or mimetic pressure.

Figure 1 "Conceptual Framework" summarizes the relationships proposed here between MNCs' entry mode choices and institutional strategies.

4. Proposition

MNC's business units using wholly owned modes of entry would have higher MNC's parent isomorphism pressure (Davis, Desai & Francis, 2000). To response this pressure, we propose that MNCs need some membership strategies. These strategies involve the definition of rules of membership and their meaning for an institutional context.

An organization's ability to affect the membership rules of an organizational field is positively associated with its control of institutional information and the degree to which it is perceived as a leading organization in the field (Lawrence, 1999). The relationships between MNCs' entry mode choice, parent isomorphism pressure and membership strategies lead to proposition one:

Proposition 1: MNCs using high level of control entry mode (e.g. wholly owned modes of entry) will favor

membership strategies than MNCs using other modes of entry.

MNC's business units using exporting modes of entry would have higher MNC's local market adaptation pressure (Davis, Desai & Francis, 2000). To response this pressure, we propose that MNCs need some standardization strategies. These strategies are concerned with the establishment of legal, market or technical standards that define the normal process involved in the production of some good or service (Lawrence, 1999). The relationships between MNCs' entry mode choices, local adaptation pressure and standardization strategies lead to proposition two:

Proposition 2: MNCs using low level of control entry mode (e.g. exporting modes of entry) will favor standardization strategies than MNCs using other modes of entry.

MNC's business units using multiple modes of entry would have similar pressure of both parent isomorphism and local market adaptation level (Davis, Desai & Francis, 2000). To response these pressures, we propose that MNCs may achieve a balance to adopt both institutional strategies. That suggest proposition three:

Proposition 3: MNCs using median level of control entry mode (e.g. multiple modes of entry) will favor similar level of both membership strategies and standardization strategies.

5. Discussion

Prior research in international business field have proposed many factors that affect the choice of an entry mode for a selected target market. This paper provide a way to explain how MNC with different entry mode choices to deal with institutional pressures. This study proposes that the MNCs using different entry mode choice adopt different institutional strategies to respond two primary institutional pressures---internal (parent) and external (host country). The concept of institutional strategy is intended to move the discussion of institutional setting beyond notions of environmental determinism toward more examinations of the complex dynamics of institution and field. The proposition in this paper deduce how MNC with different entry mode choices cope with these institutional pressure.

For practice implication, we propose a way to manager of MNC as they attempt to understand the strategies that MNC with various entry modes should response to the institutional pressure. In order to provide a constructive alternative explanation for multinationals' entry mode choice in institutional perspectives, further empirical research and literature review is required.

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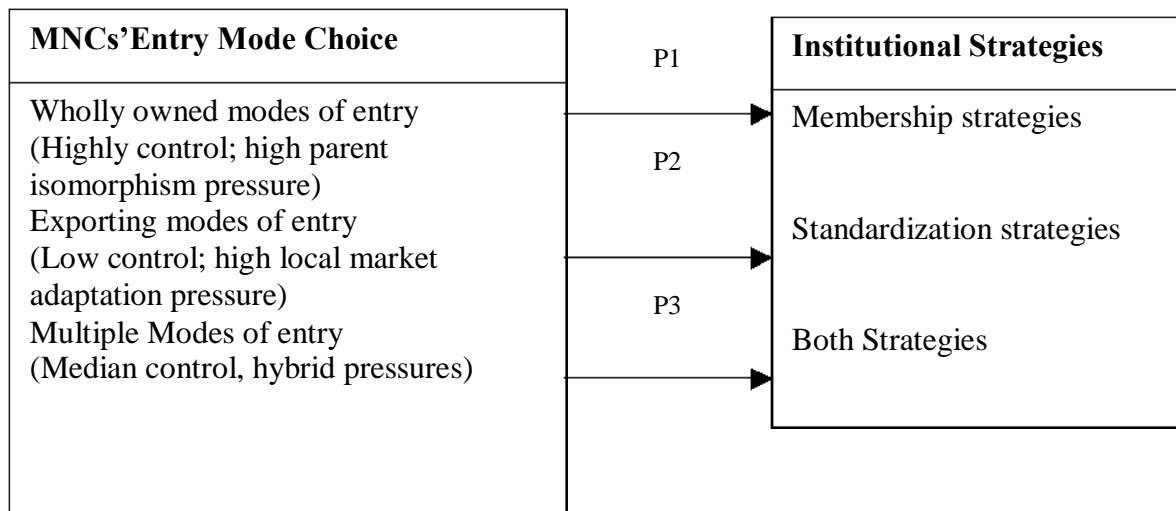


Figure 1. Conceptual Framework

Complexity and Commitment in Supply Chain Management Initiatives

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Abstract

While the benefits of supply chain management have been widely reported within industry, adoption of supply chain management initiatives have been slow and below industry expectations. To better understand and effectively address this problem of adoption within industry, this paper takes a closer look at the individual supply chain management initiatives to achieve a new understanding on the barriers that hamper the adoption process. This paper presents a framework that categorises different SCM initiatives according to a complexity-commitment continuum. By analysing three initiatives from the grocery industry, we argue that the inherent complexity of SCM initiatives poses barriers to adoption due to the degree of organisation commitment required.

1. Introduction

Over the last two decades, organisations have progressively moved towards establishing closer relationships with business partners to collaboratively achieve competitive advantage [1]. Several studies suggest that the scale of competition is shifting from between firms to between groups of firms such as supply chains [2] [3]. The concept of supply chain management emerged aiming at leveraging the benefits of inter-organisational partnerships through systemic thinking and integrating business processes to ensure certainty and efficiency in the flow of information and materials from upstream to downstream [4]. Although the benefits have been widely reported within academia and industry [5][6], the extent of adoption of supply chain management initiatives still falls short of industry expectations [7][8]. While many organisations have piloted initiatives such as Efficient Consumer Response and Collaborative Planning, Forecasting and Replenishment with selected business partners, there are considerably fewer examples where these initiatives have been adopted on a supply chain level involving multiple trading partners [5].

To better understand and effectively address this lack of adoption, we have to identify and understand the barriers that hamper the adoption process. Existing research tend to focus on inter-organisational barriers [9] [10] that involve trust issues, the willingness to participate, mutuality of benefits, risks and costs, as well as asymmetries in technical, organisational and cultural

systems. Furthermore, barriers in the process of implementing these initiatives can be attributed to difficulties in establishing partner selection criteria [11], complexities of project management across multiple organisations and so forth. We argue that inherent complexities within specific supply chain initiatives pose an important barrier to adoption that has not been adequately addressed so far. Generally, we can distinguish between three levels of barriers that affect each other. Firstly, inherent complexities pose significant challenges for individual organisations to adopt SCM initiatives; secondly, on an inter-organisational level, existing asymmetries between organisations further challenge the adoption process. Finally, the process of implementation itself poses further challenges as it involves multi-party development projects. As the first group of barriers remains largely unaddressed so far, we believe that a better understanding of these barriers inherent to the SCM initiatives is essential for the discussion of SCM adoption.

In this paper, we argue that the inherent complexity of SCM initiatives poses barriers to adoption due to the organisational commitment that is required to address these complexities. In doing so, we will present a framework that categorises different SCM initiatives according to a complexity-commitment continuum. Using three specific SCM examples from the grocery industry, we show that newer SCM initiatives have become increasingly complex, impacting on individual organisations in terms of the required managerial commitments for the initiatives to be adopted. The next section will introduce supply chain management and our framework, followed by a section on our deductive analysis using the industry examples, and then a final discussion on the implications for further research.

2. Supply Chain Management Initiatives: A Continuum of Complexity and Commitment

2.1 Supply Chain Management: A Vision of Intra-firm and Inter-firm Synchronisation

Mentzer et al (2001) suggests that supply chain management (SCM) can be defined as:

‘The systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across

businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole' [4, p.18]

Basically, SCM envisions managing and coordinating the flow of information, products, services and financial resources from upstream suppliers to downstream customers along the supply chain in order to improve customer service and ultimately supply chain profitability. To embrace the overall concept of supply chain management (SCM), individual organisations have to, firstly, adopt a systems perspective of their business, that is, an understanding of the interdependencies between individual actions and the implications of managing upstream and downstream flows of products, services, finances, and information across trading partners. Secondly, and more importantly, supply chain management requires organisations to implement this supply chain orientation involving suppliers and customers. [4, p.11]

From a strategic perspective, SCM envisions the synchronisation of supply chain activities, or processes, to compete against other supply chains [2] on a network level. In order to achieve the envisioned level of information and process synchronisation within and across organisations, organisations in various industries aim at adopting and implementing specific industry-based supply chain management initiatives.

2.2 Supply Chain Management Initiatives: Adopting and Implementing the SCM Vision

Supply chain management initiatives provide concepts to enable organisations and their trading partners to implement industry best practice to achieve the benefits of SCM. In various industries, a range of supply chain management initiatives exist that aim at orientating organisations towards achieving the ultimate SCM vision that involves the integration of all intra-firm and inter-firm policies and processes. To support our argument that new and increasingly sophisticated SCM initiatives pose inherent challenges to adoption, we will show that these initiatives cumulatively build on each other and that they vary in complexity according to the extent of intra-firm and inter-firm integration they require. Generally, SCM initiatives move beyond the traditional arms-length interaction, where organisations operate in a laissez faire environment and interaction is limited to transactional exchanges. As new information technology and process optimisation strategies become available and more developed within industries, new SCM initiatives propose closer, more collaborative, trading partner relationships. The following section introduces a framework to organise the different types of SCM initiatives according to their level of inherent complexity and extent of organisational commitment required.

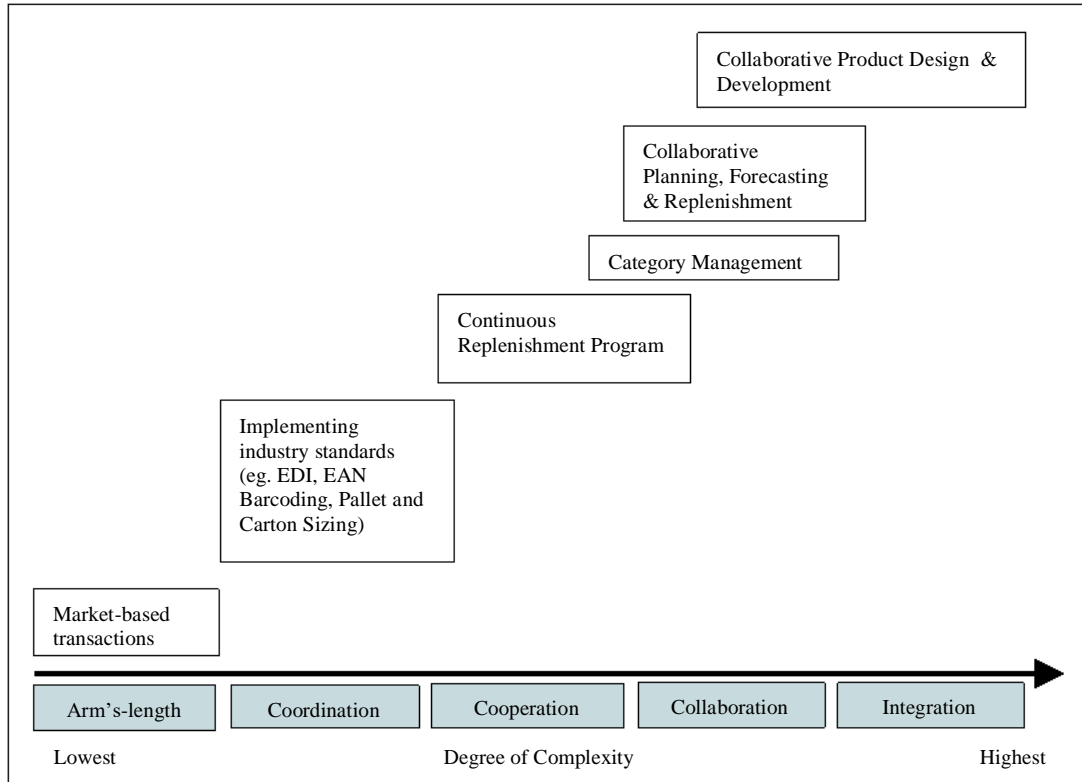


Figure 1. A continuum of SCM initiatives

2.3 The Complexity-Commitment Continuum

In his study of relational change strategies, Himmelman (1996) suggested a set of strategies that build upon each other along a continuum of commitment and complexity [12]. We have adopted this model as the basis for developing a framework in order to organise the different types of SCM initiatives according to their level of complexity and commitment accordingly. We suggest that there is an increasing complexity inherent in different types of SCM initiatives that require cumulative levels of organisational commitment as we approach a level of strategic integration among organisations. Figure 1 shows different types of SCM initiatives along this continuum of increasing complexity.

2.3.1 Different types of SCM Initiatives

Coordination Initiatives

Coordination initiatives envision organisations altering the way information is exchanged and managed and involve implementing industry data standards so that organisations can more efficiently manage the flow of information and flow of materials between organisations. However, coordination initiatives do not expect organisations to alter existing business processes. Some examples of coordination initiatives include adopting standardised messaging infrastructures such as electronic data interchange (EDI) based on EDIFACT or similar standards that might use Extensible Markup Language (XML). Apart from informational exchange capabilities, initiatives to improve the materials handling infrastructure between trading partners include product identifying standards, such as Universal Product Code (UPC) and European Article Numbering (EAN) barcoding standards, containerisation and pallet sizing.

Cooperation Initiatives

Cooperative initiatives see organisations exchanging information, altering operational activities and sharing supply chain resources. Cooperation initiatives present a series of industry process standards focused on optimising the flow of information and materials along the supply chain. The initiatives require basic coordination capabilities, as described above. More importantly, these initiatives also require organisations and their trading partners to adopt new processes for performing daily operations. Some examples include Just-in-time (JIT) delivery, Continuous Replenishment Program (CRP) and Quick Response (QR) in the electronics, grocery and textile industries respectively.

Collaboration Initiatives

Collaboration initiatives require organisations to exchange information, to alter operational and tactical activities and share resources in an extensive way.

Moving beyond cooperation initiatives, they add another level of complexity by requiring organisations to align processes at the tactical level, including planning, forecasting, sales and marketing and purchasing. These initiatives also assume the existence of infrastructural and process capabilities from coordination and cooperation initiatives to effectively carry out collaboration initiatives. Some examples of initiatives include Category Management and Collaborative Planning, Forecasting and Replenishment.

Integration Initiatives

Integration initiatives suggest the next step up from collaboration initiatives and involve process standardisation at the strategic level of the organisation. Joint product development for example, requires not only alignment of strategic objectives and involvement of strategic processes such as research and development to design and develop the product concept, but also the need to be able to agree on a way to market, manufacture and distribute the product to the consumer. This requires operational cooperation, collaborative tactics and a sophisticated underlying communication infrastructure as a prerequisite to enable the exchange of strategic information, such as product designs, and joint planning and logistics processes. This implies that for integration to be achieved, all the previous types of initiatives have to be in place.

2.4 Increasing requirements for organisational commitment

Having argued that SCM initiatives become increasingly complex, we can state that this inherent complexity requires increasing organisational commitment likewise. For the purpose of our framework we distinguish four major levels of management in organisations – the infrastructure level, operations level, tactical level and strategic level. As complexity increases for each of the above initiatives, the level of commitment required by organisations in terms of time, resources and managerial attention to achieve the visions increases as we approach integration type initiatives (see figure 2). With coordination initiatives, commitment is predominantly at the infrastructure level of management. With cooperation initiatives, commitment on the infrastructure and the operations level is essential, and so forth. Finally, with integration initiatives, all management levels of the organisation are impacted and therefore commitment has to be lead by strategic management but will involve resource and managerial commitment from the infrastructure, operations and tactical level as well.

To show the validity of our framework and to ultimately support our argument that the inherent complexity of SCM initiatives poses barriers to adoption due to the organisation commitment required, we will analyse three

exemplary initiatives from the grocery industry in the following section. We will examine the level of standardisation that each initiative requires and show their cumulative nature (one initiative based on the achievements of the other).

This will allow us to deduce the organisational impact of the initiatives in terms of the required managerial commitments according to the above illustrated management levels.

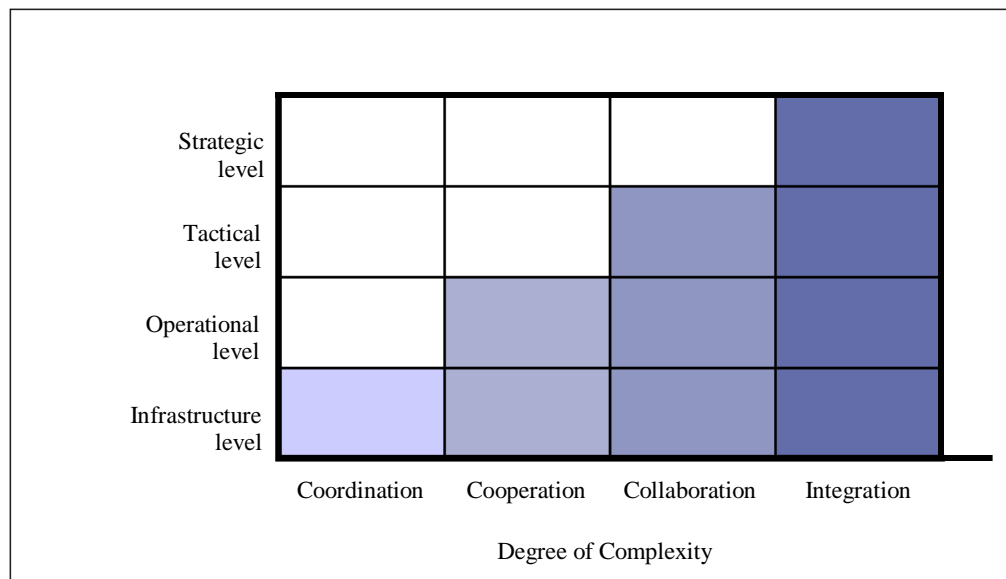


Figure 2. The Complexity-Commitment Continuum

3.0 Exploring Grocery Industry Initiatives: An illustration of the framework

3.1 Methodology

For the purpose of our analysis, we have chosen to explore three initiatives that are well known within the grocery industry – Electronic Data Interchange, Continuous Replenishment Program and Collaborative Planning, Forecasting and Replenishment. These initiatives have been chosen to illustrate the extent of organisational commitment required to achieve the envisioned level of coordination, cooperation, and collaboration respectively. For the purpose of making a clear comparison between these initiatives, we will focus our analysis on the replenishment aspect of each initiative. For each initiative, analysis will be organised in three sections: (1) review of the vision and aim, (2) description of the extent of standardisation required, and (3) description of the extent of organisational commitment required to achieve the envisioned level of standardisation.

3.2 Electronic Data Interchange (EDI)

3.2.1 Vision and Aim

Electronic Data Interchange (EDI) envisions a seamless exchange of information between two or more organisations to carry out daily replenishment operations. Taken as an initiative, EDI aims to set up an inter-

organisational communications infrastructure that allows two or more businesses to electronically transmit standard transaction documents in a structured format from one company's business process application to another's business process application [13][14]. EDI's vision impacts on the replenishment process in one major way. By adopting EDI message standards, transaction documents can be recognized and understood swiftly and without unnecessary delays and errors from inaccurate interpretation and manual data entry. For example, EDI messages can be used to invoice buyers, send purchase orders, and authorise items for delivery and transfer. Shipping schedules can be transmitted directly to a shipper's computer and responded to with an electronic shipping notice more quickly than if manually processed. Because all these processes can be performed more efficiently and frequently, with fewer errors, lead times and inventory holding costs are significantly reduced [15].

3.2.2 Extent of Standardisation

Infrastructure Standardisation

EDI requires organisations to standardise the message format that is exchanged such that business applications at both ends of a transaction can transmit and receive the messages electronically. Standardisation at the data level enables organisations to transact electronically without having to implement a new system or to make major changes to existing systems. EDI standards are made up

of four major components. These include (1) transactions sets, (2) segments, (3) data elements and (4) transmission control standards [14]. Basically, an EDI transaction set identifies a standard business document (eg. Invoice document), and segments are groups of data elements identifying the details within each document (eg. Address information, supplier name, items ordered, total amount, etc). Finally, transmission controls standards apply to the secure way EDI messages are packaged for transmission. These standards ensure that EDI messages reach the intended party in the intended form.

Operations and Tactics Standardisation

There are no formal requirements within the traditional EDI vision to adopt a standardised operations process, nor standard processes at the tactical level.. This means that businesses can organise their operations functions in whichever way they deem fit as long as they can transmit and receive the necessary transactional documents in EDI format to and from another party.

3.2.3 Extent of Organisational Commitment

Primarily an infrastructure level project, resources and services of the IT function is required to implement the EDI message standards and update existing business applications to allow the output and input of messages in conformity with the chosen standard. Once the infrastructure is in place to conduct transactions via EDI, the commitment on each participating organisation is to maintain this standardised communications link, or interface. In terms of impact on organisational tasks, processes and people, EDI does not require changes to be made to existing business processes.

3.3 Continuous Replenishment Program (CRP)

3.3.1 Vision and Aim

Continuous Replenishment Program (CRP) is a major strategy under the Efficient Replenishment pillar of the Efficient Consumer Response (ECR) movement. CRP envisions suppliers, distributors and retailers cooperating towards achieving a smooth and continuous flow of product along the distribution channel, thereby, reducing channel uncertainty, inventory levels and transportation costs [16][17]. CRP encompasses three alternative replenishment arrangements – direct-store-delivery, cross-docking and flow-through [9]. The major achievement of CRP is that the stock level and order requirements at the retailers' stores are revealed and shared with the manufacturers, and manufacturers use this information to fulfill store level orders more frequently and in smaller batches. With direct-store-delivery, orders are delivered directly from suppliers to individual stores, bypassing the distributor. With cross-docking, suppliers deliver consolidated store orders to a distribution center, where they are unpacked, sorted into

their store destinations and dispatched. Finally, with flow through, specific store orders are packed at the suppliers and delivered to the distribution center, checked and immediately dispatched without any sorting required. This improved flow of goods aims at eliminating buffer stock at the distribution center, reducing errors in deliveries and improving order response time, thereby, reducing out-of-stocks in stores. To achieve the maximum potential of the CRP vision, trading partners need to be able to facilitate high information coordination and be willing to align replenishment policies and operations with their trading partners' [17].

3.3.2 Extent of Standardisation

Infrastructure Standardisation

To facilitate the fast and accurate flow of replenishment information between retailer, distributor and supplier information systems, EDI is an essential enabling technology in CRP [18][19]. CRP requires stores to be able to electronically transmit information on stock levels and order requirements to a central buying office, where individual store orders are consolidated into an EDI purchase order message and transmitted to individual suppliers on a pre-agreed time schedule. Suppliers need to be able to then respond by transmitting an Advanced Shipping Notice (ASN) in EDI format either directly to the store or distribution centre to notify them of impending deliveries. Essential for enabling efficient handling of shipments and production of ASNs, suppliers need to be able to produce a bar coded serial shipping container code (SSCC) to identify shipments. Application of product identification standards, such as the European Article Numbering (EAN) system, in the form of bar codes on pallets and cartons are also essential for identifying and sorting at distribution centres. Bar codes on cartons and pallets are scanned and the data directly updated on the inventory management systems. This eliminates time consuming and error-prone manual data entry, thus, increasing the efficiency of the receiving, sorting and dispatching tasks.

Operations Standardisation

The CRP vision presents a change in the way orders are traditionally sent, received and fulfilled. Traditionally, individual store orders are aggregated at the retailer's DC and a purchase order sent to the suppliers, which then deliver a large shipment of goods to the DC. Orders are, generally, large and are sent infrequently and provide essentially no visibility of consumer or retailer ordering patterns for the manufacturers. However, in CRP, suppliers have visibility of store level requirements in their EDI orders and are expected to respond to this requirement almost immediately. This means that, firstly, suppliers must have the capability to respond to complex purchase orders that consist of many items in small

quantities and for multiple stores. Secondly, suppliers must be able to deliver these small batches of orders more frequently with a shorter lead-time (around 1 day typically).

Tactics Standardisation

In terms of replenishment processes, CRP only attempts to improve logistics and distribution operations and, therefore does not involve any processes at the tactical level of the organisation.

3.3.3 Extent of Organisational Commitment

The adoption of the CRP standard replenishment process impacts participating organisations at two levels of the organisation – the infrastructure and operations levels. At the infrastructure level, all participating firms are required to commit resources to implement a standard way of communicating messages to each other, and recognising shipments, cartons and items. In the grocery industry this is done using EDI and EAN product numbering and barcoding standards, thus, EDI and barcode compliance are a prerequisite for CRP. At the operations levels, participating retailers and manufacturers must alter the way they traditionally send, receive orders and dispatch orders. Retailers must have capabilities to send out purchase orders with individual store requirements and sort individual store order deliveries from different suppliers at their distribution centres. Suppliers, on the other hand, are required to have complex order processing capabilities to handle complex orders from retailers. Suppliers must also alter the way they traditionally dispatch orders to retailers, from large, infrequent deliveries to small, frequent deliveries. Therefore, CRP impacts mainly on the logistics and distribution functions of both supplier and retailers.

3.4 Collaborative Planning, Forecasting and Replenishment (CPFR)

3.4.1 Vision and Aim

Established in 1997, CPFR was developed to address the gaps that were present in previous initiatives, such as continuous replenishment. As such, CPFR is seen as an evolution from ECR, and more specifically, from CRP [10]. CPFR envisions two or more organisations exchanging market information to jointly develop a market-specific business plan that describes the product to be sold, the way it will be merchandised and promoted in the marketplace, and the time frame in which this happens [20]. Developed as a nine-step guideline for retailers and their manufacturers, the roadmap instructs CPFR partners to jointly develop a front-end agreement on terms of collaboration, targets and performance metrics, create a joint business plan, jointly create a sales forecast, identify any exceptions, jointly address and

resolve the exceptions, generate an order forecast, and execute the order. By sharing promotion schedules, point-of-sales data and inventory data, a single shared forecast of consumer demand, at the detail of a product, is developed. The retailer and manufacturer can then base all internal planning activities relating to that particular product on the shared demand forecast, representing a major step towards value-chain integration. CPFR aims to increase visibility of demand information along the supply chain and leverage a collaboration-oriented relationship between retailer and manufacturer, to increase the flexibility of the supply chain in planning for and responding to volatile demand. This implies the need for an infrastructure that can facilitate high levels of information exchange, a sophisticated planning and forecasting system that is integrated with the production and logistics systems, and a willingness of trading partners to align planning objectives, promotional tactics, and replenishment policies and operations. The following section discusses the extent of standardisation embedded in the CPFR vision.

3.4.2 Extent of Standardisation

Infrastructure Standardisation

In terms of data and communications interfaces, EDI and product identification standards are prerequisites to achieve the level of collaboration envisioned in CPFR. The high frequency of iterative interaction between organisations while sharing sensitive information to collaboratively develop forecasts makes it even more critical for organisations to adopt data standards. Using the EDI infrastructure, organisations can transmit and receive critical data swiftly and securely while ensuring a high data integrity. Moreover, EDI can facilitate information exchange between different functional units, which under CPFR, are envisioned to collaborate closely with each other. In terms of efficient handling of goods, the requirements are very similar to CRP, thus, organisations are required to adopt the bar coding standards infrastructure for CPFR as well. This is important in CPFR because point-of-sales data is extremely valuable in CPFR for capturing consumer demand necessary to generate sales and order forecasts.

Operations Standardisation

To effectively conduct CPFR, organisations must have the capabilities to perform replenishment operations very much in same efficient way as in CRP. Therefore, the operations process standards, in terms of order receiving, sorting and dispatching, are necessary also to achieve efficient delivery execution in CPFR. However, unlike previous initiatives, inventory management is now integrated with the planning and forecasting processes [5].

CPFR represents a radical transformation in the way businesses plan for promotions and develop forecasts to improve their replenishment operations in response to consumer demand. Evolving from having established a shared understanding on how orders are fulfilled, as envisioned in CRP, CPFR takes process standardisation to the next level, requiring a retailer and a manufacturer to adopt a standardised way of business planning. Retailers and their manufacturers are required to share information about their business development activities for a particular product within a period of time. Based on this planning information and unprecedented access to inventory level information from Distribution Centers to stores, trading partners jointly develop and manage a forecast over this period of time. With even greater demand visibility, forecast accuracy increases and manufacturers can match production to demand and fulfil orders more effectively, reducing inventory levels along the pipeline and out-of-stocks in retailers' stores.

3.4.3 Extent of Organisational Commitment Required

CPFR requires participating organisations to adopt standard business information formats, standard replenishment policies and operations, as well as standard processes in business planning and forecasting. The extent of data and process standardisation embedded in the CPFR vision requires commitment at the infrastructure, operations as well as tactical levels within each participating organisation. At the infrastructure level, CPFR requires organisations to commit IT resources to adopt message and product numbering standards to facilitate communication of basic EDI messages and numbering and barcodes as before. Additionally, due to the iterative nature of the collaborative forecasting process, more sophisticated information technologies, such as collaborative hubs, might have to be implemented to enable real-time collaboration. At the operations level, the impact here is similar to CRP, each participating organisation must standardise the way they receive and dispatch orders, thus, impacting on the logistics and distribution functions. However, there is a new and more demanding need to standardise ways of planning, forecasting and managing product life cycles which extends the demands on companies to tactical management and longer timescales. This new level of standardisation will impact on the merchandising function (for retailers), sales and marketing function (for suppliers), and planning functions (for retailers and suppliers). More importantly, whereas previous initiatives like CRP focused on optimising individual units and not the whole process or company [5], CPFR envisions several functional units within organisations, and to some extent across organisations, to collaborate to improve the performance of the replenishment cycle.

4.0 Discussion

Through exploring the extent of standardisation required by each of the three grocery industry replenishment initiatives, we find that the level of standardisation increases cumulatively as we move from EDI to CPFR. Each initiative was observed to require the capabilities of the earlier initiatives, and at the same time, requiring new capabilities with more complex and demanding effects. As described above, EDI requires organisations to adopt a set of industry message standards. CRP requires organisations to standardise their messages as well as standardise the way orders are received, sorted and dispatched. CPFR finally requires organisations to standardise messages, standardise the way orders are received and fulfilled, and besides this, standardise the way promotions are planned, forecasts are created, and performance is measured.

Table 1: Summary of analysis

Initiative	Level of Standardisation	Impacted organisational parts
EDI	Infrastructure: data, communication interface	Technical functions: IT
CRP	Infrastructure: data, communication interface, product identification (barcodes) Operational: Order receiving, sorting and despatching processes	Technical functions: IT Operational functions: logistics and distribution
CPFR	Infrastructure: data, communication interface, product identification (barcodes) Operational: Order receiving, sorting and despatching processes Tactical: Business planning processes	Technical functions: IT Operational functions: logistics and distribution Tactical functions: sales, marketing, purchasing, planning

Hence, as the extent of standardisation becomes greater, organisations face the need to commit an increasing amount of resources and managerial attention to achieve those targets. In EDI, the focus is at the infrastructure level. Major commitments of resources have to come from the IT function only. There is little commitment necessary from the rest of the organisation. In CRP, the focus extends beyond the infrastructure level to incorporate resources and managerial attention at the operations level. This affects not only the IT function, but also the logistics and distribution functions, where orders are received, sorted and dispatched. In CPFR, the focus is extended further. Organisations must now commit managerial attention and resources at the infrastructure and operations levels of the organisation, and also at the tactical level, involving sales, purchasing, or merchandising (at retailers), and planning functions

within the organisation. Moreover, CPFR requires close collaboration between the functions at the operations and tactical level to enable a responsive replenishment cycle.

By analysing the requirements of the various initiatives, we see the level of commitment compounding as complexity increases from coordination to collaboration along the supply chain. The number of functional parts involved in operationalising the initiatives increases, implying that greater levels of commitment in terms of time and resources, and involvement of more senior management, are required by each participating organisation to manage the interdependencies of the different parts in achieving the vision.

5.0 Conclusion

This analysis supports our argument that collaborative supply chain initiatives create their own barriers to adoption because the level of complexity inherent in its vision becomes increasingly complex and expensive to implement within each organisation, and more critically, with multiple trading partners.

As supply chain initiatives become more complex due to an increasing need for standardisation, the adoption within the individual organisations is challenged by the degree of organisational commitment that is required. With more people, more organisational units and technical systems involved, the adoption respectively becomes more complex and expensive.

These barriers to adoption at the individual organisational level have to be taken into account when extending the analysis to an inter-organisational level involving multiple business partners. With these inherent complexities complementing those barriers stemming from organisational asymmetries and project management across organisations, we can begin to understand SCM adoption in a more holistic way. Just as the single initiatives have a cumulative nature of complexity and commitment it might be worth researching whether this is mirrored in the project management to implement these initiatives. Further research into the nature of projects for the implementation of SCM initiatives should aim at exploring the project management challenges that come with implementing increasingly complex initiatives with multiple trading partners.

6.0 References

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The Individual Learning Performance Using e-Learning In The Organizational Context

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Abstract

Previous research on e-Learning in the business firms has remained a learner's characteristic perspective and even if the causes for learning performance have been clarified to some degree, these have not been practical research. However, the present study focuses in verification for the influential factors from an organizational context point of view on the individual learning performance.

The results of this study are as following,

- 1)e-Learning operation strategies related with management strategies have significant positive relations with the individual learning performance.
- 2)Organizational atmosphere is significant partially. - Learning motivation of organization has significant positive relations with the individual learning performance. But Innovative disposition of organization is not significant.
- 3)Reward / evaluation system has significant positive relations with the individual learning performance.

The academic significant of the present study lies in that, while previous research on e-Learning has remained conceptual or perspective on individual(learner's)

characteristic about training effect, the present study tried to approach from the organizational context standpoint.

Practical issues that the present study presents are that e-Learning managers should realize the importance of, and try to find ways to promote organizational learning motivation to adopt use of e-Learning system. Besides e-Learning operation strategies and a more practical reward / evaluation system should be implemented.

I. Introduction

Despite the changes in the world, the notion that companies exist for the pursuit of profit is the same. Corresponding to the fast paced environment, with a view to occupy a competitive advantage, we have raised our voices that we should accumulate and administrate intellectual capital into financial and material capital. The companies pursuing knowledge management, as a method of the knowledge management for the creation and transition of knowledge, seek learning in order to enhance the performance of their employees, departments, and their own companies. In other words, they aim at influencing the performance of their companies by attempting the creation of competitive advantages, future

intention, and business improvement through learning. This way, the best alternative to accumulate quality capital within an organization is considered e-Learning.[31]

However, the studies on e-learning so far have been mostly educational approaches, while their content were confined to the build-up, use, and operation of e-learning itself and very few studies have demonstrated and analyzed any factors which influence the practice of e-learning from an enterprise point of view.

Under these backgrounds, this study has its objective in inducing the influential factors of e-learning which many companies have recently been adopting with a greater recognition of its significance.

II. Literature Review

2.1 The Definitions of e-Learning

e-learning is identified to design, deliver, select, expand, and coach learning by utilizing technologies for all kinds of learning. This is not simple learning but utilizes Internet technology which delivers a variety of solutions for the enhancement of knowledge and performance. This is identified to include knowledge management or electronic performance supports beyond a simple on-line CBT (Computer Based Technology).[23]

‘e’ of e-learning means ‘Effective, Global, Entertaining, Evolving, Educationally Sound, Exciting, Affordable, Expensive, User centric, Need to know, Enhancement, Collaborative, Extended, Accessible, Reliable e-Learning’. The definition of e-Learning is, in a different point of view, classified diversely by base technology, delivery method, use scope, etc but it is generally used having almost the same meaning as on-line education and cyber education.

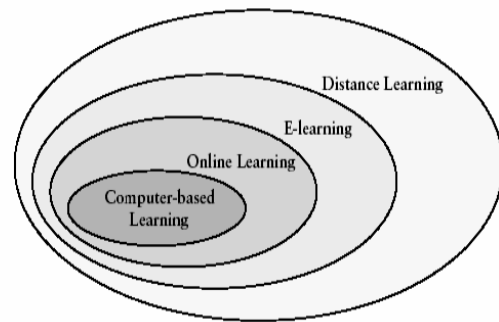


Figure 1. Subsets of Distance Learning [36]

III. Research Methodology

3.1 Method

As there are very few studies on the success factors in the enterprise of e-learning, we have decided to induce the influential factors of e-Learning by inquiring on the main factors of success and influence of many different fields covering e-learning, knowledge management, information systems, organization innovation, etc. This is because e-Learning is a sector belonging to knowledge management, while utilizing information systems and the innovation of organizations have recently developed in association with the issue of organizations creating knowledge and pursuing learning. Reflecting the definition of an organization's administration and innovation by Venkatraman, Loh & Koh(1994), it includes meanings covering an organizations' adopted change, the elements which bring changes to organizations, administration routine, and procedures, and an extensive view considering the association between organization and the external environment, etc.[15] Therefore, in the event that e-Learning is adopted, developed, and practiced within an organization, it should be interpreted in the same context.

Consequently, the consideration of influential factors in an organizations' innovation is required as a previous study of e-learning..

3.2 Participant

This study has been carried out with a purpose to discover the factors which influence the learning performance of learners when the members of an organization learn through e-Learning. Therefore the unit of analysis is individual.

For this study, we made questionnaires for the companies chosen at random in order to test the reliability and validity of the measuring tools. Besides this, considering that e-Learning can be carried out in the computerized sector, we did not confine ourselves in targeting a specific industry. As a result of doing e-mail surveys of 300 people totally who have ever experienced or currently experience e-learning, 277 of the responses were returned in 2 weeks. Among them 257 responses were used for the material analysis except for 20 untruthful responses. The questionnaires were composed of 74 questions and every category used a single balanced 5 point Likert scale for the simplification of answering. Also the responders were anonymous. The collected data was worked on at SPSS 11.0 program.

3.3 Independent variables

3.2.1 The Association of Operational Strategies of e-learning and Management Strategies

As a result of the previous study, a great deal of references emphasize on the importance of strategy. [21]

Chandler identifies that strategy is a basic long-term goal, purpose, and the crystallization of both allocation of resources and behavior patterns in order to achieve them while Ansoff defines it as the decisions, rules and guidelines of deciding the scope of an organization and its growth direction.[2] In addition, Porter (1985) expands on this meaning by stating that it includes the steps organizations take for competitive gains.

Company education is eventually designed to achieve the high performance level a company aims at by fostering its employees' individual capacity and the company in the long run can specify the strategy of the company. Therefore, the meaning of strategy in this study is dealt with as a guideline which encourages the members of an organization to perform targets for organization's goals in order to gain a competitive advantage in the transition environment. Accordingly, the association of e-Learning strategy with other management strategies in an organization has been highly regarded. We have decided that not a temporary measure but a long-term operational strategy is required to gain the source of competitiveness.

For the association of strategy between e-Learning and management, we have measured the existence of a direction which can measure whether the practice of e-learning is helpful for the organization's goals and the existence of a complementary integration between off-line classroom education and on-line e-learning.

3.2.2 Organizational Atmosphere

The distinction of culture and the atmosphere of an organization has not been clarified. Yet, according to Ashforth the organization culture is conceptually identified as a value proposition shared with the members of an organization whereas organizational atmosphere as a concept shared with the members of an organization. [3] In other words, organizational culture emphasizes basic values, propositions, artificial creation etc which influence each member of the organization and its collective behavior whereas an organizational atmosphere emphasizes the image of the organization of which the members sense.[21] This study has induced two divided factors; one is learning motivation in which the members of an organization recognize their organizational atmosphere[10][19] and the other one is its innovative

tendency.[33]

Learning motivation means in what degree people recognize the necessity of information obtaining and sharing, and to what degree people comprehend the purpose of an organization's carrying out e-learning. Furthermore, they are measured by the degree of recognition that knowledge is competitive, the degree of comprehension shown in an organization that knowledge sharing is mutually profitable, the degree of knowledge obtaining desire, the degree of comprehending an organization's learning purpose, etc.

Rogers identifies innovation saying, "adopted and utilized ideas or practical policy or objects that individual or organization recognize as new" Havelock(1969) expands its scope of meaning saying "Utilization and diffusion of knowledge". Therefore, in this study the innovative tendency is identified as an inclination of utilizing and diffusing knowledge through the adoption of new systems. The innovative tendency is measured by the degree of positive and favorable feedback about the adoption of new systems, and the degree of creation and venture intention, etc.

3.2.3 Reward/ Assessment System

As a result of the previous study, both a reward or assessment system[31] has been proved as influential factors of knowledge management and information systems.

Therefore, we regard these as one factor. In this study, the reward or assessment system means the formalized, objective material and non-material reward provided internally by the organization which are directly involved with learners or organizations for the accomplishment of e-Learning as well as the systemization of assessment rules related to the degree of use.

Looking at the past case study on information systems, the indexes of the actual and intended use of system and

users' attitude, etc were used for the measurement of success. Other perspectives focused on the measurement of cost or profits. Yet, as the accurate measurement of cost or profit is impossible, alternatively, the existence of a developed material reward system such as pay rises, incentives, etc, and the existence of a developed non-material reward system such as promotion, encouragement, recognition, etc have been measured. In addition to this, whether or not there are developed assessment systems of use frequency, of managing the type of used information, of voluntary use, of information satisfaction about the difference between seeking information and received information, and of information comprehension is important.

3.3 Dependent variables

As there are few case studies that clarify the direct or indirect influence of e-Learning to the performance of an organization, it seems to be hard to consider organization performance such as ROI or average profit growth rate, etc as dependent variables. Therefore, this study has been accomplished to discover the influential factors of the performance of individual e-Learning. Also dependent variables of each factor are defined as individual performance which includes user satisfaction [8][9] and the improvement of work performance.[8] The user satisfaction seems to be the more proper indication of the assessment of performance than the degree of utilization when the use of information systems is systematically and traditionally compulsory.

3.4 Hypothesis

H1: The association of strategies between e-Learning operation and company's management enhances the performance of individual learning.

H2-1: The organizational learning motivation enhances

the performance of individual learning through e-learning.
H2-2: The stronger the innovative tendency within an organization, the higher the performance of individual learning through e-learning.

H3: The well developed reward or assessment system of e-Learning enhances the performance of individual learning.

IV. Analysis

4.1 Analysis of Validity and Reliability

This study has been carried out on the factor analysis about concept validity in order to discover whether the abstract concepts that surveyors desired to measure were actually measured by proper measuring tools. In other words, we have carried out a factor analysis of concept validity in order to discover whether the manipulative definition of concepts was proper.

There are no absolute standards defining what degree of factor loading quantity can be meaningful to adopt as variables. Yet, 0.4 and above can be regarded as an average meaningful variable and above 0.5 is considered a very decisive factor.[30] Accordingly, we have arranged 0.4 of factor loading quantity for the distinction validity while excluding a variable of 0.344 which is clustered as a factor but reaching below the standard of factor loading quantity. Also, the result of measuring Kaiser-Meyer-Olkin(KMO) and Bartlett's Test for the validity proof of factor analysis showed Bartlett's test of Sphericity of 10394.926 and its significance level of .000, thus proving the factor analysis was proper. In addition, the measurement of KMO MSA(measure of sampling adequacy) of .921 ($> \alpha=0.5$) appeared suitable to be selected as a variable for analysis.

Generally speaking, Cronbach's alpha coefficient showing 0.6 and above indicates relatively high reliability while allowing the analysis by integrating the entire

variable as one measure.[30] In this study, all the questions showed relatively high reliability of 0.7 and above as a result of the reliability analysis.

V. Results

The results of this study are as follows.

Firstly, the association of strategy between e-Learning and company management which is a strategic factor of e-Learning appear to enhance learning performance. This indicates that when an organization has clarified its purpose of e-Learning and established a guideline of how to efficiently fit each member's ability into the organization individually it shows a high performance of learning.

Secondly, the result of the organizational atmosphere shows the most remarkable feature. The innovative tendency of an organization, covering knowledge management, information systems, organization innovation, etc which were presented in the existing references commonly as very important influential factors, have been declined. Instead, organizational learning motivation has been adopted. It is understandable that the recognition of the necessity of knowledge obtaining and sharing and having positive and active attitudes toward learning give relative significance to the performance of individual learning. However, regarding the fact that the organization's innovative tendency has been adopted as an influential factor can be interpreted in many different ways.

In other words, there are two possibilities estimated of two types companies both adopting e-Learning each with different innovative tendencies, or companies which adopt e-Learning in order to revive a new atmosphere because they have a weak innovative tendency. Therefore, a further study is required regarding this matter.

Thirdly, the reward or assessment system has been discovered as a meaningful factor of enhancing the

performance of individual learning. The original purpose of e-Learning was enabling learners to voluntarily learn without the restriction of time and space. Actually, reflecting that the reward or assessment system affects the performance of individuals, this shows that a certain degree of compulsory learning is required.

VI. Conclusion and Discussion

The significance of this study can be considered from both a theoretical and practical perspective. Firstly, regarding the theoretical perspective, the studies so far have been concentrating on the effect of education by the characteristics of learners whereas this study has tried an approach on an organizational perspective so that we could induce the factors targeting the field of organization management which is related to e-Learning. As a result of demonstration, in particular, the fact that organizational atmosphere appears to be a more significant factor for the development of strategies and systems indicates that Korean characteristics are reflected by the study sample.

Through the examination of three meaningful factors found in the companies which are practically carrying out e-Learning but the measurement of learning performance is impossible, we are able to present an indirect standard of assessing the success of e-Learning. Also, we have discovered an essential requirement enabling prospective companies which will accomplish e-learning to reduce any possible failure. Of course, these factors could not be sufficient. However, this could be utilized as a guideline for the organizations which fall behind but would like to save even a step.

The limitations of this study can be pointed out as follows. The assessment is desirable when carried out objectively but considering the features of e-Learning there are some difficulties of objective assessment, in which it is very hard to measure cost or profit in currency due to their intangibility and it takes time for learners to acquire knowledge rather than showing an instant learning

performance, etc. Besides this, under the circumstance where there is no established method to measure the standardized performance by e-Learning, it is tough to eliminate many other extraneous variables when measured in ROI which is presented as a representative measuring standard. This is the reason this study has selected not organizations but individuals for its analysis unit. As we have considered learners' satisfaction and performance improvement as dependent variables, we believe that a further study which will discover any functional relation between an individual's learning performance and the performance of an organization is required. In addition, I hope more specified studies based on the result of this study will be accomplished in order to discover an association between organizational culture and learning.

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Role of Application Service Providers in Infrastructure Development For Web-enabled Course Administration Tool

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Abstract

For the effective teaching, the teacher must monitor the effectiveness and performance of the teaching methodology and techniques. For this purpose teacher can use various tools. The effective teaching can be achieved by using different elements of teaching. This paper proposes a system tools called OCAT-PA – Online Course Administration tool for Performance Analysis. This tool can be implemented as standalone system, client-server system or web enabled system. This paper focuses on the web-enabled implementation of the tool. It also focuses on the involvement of the Application Service Providers. This paper discusses the role of application service providers in the proposed system with benefits.

1. Introduction

In a typical teaching activity, the teacher prepares a schedule of the course and the course material by studying the subject contents, scope, depth required, and the level of the students. He also uses his past experience in this planning. It is a challenging task to manage the work planning as per the schedule. The other essential activities may disturb this planning. The other regular activities apart from only teaching include conducting tests, regular assessment and recording feedback from the students. As such, there is need of some comprehensive tool to manage all these activities in an integrated manner. The development and use of such tool require substantial amount of investment. This paper describes the basic structure of a course for effective teaching, the architecture of the course administration tool, its implementation and role of Application Service Providers in its implementation.

2. Elements of a Course

A course is not just teaching the prescribed syllabus, but it also includes many essential elements, which forms a basic comprehensive foundation for the teacher [1]. The essential components include – syllabus, the topic list from the syllabus, teaching plan, question bank, frequently asked questions, acronyms, notes, slides, handouts, books, resources for reference, research papers, student list, attendance record, performance record, test mark record, etc.

2.1 Syllabus

The university and/or the specific authority prescribes a detailed syllabus. It includes many units with summary of each unit in short. The summary may not specify each and every topic. As such, the teacher is responsible for reorganizing the subject syllabus in accordance with the scope and level of the students. He may include more essential topics, which may not be specified in the syllabus.

2.2 Topic List

The reorganization of the syllabus as per the need results in the comprehensive topic list. The teacher prepares the topic list with the details. The details include book references, research papers, and web reference for each topic.

2.3 Teaching Plan

In teaching plan the topic list is arranged as per the weekly schedule and lectures. A list of the available weeks and topics to be covered is prepared as a teaching plan.

2.4 Question Bank

The teacher prepares a comprehensive list of questions for each topic. The questions are very necessary to assess the depth of understanding of the topics. The questions may include objective type questions, broad questions, short questions, etc. The question bank also consists of the desired answer plan of the question. This question bank is prepared per topic to make it accessible after teaching a topic.

2.5 Frequently Asked Questions

The students normally ask many questions not directly related with the subject. These questions are prepared with actual answers forming a typical FAQ. This FAQ is prepared for the whole subject, not per topic, since it is typically a smaller list as that of the list of subject questions.

2.6 Acronyms

Teacher prepares a list of all the acronyms with meaning and details, related with the subject.

2.7 Lecture Notes, Slides and Handouts

The teacher prepares notes, slides and handouts for each topic. The notes are the well-formatted documents with text, diagrams, formulae and other needed things. The slides are used during teaching for explaining the topic contents. The handouts can be distributed to the students for reference and for taking some notes during the classroom teaching.

2.8 Books, Resources for Reference and Research Papers

The teacher prepares a list of books required during the learning of the subject. He can mark the textbooks and reference books separately. He prepares a list of research papers per topic for reading. He also prepares a list of web references, online articles, web sites and other available resources as a resource list. This list may be prepared per topic or as a whole for the subject.

2.9 Student List and Performance Records

The teacher is responsible for monitoring and evaluating the performance of each student. He prepares list of students with test marks and grading for this purpose.

2.10 Lecture Record

The teacher records the actual coverage of the proposed teaching plan by preparing a lecture record while teaching during a semester.

3. Monitoring the Progress of the Course

The progress of a course can be monitored using the teaching plan and actual lecture record. The progress can be evaluated in terms of the syllabus covered. The teacher supervisor is responsible for regular assessment of this record for each course and accordingly directing the teachers to improve the performance of teaching and planning.

The teacher is responsible for regularly testing the students by organizing the quiz and tests. This will result in continuous assessment of the students by the teacher. From this record the teacher can direct the student to improve their performance and understanding of the course.

4. Structure of the Tool

The previous section describes the essential factor for effective teaching and performance monitoring. Here we propose a system for managing the course called “Online Course Administration Tool with Performance Analysis”

(OCAT-PA). The Figure (1) describes the architecture of the system.

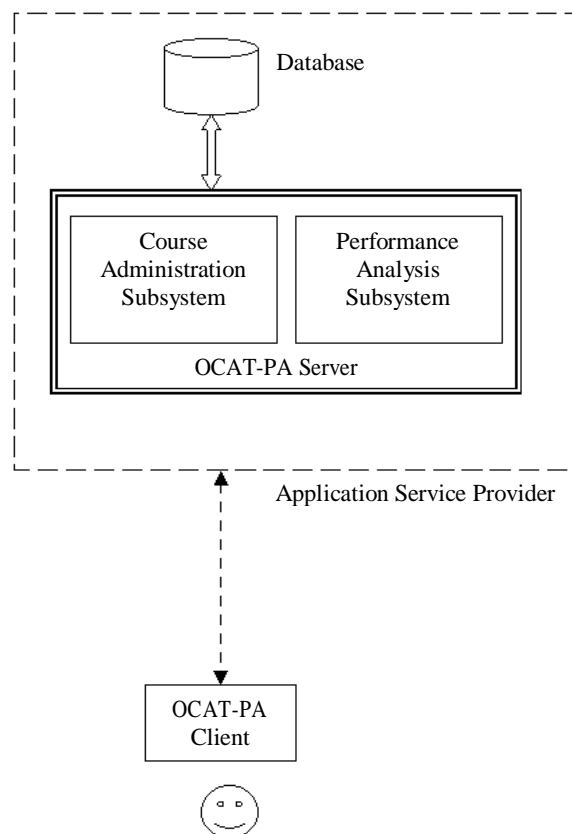


Figure 1 – Architecture of OCAT - PA

The OCAT-PA system consists of the OCAT-PA server and client as it is web based. It also shows central database.

The OCAT-PA server architecture can be assumed in basically two subsystems – Subsystem for Course Administration and Subsystem for Performance Analysis. The figure (2) and (3) describe the architecture of these subsystems.

4.1 Course Administration Subsystem

The Course Administration Subsystem is an important subsystem of the proposed tool. It includes the modules for building and managing elements and aspects of the general course and course administration. Figure (2) describes the detailed architecture of the Course Administration Subsystem.

The elements of a course include the syllabus, topic list, course calendar, teaching plan, question bank, quiz questions, frequently asked questions, acronyms, online notices, notes, slides and handouts, and reading list. The reading list contains the books, references, research papers, etc.

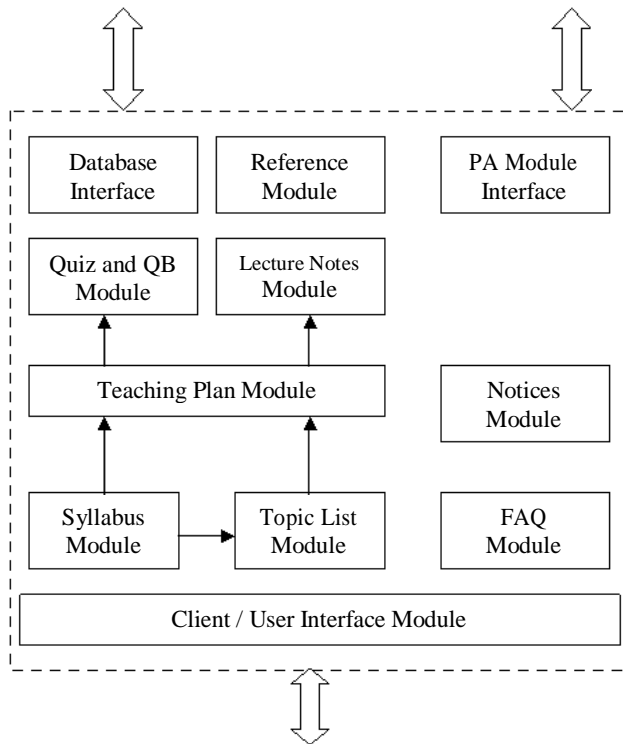


Figure 2 : Architecture of Course Administration Subsystem

The architecture shows many modules, each for handling an aspect or element of the course. It also includes the database interface module needed to communicate and interface the tool with the database. The architecture also shows an interface for the Performance Analysis subsystem.

The client/user interface module is needed to have an interface between the Course Administrative Subsystem and OCAT-PA client.

4.2 Performance Analysis Subsystem

The Performance Analysis Subsystem is a subsystem for monitoring the performance of the various aspects of the system. It includes the modules for managing the lecture record, attendance, quiz and test records.

This module can generate the progress report and various other reports to analyze the performance of students and other elements of the system.

Figure (3) shows the details of the performance analysis subsystem of the proposed tool.

It includes the modules for monitoring the lecture record, students list, students assessment and test records, quiz results, etc.

The architecture shows many modules, each for handling an aspect or element of the performance analysis.

It also includes the database interface module needed to communicate and interface the tool with the database. The architecture shows an interface for the Performance Analysis subsystem.

The client/user interface module is needed to have an interface between the Performance Analysis Subsystem and OCAT-PA client.

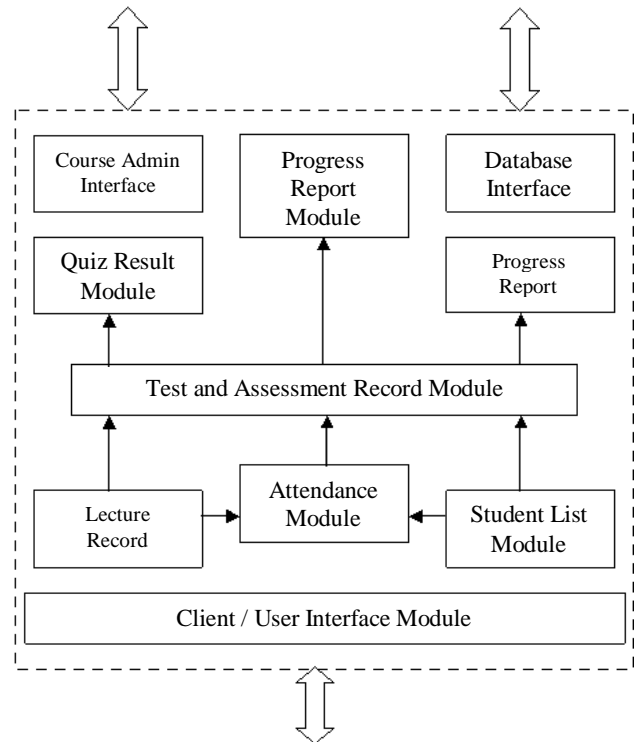


Figure 3 – Architecture of Performance Analysis Subsystem

5. Need and Role of Application Service Providers (ASP)

The teacher can use proposed tool to improve the course administration as well as management of the teaching activity. It will make the activities of a teacher well manageable. But developing and maintaining the system is expensive. It will need huge financial investment as well as manpower in developing the system. The task of maintaining the system is again challenging for the teacher.

The problem can be solved by introducing the Application Service Provider in the OCAT-PA system. The ASP will be responsible for whole development and maintenance of the system [2]. The database in the system will be larger in size and hence needs more effort to maintain and use it efficiently. Due to the ASP, it will be easy to continuously work on the system and make it more effective and better by studying the current constraints and limitations of the system.

The ASP type of business model is necessary where there is need of a common type of software which can be

development and used across many organizations. The software is not needed to be purchased by the organizations but is used through the Internet. The Application Service Provider charges the organization based on the uses of the system.

Due to ASP, the teacher and institute are free from the development and maintenance overhead. The ASP can assist them in various tasks like some data entry and report printing. Due to ASP, it becomes possible to use the system more efficiently.

The online course administration Tool with Performance Analysis system allows the teacher to improve the quality of teaching by providing a better uniform framework for course administration and management. By introducing the Application Service Providers, the system becomes more feature rich still inexpensive.

ASP can design various courses and develop standard study material; which can be useful to the teacher. This will increase the earning potential of the ASP and this way system can indirectly improve the teaching and learning process.

6. Benefits of the Tool with ASP

The OCAT-PA system is itself very useful and effective. By introducing the Application Service Providers the system performance and usability can be improved.

Apart from this obvious benefit, there are several advantages of using the ASP based OCAT-PA system, which are listed below.

- The educational institutes are free from the development and maintenance overhead.
- Due to web based implementation, it becomes accessible from anywhere, anytime.
- The system is inexpensive as there is no need to purchase the software.
- The system can be constantly improved.
- The system provides a standard framework of course elements for a teacher, which can improve overall performance of the teaching process.
- The ASP can provide value added services like pre-designed courseware, expert assistance in managing the teaching plan, etc.
- It provides a feature rich but inexpensive system
- It can improve the inter-institutional relations.

7. Conclusion

The online course administration Tool with Performance Analysis system allows the teacher to

improve the quality of teaching by providing a better uniform framework for course administration and management. By introducing the Application Service Providers, the system becomes more feature rich still inexpensive.

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Business Model For Developing the Courseware For eLearning and Self Paced Learning of Programming Languages

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Abstract

Teaching and learning programming language is a challenging task at the undergraduate level. This paper focuses on the basic elements required in learning the programming languages at undergraduate level. In this paper authors share their experience of the development of course material using the multimedia tools. They found that it is difficult to maintain the system, as it requires constant development. They propose a component model in the continuing development of such multimedia courseware incorporating the industry with a business model to support this development.

1. Introduction

In teaching a course the most important aspect is the courseware of the subject. The structure of the courseware depends upon the kind of the subject also. The quality and depth of teaching can be well defined and managed using the quality of the corresponding courseware. Due to advancement in the technology, the newer techniques and tools can be incorporated in developing better courseware for enhancement of teaching.

This paper explores the structure and elements of a courseware in general and explains how they are different for the programming language subjects. It also focuses on the use of newer multimedia and presentation tools in preparation of the better courseware. The paper discusses these aspects in the context of an effort to develop the courseware for teaching and learning the C Language Programming. It also discusses the difficulties and obstacles in such effort of developing courseware. The paper then introduces a new concept of development of better courseware with the help of software development industry based on a business model. This business model is beneficial to both industry and academic institutes.

2. Structure of Courseware

A course configuration includes many essential elements, which forms a basic comprehensive foundation for the teacher [1]. The essential elements include – syllabus, the topic list prepared from the syllabus, teaching plan for the semester, question bank, frequently asked questions, acronyms, class notes, slides, handouts,

reference and text books, resources for reference, research papers for each topic, list of enrolled students, attendance record of the students, students performance record, and test mark record. The figure-1 shows the most common configuration of a courseware.

The syllabus is prescribed by the governing authority like a University. It consists of a broad list of topics and summaries of subject which is expected to be covered in the course.

The topic list is the detail list of topics which are implied by the syllabus. Some topic may not be explicitly specified in the syllabus, but may be needed for deep and detail understanding of the subject.

The teacher then prepares a teaching plan dividing the topic list in the number of weeks and topics to be covered per week. This teaching plan guides the teacher in teaching and managing the teaching during the entire course. It keeps track of the teaching and teaching related activities in the entire duration.

The other essential elements of the courseware include the question bank, frequently asked questions, acronyms, lecture notes, slides and handouts. It also includes the text and reference books, web addresses of the web resources, and research papers.

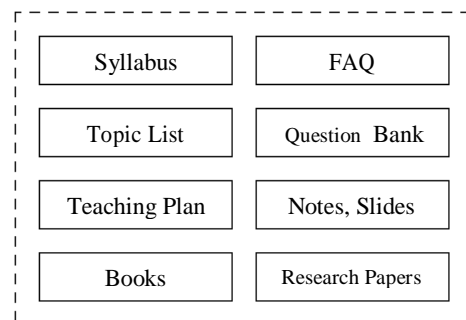


Figure 1– Courseware Configuration

3. Courseware for Programming Courses

The courseware elements discussed in previous section may not be appropriate in the course on programming languages. The programming language learning and

teaching is mostly related to the actual programming. It is mostly non theoretical. Due to this major difference the courseware for the programming language course is mostly different.

The elements of the courseware for the programming language teaching and learning as shown in figure-2, involves the syllabus, topic list, teaching plan, objective questions on programming, questions involving analysis and design of the programs for the given problem, results and variations of the various programs, different version of the program.

The programs involve execution. The courseware should be able to express step-by-step execution with animations and explanations. The traditional approach of courseware development does not have this capability. These obstacles affect the quality of courseware for programming language subjects.

As such the courseware for such subjects should be developed with the help of modern technologies. These modern tools provides facilities to express the dynamic aspects of the courseware. These facilities may be animation, sounds, videos, texts, simulation, etc.

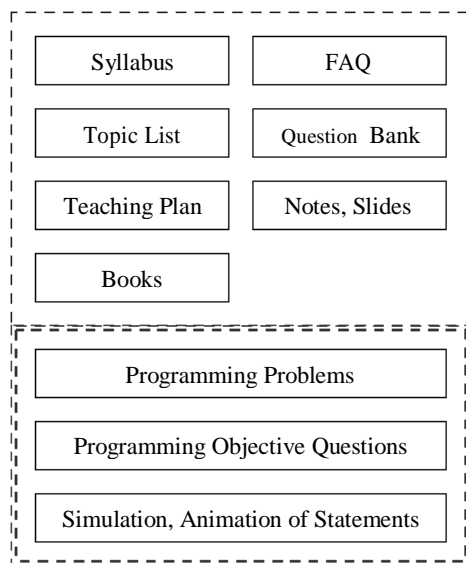


Figure 2 - Courseware Configuration for Programming Language Subject

4. Case Study

This section focuses on a case study of multimedia courseware development for the “C Programming” course [2]. The syllabus specifies, programming in C with basic programming constructs, functions, files, pointers, and advanced programming concepts should be covered.

The syllabus can be divided into the topic list as shown below. It shows about 29 topics. Each topic may be of one or two lectures duration.

The topic list for C Programming is –

- 1) Introduction to programming
- 2) Introduction to C
- 3) C programming basics
- 4) Writing first C program
- 5) Basic data types
- 6) Input and output statements
- 7) Operators in C
- 8) The for loop in C
- 9) The while loop in C
- 10) The do while loop in C
- 11) Conditional statement – if else
- 12) Conditional statement – switch, break
- 13) The goto statement
- 14) Nested loops
- 15) Introduction to functions
- 16) Functions with parameters
- 17) Local and global variables
- 18) Advanced data types
- 19) Arrays
- 20) Pointers
- 21) Strings
- 22) Structure and union
- 23) Basic file handling
- 24) Advanced file handling
- 25) C preprocessor
- 26) Command line parameters
- 27) Unsolved programming problems
- 28) Mini project
- 29) Review

Each topic from this topic list is again divided into some subtopics. For example the topic “Basic data types” can be subdivided as –

- 5.1) Need of data types
- 5.2) List and example of data types
- 5.3) Integer data type
- 5.4) Float data type
- 5.5) Char data type
- 5.6) Double data type

Each subtopic here needs basic explanation, syntax, programming examples, and unsolved problems. For each point many slides with animation are required. These slides or presentations should again be under constant development in order to include more and more new examples and novelty.

The number of such subtopics can be then calculated as 29 main topics x 5 subtopics per main topic. It comes out to be 145 subtopics in total. In practice each topic takes about 5 animation slides. In all it comes out to be about 725 slides for a subject.

Every slide needs to be developed with novelty and with the technical contents. As we want to include more and more examples always, most of the slides will be under constant updating and development.

Each slide needs the development time in the range of hours. For this project in all the total development time is much more.

5. Difficulties

As described by the previous sections, the nature of courseware for traditional is static; where only text and simple documents are sufficient to express the contents. It does not have any need of animation, simulation facilities to express the topics.

But, the programming language subjects are of dynamic nature. Most of the topics in these subjects need the explanation using some sample execution of the program or programming statements. Due to this difference the programming language subjects courseware should be developed in some different manner. In the teaching and learning of computer programming we may develop the courseware which can itself deliver knowledge to the learner even in the absence of any trainer or teacher.

As our case study describes the courseware can be developed in the form of many animated slides. The slides can be developed with many software tools like Power Point or Flash available in the market. Many new tools always emerge in the industry. It is a challenging task for the teacher to learn to use these tools proficiently and apply them in the development of the courseware.

It will be a difficult task for a teacher to self develop and use these slides constantly. As seen in the case study, it will take much time to develop the courseware as there are large number of dynamic subtopics. We can define the dynamic subtopic as a subtopic which needs constant updating. In the programming languages, we need to update the programming example, style of teaching the topics always.

The most significant reason of these difficulties is in the fact that, the multimedia courseware development and teaching with this multimedia courseware are two different aspects and we are forcing the teacher to become multimedia courseware developer.

In order to develop the multimedia courseware for e-learning as well as self paced learning, we need to develop the courseware professionally with the help of industry and utilize it in the actual teaching and learning process.

6. Developing Courseware with Industry

The problems in the development of multimedia courseware of programming languages can be solved by introducing the industry-academic partnership in the development of these courseware. This partnership will enable us to get best of both the worlds.

The development of the courseware can be performed by the industry experts while, the contents of the courseware will be described by the expert persons from academic institutions.

The courseware is one type of software. It is not needed as a whole at a time. It can be delivered in parts also. These parts may be developed independently based upon the topic list of the subject. This will also enable the developer to upgrade a part of the courseware system at a time as well as whole team can work in parallel on the whole project.

The developers have expertise in using the latest software development tools. As such less time is needed to develop the courseware as compared to that of the time taken by the teacher to develop the courseware.

The structure of the courseware, contents, illustrations, examples can be depicted by the teacher. Developer can utilize this information and the teacher's experience in the development of the more effective courseware.

The partnership can be based on a business model. The business model may involve the production and marketing of standard quality courseware. The academic institutes will get their share in the financial aspects.

7. Benefits

Student is the focal point of all the teaching learning processes. The multimedia courseware development for e-learning and self paced learning of the programming languages and its direct use by the teacher while teaching the subject will result in the better understanding and more exposure to the students.

Apart from this direct benefit many other possible benefits are –

- Better and production quality in multimedia courseware as it is developed by industry experts

- Better quality of educational contents as the content is developed by the experts from academic institutes

- It will improve the collaboration between industries and academic institution

- Increased number of programming examples can be possible since a team is working on the development, not only a teacher

- Industry can make collaborations with many academic institutes which will result in more

detail and better quality of technical and educational contents in the courseware.

The industry can constantly work on the development of the courseware; producing more effective and high quality courseware.

The development time needed for the courseware development will be much less than that of the time taken by the development within academic institutes.

A faculty can be involved in the development of more than one courseware; which was difficult with the development within the academic institutes.

As the courseware is in the form of a multimedia presentation product for e-learning, it can be marketed. This will result in revenue generation for the academic institutes.

The multimedia courseware will also be available for the other people outside the academics.

The other people which will use the multimedia courseware for self learning and not involved in academics, can avail the excellent faculty indirectly.

This system will produce the courseware which will be suitable for the distance as well as continuing education

This approach is so beneficial that its application in other areas will also result in better quality learning material.

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8. Conclusion

Multimedia courseware is the most important aspect of teaching programming subjects. This courseware can be developed by the teacher himself, but this will not produce production quality courseware. The academic collaboration with the industries in the courseware development will result in production quality, better courseware. This courseware will be in the form of self learning package. It will be beneficial for the people who want to avail good faculties and learning facilities.

This collaboration of industry and academic institutes will improve the penetration of distance and continuing education of computer programming languages.

This approach will be beneficial not only in programming subjects but all other courses also.

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Requisite Information Collaboration and Distributed Knowledge Management in Software Development

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Abstract

The paper suggests a framework advocating an integrated approach to software development stipulating the interconnection between Design, Organization and Business value networks (DOB). These three focus areas span collaborative development processes applying a range of facilitating tools, including distributed knowledge management product state models. The paper draws upon a series of discussion with Scandinavian IT Group (SIG). With an interest in how performance in their new organization develops SIG invited the research group to study measures of organizational performance and the use and effect of knowledge management tools in software development. The paper does not represent the viewpoint of SIG but outline our framework and major research questions. The paper is a research in progress contribution.

1. Introduction

Upon explorations within an action research framework in a software developing company the objective of this project emerged as a contribution to knowledge management enhanced vigilance and flexibility in software development upon further “Studies in Requisite Information Collaboration and Knowledge Management” (SIRICUM). Action research stipulates that researcher and practitioner have a common interest in addressing a select set of problems expecting to find how the company may better take advantage of resources, tools for project management and for distributed collaboration, developing fitting and efficient knowledge management practices. Knowledge management methods, mechanisms, and practices are captured in a framework, DOB (table 1) for analyses of integrated development processes.

1.1 Case Company: Scandinavian IT Group

Scandinavian IT Group (SIG) with 45 years of experience in building complex and business critical systems specializes in the development, maintenance, integration and operation of IT-solutions for the international airline industry, as well as for other service-oriented businesses, committed to continuously seek new ways for these industries to improve their overall performance.

SIG (www.scandinavianit.com) employs more than 1300 people and has a turnover exceeding USD\$ 200

Million. SIG has developed more than 600 business solutions for the airline industry covering all core processes of an airline, ranging from management and planning activities to ticketing, check-in and aircraft handling, and delivering cost savings as well as expanded airline customer services. In particular, SIG delivers airport and enterprise solutions. Airport solutions vary from mobile self-service applications to security and airport administration solutions. The enterprise solutions seek to support basic enterprise functions fitting the client organisations' needs technologically and financially. Within infrastructure management SIG delivers world record-breaking service levels for mission critical non-stop operations on all major platforms and advanced desktop, messaging, helpdesk and support services.

2. Positioning the Research

Inspiration derives from a decade long research at Carnegie Mellon University where the “n-dim” group pursued in particular, information flows in product development in engineering manufacturing and recently has taken up their ideas in the context of workflow management systems and computer support for cooperative work applying the concept of information spaces for new product design teams (see: <http://www.ndim.edrc.cmu.edu/paperstop.htm>). This group has stressed the importance of participant action research as a necessary approach to develop models of information and knowledge management in relation to design and development. Their studies in product manufacturing engineering may not carry over to software design but may offer relevant lessons on design teams in product development and their collaboration with other units in the company (e.g. engineering services support, development and research support). We suggest an extended model to the n-dim incorporating distributed knowledge management within the business value network. Further, we also study the information flow (as one type of workflows) and how to conceive of knowledge workflows and (other) collaborative workflows (Majchrzak et al 2000).

Another inspiration we draw from studies at Trento University where a group of researchers supported by European funds is studying the implication for architecture and technologies if adopting a social and subjective rather than an objectivistic epistemology of knowledge (Bonifacio et al 2002). They explore the

enterprise portal as a distributed knowledge vehicle contingent upon a context description language with partial mappings between the local community (the team) and the organization wide context using links to semi-automatically map the one on the other. To overcome problems and limitations of simple matching this group suggest communication protocols to implement meaning negotiation between autonomous software agents. To bridge organizational units a broker is suggested to enhance the ability of a team to exchange knowledge across semantic boundaries. Like the n-dim group the suggestions of vehicles to cope with complex social interaction are confined relatively to the work group (design team) whereas the wider organizational universe is treated as a homogenous (outside) group.

In Denmark, our long running tradition on socio-technical studies has been complemented with studies in software process improvement using the standard capability maturity model (CMM) (e.g. Mathiassen and Sørensen, 1996, Kautz et al. 2001). Another line of research is knowledge mapping where identification of who-has-what-knowledge takes precedence over information and knowledge workflows (e.g. Eppler 2001, Nielsen and Pries-Heje 2001/2002).

3. Research Method

In our framework we expect to move beyond the technology-for-all issues of knowledge management in enhancing efficiency and effectiveness in software development where collaboration takes the form of participation, cooperation and partnerships. We employ a principle of inter-disciplinary teams of researchers each with a focus on the process-structure dualisms related to our framework.

Research will apply tools to capture and measure the organizational developments to discover ways of working and collaborating within SIG in using the RUP methodology and other support tools learning how the organization explore business opportunities and fulfil customer requirements.

From observations and data on workflows, ways and means of collaboration, and information flows within “groupings” (i.e. teams, organizational units, projects and subprojects) at SIG we develop four studies described below. To increase the value of each study we coordinate our research within the DOB framework and develop suggestions how to explore and exploit knowledge management issues and opportunities to enhance organizational learning, flexibility and adaptability.

The DOB Framework	Conditions	Process	Performance Objectives
Design	Resources Structural and process conditions	Project management Participation Goal achievement	Operational effectiveness
Organisation	Entrepreneurship Commitment Ownership	New services Decision support Coordination	Process effectiveness
Business Value	Purpose Finance Business Partners	Assets management Form of competition Partnerships	Business effectiveness (profitability)

Table 1: The DOB Framework.

The table reflects processes of application development present in all software engineering though not always highly integrated. We do not consider design, organization and business value network as stages in development but as relationships decisive to improve the business value of software engineering processes by collaboration based alignment of units responsible for the software development where software is both product and process to the designers, to the implementers as well as the end-users.

The research group collaborates with SIG management in developing appropriate interventions and experiments in using tools and in applying principles derived from our studies. On workshops and seminars with SIG we will discuss findings on organizational performance and develop suggestions of new knowledge management tools, guidelines and organization as part of the overall action orientation. Finally, we will develop our framework as a research synthesis along with other research findings.

4. Research Contribution

Competitive advantage from innovative application development requires an integrated framework for software engineering.

Our research questions are the following:

- A: How to apply workflow models for distributed design activities using collaborative tools in a virtual organization?
- B: How can pre-requirement specifications be enhanced by business value network methodologies?
- C: How does the methodology of workflows and knowledge flows reaching into the business value proposition contribute to software design processes?
- D: How do distributed knowledge management models add new insights and understanding to our methodologies and models of development of software?

The relations and interactions between the three focal objectives condition collaboration processes and tools.

Beneath, we outline our research questions.

4.1 Question A: The Design Process

We will look at the *design* process as a *participatory* process with distributed knowledge and information workflows reflecting development activities in a virtual organization.

Workflows with distributed activities have been used for many years as buying, production, selling, logistic, and management often are distributed activities usually manually supported by computers' information processing. Today distributed activities forming inter-organizational systems require integrated applications in business value networks. Many different transaction models have been proposed as a tool to manage requisite information workflows trying to relax the ACID (Atomicity, Consistency, Isolation and Durability) properties in order to get better performance, parallelism, and availability (Frank 1999, Frank & Zahle 1998).

In coping with ACID properties in design, we will explore how CSCW systems and workflows support distributed software engineering and knowledge management. How are relaxed ACID properties used in innovative solutions to requisite information interchange within collaborative design processes (Majchrzak et al 2000)?

The design process is collaborative taking advantage of tools (e.g. e-mail, conference systems, web-sites, document sharing, subject catalogues, keywords) vital to the progress and coordination between groups of developers and users. Successfully to choose and implement appropriate groupware in distributed collaborative settings implies getting distributed groups to collaborate on select, relevant issues in their work, which we position also as a knowledge management issue focusing on distributed development organizations.

4.2 Question B: The Organization Process

The relation between *design* and *business value network* emerges from the perspective of strategic alignment, which, in its current form is constrained by the fact that IT-designers - and in particular IT-design projects - rarely have the mandate to develop or to critically examine and evaluate business related IT-strategies.

The challenge, how to get designers into business process modelling and how to get business consultants into design, has rarely been realized though often been advocated. In a deductive and linear system development approach business objectives have been transformed into requirement specifications with little reference to business value opportunities. Adoption of a pre-assessment approach (e.g. MUST, see Bødker et al 2000) with enhancements of performance-based procurement measures transform the relationship between design and business value networks, if properly supported, into a multi-dimensional framing of efficiency and effectiveness of software development processes.

The research questions addressing these issues include

which characteristics of value may be defined, and to what extent and how are these characteristics of value supported in the development process?

4.3 Question C: The Business Value Network

A study of relationship between *organization* and *business value networks*.

Development of business value networks requires value measures and to link these to the design of software using models and methodologies. Within a distributed knowledge framework these values would reflect various patterns of knowledge representing emergent and maintenance spaces and types of knowledge, cf. figure 1 (Davis et al 2001).

In previous research a product model methodology has been suggested as a mechanism to interrelate business value, application development and *design*, addressing exchange of emergent as well as maintenance knowledge and exploring how product model development processes may strengthen both value networks and organization of information systems development (Pedersen and Larsen 2001, Pedersen 2002).

Models Supporting Knowledge Exchanges of Emergent and Maintenance Knowledge

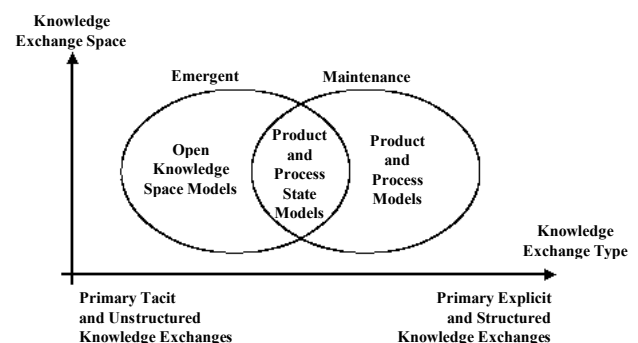


Figure 1: Models Supporting knowledge Exchanges of Emergent and Maintenance Knowledge.

In relating product models to workflows (cf. Larsen 2003), a synthesis of process and product models may be explored proposing a knowledge management tool for quality assurance in SW development and fulfilment processes.

In the DOB framework development processes are distributed, so we need to research if a product model approach is valid across several contributing business lines and business partners. How to integrate the stakeholders in a product model at the level of both transactions and knowledge exchange represents both a practical and a theoretical challenge extending the question how knowledge management systems support communication and analysis in design teams (Gray 2001).

4.4 Question D: The Integrated Software Development Framework

This research question focuses on our very framework. It is the ambition of the researchers to learn from practices in SIG, eventually to suggest a range of approaches and tools in an effort to enhance software engineering quality, systems development and collaboration between participants while attending to business value networks. The framework ignites a range of activities broader in scope than most design projects, yet required in application development for business networks. We will explore iterative and recurrent activities across design, organization and business value networks (Simonsen 1999).

Moreover, we will epistemologically test the framework parameters to evaluate the robustness of the framework. In our action research issues found in practice will inform our synthesis with the ambition to generate positive performance effects in practice.

5. Perspectives

The four issues have been described in terms that reflect both questions of design, organization and business since we perceive these as highly interrelated and therefore to be studied in close connection.

Though guided by the DOB-framework the research activities will reflect back upon this framework inspiring revisions and suggestions. From the project activities studied at SIG we will add new mechanisms to help specifying the framework making it more useful and powerful to both practice and research. How far does the framework take us towards an integrated methodology? By which mechanisms and tools does the framework come alive to customers, managers, users, developers and designers? And how do we as researchers ourselves take advantage of the framework in designing and implementing our research?

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Building a Value Model of CRM system through Value-focus Thinking and QFD

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Abstract

Customer Relationship Management (CRM) is increasingly important since the emerging of electronic commerce in the past years. However, most of the current researches that deal with the decision-making problems of CRM system investments are from the perspective of the information technology adoption and organizational innovation. It is still very difficult for enterprises to measure the value of CRM systems and the subsequent decision-making on adoption priority of various CRM functions. Based on the Value-focused thinking and Quality Function Deployment (QFD) process, this paper developed a multi-layered transformation matrix, and proposed a measurement process that can be driven to a quantified value model. In order to verify the effectiveness and feasibility of the model, twelve CRM experts were interviewed including senior managers in leading management consulting companies, CRM system providers, and market researchers. Following the on-site interview, a questionnaire survey was conducted with 1000 firms in the list of the Common Wealth top 2000 firms of Taiwan. The analysis result based on 188 valid replies indicates that the outcome of the proposed value measure model has significant correlation with the investment intention of CRM systems.

1. Introduction

The widespread internet technologies and e-commerce applications create a great opportunity for business organizations to communicate with their individual customers at a much lower cost than the past. Companies recognize that Customer Relationship Management (CRM) is essential to business today. According to the CIO research reports of CIO.com in 2002 [6], approximately half of the 224 survey respondents have already implemented or are in the process of implementing CRM. "CRM is the future," said one CIO surveyed. "It is necessary to stay competitive."

The CRM technology market is rapidly evolving, and new technology advancements in e-mail response, data management, business intelligence, personalization, and profiling are happening all the time. The Internet challenges firms to create compelling customer experiences and tap new efficiencies. More and more

companies try to use customer service as a competitive weapon and put heavy investment in CRM systems. Unfortunately, Nucleus Research [21] has found that one in eight CRM deployments fails to achieve a positive ROI, and the biggest barriers to a positive ROI are launching a project without attainable business objectives and investing too much time or money in a solution.

Just like most of the IT investment, most of the current researches focus on technical-economic view of CRM adoption in reducing transaction costs, streamlining process efficiency, and getting competition advantages. Unfortunately, many CRM applications are priced based on vendors' internal revenue targets – and not on the value the solution provides. [21]

How companies evaluate their CRM needs and the value of CRM systems? "Conventional approaches to decision-making focus on alternatives." Keeney [11] argued in his book: "Values are more fundamental to a decision problem than are alternatives. Alternatives are the means to achieve the more fundamental values." Keeney illustrates the concepts and procedures of "Value-focused thinking" and various selected applications that including the choice of NASA space missions, transporting nuclear waste, research on climate change, air pollution in Los Angeles and design of integrated circuit testers. This methodology is also applied to the complex strategy decisions of British Columbia Hydro, Power Authority [12] and the internet commerce [13].

Keeney measured the value of e-commerce to the customer through "Customer Values." He interviewed over one-hundred individuals about all the pros and cons of using e-commerce that they experienced or envisioned. The results were organized into 25 categories of objectives. These categories were separated into 16 means objectives and 9 fundamental objectives used to describe the bottom line consequences of concern to customers [13].

The present study extends Keeney's methodology and creates the value model for CRM system that including two dimensions—customer values and business values. Through value-focus thinking and QFD, This paper also develops an actionable process to measure the CRM systems value.

2. Develop the value Model of CRM system

Customer value analysis is the start point of marketing research [10]. Businesses frequently use the concept of a value proposition to characterize the combination of end-result benefits and price to a prospective customer from purchasing a particular product or service [13]. It is also important to one to one marketing and business management [1][16].

Keeney's approach shows the way to measure the customer value of a product or service. For CRM systems, we need to consider not only just the end customers but also the organizations adopt the CRM systems. The business firms or organizations are the final decision maker of CRM system investment, not end customers.

"Who will benefit from CRM system?" Almost all of the people interviewed by the authors would agree that both the customers and the businesses that invested CRM system should be benefited. The values of CRM system to business is named as "business values" of CRM system in this paper. For the business value, we define it as the value proposition to characterize the combination of end-result benefits and price to a prospective business organization from purchasing a particular CRM system.

A common value model is the additive value function. We define the customer value of CRM is the sum of the value to end customers and the value to businesses.

$$V_{CRM} = V_{Customer} + V_{Business} \quad (1)$$

The equation (1) is very simple and straight forward. But the question is how to measure customer values and business value of CRM systems. Since the CRM system functions should meet customer needs, and create benefits to business through CRM processes and system functions for lower operation cost, streamlining process efficiency and increased sales or profits. Quality Function Deployment—QFD will be the idea methodology to convert the fundamental customer values to the necessary CRM processes and CRM system functions, and finally the benefits to businesses.

Since 1966, Quality Function Deployment (QFD) has been used world wide in every industry and sector to: prioritize spoken and unspoken customer needs; translate these needs into technical characteristics and specifications; build and deliver a quality product or service. Hauser and Clausing illustrates the QFD process is a chain of "What" and "How" conversions and translations. It will end up to a completed "House of Quality" [9]. In order to build the "House of Quality" and get the fundamental business values of CRM system, we need to link the customer needs to CRM processes and then convert the processes to required CRM functions. Figure 1 illustrates the process of these conversions. There are three steps (or three levels in the "house of quality"):

1. Link the customer needs (the customer values or fundamental objectives) to the means that businesses used to satisfy customers (the means objectives).
2. Convert the means objectives to related CRM processes.

3. Convert the CRM processes to related functions of CRM system.

Before we start to implement these steps, we need to understand the various deployment factors in above QFD process.

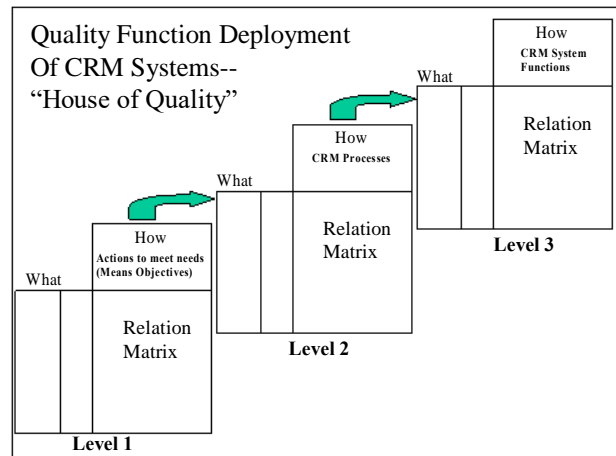


Figure 1 QFD process for CRM system

2.1 Customer values

"The best way to find out the customers value is to ask them." Keeney uses concepts of value-focus thinking in three steps [13]:

1. Develop a list of customer values,
2. Express each value in a common form,
3. Organize the values to indicate their relationships.

The results are a set of means objectives and a set of fundamental objectives. The fundamental objectives also provide the foundation for developing a quantitative model of customer values.

Base on the research result of Keeney, the authors collect other 8 papers regarding the customer values of product or service, and summarize the customer values into 8 fundamental value categories (fundamental objectives) in Table 1 [4][5][7][8][10][13][14][18].

Table 1 Fundamental customer values

Reference	13	7	8	14	18	5	10	4
Customer values								
Offer multiple services		√			√		√	√
Assure reliable service		√	√			√		
Minimize cost	√		√		√			√
Minimize time spend	√	√	√	√	√	√	√	√
Maximize service hours		√			√			√
Maximize convenience	√	√					√	
Maximize safety	√	√		√				
Maximize personal service			√			√		√

According to the approach of Keeney's value-focus thinking, these 8 fundamental objectives is defined as the customer value of CRM system and will be used in the first level of QFD (see appendix 1). The 16 means objectives developed by Keeney are reviewed and are used for presenting the action of businesses to meet

customer needs.

2.2 CRM processes

Peppers et al. [16] explain the four steps in the implementation of one to one marketing, which including Identify, Differentiate, Interact and Customize. The first two steps are the process of internal analysis of businesses. The other two processes are the implementation processes. For step one, enterprises need to define the target customers and record the custom, preference and shopping behavior. Step two is using 20/80 rule to find out the most profitable group of customers. It is very important to treat them differently so that the company can keep the customers and make more profits. Step three is to establish the interactive and automatic communication channel with customers. Enterprises can deliver timely information to customers and communicate with customer efficiently. Finally, enterprises should customize their products, services or even company procedures according to the differentiation of customers.

Srivastava et al. [19] define three core business processes in marketing: Product Development Management, Supply Chain Management and Customer Relationship Management. They further explain the detail processes of CRM including the eleven tasks. The other five articles regarding the CRM processes are reviewed [2][3][16][17][19] [20]. The summarized result is shown in Table 2.

Table 2 CRM Processes

Reference	19	17	16	3	2	20
CRM Processes						
Identifying potential new customers	√	√	√	√	√	√
Determining the needs of existing and potential new customers	√	√	√	√	√	√
Learning about product usage and application	√			√	√	
Developing/executing advertising programs	√				√	√
Developing/executing promotion programs	√				√	√
Developing/executing service programs	√				√	√
Developing/executing sale programs	√				√	√
Acquiring/leveraging information technology/system for customer contact	√	√	√	√	√	√
Managing customer site visit teams	√				√	
Enhancing trust and customer loyalty	√	√	√	√	√	√
Cross-sell and up-sell of product service offerings	√					√

In the step 2 of QFD process, the means objectives are converted and linked to the CRM processes (see

appendix 2).

2.3 CRM functions

There are many CRM system providers in the market. The functions of those CRM applications are different. Since there is no unique definition of CRM system, it is very difficult to get a complete list of CRM functions. According to the research report published by Marketing Intelligence Center (MIC, the leading market research institution at Taiwan for high-tech industries), CRM system can be classified to customer interaction system and customer relationship planning system. Customer interaction system can help enterprises to collect customer intelligences through different contact channels (face to face, telephone, web and call center). The customer relationship planning can analysis customer data (data mining) and optimize the customer relationship to increase sales/profit and enhance campaign management. Data mining, Online Analytical Processing (OLAP), interactive web page, Computer Telephony Integration(CTI), Automatic Speech Recognition(ASR), Interactive Voice Response (IVR), Automatic Call Distributor(ACD), Private Automatic Branch Exchange (PABX/PBX), Voice Over IP (VOIP) are various technologies and functions in CRM applications (see Figure 2 and Figure 3).

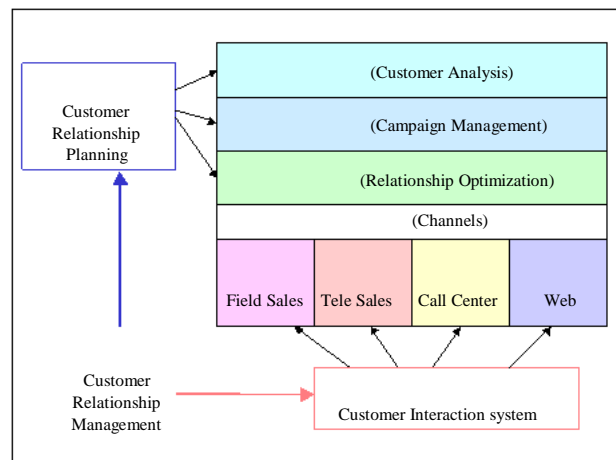


Figure 2 QFD process for CRM system

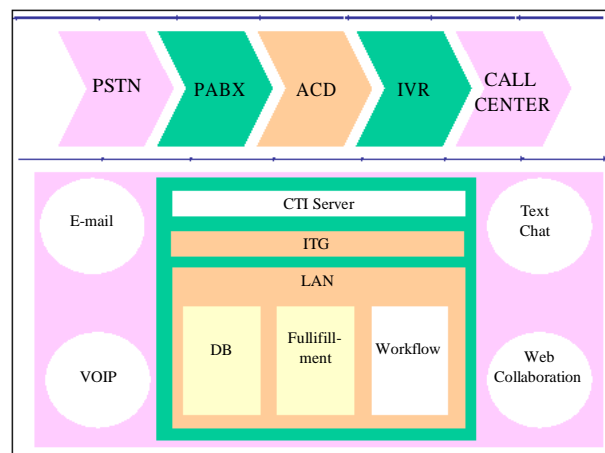


Figure 3 Technologies and functions in call center

Some of the CRM system providers divided their system functions into three areas: sales force automation, marketing automation, Customer-service automation. This definition encourage more software companies convert their conventional business software to the CRM applications. The increased CRM market competition makes the survey of CRM functions more difficult.

With the help from 3 CRM market researchers, this paper survey the product features of 11 CRM system providers including Oracle, eGain, ServiceSoft, ServiceWare, Primus, Quintus, AskJeeves, Kana, BrightWare, PeopleSoft and AKuP. 21 CRM system function categories are summarized in Table 3. In the step 3 of QFD process, the CRM processes will be converted and linked to the CRM functions (see appendix 3).

Table 3 CRM Functions

Web based Service	Help Desk for Service Agents	Sales/Marketing Support
Member Registration/ Identification	Sales Order Management	Market Research Support
VOIP	Customer Profile Management	Support New Product Development
On-line Chat	Data Analysis (Data Mining)	Promotion/Campaign management
Email reply management	Workflow for service agents support	Support Tel-sales Management
Email Auto Reply system	General database information search	Support Direct Sales Management
Web self-service	Customer service Knowledge database	
On-line help (search engine)	Service Agents Performance management	
Sales Automation (Web sales)	MRO service, scheduling and control	

3. Building the value model

The three QFD steps are conducted by authors through the interviews with 12 people with different CRM expertise (see Table 4). The purposes of the interview are:

1. Review the whole process to make sure it is effective and feasible.
2. Verify the completion of the list in customer values, means objectives, CRM processes and CRM functions.
3. Implement the QFD process with the help from independent CRM experts to build a generic value model for empirical study.
4. Follow up Keeney's value focus thinking methodology to covert the 21 CRM functions to fundamental objectives of business value.

The value model and processes are fine tuned according to the comments from those CRM experts. All the forms used in QFD and value-focus thinking are

reviewed and verified. No major defects are found.

Table 4 interviewed CRM experts

Classification	Area of expertise	No of people
Senior managers in leading consulting firms	CRM consulting	2
Senior managers in Market Research org.	market and technology trend research of CRM	2
Senior business managers in finance and telecommunication	CRM system users	4
Senior managers of technology provider	CRM technology provider	2
Senior managers of application provider	CRM application provider and integrator	2

Figure 4 explain the process to evaluate the CRM system through the value model. Enterprises can use the forms in Appendices to measure the CRM customer values and convert the customer needs to CRM business values through Value-Focus Thinking (VFT) and QFD methodology. Different companies might have different relationship matrix and weighting in three levels of QFD. This will enable the firms to build their own value model for their own and meet the needs of different industries.

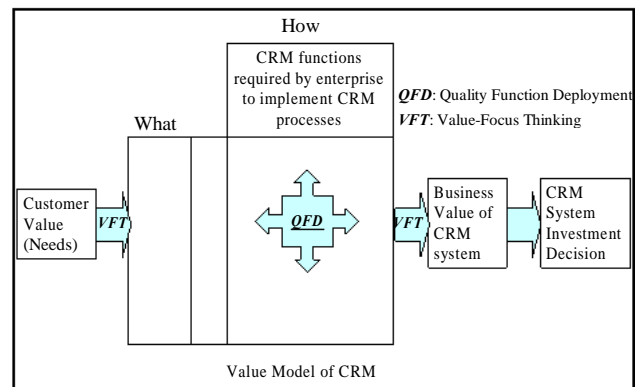


Figure 4 Implementation of VRM Value Model

The value model can provide the foundation for developing a quantitative model of CRM system values. Keeney develop an equation to quantify the customer value in his paper published in management science. Let O_1, \dots, O_n be the set of n fundamental objectives of a specific product or service. For each objective O_i let X_i be a measure that describes the product or service with respect to O_i and let x_i be a specific description. The vector $x = v(x_1, x_2, \dots, x_n)$ provides a description of the product or service and the process to obtaining it. The customer value can be quantified as:

$$v(x_1, x_2, \dots, x_n) = \sum_{i=1}^n k_i v_i(x_i) \quad (2)$$

Where k_i is the weight that indicates the relative priority of objective O_i and v_i is a scaling of the relative desirability (i.e., value) of different values of O_i . During the process of QFD, the importance is the weight that

indicates the relative priority of deployment factors. The weight accumulation and conversion in QFD process could be very helpful to decide k_i for each value factor. The equation of business value is similar to the equation of customer value, but the fundamental objectives (value factors) are different. The business value can be quantified as:

$$v(y_1, y_2, \dots, y_n) = \sum_{j=1}^m k_j v_j(y_j) \quad (3)$$

The value model we defined in equation (1) can be further developed to the following equations:

$$V_{CRM} = \gamma V_{Customer} + (1-\gamma) V_{Business} \quad (4)$$

$$V_{Customer} = v(x_1, x_2, \dots, x_n) = \sum_{i=1}^n k_i v_i(x_i) \quad (5)$$

$$V_{Business} = v(y_1, y_2, \dots, y_n) = \sum_{j=1}^m k_j v_j(y_j) \quad (6)$$

Where γ is the relative weight of $V_{Customer}$. Since there are only two components in V_{CRM} , the relative weight of $V_{Business}$ is $(1-\gamma)$.

4. Design of research framework for empirical study

The main objective of this study is to create an actionable process to measure the CRM system values and help enterprises to make decisions regarding CRM system investment. The above building processes and value model should be able to apply to different companies in different industries. In order to verify the validity of this value model, following the on-site interviews with the CRM system experts and users, an empirical study was designed and conducted.

The hypotheses of the empirical study are illustrated in Figure 5. The independent variables X1 and X2 are the two dimensions ($V_{Customer}$ and $V_{Business}$) of CRM value model developed by this study. There are 8 factors of customer values which are shown in Table 1. These 8 factors are measured by requesting the respondents to answer their perceived importance of each fundamental objective on a 5-point Likert scales. Both CRM experts and the pre-test result of survey suggest that CRM functions will be easier for people to compare the relative importance for business values measurement. $V_{Business}$ is measured through 21 CRM system functions (see Table 3) instead of 10 fundamental objectives of business values. These 21 factors are measured by requesting the respondents to answer their perceived importance to their business for each CRM function on a 5-point Likert scales.

The dependant variable Y is the evaluation result of

CRM system. It is measured by the intension of investment on CRM system (i.e. the possibility of investment). Z is the possible moderator that might affect the validity of CRM value model developed in this study. We define Z as the industry of the respondents' enterprises. The classification of the industry is based on the industry code defined by Common Wealth in the annual survey of top 2000 companies at Taiwan.

The validity of the value model will be verified through the test of three hypotheses:

- H1: The investment possibility of CRM system is highly correlated with customer values.
- H2: The investment possibility of CRM system is highly correlated with business values.
- H3: The positive effect of customer values and business values on the investment possibility of CRM system is consistent for different industries.

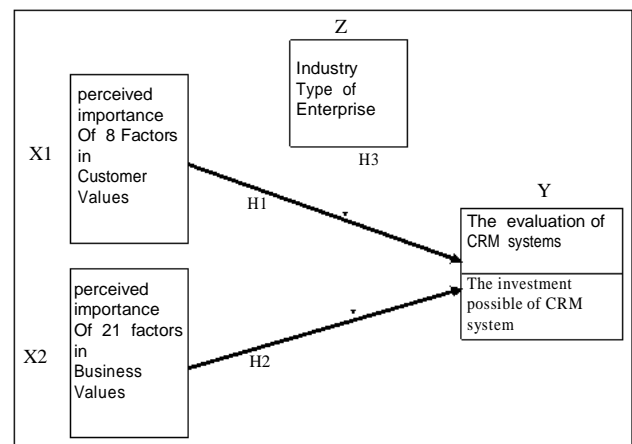


Figure 5 Hypotheses and model of empirical test

5. Results of empirical study

The survey instrument was developed to fit the study based on the literature search, previous interviews with 12 CRM experts and a pilot test. The sampling frame includes a wide range of industries such as computers, electronics, mechanical, automobiles, chemicals, pharmaceuticals, etc. A stratified random sample of 1000 firms was chosen from the database of Common Wealth top 2000 firms of Taiwan. The questionnaires are sent to the managers who are responsible for, or highly involved in evaluating CRM system investment decisions. Two hundred and fifty three questionnaires were completed and returned (25.3% overall responses rate). One hundred and eighty eight questionnaires are usable (18.8%) after eliminated the invalid questionnaires due to missing data.

The Cronbach's alphas of construct X1 and construct X2 are 0.8963 and 0.8013. They are all above 0.70 and demonstrate adequate internal consistency [15]. A series of exploratory factor analysis were employed for the multi-items to further purify the measurement indicators. The method of principle components in conjunction with the latent root criterion, which demands factors with eigen values greater than 1 to be considered significant, was the technique for extracting factors. A cutoff value of 0.5 was

adopted as criterion for screening significant factor loadings. The results were listed in Table 5 and the construct validity is verified.

Table 5 EFA (Principal Component Analysis)

Comp.	Eigen Value	Factor Items	Factor Loading
1.786		Offer multiple services	.644
		Assure reliable service	.637
		Minimize cost	.764
		Minimize time spend	.733
		Maximize service hours	.753
		Maximize convenience	.736
		Maximize safety	.786
		Maximize personal service	.639
1.637		Member Registration/ Ident.	.646
		VOIP	.623
		On-line Chat	.732
		Email reply management	.760
		Email Auto Reply system	.804
		Web self-service	.779
		On-line help (search engine)	.708
		Sales Automation (Web sales)	.781
		Sales Order Management	.712
		Customer Profile Management	.808
		Data Analysis (Data Mining)	.812
		Workflow for service agents	.798
		General database search	.844
		Service Knowledge database	.804
		Service Performance mgmt.	.850
		MRO scheduling and control	.754
		Support New Product Develop.	.807
		Promotion/Campaign mgmt.	.771
		Support Tel-sales Mgmt.	.767
		Support Direct Sales Mgmt.	.791
		Support New Product Develop.	.762

When $\alpha=0.01$, the correlations among independent variables and dependent variables are highly positive (see Table 6). The positive correlations are consistent across industries. The 188 valid questionnaires covered 16 industries. Since the distribution of the samples in different industries is not the same, the number of samples in several industries is less than 5. A Median Test is conducted to verify the hypotheses H3. The median test result shows $p=0.25$ is higher than $\alpha=0.01$ (see Table 6). This test result confirmed that different industries had same distribution possibility on the CRM investment possibility. The numbers of samples in different industries did not affect the validity of correlation analysis.

Table 5 Correlation Analysis

Independent Variables	CRM investment possibility	
	Pearson Correlation	Sig. (2-tailed)
Customer Value	0.67	0.00
Business Value	0.73	0.00

Table 6 Median Test

The possibility of CRM system investment	
N	188
Median	1.00
Chi-Square	18.32
df	15.00
Asymp. Sig.	0.25

6. Conclusions

The main contribution of this paper is the actionable process to measure the CRM systems value. Different companies can follow the above building processes and create their own value model. Through the value-focus thinking and QFD methodologies, enterprises can understand their customer better and find out the customer values of their product or services. There are several important potential applications of the proposed model: it can help the firms to evaluate the CRM system investment, and it can be used as a decision making tool for adopting priority of various CRM functions as well as for improving the customer management processes.

For academic research, it is still a long way to create a complete value model and to prove the effectiveness of the value model. The equations (4),(5) and (6) could be further developed to compute based value evaluation system. There is not solid theory development and test for the value model and the building process. This study is just a start point. More empirical researches or case studies might be helpful to further develop the research framework.

7. Appendices

Due to the size and format issues, the appendices are attached after references.

Appendix 1- Level 1 of the house of quality

Appendix 2- Level 2 of the house of quality

Appendix 3- Level 3 of the house of quality

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Appendix 2 Level 2 of the house of quality

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Prototyping for an E-Learning System of Organizational Procurement

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Abstract

This paper attempts to integrate concepts of framing, uncertainty expression, and negotiations to build a framework for influencing factors of pricing for organizational procurement and empirically explore it. System requirements based on the framework is analyzed by UML in building an E-Learning simulated system for novices of purchasing via hints from knowledge collected from veterans of procurement. Framework for negotiation of organizational market is built based on literature review of organizational negotiation and in-depth interviews with several top procurement representatives of Taiwanese high technology companies. Popular verbal terms using in purchasing area for possibility frequency and quantity are collected and analyzed, hypotheses for subjective estimation vs. verbal expressions under different types of market conditions, distributive bargaining vs. integrative negotiation, and risk choice framing are tested. The quantitative and qualitative data are collected to construct a verbal model for managerial decision-making on the organizational market. Findings on patterns of verbal expression among purchasing personnel with different backgrounds and risk attitudes might be useful for building a data bank in e-negotiation between buyer and seller. Also the relationship between framing, personal risk attitudes and efficiency and preference of pricing decision for an organizational procurement are proposed to assist the trades between industries.

1. Introduction

In the past years, many organizations have tried to expand or broaden their supply chains in e-marketplaces. Transitioning from traditional organizational markets approaches to an e-business model and adopting new technology present many organizational challenges. Building an Internet infrastructure and attracting more participants initially may not ensure the longevity of an e-marketplace. Risk attitude of purchasing personnel in a company, verbal expression and framing used for communication between buyer and seller are concerned as influencing factors during an organizational procurement.

Subjective verbal expression usually used to substitute digital variables during trade negotiation. Study of subjective verbal expression and framing become very important issues as the traditional organizational market move to electronic commerce via internet. Therefore, this research tries to cover the findings of studies on organizational procurement, personal risk attitude,

personal verbal expressions, framing and decision theory. The research methodology is comprised of three approaches:

- (1) Literature review for building a research framework in organizational procurement.
- (2) Interviews with top-level executives in some leading Taiwanese companies engaged into organizational procurement to validate and justify the Research Models.
- (3) System requirements based on the framework is analyzed by the Unified Modeling Language (UML) in building an E-Learning simulated system for novices of purchasing via hints from knowledge collected from veterans of procurement

2. Literature Review

Nicosia model, Howard-Sheth model, Engel-Blackwell model, Bettman information-processing model, and Andreasen model are descriptive theories and models that attempt to capture buying behavior. These models all share a similar list of six fundamental stages of the buying process. The stages are: (1) need identification, (2) product brokering, (3) merchant brokering, (4) negotiation, (5) purchase and delivery, and (6) product service and evaluation [11]. The merchant brokering stage combines the "consideration set" from the previous stage with merchant-specific information to help determine who to buy from. This includes the evaluation of merchant alternatives based on buyer-provided criteria (e.g., price, warranty, availability, delivery time, reputation, etc.). The major task of negotiation stage is how to settle on the terms of the transaction. Negotiation varies in duration and complexity depending on the market. In traditional retail markets, prices and other aspects of the transaction are often fixed leaving no room for negotiation. In other markets (e.g., stocks, automobile, fine art, local markets, etc.), the negotiation of price or other aspects of the deal are integral to the buying process.

Conflict can occur when the two parties are working toward the same goal and generally want the same outcome, or when both parties want a very different settlement. Multi-issue negotiation may produce mutual beneficial results to both negotiators while single-issue negotiation can not. However, there are difficulties in automating a multi-issue negotiation, since the search space grows dramatically as the number of issues increases. Although many concession strategy learning mechanisms have been proposed to deal with the problem, recent research uncovered that the fixed strategy of

concession and the fixed-pie bias are two major interferences in the automation of multi-issue negotiation [10]. In a single-issue negotiation, the term negotiated is limited to price. Most companies on the Internet are generally against it since it brings out price wars that not only causes chaos in markets but also ignores the importance of other issues such as warranty period and delivery time. Multi-issue negotiation is more beneficial comparing to single-issue negotiation [13].

Considerable research has examined the effects that alternative descriptions or “frames” can have on decision making- particularly how framing influences people’s preferences and choice for reviews [6, 7,16]. Frame that a decision-maker adopts is controlled partly by the formulation of the problem and partly by the norms, habits, and personal characteristics of the decision-maker [17]. According to prospect theory[4], outcomes are experienced as either gains or losses relative to a subjective reference point. Subjective value is predicted to be a concave function of utility in the domain of gains and a steeper convex function in the domain of losses. This S-shaped function implies risk aversion in the gains domain and risk seeking in the losses domain. In other words, prospect theory predicts that people would adopt the *final state* of affairs if nothing were done as their subjective reference point in response to prospects formulated as gains and they would adopt the status quo as their subjective reference point in response to prospects formulated as losses [8].

The traditional models of bargaining [15, 20] relied on the assumptions that the preferences and choices of bargainers’ could be explained by expected utility theory. The general results from these studies are that positively framed bargainers are more cooperative, more likely to settle, and receive greater profits and benefits than their negatively framed counterparts. In keeping with the prospect theory, framing has only an indirect impact on negotiator behavior through its affect on risk attitude. Murningham [12] noted that risk aversion is consistently advantageous only in situations of which settling involves a greater risk than not settling. The study of Schuur [17] confirmed that prediction. Other framing studies showed that positive framing was generally more advantageous.

The study of Bottom and Stud [2] integrate the findings into a more general explanation of the role of framing in bargaining. Framing determines risk attitude. The structure of the negotiation and the alternatives to settlement determine the effect of risk attitude on bargaining behavior and outcomes. Because of the conflict between distributive and integrative aspects of bargaining, negotiators come to a dilemma. Framing and risk attitude affect the approach negotiators take in dealing with the dilemma.

Verbal expression allows that replace digital expression with verbal vocabulary. To get the comparison between different expressions, the method employed was that of ratio scaling. The distinguishing characteristic of a ratio scale is that a true or absolute zero point can be defined; meaningful ratios can therefore be derived. Ratio

scaling uses magnitude estimation in which any value is assigned to a referent concept, and then all other stimuli are judged in relation to the referent concept. Magnitude estimation was employed to find the numerical equivalents of 39 expressions of frequency ranging from never to always, and 44 expressions of amount ranging from none to all [1].

On the attached form of Bass’s study [1], subjects are asked to assign a number to what he/she conceives “sometimes” to mean. Then, using the number which have assigned to “sometimes” as a standard, assign a number to each of the other words on the form indicating each word’ value relative to sometimes. Instructions used the referent “some” instead of “sometimes” when judgments of amount were to be made instead of judgments of frequency. The referent concepts “sometimes” (frequency) and “some” (amount) remained constantly throughout the experiment.

E-Learning is based on three fundamental criteria [14]:

- (1) Networkability: E-Learning is networked.
- (2) Web-based platform: it is delivered to the end-user via a computer using standard internet technology.
- (3) Integrated into a broader architecture of solutions: it focuses on the broadest view of learning-learning solutions that go beyond the traditional paradigms of training.

An E-Learning system will be a strategic business tool to increase business speed, flexibility, retention, and employee satisfaction. The E-Learning system provides a real-time and supporting learning environment for e-Business [3]. Because of traditional trainings can no longer cover all corporate trainings. Instead, E-Learning system will help to provide a more efficient way of delivering information and knowledge needed. Especially now many corporations adjust their paces to become learning organizations, what will most benefit them are knowledge and information.

In Ikujiro Nonaka’s study, the knowledge creation process is the conversion process between tacit knowledge and explicit knowledge [5]. By his definition, explicit knowledge can be expressed in words and numbers and easily shared. Tacit knowledge, such as subjective insights or emotions, is non-articulated, and embedded in contexts and actions. It is personal and hard to verbalize or communicate. Tacit knowledge, such as bodily skills or mental models, is rooted in an individual’s action and experience as well as in the ideals or values he or she embraces. In his SECI model, the knowledge creation process within an organization takes a spiral evolution form, which consists of four types of conversions.

Lin’s Study [9] developed the concept Internal Knowledge Evolution Network to describe the knowledge evolution framework. The study extracts four types of knowledge:

- (1) Comments or remarks on published works.
- (2) Guess or supposition to the solutions for project

problems Supposition.

- (3) Proof or confirmation on the guess or supposition.
- (4) Positive or negative comments or remarks on knowledge 1-3.

These four types of knowledge increase in the process and are dependence on each other. When linking with their context relationships, the knowledge fragments created inside team construct a directed network map. And along the direction of the arrows, pieces of tacit knowledge are continuously created based on previous knowledge, and converse to explicit knowledge.

3. Research Model

A research model for studying efficiency and preference of pricing decision for an organizational procurement is illustrated in Figure 1 based on the above literature reviews. Depth interviews with experts in the industry were employed to validate the research model. The personal variables for a purchasing agent include his/her risk attitude, purchasing ability, gender, age, education, working position in his/her company, and what kind of organization he/she is working on. There four operating variables are constructed in this research. (1) uncertainty expression is represented as verbal expression or digital probability to explore the possible relationship between them. (2) relationship between buyer and seller is divided as bargaining and cooperative. In distributive bargaining, the goals of the parties are initially at odds-or at least appear that way to some or all of the parties. In contrast, in integrative negotiation the goal of the parties are not mutually exclusive. (3) market status is classified as buyer dominated and seller dominated. While there are more firms to provide the same product in the trade, the market status is treated as buyer dominated. (4) framing is

classified as positive and negative. According to prospect theory introduced by Tversky and Kahneman [18], outcomes are experienced as either gains or losses relative to a subjective reference point. In this study, positive framing is designed as the selling price exceeds the average price in the market and negative framing is designed as the selling price is less than the average price in the market.

Purchasing agent's basic variables in this model are designed as follows:

- (1) Risk attitude is classified as risk seeking, risk neural or risk averse.
- (2) Ability of purchasing is classified as high or low.
- (3) Subject's Characters include gender, age which divided as 10 classes from 25 to 65; education is classified as high school, bachelor, master or Ph. D.
- (4) Working position is classified as manager or subordinate.
- (5) Organization is the company that a subject is working for.

A questionnaire built by Wallach & Kogan [19] is used to measure the general attitude of subjects face a choice with risk. The questionnaire contains twelve decision questions which are follow up twelve scenarios. The leading role in the scenario face of two or three probable for choose. One of the choices is attracting with lower probability to success and the other choice(s) reversed. Five methods of purchasing decision problems were adopted and shown as the form on Table 1, which were based on the reference point 35,000 and were coded to evaluate preference and performance of purchasing decision alternatives for each subject.

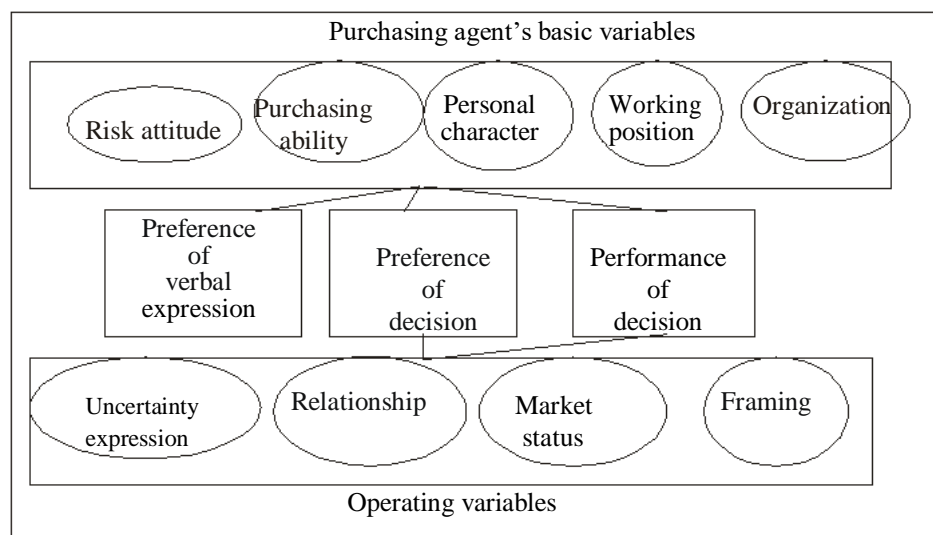


Figure 1. Research model

Table 1. Problem sets of purchasing decision alternatives

Method	Choice Problem	Explanation
I	A (39,000,80) B (38,000)	Scheme A has a higher expected value
II	A (39,000,20) B (38,000,25)	Scheme A has a higher expected value
III	A (41,000,45) B (38,000,90)	Probabilities of winning are substantial. Scheme B is the prospect where winning is more probable.
IV	A (41,000,001) B (38,000,002)	Probabilities of winning are minuscule in both prospects. Scheme A is the prospect that offers the larger gain.
V	A (41,000,25) B (39,000,25; 37,000,25)	Preference of Scheme B is in according with a value function that is concave for gains and convex for losses.

Table 2. Results of Chi- Square test

Scenario	χ^2	p	Result
Frame Method I	33.394	<0.001	Significant
Presentation Method IV	12.532	<0.001	Significant

Table 3. Frame - Method I

Frame		Method I		Total
		A	B	
Positive	Frequency	83	141	224
	Percentage	18.6%	31.6%	50.2%
Negative	Frequency	143	79	222
	Percentage	32.1%	17.7%	49.8%
	Frequency	226	220	446
	Percentage	50.7%	49.3%	100%

Table 4. Presentation - Method IV

Presentation		Method IV		Total
		A	B	
Verbal	Frequency	107	117	224
	Percentage	23.9%	26.2%	50%
Digital	Frequency	70	153	223
	Percentage	15.7%	34.2%	50%
	Frequency	177	270	447
	Percentage	39.6%	60.4%	100%

4. Experimental Results and System Requirements

16 different cases are constructed based on the four operating variables in the model. Pair of choice problems in Table 1 is a variation of Allais' example, which differs

from the original in that refers to real-life rather than to extremely large gains. To appreciate the significance of the amounts involved and the market information, note that the average price for a personal computer is about 35,000 NT dollars. Each method that this study selected has been designed with different outcomes and probabilities.

Five Taiwanese technology companies are selected to survey for validating the Research Model. The companies selected are International Semiconductor Technology Ltd., Koninklijke Philips Electronics N.V., Walsin Technology Corporation, Yageo Corporation, and WUS printed circuit CO., Ltd... Fifty questionnaires were distributed to participants in these companies. 50 participants of the study are agents who are more familiar with organizational procurement in the procurement department of the above five companies. 27 valid questionnaires were collected in this study. Two Hypotheses are proposed as:

H₁: Efficiency of pricing decision is significantly different from Positive to negative framing.

H₂: Preference of pricing decision is significantly different from verbal expression and to probability.

Since the Research Model is justified and validated, the questionnaire survey is deployed next. Items appearing in the question are collect by choices of alternative. Data are collected through a survey of organizations that are actively involved in the planning or operation of e-marketplaces. The respondents were asked to pretend that they were actually making with the choice described as the problem sets, and to make the decision they would have made in such a situation.

In the comparison of personal characteristics of a purchasing agent, effect in habitually practice of Chinese verbal expression on possibility is significant. Hypothesis H₁ is tested by Chi-square analysis shown as Table 2. Result denotes purchasing agents perform a better performance in the positive frame situation. Hypothesis H₂ is also significant with $\chi^2_{(1)}=12.532$, $p<0.001<0.05$. Analysis result reveals expression types do significantly affect preference of purchasing agent's decision. A result also shows a purchasing agent with risk seeking attitude always makes a choice with higher performance than other with other types of risk attitude.

5. Prototyping of E-Learning System

The main advantage of object technology in Information System environments is for facilitating software maintenance and scalability. UML is recently used as a standard to capture modeling artifacts. The object approach to system development follows an iterative and incremental process. According to the proposed research model and findings of this experimental study, a prototype is constructed for training novices of organizational procurement negotiation in this study.

Table 5. Performance of decision

Performance of decision		Risk attitude		
		seeking	neutral	averse
Low	Frequency	23	294	97
	Percentage	35.9%	51.2%	43.3%
High	Frequency	41	280	127
	Percentage	64.1%	48.8%	56.7%
	Frequency	64	574	224
	Percentage	100%	100%	100%

Table 6. Verbal expression of possibility

Verbal expression of possibility	Evaluation (Chinese)	Evaluation (English)
Quite certain	99%-100%	80%-90%
Certain	90%-100%	80%-90%
Probable	80%-90%	60%-70%
Likely	80%-90%	60%-70%
Chance for	50%-90%	50%-60%
Possible	50%-60%	50%-90%
Possibly	50%-60%	60%-70%
Hope	50%-50%	30%-70%
Perhaps	40%-50%	30%-60%
Uncertain	0%-50%	30%-50%
Risk	0%-20%	20%-40%
Impossible	0%-0%	0%-0%

Table 7. Verbal expression of frequency

Verbal expression of frequency	Evaluation (Chinese)	Evaluation (English)
Never	14%	25%
Very frequently	68%	59%
Sometimes	30%	37%
Usually	70%	62%
Often	70%	67%
Very often	67%	67%
Frequently	62%	60%

Table 8. Verbal expression by amount

Verbal expression of amount	Evaluation (Chinese)	Evaluation (English)
A little	20%	10%
Not much	30%	10%
Some	30%	50%
A lot of	50%	70%
Much	60%	80%
Very much	95%	80%
Pretty much	80%	90%
All	100%	100%
Completely	100%	100%

There has two main scenario parts within this E-Learning System of pricing negotiation, Scenario Architecture and Scenario Content. This study mainly confer on experimental simulation about pricing negotiation, the scenario architecture designed is as Figure 2. The scenario architecture includes Merchandise, Bargaining mix, Frame, Market status, Relation between the two parties, Uncertainly expression, Negotiation style, and Scenario display of a purchasing negotiation. The challenges and demands come from inside user of organization and learner greatly changed. Negotiation style are classified as peer room when the buyer deals with only one seller and group room when the buyer deals with several sellers simultaneously. Scenario display of a purchasing negotiation is classified as text mode and media mode (text, image with sound). In the text mode, semantic analysis and verbal behavior will be applied to analyze the dialogues the content of negotiation to cumulate knowledge from experienced agents. In the media with audio mode, pattern recognition for sounds of conversations will be added on to analyzes the meaning of dialogues.

System behavior is what a system does when responding to external events. In UML, the outwardly visible and testable system behaviour is captured in use cases. The use case diagram of this study is shown as Figure 3. The class modeling elements include classes themselves, attributes and operations of classes, associations, aggregation and composition, and generalization. Class diagram is constructed from scenario architecture and Use case diagram. The composition of class diagram is described as follow:

- (1) Procurement decision class is composed of Procurement scenario class and Member class. Methods are Decision store and Knowledge collection.
- (2) Attributes of Merchandise are Name and Description; methods are Query Merchandise and Content Link.
- (3) Attributes of Procurement scenario are Frame, Market status, Relationship, Uncertainty expression, and Negotiation style included, methods are Content link, Framing add, Market status added, Relationship added, and Procurement scenario store.
- (4) Attributes Member class are Player type, Name, Age, Occupation, Seniority, Risk attitude, Personality characteristic, Purchasing ability, Position, and Company included. Method of the class is Query member.

The negotiation styles are all designed as Real-time Interaction to mimic the real world of negotiation. Class "Scenario display mode" is a generic abstract class for two concrete subclasses Text and multimedia (text, image with audio). Procurement scenario is linked to Scenario display mode and Scenario display mode. Class "Measurement" is for three concrete subclasses Characteristic, Attitude, and Ability. Statechart model for the class "Procurement

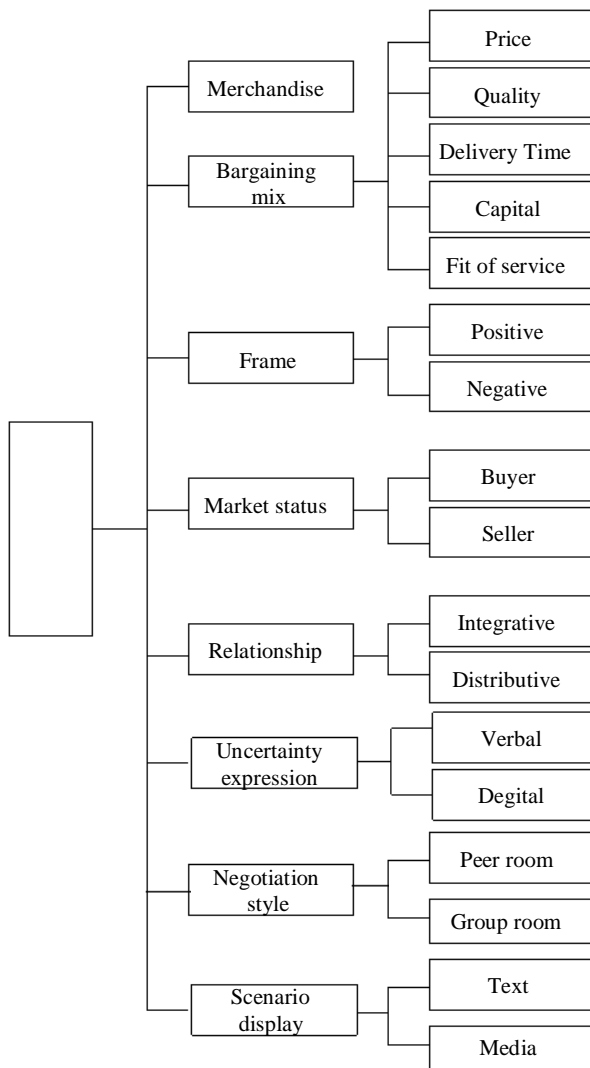


Figure 2. Scenario architecture of E-Learning system

Table 9. Use case description of E-Learning system	
Use case	E-Learning of organizational Procurement
Brief description	This use case allows a member to log in an E-Learning system to making decision for learning with various procurement scenarios. Members include learners and experts as mentor.
Actors	Host, Expert, Learner
Preconditions	Members had invited to the learning and the procurement scenario had been set up by host.
Main flow	The use case begins when the host set up the procurement scenario and invite members to take in by choosing the continue function. The system requests that the member enter the personal attributes. The member making decision and decide it by choosing submits to send it out. The system identifies the member as a learner or an expert, and process the submitted data by different ways. The system transfer experience of experts to knowledge and provide hints for learners from knowledge store.
Alternative flows	The member activates the submit function to making decision. The member chooses the abort to cancel the decision
Post conditions	If the use case was successful, the learning is recorded in the system's database. Otherwise, the system's state is unchanged.

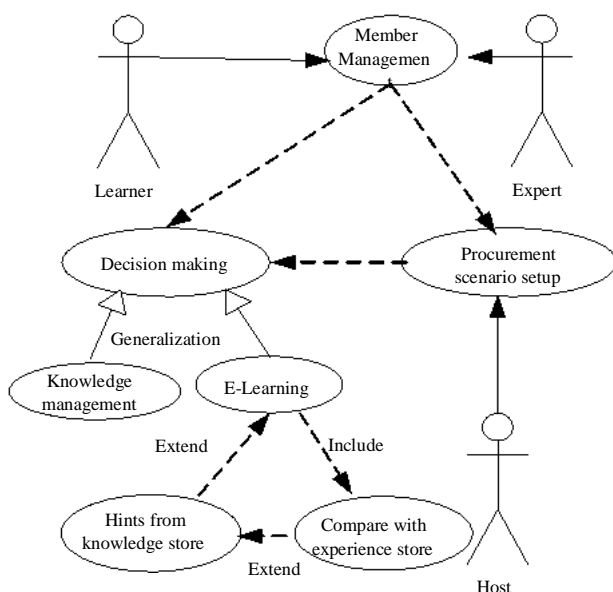


Figure 3. Use case diagram of E-Learning system

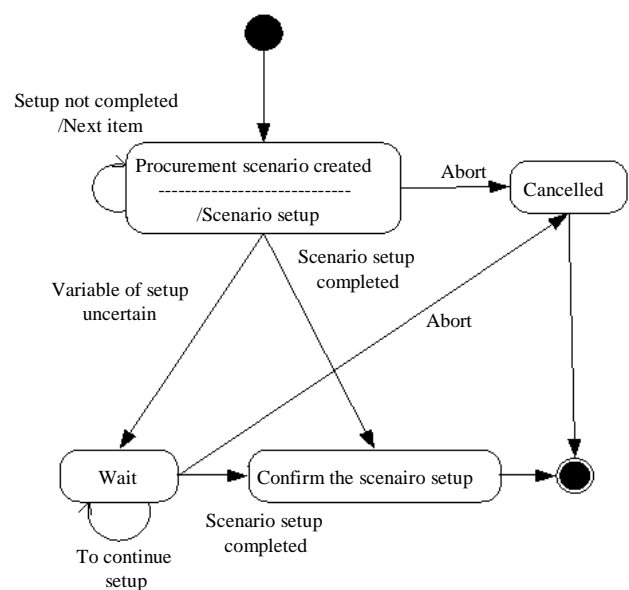


Figure 5. Statechart diagram of procurement scenario

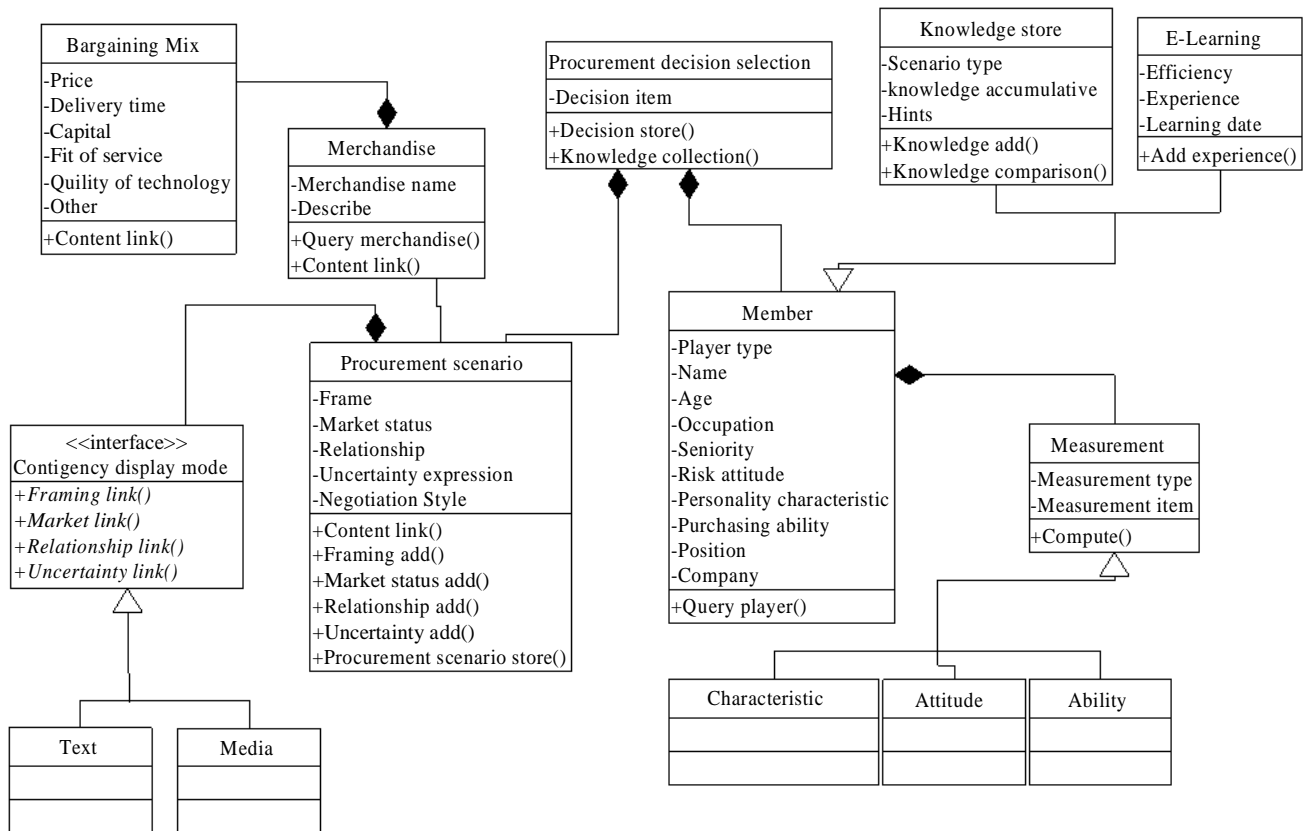


Figure 4. Class diagram of E-Learning system

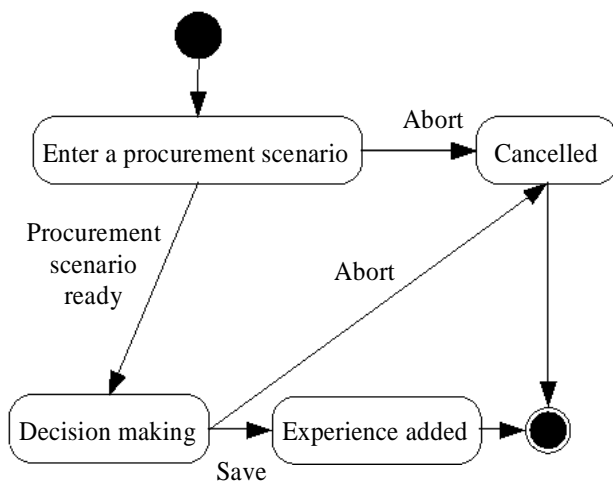


Figure 6. Statechart diagram of Knowledge store

scenario” is shown as Figure 5. The initial state of Procurement scenario is Procurement Scenario Create. There are three possible transitions out of the Procurement scenario create. On the Abort event, the Procurement scenario object goes into the Cancelled state. On the Variable of setup uncertain event, the Procurement scenario object goes into the Wait state. The Scenario setup completed event, when in the Scenario setup or Wait state, fires a transition to confirm the scenario setup.

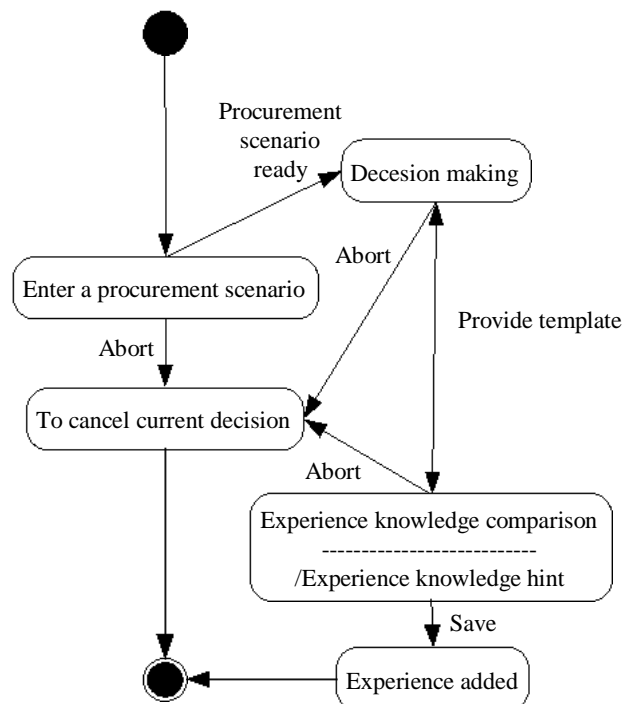


Figure 7. Statechart diagram of E-Learning

Statechart model for Class “Knowledge store” is shown as Figure 6. The initial state of Knowledge store is “Enter a procurement scenario”. There are two possible transitions out of “Enter a procurement scenario”. On “Procurement scenario ready”, “Enter a procurement scenario object” goes into the “Decision making” state. Event of Abort during “Enter a procurement” scenario or “Decision making” state, fires a transition to Cancelled. Meeting event of Save, “Decision making” object goes into “Experience added” state. Statechart model for E-Learning Class is shown as Figure 7. The initial state of E-Learning is “Enter a procurement scenario”. There are two possible transitions out of “Enter a procurement scenario”. “Procurement scenario ready” and “Enter a procurement scenario” objects go into “Decision making” state. Meeting event of “Provide template”, “Decision making” object goes into “Experience knowledge comparison” state and get into a loop until “Learning completed”. During event of “Save”, “Decision making” object goes into the “Experience added” state. Meeting event of Abort, “Enter procurement” scenario, “Decision making” state or “Experience knowledge comparison” fires a transition to Cancelled.

6. Conclusion

Goal of this research is hence to present a research model for influencing factors of pricing decision for an organizational procurement. These factors may create valuable information for e-marketplace administrators to build appropriate strategies for their businesses. The findings on patterns of verbal expression among purchasing personnel with different backgrounds and risk attitudes might be useful for building a data bank for e-negotiation between buyer and seller. Also the relationship between framing, personal risk attitudes and the efficiency and preference of pricing decision for an organizational procurement are proposed to assist the trades between industries. Verbal expressions are mostly used among purchasing agents to express their perception in the traditional market.

A model for the evolution of organizational market is built based on literature review of inter-organizational negotiation and interviews in-depth with domestic industry. Popular verbal terms using in purchasing area for possibility are collected and analyzed, and due to the purpose of the research, a questionnaire sampling is used to collect data from five high technology companies. Basic Statistical Analysis and Chi-Square Analysis are applied to analyze the purposively collected data. The results reveal framing does most significantly influence the trades, and preference of decision among purchasing persons are not significant, that might due to their experiences and professional knowledge on procurement. System requirements based on the framework is analyzed by UML for building an E-Learning simulated system for novices of purchasing via hints from knowledge collected from veterans of procurement.

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Using Pattern Recognition for Investment Decision Support in Taiwan Stock Market

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Abstract

In Taiwan stock market, it has been accumulated large amounts of time series stock data and successful investment strategies. The stock price, which is impacted by various factors, is the result of buyer-seller investment strategies. Since the stock price reflects numerous factors, its pattern can be described as the strategies of investors.

In this paper, pattern recognition concept is adapted to match the current stock price trend with the repeatedly appearing past price data. Accordingly, a new method is introduced in this research that extracting features quickly from stock time series chart to find out the most critical feature points. The matching can be processed via the corresponding information of the feature points. In other words, the goal is to seek for the historical repeatedly appearing patterns, namely the similar trend, offering the investors to make investment strategies.

Keywords: Pattern Recognition, Taiwan Stock Market, Time Series, Feature Extraction

1. Introduction

Stock exchange is influenced by many factors, including politics, economics, international statuses, significant news, and so forth. The composite result will be displayed on the market, and thus the stock price volatility is reflected. Since the stock price is the final consequence of various components, it is more meaningful to present the variation of stock price with the chart than with numerical data. Hence, stock trend chart is one of the most useful tools for stock analysis [2][7][9][10].

In recent years, Behavioral Finance has been getting more and more attention. When one is making strategies, he, who is affected by mental elements, is not always rational. Certainly, daily stock price corresponds to the current circumstances. Thereafter, stock data mining [6], which obtains knowledge through relevant analysis, reveals that investors make investment strategies according to each factor.

Consequently, using the objective approach in this paper discovers investment behavior patterns — the curves of stock price trend. First, applying feature extraction to stock time series to extract the most critical feature points. Then, do the matching of the relevant information among the feature points. The proposed new pattern recognition method can substantially improve the

efficiency of pattern matching about time series data. Thus, it is useful for investors to make decisions.

2. Literature Review

2.1 Stock Market Volatility Factors

Stock price is affected by some factors [5], including stock market, industry, and corporation factors. Stock market factors involve macroeconomics, international statuses, and domestic politics. Industry factors consist of industry conditions, business life cycle, and law measures. Corporation factors concern with dividends, operating performance, firm structure and restructuring. To sum up, stock price is influenced by all factors; either corresponding to long-term or short-term trend.

Based on the self-similarity of fractal theory [9], the shape will not be changed even if a segment of long-term trend is either magnified or minified. In another word, the shape of long-term stock price trend is similar with short-term. The fluctuation of short-term trend will not be taken into consideration while observing long-term trend. In the same way, the volatility of ultra-short term trend will be neglected while focusing on short-term trend. For example, the minute stock price volatility will not be taken into account when considering daily stock price data. Therefore, it is necessary to find out quickly the critical feature points to represent the original curves.

Since the volatility factors are subjectively defined and explained by investors, investment will correspond to individual character and mental factors; that is, there is no objective standard. Thereupon, in this paper, an objective approach is applied to pattern discovery of repeated behaviors by the historical curves.

2.2 Time Series Feature Extraction

The reason for applying feature extraction to stock time series is because the preceding matching approaches are time-consuming. The most typical models are Hidden Markov Model (HMM) [1] and Dynamic Time-Warping (DTW) [4]. The parameters of HMM require being trained; the training process takes a lot of time. Though the parameters of DTW do not need to be trained, the matching process is rather time-consuming.

The proposed Perpetually Important Point (PIP) approach [3], which is suitable for time series feature extraction, indicates that major or minor volatility may be included in the stock time series. Discovering the critical

feature points ensures to filter the insignificant minor volatility. Thus, the complete time sequence can be expressed in terms of a small number of feature points. Let P denote a time series, where the length is N . The purpose is to find out m PIPs, which works as follows:

- Step1: The adjacent two PIPs are defined on the two ends of time series; in other words, the start point p_1 and end point p_2 .
- Step2: The third PIP p_3 is the point in P with maximum distance to the first two PIPs. The maximum distance denotes the vertical distance between a point p_3 and a line connecting the two adjacent PIPs (See Fig. 1), that is, $d = y_3 - y_c$.
- Step3: The process continues searching for the next PIP in P with maximum distance to its two adjacent PIPs until sufficient m PIPs are detected, and m is predefined.

The pseudo code of the PIP approach process is described in Figure 2.

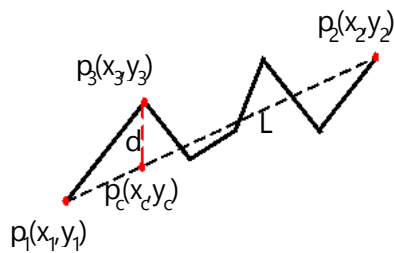


Figure 1. Time series feature extraction.

The Perceptually Important Point (PIP) approach is adapted to find out important features for human visual identification, and two approaches in extracting PIPs are provided. The first one is to find out the most significant feature points on the complete time series. The characteristics of second one is that the time interval is approximatively equal after extracting PIPs. See Figure 3 (1st PIP approach), and Figure 4 (2nd PIP approach), respectively.

The second approach is developed to find out two adjacent PIPs with maximum time interval. After the step, it is found that the each interval between two adjacent PIPs is the approximative distance. The two feature extraction approaches will lead to different results, even with the same data.

```

Function PIP( $P, m$ )
  Input: sequence  $p[1...N]$ 
  Output: pattern  $pip[1...m]$ 
  Begin
    Set  $pip[1]=p[1], pip[N] = p[N]$ 
    Repeat until  $pip[1...m]$  all filled
      Select point  $p[j]$  with maximum distance to the adjacent point
      in  $pip$ 
      Add  $p[j]$  to  $pip$ 
  End

```

Figure 2. Pseudo code of PIP[3].

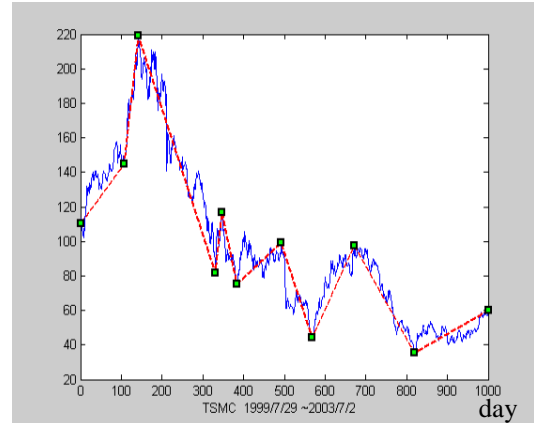


Figure 3. PIP Method 1. The feature points are represented by square points, the daily closing price are represented by solid lines, and the feature points are connected by dotted lines.

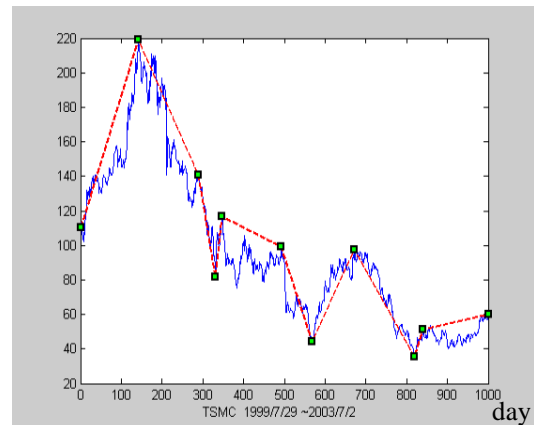


Figure 4. PIP Method 2. The feature points are represented by square points, the daily closing price are represented by solid lines, and the feature points are connected by dotted lines.

The two methods are chosen according to the problem domain. Here, the first method is preferred being applied to stock market data. The number of needed feature points can be given in advance. Since matching the original data is time-consuming; therefore, detecting the meaningful points by filtering detailed information can improve the matching work.

Let n denote the points on time series. The whole data has to be scanned once as long as seeking for one feature point. Hence, n^2 times of calculations are computed when detecting n PIPs. In real life, one usually keeps his eye only on several critical points, such as starting point, termination point, peak, valley, turning point, etc.

Therefore, only n ($n < N$) critical features are required. For this reason, n times of PIP approach calculations are computed when detecting time series, such that the time complexity will be $O(n \times N) = O(N)$. The other non-feature points can be neglected for being viewed as slight volatility.

3. Architecture

In this research, the data resource is derived from Securities & Futures Institute, where daily closing price is used to do the feature extraction by means of PIP approach firstly. Then, the angle and relative length are computed for matching similar patterns, namely resembling stock price trend (See Fig.5). Finally, the investment suggestion is given by the analysis.

3.1 Data Collection

Taiwan stock market is taken for example in this paper. The data originates from Securities & Futures Institute, where daily closing price is collected from 1994/1/5 to 2003/7/16.

3.2 Time Series Feature Extraction

The PIP approach is used to apply feature extraction to stock data because one will notice only a few significant feature points within a time period.

3.3 The Relation of Features

Calculate the slope of two adjacent feature points. Slope matching is complicated because slope lies within the range $[-\infty, \infty]$. Therefore, conversing the slope to the angle, and then using the angle to do the matching. There are some advantages of angle matching:

1. The different stock price (Y axis) can be matched with varied stocks. Hence, the stock price data needs to be normalized. For example, stock A falls within 10 to 30 dollars whose spread is 20 dollars. Stock B falls within 50 to 80 dollars whose spread is 30 dollars. The scale of stock B requires being reduced two-thirds, while stock A being magnified one and one-second can the angle matching be done.
2. Time axis (X axis) does not require being normalized. This is because there is no impact on two angles regardless of the length of time. As long as the number of the chosen feature points is equal, the data of M-day can be matched with that of N-day. For instance, 50 days of data can be matched with that of 60 days.

An error range ϵ is determined when matching, and the angles lie within the range $[-90^\circ, 90^\circ]$. Let α denotes the angle of a feature point such that $\alpha \pm \epsilon$ are regarded as the identical angles (See Fig. 6). The smaller of the error range, the more precise of the matching result; otherwise, the more similar patterns can be matched.

The time interval of two feature points may differ in various patterns, which contribute to divergent implications applied to stock market data. Therefore, the distance between feature points should be considered when matching. In comparison of different lengths of time series flexibly, let the relative time length be the measure through dividing the time interval of two adjacent feature points by the total length of time series (See Fig. 7). In Figure 7, the relative length between point 1 and point 2 is

a/N . The error of relative length is set not to be more than β when matching stock price time series.

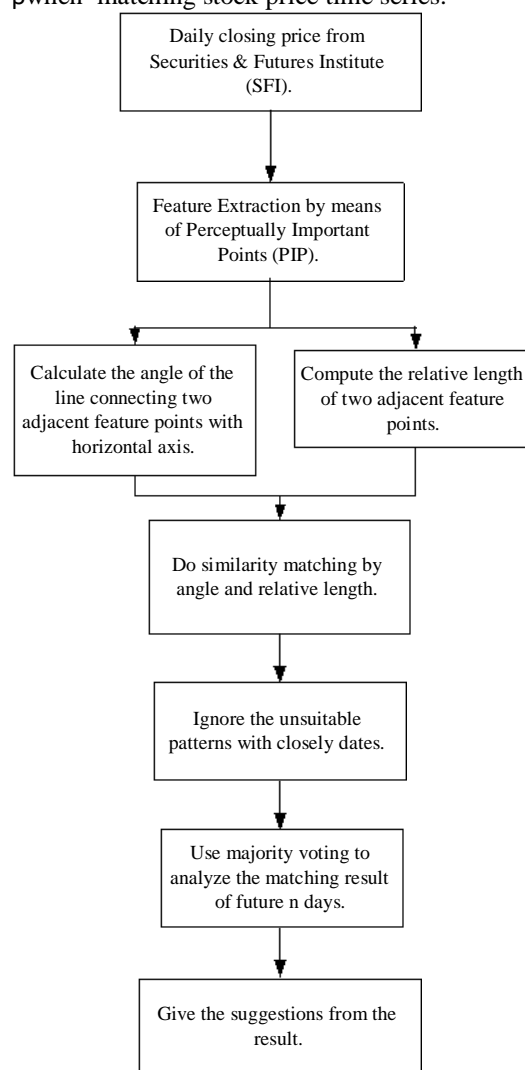


Figure 5. Research structure.

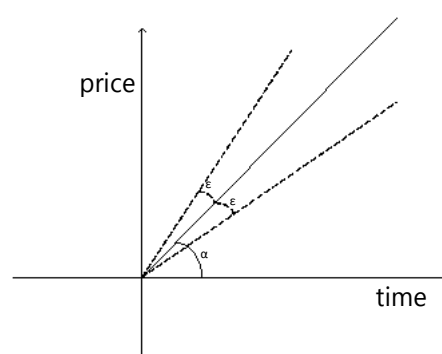


Figure 6. The matching angle is α , and the range of tolerance is ϵ .

3.4 Similarity Matching

The process of matching begins with finding out the most critical features by way of feature extraction; furthermore, compute the angle of feature point connecting to horizontal axis and relative length, described in section 3.3, for matching. First of all, angle

matching is employed with adjacent feature points. After matching the identical angles, the relative length is further matched. The matching patterns may be dissimilar even with the identical angle; that is why the relative length proceeds to be matched. The error of angle and relative length require being within the range of tolerance such that the matching of time series is regarded as identical. The stricter the making rules of similarity, the better resulting matching; nevertheless, the fewer times of matching the identical patterns. On the contrary, the looser the threshold, the matching result will be worse; yet, the more times of matching the identical patterns.

It is found in the experiment that the stocks of the same industry within the similar time period will usually result in identical trend. Therefore, finding out the same trend with different time period will be more meaningful.

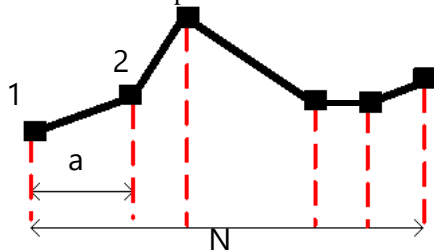


Figure 7. The relative length is a/N .

3.5 Matching Analysis

After matching similar curves, the trend in the following n days is analyzed. The future trends of the following n days will be concluded by the majority voting method. Ultimately, the resulting pattern is determined if it is significantly meaningful by setting the voting threshold. In Section 4, all samples will be presented as examples.

4. Simulation

Data Resource: Daily stock closing price from Securities & Futures Institute between 1994/1/5 and 2003/7/16.

Experiment 1: Identical industry with the same time interval.

From an industry in Taiwan, Experiment 1 takes Taiwan Semiconductor Manufacturing Company (TSMC) and United Microelectronics Corporation (UMC) as the subjects. The six feature points are extracted for matching within 50 days. The angle error ϵ is set to be within $[-8^\circ, 8^\circ]$, and the relative length β is equal to 0.1. The result is shown in Figure 8.

Experiment 2: Different industries with the same time interval.

From different industries in Taiwan Experiment 2 takes Taiwan Semiconductor Manufacturing Company (TSMC) and Formosa Plastics Corporation (FPC) as subjects. The six feature points are extracted for matching within 50 days. The angle error ϵ is set to be within $[-8^\circ, 8^\circ]$, and the relative length β is equal to 0.1. The result is

shown in Figure 9.

Experiment 3: Identical industry with different time intervals.

From an industry in Taiwan, Experiment 3 takes Semiconductor Manufacturing Company (TSMC) and United Microelectronics Corporation (UMC) as subjects within different time intervals. The six feature points are extracted for matching within 60 days and 50 days, respectively. The angle error ϵ is set to be within $[-8^\circ, 8^\circ]$, and the relative length β is equal to 0.1. The result is shown in Figure 10.

Experiment 4: Different industries with different time intervals.

In different industries in Taiwan, Experiment 4 takes Semiconductor Manufacturing Company (TSMC) and Formosa Plastics Corporation (FPC) as subjects within different time intervals. The six feature points are extracted for matching within 60 days and 50 days, respectively. The angle error ϵ is set to be within $[-8^\circ, 8^\circ]$, and the relative length β is equal to 0.1. The result is shown in Figure 11.

Experiment 5: Self-matching on the same stock.

Do the self-matching on the same stock to search for the repeatedly appearing trend. Experiment 5 takes United Microelectronics Corporation (UMC) and Taiwan Semiconductor Manufacturing Company (TSMC) as subjects. The six feature points are extracted for self-matching within 50 days. The angle error ϵ is set to be within $[-8^\circ, 8^\circ]$, and the relative length β is equal to 0.1. The result is shown in Figure 12 and 13.

4.1 Simulation Result

In Experiment 1 and 2, it is concluded that the proposed approach in this paper can be applied to either the identical or different industries. In other words, the investment behavior may be the same even between low-correlated industries.

In Experiment 1, TSMC and UMC, both belonging to the electronics industry, have similar curves within [2001/2/21, 2001/5/4] and [2000/11/17, 2001/1/31], as shown in Figure 8 (a1) (b1). It indicates that the strategies of investors are similar because time-space background and influential effects are very close. It is found that the trends of the two stocks are similar in the following 10 days. For example, the trends of the two stocks go downward in the following 10 days, which are shown in Figure 8.

In Experiment 2, TSMC belongs to electronics industry, while FPC belongs to plastics industry. There is low correlation between the two stocks; however, the similar curves appeared in different time interval, as shown in Figure 9. It indicates that the investment strategy may be the same even in different industries.

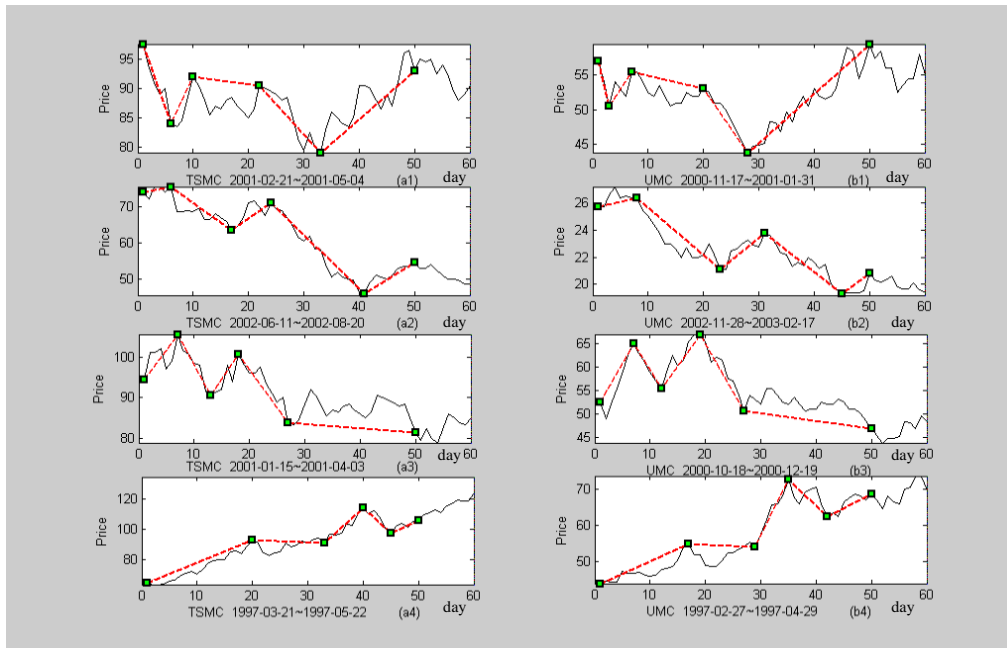


Figure 8. Experiment 1: The figures on the left (TSMC) respectively correspond to the right ones (UMC). (i.e. (a1) is similar with (b1)). The original data is represented by solid curves, the future trend is represented by dotted lines, and the square points stand for feature points. The previous 50 days are for matching, while curves of the last 10 days are the following trend.

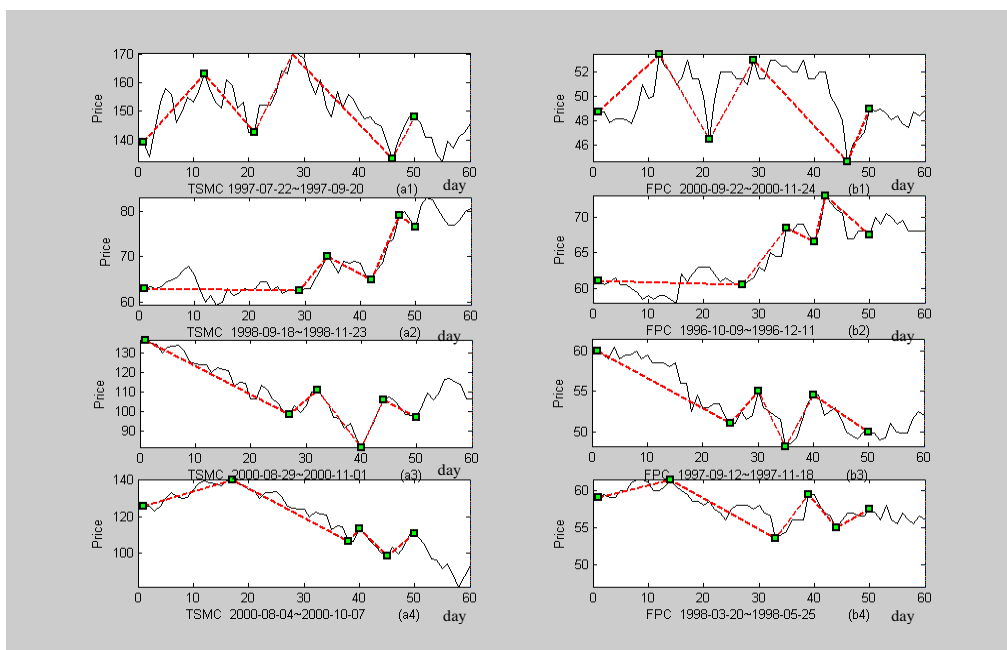


Figure 9. Experiment 2: The figures on the left (TSMC) respectively correspond to the right ones (FPC). (i.e. (a1) is similar with (b1)). The original data is represented by solid curves, the future trend is represented by dotted lines, and the square points stand for feature points. The previous 50 days are for matching, while curves of the last 10 days are the following trend.

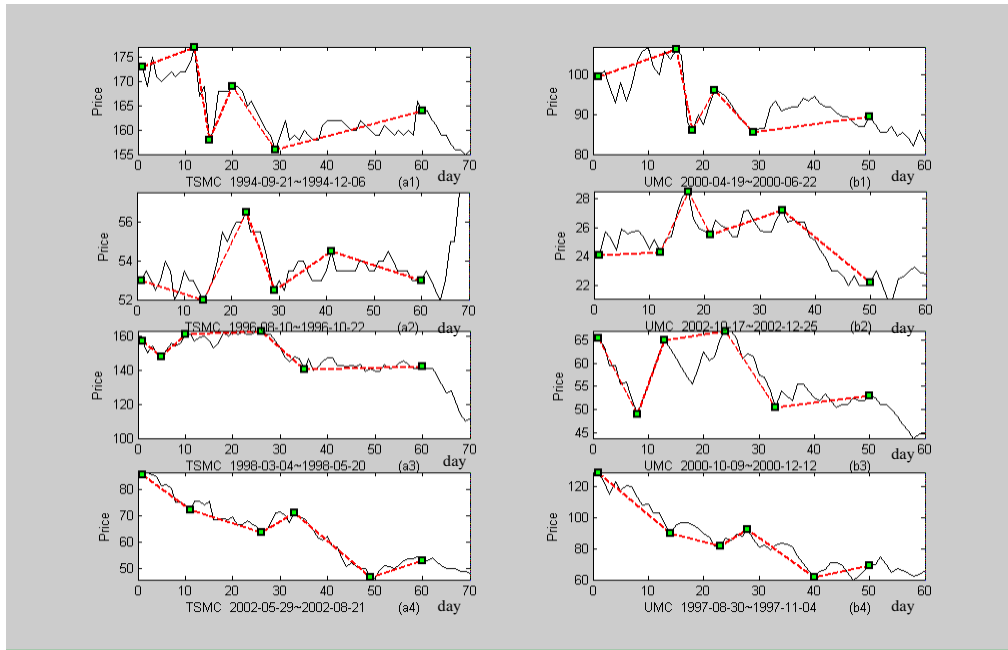


Figure 10. Experiment 3: The figures on the left (TSMC) respectively correspond to the right ones (UMC). (i.e. (a1) is similar with (b1)). The original data is represented by solid curves, the future trend is represented by dotted lines, and the square points stand for feature points. The previous 60 days for the left figures and 50 days of the right ones are for matching, while the curves of the last 10 days are the following trend.

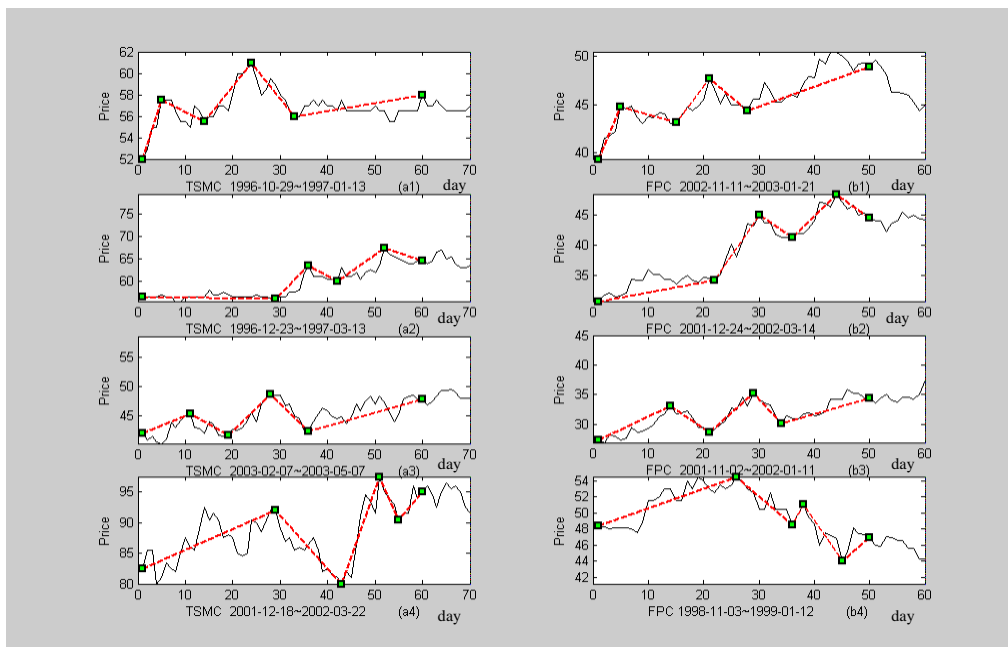


Figure 11. Experiment 4: The figures on the left (TSMC) respectively correspond to the right ones (FPC). (i.e. (a1) is similar with (b1)). The original data is represented by solid curves, the future trend is represented by dotted lines, and the square points stand for feature points. The previous 60 days for the left figures and 50 days of the right ones are for matching, while the curves of the last 10 days are the following trend.

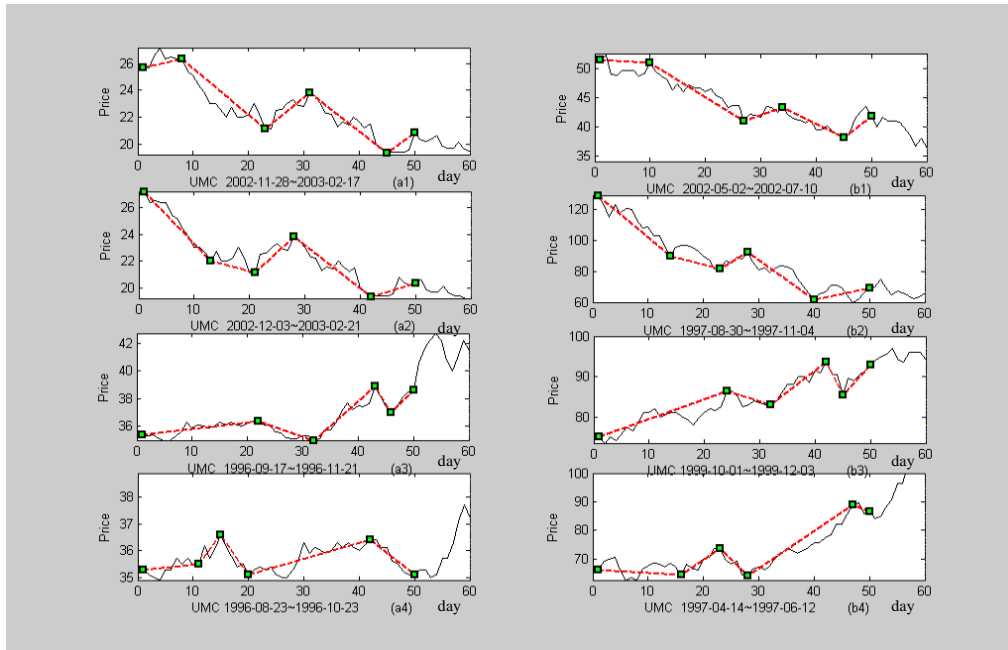


Figure 12. Experiment 5: The figures on the left (UMC) respectively correspond to the right ones (UMC) for self-matching. (i.e. (a1) is similar with (b1)). The original data is represented by solid curves, the future trend is represented by dotted lines, and the square points stand for feature points. The previous 50 days are for matching, while curves of the last 10 days are the following trend.

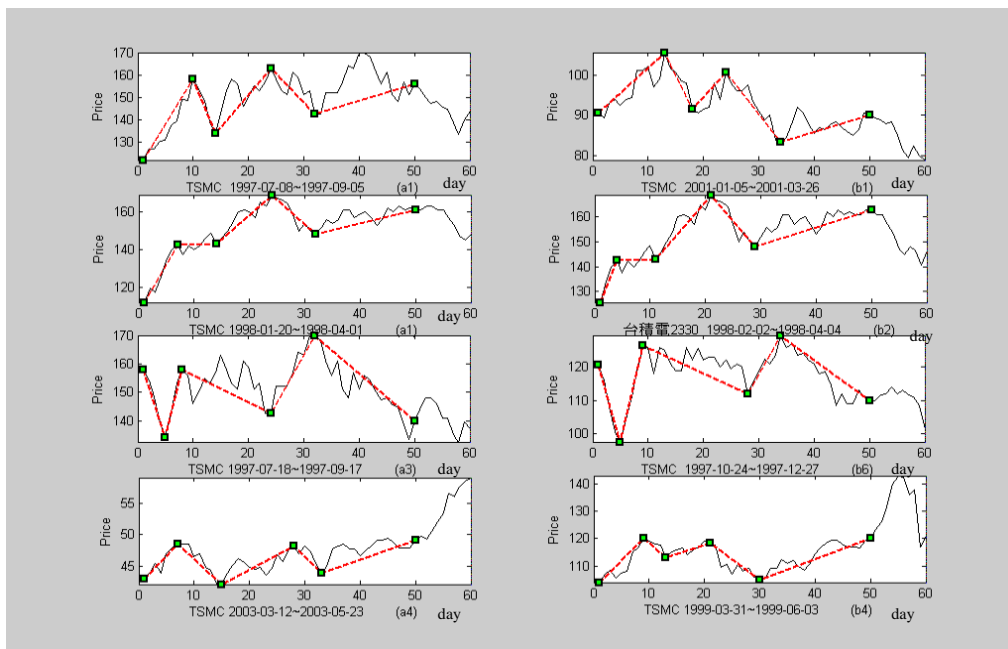


Figure 13. Experiment 5: The figures on the left (TSMC) respectively correspond to the right ones (TSMC) for self-matching. (i.e. (a1) is similar with (b1)). The original data is represented by solid curves, the future trend is represented by dotted lines, and the square points stand for feature points. The previous 50 days are for matching, while curves of the last 10 days are the following trend.

This is because the influential factors may be dissimilar during the same time interval. Nevertheless, the trend in the following 10 days is varied in accordance with different industries.

In Experiment 3 and 4, it is concluded that the proposed approach in this paper can be applied to different time intervals. Because the influential factors will differ according to the stock, the similar curves may appear in different time intervals.

In Experiment 3, different time intervals applied to the same industry can be matched with similar curves. It indicates that the similar trends will still appear in the following 10 days, which is shown in Figure 10 (a3) (b3), and (a4) (b4).

In Experiment 4, different industries with different time intervals can result in the similar curves. The reasons will be (1) all factors that affect the stock price will constitute the identical background even in different industries during different time intervals. (2) The long-term or short-term investment strategies will result in the similar curves. In other words, magnifying a segment of long-term curves is similar with the original long-term curves. However, it is found that in the following 10 days, the trends are not so significantly similar. Perhaps the investors have different judgment standard on different industries.

In Experiment 5, it is found that self-matching on the same stock, as shown in Figure 12 (UMC) and 13 (TSMC) respectively, will match the similar curves. Moreover, the trends in the following 10 days are still similar. In Figure 12 (a4) (b4) and Figure 13 (a2) (b2), the upward trend and downward trend are significantly appeared in the following 10 days respectively.

5 Conclusion

This paper applies feature extraction to stock time series data on critical feature points for similarity matching. The proposed approach is adapted to match either various industries or low-correlated stocks regardless of its data characteristics. The resulting Experiment indicates that stock price volatility will repeatedly appear along with investment strategies. Hence, investors can make current strategies according to the historical repeatedly appearing patterns.

The quantity of feature points is dynamically determined according to stock price data. It is important to describe the original data more appropriate, hasten the searching speed, and improve the accuracy. In addition, the stock volume can also be considered such that the effects will be improved greatly.

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Architecture of the Product State Model Environment: The QualiGlobe Experience of Production Efficiency

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Abstract

This paper addresses the issue of using product models to support product lifecycle activities with particular focus on the production phase. The motivation of the research is that products are produced more costly and with longer lead-time than necessary.

The paper provides a review of product modelling technologies and approaches, and the overall architecture for the Product State Model (PSM) Environment as a basis for quality monitoring. Especially, the paper focuses on the circumstances prevailing in a one-of-a-kind manufacturing environment like the shipbuilding industry, where product modelling technologies already have proved their worth in the design and engineering phases of shipbuilding and in the operation phase. However, the handling of product information on the shop floor is not yet equally developed.

The paper reports from the Brite-Euram project (No. BE97-4510) QualiGlobe focusing on the development activities of the PSM architecture. An example discusses how to handle product related information on the shop floor in a manufacturing company and focuses on how dynamically updated product data can improve control of production activities. This prototype example of welding a joint between two steel plates serves as proof of concept for the PSM architecture.

1. Introduction

Enhancing the manufacturability of products demands an increasing exchangeability of information (Alting 1994, Pedersen & Larsen 2001). This paper addresses the issue of using product models to support product lifecycle activities with particular focus on the production phase.

In a manufacturing company, production operations involve information about the product. This information normally has a relatively static nature because it is a specification of how the product is intended to be. Production operations also involve manipulation, generation and use of product information which has a dynamic nature and involve information which describes the current condition or state of the product.

The product state is changing as a result of physical processing (cutting, welding, handling etc.). The state of a product at a given time, is therefore the accumulated result of the processes applied to the product that given time, cf. Larsen et al. (2001).

The product state information includes logistic information as well as the physical properties of the product. Both types of information typically describe conditions, which in some way will influence the subsequent production steps for the product. It is important to notice that this product information describes the actual conditions or circumstances of the product, not the planned. In response to this, the Product State Model (PSM) is defined as opposed to the Product Model, cf. Lynggaard (1996) and Sphitalni et al. (1998), which in this paper is considered as the model of the planned product.

2. Research Method

This research reports from the Brite-Euram project QualiGlobe (Product Quality State Based Fabrication in Global Production Environment), which started in 1997 and is finishing in 2001. The purpose of the project has been to define a so-called Product State Model and related applications.

The project partners were: Odense Steel Shipyard Ltd. from Denmark, Fundacion Robotiker from Spain, Institut für Schweisstechnische Fertigungsverfahren der Rheinisch-Westfälischen Technischen Hochschule from Aachen, Germany, Det Norske Veritas Ltd. from Norway, Svejsemaskinfabrikken Migatronics Ltd. from Denmark, and Fincantieri Cantieri Navali Italiani Spa. from Italy.

During the course of the project all partners have been involved in the development and testing of the prototypes. This paper will present some of the results from this work.

The research questions (RQ) pursued in this article are:

- RQ1: Why is a PSM needed in a manufacturing process?
- RQ2: What are modules in a PSM Environment that are necessary for the manufacturing process to execute efficiently?
- RQ3: How are the modules related?

The data founding this article was gathered through internal documentation and supplementary interviews. Extensive internal documentation were available, e.g. functional analysis (IDEF0) of the material flow of the production process and of the control of the production process, results and documentation of several Ph.D. and master theses, and other research project documentation

from the QualiGlobe project at Odense Steel Shipyard (OSS). This material provided substantial empirical insight into shipbuilding at OSS. Furthermore, various applications of information technology in the production preparation and production were analysed, i.e. robot controllers, product models, and intranet applications.

One of the objectives of the QualiGlobe project is to specify the product and process quality state model. The model is the basis for the monitoring and pre-adjustment activities, and the calculation of the part quality after processing. The quality model considers both the product and the process aspects, and the relation between them.

2.1 The Case Company Odense Steel Shipyard

Odense Steel Shipyard (OSS) had in 2002 a turnover of over 8,5 billion DKK and more than 8000 employees incl. 3000 in Denmark. In 1997 and 1998 OSS acquired three shipyards near the Baltic Sea, i.e. Volkswerft Stralsund GmbH in Germany (www.volkswerft.de), Baltija Shipbuilding Yard JSC in Lithuania (www.baltijos.lt), and Loksa Shipyard Ltd. in Estonia (www.ls.ee). OSS is a subsidiary of the A.P. Moller-Maersk Group.

OSS (www.oss.dk) builds double hulled VLCC's (very large crude carriers), crude oil carriers, and container vessels e.g. the worlds largest container carrier and reefer vessels (length: 347, breadth: 43 m, depth: 24 m, draught: 14,5 m, and 6600 TEU, 20 foot containers including 700 Reefers, operated by only 17 persons). In addition to the subsidiary yards in Estonia, Lithuania and Germany, the OSS Group has acquired a subsidiary repair yard in Egypt. Over the years, the primary customer is the owner of the shipyard, i.e. the A.P. Møller Group. In addition, the shipyard also charter ships to the A.P. Møller shipping company.

3. The need for a Product State Model

Today information applied for controlling processes in production is mainly provided by process planning systems and process specification documents. In addition, static product data (CAD drawings, bill-of-material, etc.) serves to support the manufacturing process. Production staff on the shop floor further adds (or modifies the) process data based on experience and knowledge. Finally, to some degree, they take into consideration specific facts about the current and actual conditions of a particular part. Automated processes are also able to adapt to real conditions by use of sensors, and thus compensate for the difference in the planned and actual circumstances. However, this is only true within limitation and depends on the magnitude of the variations. So far humans are better to adapt the process to the real product conditions than the automated equipment.

Following the above, we realise that we accept that the actual conditions differ from the specifications and consequently allocate human effort and skills, and make investment in technology and new operating procedures, in order to compensate for variation. Additionally, we

establish buffers in production plans in order to compensate for the temporal aspect, i.e. possible delays in production due to prolonged processing time or extra time required for repairing.

Hence, it is a fact that in order to achieve the desired quality, the cost is higher than necessary and the lead-time is longer than necessary.

The alternative of gaining more accuracy in the production process is extremely expensive in the manufacture of large, complex, one-of-a-kind products like a ship. Therefore an approach is needed, which allows us to handle the variations as natural phenomena and not as disturbances with damaging effects on logistics, cost, time and accumulated quality.

4. Product Modelling

This section reviews the product modelling literature in order to give insight to the development and elaboration of the Product State Model. Product modelling is an approach to structure knowledge and information related to a product. The traditional purpose of product models is to facilitate the specification activities of the manufacturing company. In the following some of the dominating schools within the Product Modelling community are presented.

University of Erlangen-Nürnberg: Product and product related models to support the Design for X engineering design (e.g. Meerkamm 1993). This Design for X approach contains knowledge and information regarding the application domain. In the paper the focus is on Design for Manufacturing (DfM). The system contains three parts: a component model for definition of product components. The component model is again divided into four elements: a geometry element, a technology element describing tolerances, surfaces, materials, and material characteristics. Furthermore, the component model contains a function element describing the components function surfaces, forces and moments, etc. The fourth element is the organisation element assigning an identification number, a responsible person, and the status of the component. The synthesis part contains generic object oriented descriptions of the components. These are building blocks that by synthesis lead to the product components. Finally, the analysis part contains analyses of consequences for the particular solutions in relation to e.g. tools or tolerances. The analysis proposes courses for corrections.

Helsinki University of Technology: Feature modelling and product models supporting reuse throughout the lifecycle of the product (e.g. Ranta et al. 1996, Ranta & Mäntylä 1997). Mäntylä et al. have been engaged in the discussion of the requirements regarding the structure for product models supporting reuse over the lifecycle of the product model (Ranta & Mäntylä, 1997). As an analogy to design patterns used in software development, the reuse entities are categorised into three types of presentation entities, i.e. macroscopic principles for the early stages of the lifecycle containing physical

laws, mechanical structure, etc. The second type is product design patterns for the intermediate stages representing key aspects of a common structure, and microscopic features for detailed description at the late stages of the lifecycle.

Product modelling in a lifecycle perspective is an upcoming research area, whereas feature modelling is a matured area at the Helsinki University of Technology, cf. Laakko & Mäntylä (1993), Mäntylä et al. (1996), and Ranta et al. (1996).

Royal Institute of Technology (KTH), Stockholm: Feature modelling and the concept of Product Model Driven Direct Manufacturing, where the process parameters and scanning patterns are derived from the product model and from the use of a process model (e.g. Kjellberg & Carleberg 1993, Kjellberg 1995). The product model contains geometric, dimensions/tolerances, functional surfaces, and technical data. Moreover, it also refers to company specific information, product background, history, synthesis & analysis results, reasons for decisions etc.

Fraunhofer Institute, Berlin: Product and product related models containing of (1) the product model, which contains geometric description, structure description, and process description, (2) the factory model, entailing an equipment model, capacity and scheduling model, and a plant layout model, (3) the process model, which contain an operation model and a tool path model, and (4) the application model, containing application knowledge derived from service and maintenance (Krause et al. 1993).

University of Tokyo: The product modelling activities are focused on geometric constraints and geometric reasoning. Also, a generic product model for representing all types of artefacts is developed to appear in course of manufacturing and to support a virtual manufacturing environment. The product model contains description of material, intermediate products and manufacturing resources such as tools, machines, etc. Process modelling includes kinematics models, assembly models, form-feature modelling, dimensioning, and tolerance modelling, cutting process simulation, etc. (e.g. Kimura & Suzuki 1986 and Kimura 1993).

The Technical University of Denmark: The Chromosome Model is based on the Theory of Domains by Andreasen (1980), which explains product development as a synthesis of three different views on the product (domains), which are incorporated in the model: (1) Process. The process domain describes the interaction between the product, the operator and the surroundings. (2) Organ. The organ domain describes materialised design solutions, which provide the product's intended functionality. (3) Part. The part domain contains a description of the physical components and assembly structures (e.g. Andreasen 1980 and Mortensen 1998).

Institut National Polytechnique and the Université de Nancy, France: Co-operative Computer-Aided-Integrated Design (CAID) is a methodology and product model for integrated design using a multiview system.

The integrated design methodology is based on the co-operative work between all actors of a product life cycle (e.g. Tichkiewitch & Véron 1997).

Eindhoven University of Technology: The Relation-Based Product Model is suited for integrating Design and Manufacturing as manufacturability checking is embedded into the design process (e.g. Net et al. 1996). The product model is based on relations between geometrical entities with a tolerance model. For example, when assembly analysis is performed, numerical code for a machining centre, or command code for a co-ordinate measuring machine (i.e. verifying geometry) is created, then the product description is interpreted for implications in those specific applications.

University of Twente, Netherlands: Product models based on features, and product models for Model-Based Maintenance are based on Function-Behaviour-State modelling. A State aspect of a system is considered as a set of object attributes, which physically can be measured or monitored by sensors. A system's Behaviour is here defined as a set of transitions of states, and the Functional aspect is the top-level description of what the user can perceive from the system's Behaviour. Function-Behaviour-State modelling describes faults and deterioration of mechanisms in terms of user perception and measurable quantities. The product model is used as a reference for monitoring, fault diagnosis and prevention of breakdown (e.g. Houten et al. 1998).

Summing up the above mentioned schools of thought it shows that product modelling is an approach to structure knowledge and information related to a product with the purpose of facilitating the specification activities of the manufacturing company.

The various product modelling approaches differ in application domain and their level of detail. For example, the DfX tool by Meerkamm (1993) is more focused on implementation of product and product related models focusing on the particular analysis and synthesis tool, and consequently the interaction with the engineering designer, as opposed to the approach suggested by Krause (1989).

The concept of the Product Model Driven Direct Manufacturing (Kjellberg & Carleberg 1993, Carleberg 1995) focuses on the manufacturing process. The concept does provide same functionality as what is intended with the PSM of feeding realised production information forward to further production process activities – however this is limited to geometrical features, whereas the state description of the PSM may contain a wide scale of different attributes.

A product model being representative for the product throughout the production has to a product and product related model, cf. Krause et al. (1993). In order to optimise the production process, a product model should be used as a reference for monitoring. A feedback of realised process parameters Kjellberg & Carleberg (1993), i.e. from use of a process model, should be supplemented with product properties. These product properties represent the state identified of the realised product.

5. The Concept of the Product State Model

The Product State Model stores information about the product generated during production. Through a feed-forward mechanism the information can be made available in the subsequent productions steps where it can be used for adjusting the planning and control of processes. Naturally, the Product State Model describes the output quality of a certain process and thus also can be used for adjusting that same process before it is performed to the next product. The Product State Model's historical data also provides a solid basis of production information for design of new products as well as definition of production methods. However, the main idea explored in this paper is the ability to feed the product information downstream in the manufacturing process so that subsequent processes for the same product are carried out based on individual and updated product data.

The idea of the PSM is directed towards the reduction of accumulated manufacturing errors based on experiences from the development of a Product State Model (PSM) (Lynggaard 1996, Larsen 2003). The main sources of variation in mechanical assemblies are dimensional variations, form and feature variations, and kinematic variations. In particular, the manufacturing deviations caused by cutting and welding of steel plates are due to the high heat input, shrinkages and deformations (Larsen et al. 1999, Langer et al. 1999).

The PSM is designed to collect the state changes of a product or a product part at each step in the production process. Hence, it is possible to perform a geometric quality control of the production process, as the collected product state information is available for later production processes. For example, as the state of each product part is documented in the PSM after the cutting process (using a 3D vision and theodolite system), a global optimisation of the assembly process is feasible in order to improve conformance. Furthermore, the collection of state based descriptions of a product provides an automatic documentation of the product. Exchange of information between the PSM and the sources of the shop floor data collection is based on standardisation, here using the eXtensible Markup Language (XML).

5.1 Definition of the Product State Model

A Product State Model records and stores information about the product generated during production. It enables that information can be made available in the subsequent production steps where it can be used for adjusting the planning and control of the processes. The product state information is a supplement to the information provided by, or derived from, the product model, which is the specification of the product. By providing product state information along with the static product information the basis for planning and executing a process is enhanced. Here we define the Product State Model based on the following tasks that it should be able to facilitate or perform, cf. Lynggaard et al. (2001).

A product state model should

- uniquely identify individual products and parts and their assemblies/aggregations
- formalise the information about the actual conditions regarding the product
- store information from multiple sources
- collect information continuously
- enable exchange of information between applications.

In the QualiGlobe project a concept for the Product State Model has been defined in terms of a data structure and formats for describing product properties. Properties may be physical information, e.g. dimensions, surface conditions, material characteristics, position and orientation in space as well as other quality measures. It is required that this information is described in such detail that it can be applied for planning and controlling processes. E.g. the actual edge geometry of one plate is measured after the cutting process, so that it is possible to estimate the gap measure by use of the information about the two plate surfaces that constitute the joint. See the example in figure 1.

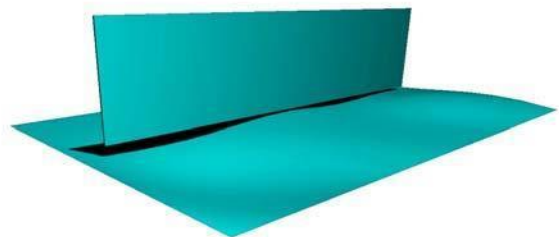


Figure 1: Gab between plate surfaces.

6. The Case study of the QualiGlobe Project

6.1 The Architecture of the PSM Environment

The basic approach taken in the QualiGlobe project was to document the actual conditions of individual parts throughout the production process. The general scenario is described in the following.

In a given process for a given part, the state in terms of output quality is registered. The information is stored in the Product State Model, which also holds product state information about that particular part, collected during previous processes. Then the part is transported to its next processing operation. Before it arrives and starts processing, detailed information about this particular part has been fed from the Product State Model into the process-planning loop where processing parameters, processing time, etc. are determined. The processing time has also been fed into the production-scheduling loop in order to update the current schedule. When the part arrives at its processing station, detailed information about this particular part again has been fed from the Product State

Model into the process control system so that the processing station is configured exactly to the conditions of that particular part.

This approach allows process planning and control as well as detailed production scheduling to take the actual conditions of each part into account. Thereby the processing is improved, i.e. higher quality at lower cost and with shorter throughput time, and the scheduling nearly becomes deterministic because the estimated processing time is more precise.

A range of modules has been defined and developed in the QualiGlobe project. Table 1 describes the individual models, whereas Figure 2 illustrates the modules and their interaction on an architectural level.

PPM	Product Part Measurement (PPM) refers to different types of measurement systems used for determining the characteristics of parts and products. Examples are vision and laser systems for dimensional measurements. Any type of measurement systems could be adopted depending on the type of product state information required.
PPD	Prediction of Process Data (PPD) is a process planning application. As opposed to other types of process planning applications it is able to take information from the Product State Model as input. For example, this means that it is able to divide a welding line in segments and applying different process parameters to each segment.
OPC	The Online Process Control (OPC) module is used to adapt the welding process parameters to the current conditions and hence adjust for smaller deviations, while the welding is taking place. It is similar to existing adaptive sensor systems, except the fact that it applies more advanced algorithms and that it resides outside the robot controller. The latter means that it can be used for different types of robots.
PS	The Power Source (PS) is similar to existing welding power sources, except for improved interfacing capabilities. The interface is used for improved reading and writing of power source parameters when controlling and monitoring the welding process.
DAS	Data Acquisition System (DAS) refers to the sensors and acquisition device, which collects physical signals from the equipment involved in the welding process.
QM	The Quality Monitoring (QM) is an application, which visualises and analyses the data collected by the DAS. It is able to detect some types of welding errors automatically.
QAR	Quality Assurance Report (QAR) refers to an application used on top of the Product State Model (PSM). It is used to document the quality of a welded part with respect to the requirements of the quality assurance procedures.
CE	Compensation Estimation (CE) is another application used on top of the Product State Model (PSM). It is used in the production scheduling loop because it provides information on the required extra work on a certain work piece due to insufficient quality.
RC, CAD, OLP	The Robot Controller (RC), Computer Aided Design (CAD) and Off-Line Programming (OLP) are existing systems involved in the PSM Environment. However, these systems are not directly involved in

	any QualiGlobe project developments, although they are necessary modules of the manufacturing process.
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Table 1: Module description of the PSM environment in the QualiGlobe Project.

The architecture of the PSM Environment is described below. A file from the CAD system (i.e. the Product Model) in IGES standard provides the input for the Product State Model (PSM). The IGES standard was chosen for the prototype, as it was sufficient to use a 2D wire frame model instead of a 3D solid model. The PPM is the interface with the measurement tools from where the detailed geometrical representation is coming, unless it has been collected previously in the process. Measurements of out of plane, i.e. how wavy the plate has become as result of previous production process (here welding), and the fluctuation from a straight line of the edges of plates that are going to be welded on the part block is available from the PSM already. In this way the fit between block and plates can be evaluated.

The OLP plans the welding sequence and distribution of welding capacity on the welding tasks, and generates robot programs and a configuration file for the robot and welding equipment. Furthermore, the OLP provides data for the PSM for later analysis of the realised goodness of the planned quality. The QM is calculating the quality of the product part. Moreover, the QM organises the information received from the RC and DAS into a product state report and stores the information in the PSM for later analysis.

As a part of the near environment, the RC co-ordinates the movements of the robot and the setting of power source parameters, whereas the OPC assures that the welding parameters are according to the input from the OLP, and on basis of the immediate signals of the measurement of the gap from of the (arc-) sensor. During the welding process, the DAS measures and collects data about the welding process via sensors and directly from the RC in order to evaluate the quality of the weld. DAS forwards the signals onto the QM for evaluation.

The architecture of the Product State Model Environment is summarised in the following figure.

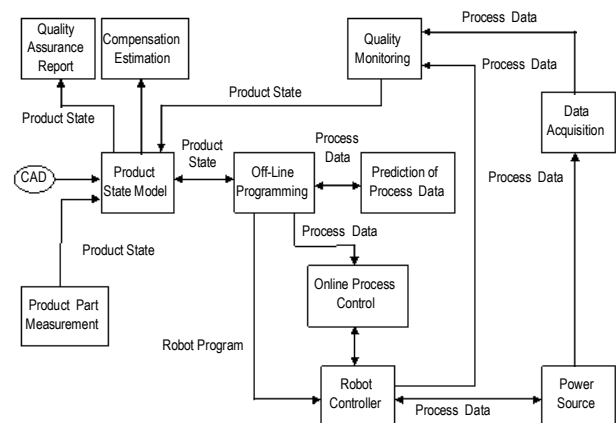


Figure 2: Architecture of the PSM Environment in the QualiGlobe Project.

The foundation for optimising the subsequent production processes based on product state information is that the PSM continuously contains updated data from the feedback from PPM and QM.

6.2 Module Dynamics of the PSM Environment Architecture

In order to illustrate the dynamics of the PSM Environment Architecture, the following section describes a typical example of robot welding of ship elements. The example contains five steps, which are:

- Step 1 – Measurement of product state
- Step 2 – Processing planning of welding and rescheduling
- Step 3 – Welding of the work piece
- Step 4 – Determine the output quality from the welding process
- Step 5 – Reporting of quality and compensation work

The individual steps are described below.

6.2.1 Step 1 – Measurement of product state

Step 1 involves measurement of the output quality of one or more processes. E.g. plate edge measurement of two plates to be joined, or the edge of one plate and out-of-plane deformation of the surface of another plate. The information from each measurement is transferred to the product state model. This step involves the PPM and PSM modules from the PSM Environment architecture.

Alternatively the two plates could be erected and tack welded and measured immediately after. This would give a more precise measurement and it would include information about the tack welds as well. However, it would delay the product state information and thus prevent more precise scheduling.

6.2.2 Step 2 – Processing planning of welding and rescheduling

Based on the part measurements the gap can now be estimated. This provides us the opportunity to perform process planning including generation of robot programs based on more precise part information. This again gives us the possibility to calculate a more precise robot welding time based on process parameters, which are derived from the actual state of the part.

This step involves the PSM, OLP and the PPD from the PSM Environment architecture.

6.2.3 Step 3 – Welding of the work piece

Upon configuring the robot and its process controller with the newly generated robot program, the welding process is carried out. Still, inaccuracies in the prediction of the groove geometry from a Product State Model or a measurement system necessitates that the process is adapted in real-time. Also deformation due to heat input

while processing results in changes of the product properties during the process. Therefore the process is controlled in real-time with a seam tracking-module and an advanced module for adaptive process control.

At the same time, while welding, a range of parameters is acquired and stored from the process for further analysis.

This step involves the RC, PS, OPC and DAS from the PSM Environment architecture.

6.2.4 Step 4 – Determine the output quality from the welding process

After completion of the welding process it is required to know the result. This is in order to determine whether the result is in accordance with quality requirements, whether the output quality has any impact on subsequent manufacturing processes. The first aspect is to some extent handled by automatic evaluation of parameter sets from the welding process. In this way we are able to determine some types of possible errors automatically. Hence, not all types and instances of common errors are necessary successfully identified.

The second aspect is performed by collecting data from the process itself and by performing structural 3D measurements of the work piece after the welding process.

Again, all product information is stored in the Product State Model. This step involves the QM, PPM and PSM modules from the PSM environment architecture.

6.2.5 Step 5 – Reporting of quality and compensation work

Based on the output quality measured in the previous step, conclusions are drawn and relevant reports are generated. One report generated is defining the compensation estimation, i.e. in case the weld requires repair or results in other types of compensation, the type and amount of repair work including additional required lead-time are reported. This report is used for production managers in relation to production scheduling. Another report is used for documenting the quality, and is thus used in the quality assurance procedures.

This step involves the CE, QAR and PSM modules from the PSM Environment architecture.

7. Discussion of Results and Benefits

The QualiGlobe project is a research project and therefore full scale benefits remain to be seen. However, as described below some commercial products are already made available based on the research results.

7.1 Results

A result of the QualiGlobe project is the identification of, description of and relation between all the modules described in this article. In addition, the concept of basing the manufacturing on a Product State Model (PSM) has been developed and tested in a small scale. Nevertheless, the concept may not in its entirety be viable at this time.

One reason alone is that Product State Models that are mature and feasible for industrial applications remain to be seen. The PSM in the quality project is a dedicated and limited pilot system, which may be used accordingly, in industrial applications. Another approach, in order to implement this concept, is to add product state data structures to existing product modelling systems.

Some of the other results of the Qualiglobe project are immediately ready for manufacturing applications. The Data Acquisition System (DAS) is today a commercially available product; Robotiker (Spain) as well as Migatronic (Denmark) have improved their Power Source (PS) products with an open communication interface developed in the project.

Yet some modules, e.g. the Quality Monitoring (QM) and Online Process Control (OPC) developed by ISF (Germany) are examples of industrially applicable systems that improve the current level of process control and monitoring.

Finally, the quality monitoring and process control applications at Fincantieri (Italy) and Odense Steel Shipyard (Denmark) have adopted some of the results.

7.2 Benefits

The experiences and benefits gained from the QualiGlobe project are:

- experience on how to implement a Product State Model, which can be used in future development initiatives
- several vision and laser measurement technologies developed and adapted for shipyard applications
- improved process planning for robot welding applications, resulting in better quality
- improved online process control for robot welding applications, resulting in better quality
- an enhanced welding power source technology for integrated control and monitoring applications
- a data acquisition system, ready to use, for robot welding applications
- a quality monitoring application that is able to detect some types of welding errors
- a quality assurance report generator based on production data collection
- a support application for production scheduling using information from quality monitoring

The Product State Model approach, and related technologies, as described in this paper has been developed in order to reduce the direct and indirect cost of lack of quality in manufacturing processes. In terms of benefits provided by this new concept, it is relevant to mention the increased focus on quality, not only as a measure of output from processes and awareness among employees – but also the consequence of quality as an input to subsequent processes. Thus adapting all processes to the real conditions is making sure that the correct

process is being applied – as opposed to a robust process that will work, though this is not without undesired side effects such as unnecessarily high heat input.

Another benefit is in terms of logistics. By preplanning processes based on measured part data, the processing time is calculated more precisely. Thereby, production schedules can be made more precise and are likely to be observed. Finally, the QualiGlobe project is providing applications for improved process control and automated documentation of quality.

8. Conclusions and Perspectives

The paper provides a review of product modelling approaches as well as empirical insight from the efforts on reducing the accumulated manufacturing errors based on enriched product information. Hence, the article contributes to the design structure for a PSM environment identifying the interacting modules as a basis for information sharing in the shipbuilding industry.

This paper has presented a new manufacturing concept based on a Product State Model. An architecture for the PSM Environment is suggested determining a set of relevant application modules and their relation. In theory, this concept leads to shorter lead-time, improved product quality and reduced production costs in shipbuilding and similar production environments.

The QualiGlobe project has validated central elements of this new concept by developing and testing prototypes. In addition, several technologies that are improving current monitoring and control of welding processes have been developed.

In perspective, standardisation and digitalisation of information is of increasing interest as Odense Steel Shipyard, Ltd. is in the middle of outsourcing part production activities, primarily to the Baltic region.

The Product State Model opens new possibilities for e.g. process planning. In fact several systems involved in industrial process planning, control and quality monitoring applications need to operate in a new way when adopting the Product State Model (PSM) approach. Therefore the QualiGlobe project has developed new applications for process planning, control and monitoring.

Acknowledgement

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**B2B Collaboration:
Economic Value and Investment in Technology**

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Tracks: collaboration commerce, e-commerce management

Abstract

To collaborate with partners a company must reengineer its business processes for information and knowledge sharing, and for operations coordination. Digital technologies have proven very effective in supporting such collaborations. Companies may collaborate vertically with their suppliers and customers, or they may collaborate horizontally with other manufacturers. The benefits of collaboration would obviously depend upon how the partners, together, extract economic value from the market. This value would be different in different demand and/or cost scenarios. The decision to invest in collaboration technologies, on the other hand, is usually made by individual companies. There is clearly a tradeoff between the capabilities a company may create through investment in digital technology, and the market benefits it may obtain from collaborating with partners. In this paper we explore (1) how markets can be leveraged to create economic values in collaboration, and (2) how optimal investment (in technology) can be made using these collaboration values.

Personalizing Quantitative Homework Assignments To Facilitate Student Learning

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Abstract

Electronic business tools, technology, and approaches have enabled organizations to reach new customers and markets more effectively and efficiently than ever before. A parallel process has occurred in the education industry. In many of these educational ventures, the desire to reach underserved populations is a primary motivation. In others, efficiencies and cost reductions are paramount. Still other e-learning and innovative teaching initiatives have been initiated by the sincere and direct desire to improve existing educational effectiveness.

The project described in this paper is focused on educational effectiveness of teaching operations management to college students. The idea is to have a student-friendly approach to developing customized homework problems where each student has the same problem type but unique values, answers, and decisions. In this way, we seek to encourage student interaction and discussion of the problems while minimizing the risk of cheating through rote copying.

1. Introduction

Electronic business tools, technology, and approaches have enabled organizations to reach new customers and markets more effectively and efficiently than ever before. Just a few short years ago, people interested in buying a book had to travel to their local bookstore to physically sift through inventory on the shelves. If the book they were looking for was not available, they were forced to settle for an alternative selection, place a special order and wait days or weeks for delivery, or leave empty handed. Booksellers, most notably Internet-based Amazon.com, have helped to revolutionize the customer purchase process by changing the very mechanisms with which the customers access and acquire books. Geographic limitations of customers have been eliminated while inventory searches are completed electronically in seconds where relevant results and independent evaluations readily available. Even the special order process has been reengineered. Customers of some Borders Books stores, for example, can have their hard to find texts custom printed, cut, and bound in minutes while they wait.

To most customers, the e-business phenomenon seems to have occurred at these very visible levels. In actuality, though, these front-end capabilities require sophisticated

back-office processes built around an electronic infrastructure predicated on integrated business systems. Reaching new customers, better serving existing customers to increase their purchase quantities and qualities, and lowering the costs of doing business are primary goals.

A parallel process has occurred in the education industry. Like business organizations, secondary and post-secondary educational institutions are finding new ways to attract and service students with greater efficiencies. The University of Phoenix is a leader in electronic learning, delivering dozens of degree programs to underserved populations primarily through Internet-based processes. More recently, on-line secondary schools have gained ground. In these high schools, virtually all curricula are delivered using electronic means where student and instructor may never actually meet face-to-face.

In many of these educational ventures, the desire to reach underserved populations is a primary motivation. In others, efficiencies and cost reductions are paramount. This is especially true in some government supported institutions where budget cuts have had a disproportionate impact. Still other e-learning and innovative teaching initiatives have been initiated by the sincere and direct desire to improve existing educational effectiveness.

The project described in this paper is focused on educational effectiveness of teaching operations management to college students. Most of these students are of traditional age and begin college directly out of high school with little professional business experience. Unlike graduate students and older individuals, who may have developed the discipline and motivation to thrive in a fully e-learning environment, these undergraduates often desire the structure and socialization that comes with a classroom setting. Distance and e-learning options are available to our students but remain a small fraction of course credit hours completed and are often utilized simply to access courses that are not offered at the time or location of the student's choosing. From a competitiveness position, though, these e-learning options will only improve and become more of a viable alternative for our student population. As instructors, our core competency must be to develop pedagogy to facilitate active learning and a community classroom.

The challenge for the instructor becomes not only how to pique student interest in this quantitatively-oriented operations management but to add genuine value to the

student's business education. At one point in time, a student grade in this course was based solely on multiple-choice exams. However, this did little to meet the needs of businesses who seek new graduates possessing computer skills that can be employed in solving problems and making decisions. As a result, spreadsheet-based homework assignments have become a more prominent component.

These assignments provide opportunity for integrated problem solving, model building, and decision making for this student population. Today, homework assignments account for up to 30 percent of our student's final grade. A student survey during the Spring 2003 semester indicates that more than 4 out of 5 operations management students viewed the homework assignments as being an important or very important component to their learning processes. Furthermore, voluntary student comments written on standardized university-level student evaluation of instruction (SEIs) are overwhelmingly positive with regards to homework. These clearly indicate that students perceive homework as a valuable addition to the course.

While these student perceptions are encouraging, as instructors we remain concerned about the loss of control that occurs with assignments completed outside of the classroom. Student interaction and dialogue on problem solving is indeed an important factor in the learning process but cheating via rote copying must not be dismissed out of hand. Indeed, published studies show that academic dishonesty is not a rare practice in undergraduate programs and student attitudes towards cheating is more accepting than it was years ago. Instructor concern with the impact rote copying of homework is especially relevant given that a gap exists between student performance on homework assignments and on corresponding in-class exam problems. Therefore, while student perception regarding the value of homework is encouraging, the efficacy of homework in student learning processes is less clear.

The goal of this project is to develop a means to develop and deliver quantitative homework problems that foster student interaction and collaborative learning while discouraging the rote copying of answers. Furthermore, the method must ensure student accessibility to the technology employed and to homework assignment delivery. In addition, instructor concerns must be addressed so that not only are effective assignments developed, but efficiency in grading facilitated. To achieve these goals, concepts of personalization and mass-customization from e-commerce and operations management were embraced.

2. Principles Used in Developing Homework Delivery System

2.1 Technology

Homework development and delivery is accomplished via a combination of Internet-based and microcomputer-based technologies. The homework generating programs are obtained by students by

downloading from the instructor's website ensuring easy access and distribution. This process is very well known to most students before they even enter the operations management course.

The homework problems are encoded using Microsoft Excel and Visual Basic for Applications (VBA), which comes standard with the Microsoft Office package. The VBA program is set to automatically launch upon opening of the Excel workbook, generates the homework files, and outputs the customized assignment in a Microsoft Word file. Students must then use Excel to solve the questions posed. Each assignment requires explanations of the decisions they made. This helps to meet the needs of future business employers who seek students with strong spreadsheet, analysis, and decision making skills.

2.2 Personalization

Personalization and mass-customization are two closely related concepts that require sophisticated back-office support mechanisms to make the user front-end appear seamlessly unique to each individual (Turban, 2002). Personalization in e-commerce is often achieved via cookie files which track and store pertinent user information so customized web pages can be rendered, tailored advertisements can be generated, and relevant related products and services or information can be displayed for consideration. Personalization can also encourage customer self-service as individuals who readily find pertinent information are willing to act upon it.

Personalization of homework problems is employed so that each student receives unique values in their assignment. Student self-service is utilized via dialogue boxes that automatically launch when the Excel file is opened. The dialogue boxes ask for the student name and the last four digits of their social security number. Error trapping routines ensure valid values are entered. The social security number entered becomes a seed to lookup one of (currently) 1000 problem variations in the database.

2.2 Mass Customization

Mass customization is an operations management process strategy that attempts to blend the efficiency of product-focused and repetitive-focused strategies with the flexibility of process-focused approaches. To achieve mass customization, organizations must excel at effective scheduling techniques, modular techniques, and rapid throughput techniques (Heizer and Render, 2003).

2.2.1 Scheduling Techniques

For organizations, effective scheduling techniques are a key because of the high variety of products made, the need to achieve high capacity utilization, and the desire to keep inventories low. In homework problems, variety is achieved by generating unique values for each student and is controlled using VBA and an instructor developed database. While current problem variety is arbitrarily set

to 1000 combinations in the database for testing purposes, utilizing random number generation routines will increase this to an essentially infinite number of combinations in the near future. A more difficult scheduling problem occurs in grading the assignments. Currently a manual grading approach is being implemented via VBA code. Scheduling in this sense occurs through logical layout of the grading key that is synchronized with the homework questions posed.

2.2.2 Modular Techniques

Modular techniques are often used in repetitive-focused processes such as assembly lines to achieve a specified balance of variety and volume. This concept often simplifies the scheduling concerns noted above. Modular techniques are also applicable in the mass customized homework assignments. Consider, for example, a forecasting problem where several forecasting techniques are applied. The homework combinations can be generated so that the decisions lead students to choose different forecasting methods as the best. As such, student interaction can be encouraged as individual analysis is required to make the correct decision in each setting.

2.2.3 Rapid Throughput Techniques

Rapid throughput techniques are a characteristic of most product focused process strategies such as making steel or paper. Very specialized equipment and facilities requiring significant capital outlays make large volumes of product with low differentiation. Customization is then achieved after manufacturing as finishing processes customize sizes and packaging. For homework problems, this issue speaks directly to the grading process. Automation of grading, where spreadsheet answers are evaluated via grading agents is foreseen. In this way, a single instructor could accommodate any number of students with little additional variable cost.

3. Conclusion

In this project, we have attempted to apply the e-business and operations management concepts of personalization and mass customization to student homework problems. The idea is to have a student-friendly approach to developing customized homework problems where each student has the same problem type but unique values, answers, and decisions. In this way, we seek to encourage student interaction and discussion of the problems while minimizing the risk of cheating through rote copying.

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Planning and Specifying the Composition of Web Services

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Abstract

As the Web services paradigm becomes popular and more and more applications are created and deployed as Web services, the need for developing new solutions tackling the composition of Web services becomes manifest. However, emerging web service standards and existing methods are not sufficient for realizing the goal of flexible and dynamic composition of Web services, although some preliminary work has been conducted in the area of services composition. This situation has raised the interesting research points for creating and developing new approaches for the Web services composition. In this paper we separate the design and implementation phases of the composite services, and concentrate on the research of the way a composite service is constructed in terms of its constituent services. We call this way the composition logic of a composite service. We firstly propose well-defined notions “composition structures” to represent the joints among the constituent services and generate the reliable structure of a composite service, and then we provide a specification mechanism to clearly specify the internal dependencies of a composite service in terms of the notification and dataflow dependencies. Our solutions for planning and specifying the composition of Web services can effectively support the properties of modularity, interoperability, dynamic reconfigure-ability and fault-tolerance for a composite software system in the dynamic Web environments of business applications, which are a organic part of our framework for tackling the challenges of Web service discovery and composition on which we are working.

1. Introduction

Web services are becoming the prominent paradigm for distributed computing and electronic business, because they represent a novel approach and framework for creating and deploying application-to-application communication on the Web. By Web services, we refer to self-contained, Internet-enabled applications capable not only of performing business activities on their own, but also possessing the ability to engage other Web services in order to complete high-order business transactions. Examples of such Web services include bill payment, customized on-line newspapers, or stock trading services and so on. The platform neutral nature of Web services creates the opportunity for developing composite services by using existing atomic or composite services possibly

offered by different organizations. For example, a travel-plan-service-package can be developed by combining several atomic services such as booking-air-ticket-service, booking-hotel-service, making-reservation-for-restaurant and renting-car-service, etc., based on their WSDL descriptions [4].

As the Web services paradigm becomes popular and more and more applications are created and deployed as Web services, the need for developing new solutions tackling the composition of Web services becomes manifest. However, emerging web service standards (e.g., WSDL, UDDI, WSFL and BPFL4WS) and existing methods are not sufficient for realizing the goal of flexible and dynamic composition of Web services. Although some preliminary work has been conducted in the area of services composition, mostly in aspects of workflow-like service integration, service conversation, and B2B protocol definition [1, 2, 3]. However, these approaches are either not flexible or too limited, there is still a lot of research that needs to be done in this direction. This situation has raised the interesting research points for creating and developing new approaches for the Web services composition.

The real challenge in services composition lies in how to provide a complete solution that supports the entire life cycle of services composition, i.e., planning, definition and implementation. By planning, we mean that according to user's requests, a composition plan that how to complete the user's tasks which maps his requests needs to be proposed firstly, afterwards, then the candidate atomic or composite services that possibly complete these tasks need to be discovered, correspondingly. During this phase, every task from the user side needs to be mapped to each service. The outcome of this phase is the synthesis of a composite service out of desirable, or potentially available, atomic services, and the structure of a composite service is generated and formed. At the definition phase, the internal dependencies of the composite service need to be clearly defined and specified. The outcome of this phase is the interdependencies specifications of services composition. Finally, the implementation phase implements the composite service bindings based on the services composition specifications. The first two phases serve as the blueprint and reference of the third phase within the entire life cycle of services composition. Therefore, the first two phases are crucial for the implementation of Web services composition. Without the appropriate planning and definition of Web services composition, it is impossible to implement Web services composition and

satisfy the user's requests. Thus the first two phases within the entire life cycle of services composition are very important, and they correspondingly raise two interesting research points, one is how to systematically plan and model the structure of a composite service? Another is how to clearly specify the inter-relationships of a composite service? If these two issues can be properly solved, the development and implementation of Web services composition would be greatly facilitated. However, the existing standards and approaches haven't systematically addressed these issues, or are not enough to effectively tackle these issues.

In this paper we concentrate on first two interesting issues and propose the well-defined notions "**Composition Structures**" to plan and model the structure of a composite service during the planning stage of services composition, and then we come up with a specification mechanism that effectively tackles the definition stage of the entire life cycle of services composition, as it can clearly specify the internal dependencies of the composite service which effectively facilitated the implementation of services composition. In the planning stage of services composition, our objective is to easily generate the composition process and to support the composer in selecting most suitable services. Thus we modified and enhanced the task structures notions [7] and developed our new composing notions for the services composition: composition structures. These composition notions capture the most critical aspect of services composition: **joints** among the several services; and address the use of libraries of well-defined building blocks to represent the joints and connect the services, which provides a kind of reliable and lightweight mechanism for services composition. By using these notions and notations, the basic structure of services composition can be generated, afterwards, and the complete and nested structure of services composition also can be generated based on the basic structure of services composition if it is necessary. Naturally, our assumption is that the composer will prefer dealing with appropriate and fewer services where possible, which increases the security and the trustworthiness of the resulting services. During the definition stage of services composition, we would like to provide a specification approach which specifies the internal dependencies of a composite service. We view every service as an independent unit of computation. Our work is motivated by the observation that a composite Web service is constructed by composing several constituent Web services, which are executed in a heterogeneous environment. The resulting composite Web service might be very complex in structure and relations, containing many **notification** and **dataflow** dependencies among their constituent services. Furthermore, the execution of such a composite service may take a long time to complete, and may contain long periods of inactivity, often due to the constituent services requiring user interactions. In a distributed environment, it is inevitable that long running composite service will require support for fault-tolerance and dynamic reconfiguration: machines may fail, services

may be moved or withdrawn and application requirements may change. In such an environment it is essential that the clear specification of the structure and internal dependencies of the composite service need to be clearly specified, and this specification need support the properties of modularity, interoperability, dynamic reconfigure-ability and fault-tolerance for a composite software system in the dynamic Web environments of business applications.

Thus the focus of this paper is on the following:

- We propose well-defined notions and notations "composition structures" to capture the most key aspect of services composition: joints among the several constituent services; and represent these joints and connect the constituent services. By using "composition structures", the structure of a composite service can be reliably generated and formed.
- Afterwards, we come up with a specification mechanism that can clearly specify the internal dependencies of a composite service which include the notification and dataflow dependencies, and it can effectively support the properties of modularity, interoperability, dynamic reconfigure-ability and fault-tolerance for a composite software system in the dynamic Web environments of business applications.

The outline of this paper is as follows. Section 2 firstly addresses our novel notions and notations: composition structure, which has four basic building blocks such as and-split, or-split, and-join and or-join. Section 3 comes up with our specification mechanism for the services composition, and last two sections present the related work, summarize our contributions and conclude the paper.

2. The Composition Structures

As we know, the dynamism and unpredictability of the business applications and Web environment require that the Web services composition have the ability to adapt to unknown situations. We believe that some form of enhanced features from reflection and process modeling will provide the right ingredients to enable adaptability.

Reflection [5] is the act of revealing a system's implementation, and allowing changes to that implementation in a controlled manner. By inspecting internal aspects of a system, its competence may be improved, either through better performance or greater adaptability. The concepts of reflection have been applied in many areas of computing and information technology, where it has been employed as a means of building up flexible and extensible computer systems – ones that can evolve and adapt to changing circumstances and expectations [6]. In this paper we apply to the concept of reflection and inspect the internal aspects of a composite service, which includes two main parts: the structure of a

composite service and the internal dependencies of a composite service. Correspondingly, we come up with our solutions in order to tackling these two parts. We believe our solutions tackle the most critical aspects of a composite service, and satisfy the requirements of the flexibility, adaptability and reliability for a composite service.

During the process modeling of a composite service there is a vital aspect and a hard point that needs to be firstly tackled: that is how to deal with the joints among the constituent services. Here we would like to propose our notions: composition structures based on the concept of task structures. As we know, a composite Web service involves the completion of several Web services. These several services need coordinate to complete a specific task. This kind of coordination is actually the coordination of several tasks, which has the process style. For example, Flight-booking service need to be finished before Accommodation-booking service commences. After finishing Accommodation-booking service and Attraction-searching service, the composite service needs to choose one service between Bicycle-booking service and Car-rental-booking service. After that, Events-planning service takes place. Processes focus on the coordination of tasks. Any process specification language should at least be capable of capturing sequential composition, moments of choice, parallel composition, and various forms of synchronization. Task Structures [7] is notions and notations for describing the various tasks within a process, and their interdependencies. In this paper we enhance the notions and notations of task structures specifically for the Web services composition. Here we only apply to these enhanced notions and notations to generate and model the structure of a composite Web service, and use another solution to specify the inter-dependencies among the constituent services of a composite Web service. We believe this kind of treatment is more reasonable, because the composing structure and the dynamic inter-dependencies of a composite Web service are two different facets of a composite service and have their own characteristics. It deserves to obtain the different treatments and apply to the different approaches and solutions.

Thus the composing structure of a composite Web service may be composed from one or more of five particular building blocks, here we call them “**Composition Structures**”. (Naturally, we might introduce more composition structures similar to process patterns in workflow research community [8,9,10]. However, here our purpose is to generate and model the structure of the coordination of several Web services, which is different from modeling the control structure of workflow, although they have some similarities. After all, the composing structure of a composite service is different from the control structure of workflow. Moreover, over-introducing the building blocks might lose flexibility and manageability for a composite service. This aspect of research is beyond the scope of this paper).

Sequential-composition: After Service A has been

performed, only Service B will be performed. This is called **Sequential-composition** between two services.

AND-split: After Service A has been performed, both Service B and Service C will be performed. Service A is said to **trigger** the other services.

OR-split: After Service A has been performed, either B or C, but not both, will be performed. This is called a **decision point**.

AND-join: Service C cannot be performed until both A and B have been performed. This form of join is called a **synchronizer**.

OR-join: Service C will be performed whenever either A or B, but not both, have been performed. This form of join is called a **discriminator**.

The above notations are not limited to relations among three services, and they might be extended more than three services. For example, Service A can **trigger** more than two parallel services at the same time.

Please note the above notations are not only notations, but also they are notions, since they express a kind of semantics and satisfy the requirements of process specification language which captures sequential composition, moments of choice, parallel composition, and various forms of synchronization.

3. Specifying the Internal Dependencies of a Composite Service

3.1 Specification Approach

In terms of the composition structures notions, the reliable structure of a composite service can be generated and formed. In order to describe the dynamic dependencies of a composite service, and there is the second part of work which needs to be done. We need to clearly specify two vital inter-dependencies of a composite service: the **notification dependency** and the **dataflow dependency**. The notification dependency means that there exists the sequential relation between two services or two services structures. For example, Service 2 can't be started if Service 1 has not completed; the dataflow dependency means that there exist the data-flowing relations between two services or two services structures. For example, Service 2 needs the data of Service 1; Accommodation-booking service needs the data of the Flight-booking service such as the date, location and the number of clients, etc. We assume that every dataflow dependency also has the notification dependency.

Notification Dependencies. Each notification dependency takes the form:

Notification from {...}

For example, Service 2 can't be started until Service 1 is successfully completed.

Service 2


```

{
  Notification from
    {Service 1 if Service 1 success}
}

```

Dataflow dependencies. If we use the textual representation in the dataflow dependencies, each dataflow dependency takes the following form:

```

Service 2
{
  Inputs {input-X from
    {output-x of Service 1};
    input-Y from
    {...};
    ...
}

```

For example, the input-A of Service 2 needs the output-a of Service 1; and the input-B of Service 2 needs the output-b of Service 1.

```

Service 2
{
  Inputs{input-A from
    {output-a of Service 1};
    input-B from
    {output-b of Service 1}
  }
}

```

3.2 Example

Now that we have the specification mechanism to specify the composing structure and dynamic inter-dependencies of a composite service, a complete specification of a composite service can be formed. If we take the “Travel Solutions” example, its complete textual specification can be written in the following:

```

Composite-service “Travel Solutions”
{
  AND-split from beginning splitting to Flight-booking
  service and Attraction-searching service
  {
    Service Flight-booking
    Inputs {date; location; the quantity of the
    tickets; ...},
    Service Accommodation-booking
    Notification from {Service Flight-booking if it is
    successful}
    Inputs
    {outputs (date; location; the quantity of the
    tickets; ...) of Flight-booking service}
  };
  Service Attraction-searching
  Inputs {location, ...},
  AND-join from Accommodation-booking service and
  Attraction-searching service to a decision point (OR-split),

```

```

OR-split from Accommodation-booking service and
Attraction-searching service to Bicycle-booking service or
Car-rental-booking service,
  Service Bicycle-booking
  Notification from
  {Service Accommodation-booking and Service
  Attraction-searching if they are successful}
  Inputs {...};
  Service Car-rental-booking
  Notification from
  {Service Accommodation-booking and Service
  Attraction-searching if they are successful}
  Inputs {...},
  OR-join from Bicycle-booking service or
  Car-rental-booking service to Events-planning service,
  Service Events-planning
  Notification from
  {Service Bicycle-booking or Service
  car-rental-booking if one of them is successful}
  Inputs {outputs(date;location;...) of Attraction-searching
  service}
}

```

Similarly, the above textual specification also can be drawn in a graphical manner with the textual annotations. Because of the limitation of space, here we will not draw the complete graphical specification blueprint.

4. Related Work

Most of the work in service composition has focused on using workflows either as a engine for distributed activity co-ordination or as a tool to model and define service composition. Representative work is described in [14] where the authors discuss the development of a platform specifying and enacting composite services in the context of a workflow engine. The eFlow system provides a number of features that support service specification and management, including a simple composition language, events and exception handling.

The work related to Web services and co-ordination or composability can be found in [25]. In this paper the authors examine the potential of using coordination technology to model electronic business activities and illustrate the benefits of this approach.

Our work in this paper is different from the above-mentioned work. Our main idea is to separate the design and implementation of a composite service, and concentrate on the research of composition logic for the composite services. Correspondingly, we come up with our sound solutions for the service composition. We believe the advantages of this way are to greatly facilitate discovery of Web services, since the generated structure by using our approaches maps the services we need to discover. Moreover it possesses more flexibility and adaptability, and the structure of a composite service may be easily changed and adapted according to the user’s realistic needs. Our work satisfies and supports the main requirements of a flexible composite software system such

as modularity, interoperability, flexibility, adaptability and fault-tolerance and dynamic reconfiguration in the dynamic Web environments of business applications. Our concrete approaches are related to the following research fields:

Generic process models: In [27], each workflow schema is associated with a family of variants. A particular task in the schema may be viewed as the root of an extensible class hierarchy, with the hierarchy expressing allowable instantiations of that particular task.

Workflow pattern: In the work of [21], a systematic overview of process control constructors is provided. The patterns address business requirements in an imperative workflow style, but are independent of any particular workflow language. They encapsulate commonly used forms of complex workflow functionality.

Architecture Description Languages: Software architecture specification is intended to describe the structure of the components of a software system, their interrelationships, and principles and guidelines governing their design and evolution [15, 16, 17]. It is common to model an application as a set of components communicating through connectors. Typically, an application is composed from components, where a component provides services to other components. A component within an application can be either a simple component, or composed out of a group of other components. The components provide and obtain service through ports. The interaction between ports can take many forms, for example, buffered message passing, one-to-many event dissemination, or synchronous request-reply communication. Currently available ADLs however do not capture the computation unit structure of a composite application. This requires describing the structure and inter-dependencies of an application. Our approaches capture this structure in terms of composition structures notations and their dependencies by specifying input and output requirements. Another advantage of describing composite structure in terms of services is that it directly enables application level fault tolerance requirements to be specified and controlled.

5. Concluding Remarks and Future Research Directions

In this paper we come up with our sound solutions for the composition logic of the composite services, which is referred to the way a composite service is constructed in terms of its constituent services. Our ideas are to separate the design and implementation phases of a composite service, and concentrate on the research of composition logic of the composite services. The advantages of this treatment are to make the composite services have more flexibility and adaptability, which greatly facilitates the discovery of the constituent services, since the structure of a composite service we generate maps the discovery of its constituent services. Our concrete approaches are that we firstly propose well-defined notions “composition structures” to represent the joints among the constituent

services and generate the reliable structure of a composite service, and then we provide a specification mechanism to clearly specify the internal dependencies of a composite service in terms of the notification and dataflow dependencies. Our work is motivated by the main requirements of a flexible composite software system such as modularity, interoperability, flexibility, adaptability and fault-tolerance and dynamic reconfiguration in the dynamic Web environments of business applications. Our solutions and specification mechanisms satisfy these requirements and support these properties. The concrete reasons are summarized in the following:

- We view every service as an independent computing unit. Our notions, notations and specification mechanism are applied to easily generate the structure of the composite computing unit (or composition structure or service) and clearly specify the inter-relations of these constituent computing units. So our solutions support the modularity and interoperability of the composite system.
- Our “composition structures” notions and notations provide a kind of flexible, adaptable mechanism to address the composition logic of the composite system, which means the structure of a composite service can be easily and reliably adapted if the users’ needs are changed.
- Our solutions provide a reliable specification mechanism for the implementation of a composite service. We believe only we have the clear specification of a composite service in an abstract manner, then it can support the properties of fault-tolerance and dynamic reconfiguration for a long running composite service on the Web.

Based on our above work, future work might include two research directions: one is to continue to research the composition logic of Web services, specifically address the composition logic in a more formal way; another is to develop the corresponding application tools or languages for our specifications of the composite services.

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A Collaborative B2E based on a P2P platform

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Abstract

Companies, large and small, are rapidly adopting Business-to-Employee (B2E) applications hoping to improve productivity of their work force. However, most B2E applications do not provide a good sense of community and lack of collaboration and interaction among its users. Consequently, employees are not motivated to fully utilize the contents and information provided by these applications. Peer-to-peer (P2P) computing is proven to be a good platform that provides and supports community by empowering users to collaborate and interact with one another. In this paper, we propose an approach to provide collaboration in B2E applications based on a P2P platform.

1. Introduction

Business-to-Employee (B2E) applications are believed to be the next wave of the "B" technology. It is estimated that over 75% of global 2000 companies will have adopted B2E applications by 2004. Not only are large corporations adopting B2E as a means to improve communication and increase productivity of its work force, but more small and medium companies are also expected to embrace the technology [6]. In another survey conducted recently by Venkatesh Shankar, et al [8], rapid adoption of B2E applications is further confirmed: more than two-thirds of the 473 firms who participated in the survey claimed that they are using the wireless Internet primarily for B2E applications. The survey results also make an interesting revelation in addition to the finding that B2E applications are going mobile: companies adopting B2E applications are not only confined to a few industries. Instead, the surveyed sectors are quite diversified; they include banking, insurance, manufacturing, telecommunications, transportation, media, utilities, retail, health care, and government. It is apparent that B2E is gaining acceptance across the board of industries.

In this paper, we will first discuss what B2E is, the desirable features of B2E, and the deficiencies of existing B2E applications. To overcome these deficiencies, we

propose a new approach to develop B2E applications based on a peer-to-peer (P2P) platform. We will briefly describe what a P2P platform is and how B2E can be built on it. Finally, we present a collaborative B2E system that is implemented by a global IT company based on Groove Network, a commercial P2P platform.

2. What B2E is

B2E is said to have evolved from the Executive Information System (EIS) of the 1980s [5]. In an EIS, senior management of an organization can access the news, financial data, company performance, information of products, competitors and vendors etc, with a single entry point. This is supplemented by emails, customized built applications, ad hoc query tools, quick and easy report writers, etc. Others believe that B2E actually began with telephone automatic systems (e.g. integrated voice response (IVR) systems) that provided simple human resources administrative functions and evolved into fully personalized portals. While it is debatable that B2E evolved from EIS projects, lessons were definitely learned from developing these EIS. For example, developers gained understanding and experience on integrating diversified data sources of an enterprise with new IT technologies and infrastructure. In addition, developers also realized the significance of politics, company culture, commitment and support from the top management in order to secure the acceptance of EIS. These experiences influence and propel the development of B2E.

B2E is to improve the effectiveness, efficiency and productivity for both individuals and teams by simplifying administrative processes, building competitive advantages through simplified workflow, collaborating and sharing knowledge with one another. Many functions and applications such as company information, R&D programs, project teams, marketing campaigns, HR functions etc, were mostly invisible to employees before, but the advent of Internet technologies made it possible for companies to create portals that integrated all these functions within one single entry point. A company can provide the most up-to-date information to its employees.

Employees can now invoke applications within the same portal without leaving the browser. Through the portal, archives of presentations made by marketing department, status reports on new products and information regarding competitors and vendors, are all accessible through the portal. The accessibility not only makes sharing work easier, but it also makes the entire company more transparent.

2.1 Desirable B2E Features

A typical B2E scenario can be described as follows: A Sales staff logs onto his personalized portal (i.e. MyPortal) in the morning. The portal contains information on the company, updated departmental information, the latest news on products, market analysis (including news on competitors, customers and vendors) done by the Marketing dept, pricing schedule, customer info, sales order status, emails, discussion forums on topics related to sales, file repository that includes sales order forms, customer PO history, new sales training materials on product specifications, and a To-Do list which includes pending sales calls, replies and responses to customers, call list for potential future customers. He will then carry out his daily task assignments and obtain supporting information using the portal.

A B2E portal can provide abundant information for a user. However, the real issue is not all on the B2E portal contents. People can become so overwhelmed by the vast amount of information in a portal that they feel alienated by them. This presents a real problem because, above all, a B2E portal should be the platform where people can relate to their company and to one another and to build the sense of community. Furthermore, any B2E portal has to be compelling to the people who use it. Based on these perspectives, we identify the following list of desirable features of a B2E portal:

(1) Basic Features

- a. Single point of entry. A B2E has one URL that will be the entry point of all employees.
- b. Tools and applications that support daily operations such as news, events, calendar, file repository, etc.
- c. Personalization. The functional aspect of personalization is to allow an employee to select what information should be presented in what order. Psychologically, personalization gives an illusion that the portal is designed to serve just one employee. The more personalization an employee does to his portal, the higher chance that he will use the portal.

(2) Advanced Features

- a. Communication
Communication should include many modes, synchronous and asynchronous such as one-to-one (email), one-to-many (broadcast message, listserver, mass mailing list), and many-to-many (discussion groups and forums), including chat room and instant

messaging. A B2E must provide channels for employees to communicate to the management and to each other.

b. Collaboration

i. Real time collaboration.

Employees will need to collaborate and interact with each other in order to improve their efficiency, productivity, often to provide better customer services. Real time collaboration includes co-browsing, co-editing, co-annotating, whiteboard drawing, chatting, and instant messaging.

ii. Offline collaboration and synchronization.

Offline collaboration is also necessary to support team work. There will be times when team members are not connected to the Internet or the collaboration does not require real time support. A B2E should support offline collaboration mode such as discussion forums. Updates done by other team members should be synchronized with members who have been offline so that they can catch up with the activities and events at a later time.

iii. Ad Hoc Collaboration.

Collaboration mode is mostly pre-defined, i.e. establishing a virtual workspace for a specific project or purpose. However, there are often times when people need to set up ad hoc collaboration workspaces to facilitate their work. For instance, a sales staff may need to collaborate with an engineering team for a short period of time. They should be able to form an ad hoc collaboration workspace to support their work.

c. Knowledge Sharing.

A B2E should support both structured and unstructured knowledge, e.g. file repository, training materials, handbook, guidelines, company procedures and policy, chat room archives, history of document annotation and editing.

d. Multiple Channel Delivery System.

A B2E should be able to deliver to multiple devices and platforms, ranging from desktop browsers, to notebook computers connected through cell phones and Wi-Fi, to PDAs and cell phones.

e. Workflow and Processes Support,

A B2E should support workflow and processes that are tailored to the company's culture and best business practices.

f. The B2E should not be restricted to single domain or application. It should be able to

span across the boundaries within and outside of a company. It should cross departments and be exposed to external entities such as clients, vendors and suppliers.

2.2 Existing B2E applications and their deficiencies

Basic B2E solutions have been around for quite some time [2]. In the 1980s, companies used phone system automation (e.g. the integrated voice response (IVR) system) to support their employees. Most notably, it was at this time that many human resource functions, such as benefit administration, could be accessed via an IVR system. In the 1990s, client/server employee self-service applications were developed. Employees could submit benefit application forms, modify their personal information, view the status of their benefit packages, apply for vacation, etc through a client/server application within the LAN. In the late 1990s and early 2000s, the advent of technologies and the availability of the Internet, in addition to the valuable experiences in building EIA systems, B2E applications were transformed into web-based Intranet or Internet applications that allowed an employee to access information anytime from anywhere. These web-based applications were then further integrated to form a fully customizable company portal. As can be seen, the B2E portal has evolved from a traditional simple IVR to a client/server application, from a limited amount of services to a full spectrum of employee services that range from accessing information on the company, product specifications, business/market intelligence on its competitors, customers and vendors, product pricing information to employee handbook, company policies and procedures, HR benefits and to online training. It is irrefutable that these solutions do improve the productivity, efficiency and effectiveness of employees. However, there are several areas that these solutions fail to address:

- (1) Lack of communication. Communication is mostly one-sided. The company disseminates information to employees and collects specific information from employees through applications. It would be difficult for employees to pass information upward. In an efficient and ideal organization, with more people in the decision making process, people who have relevant information or ideas have a better chance than ever to influence the outcome of those decisions. Existing B2E is weak to support m-way communication among employees and management.
- (2) Lack of Collaboration and Interaction. B2E applications hardly support collaboration and with very limited interaction. However, collaboration is key to improve effectiveness, efficiency and productivity. Collaboration creates good sense of community which can be the major attraction to draw employees to use B2E.
- (3) Lack of Sense of Community. Most B2E applications do not support communities. Users of such systems will hardly get the chance to interact with other users. A good sense of community support is essential to attract and retain users.
- (4) Difficulty in crossing boundaries. Most B2E applications are separated from each other. It is difficult to traverse or integrate a specific B2E application to other B2Es or to other non B2E applications.
- (5) Lack of flexibility to support ad hoc collaboration. Collaborations in most B2E are pre-defined and do not allow users to create ad hoc collaboration when needed.

3. Peer-to-Peer Platform

In the past few years, P2P has attracted enormous media attention and gained popularity by supporting two main classes of applications: file sharing, in which peers share files with each other (for example, Napster, Gnutella, Morpheus and Kazaa), highly parallel computing, in which an (inherently) parallel application runs on available nodes (for example, SETI@home and FightAIDS@home) [9].

A Peer-to-Peer (P2P) is a set of protocols on which an IT architecture is built upon to provide a distributed computing environment (DCE) [7]. Hosts are interconnected via Internet. Each host maintains its autonomy. Every host is "equal" without the distinction between Client and Server. An individual host can have its unique abilities and can benefit from services provided by its peers. The enabling technologies of P2P are due to the ubiquitous network connectivity with available high bandwidth, combined with increased process and memory capacity. In addition to file sharing and highly parallel computing, other services such as virtual communities, real time collaboration emerge.

The major deficiency of existing B2E is the missing of collaboration and hence the sense of community. Analogous to the Maslow's Hierarchy of Needs, a Collaboration Hierarchy is depicted in Figure 1. At the lowest level, collaboration can be based on emails and supplemented with FTP. The next level of collaboration is the groupware and shared network drives. A more elaborated collaboration can be provided with web applications and portals so that employees can share and collaborate anywhere anytime. The highest level of collaboration will be the real-time collaboration based on a P2P architecture. Peer-to-Peer (P2P) is proven to be an excellent computing environment to create and support collaboration and sense of community [3, 4, 7, 9]. It is this level of collaboration we are proposing in this paper.

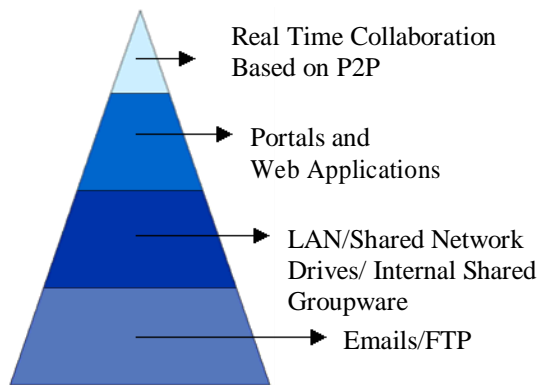


Figure 1: If Maslow was a collaborator

4. A Collaborative B2E based on P2P

A collaborative B2E can be built on top of a peer-to-peer (P2P) platform. Figure 2 depicts a high level architecture of such system.

The foundation of this architecture is based on a peer-to-peer platform. Its major services include communications, security, data synchronization, and providing components/APIs to integrate applications. For example, Groove Network is one of several commercial available P2P platforms [10].

Virtual workspaces can then be built on top of the P2P platform. A workspace is a virtual environment in which a small group of people can collaborate and interact with one another across technical and organizational boundaries. The workspace becomes a community for its members. For example, a Sales Workspace can be created and shared by sales staff who need collaboration, or just to create the sense of community. For each product development, a workspace can be created to support people who need to collaborate on that product development. An employee can belong to many workspaces at one time.

B2E Application/Portal includes those contents and applications that an employee may find in a typical company portal. The portal may include corporate directory, customer support information, e-learning system, customer support management system, marketing/sales management system, knowledge management system, etc. It can also contain other personal information and links (such as stock information, web cams to the daycare center to monitor their children, etc). The intention is to increase not only work efficiency, but also employee satisfaction and a sense of community within the organization.

Another major component is the B2E Applications Data /Documents such as customer and competitor profiles, previous proposal, etc. These are electronic records generated by B2E applications.

The B2E Integration Bridge is used to integrate B2E applications. It enables electronic records transfer between B2E applications via XML, SOAP and Web Services. The Bridge can reduce the use of emails as the primary document-sharing tool. Instead, open standard

such as Web Services based on J2EE or .NET could be used.

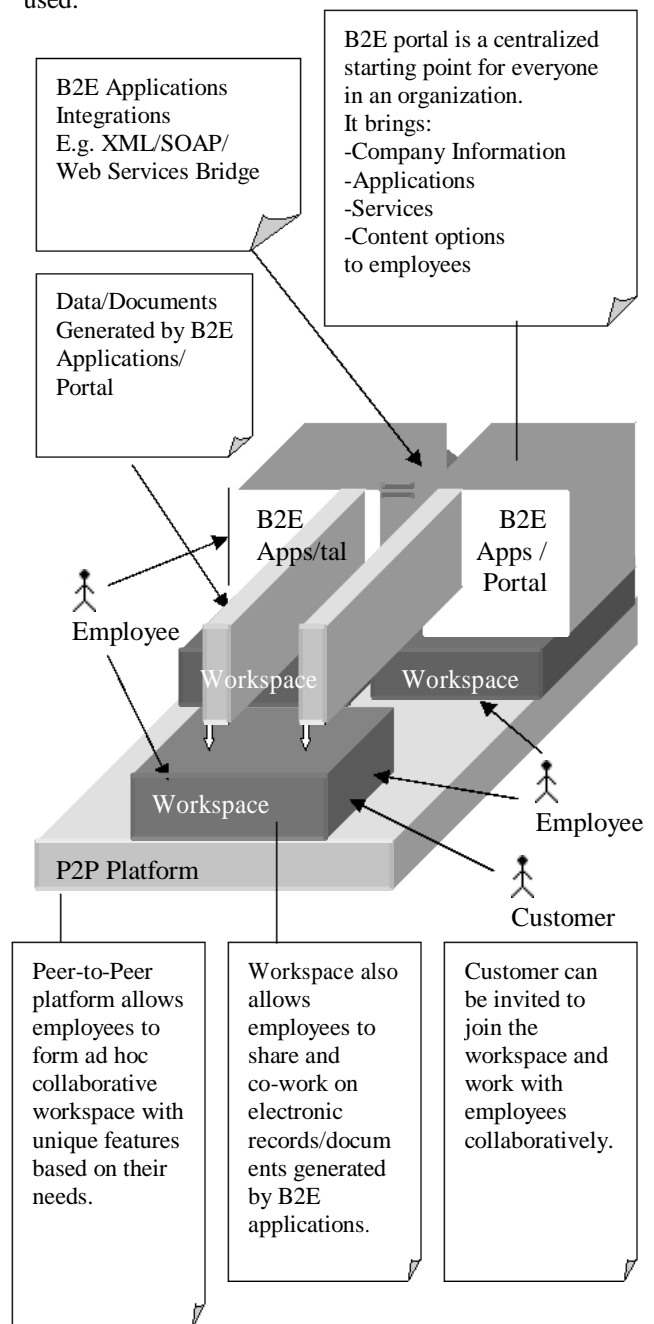


Figure 2: A high Level architecture for a collaborative B2E on P2P

4.1 Benefits

The architecture has many benefits:

- (1) A Peer-to-peer platform (e.g. Groove Network) does not require a company to reinvent itself on the existing network infrastructures. It offers a high degree of flexibility that allows applications to run across department boundaries, corporate boundaries, exposing themselves to other business partners and vendors.
- (2) Workspace can be formed easily; employees can

share and co-edit documents or electronic records generated by B2E applications/Portal. The sharing eliminates the time spending on swapping emails with attachments at the same time provides a centralized and organized way to manage the documents. Workspace can also be formed with employees and even customers from different locations or organizations.

- (3) The B2E Integration Bridge based on open technology serves all the enterprise applications integration requirements. It simplifies most of the routine data transfer between B2E applications. For those ad hoc non-routine data sharing between B2E applications and collaboration, employee can easily create workspace to facilitate the needs.
- (4) The B2E on P2P solution can be rapidly deployed with minimum custom programming needs.

5. A Case Study - B2E at KBQuest Group

KBQuest Group, Inc. is a global IT company with offices in Los Angeles, Hong Kong, and Shanghai, China. It engages in the business of software design, development, and production for its worldwide customer base.

5.1 Business Challenge

As business grew, more B2E applications were built to automate the software development processes. For example, the following applications were built to support software development process: Project Management System, Bug Tracking System, Knowledge Base Sharing System, and Configuration Management System. An Intranet was also created to enable interactions and some degree of collaboration among staff and sometimes even with the customers. The Intranet had applications such as the Online Project Tracking System and Requirements Changes Management System. Even though all of these applications were built as web-based solutions, they missed the real time collaboration capabilities. Moreover, because these applications were developed separately, it became increasingly difficult to manage and evolve to support real time collaboration. Software development requires real-time communication and collaboration among sales, development teams, and customers from different countries and time zones, but Faxes and emails with attachments supplemented with ftp sites were the only tools allowing staff from different departments and offices to share documents or electronic records.

In order to increase efficiency and to ensure the consistent quality of its creativity process, KBQuest adopted a new technology solution that would allow its teams to collaborate in real time in a virtual environment and provide a more reliable means of exchanging and working together on large programming files that were generated by B2E applications. In addition, the solution also supported mobile and offline operations with synchronization, so traveling staff could remain productive and informed.

5.2 The Solution

KBQuest built a scalable and flexible B2E based on Groove Network, a commercial P2P platform. When a user logs in his Groove space, he is able to see his personalized company portal as a welcome page. From his home page, he is able to access all workspaces that he belongs to. The B2E centralizes the entire software development process, incorporating all the B2E components, within a P2P workspace. The B2E is used primarily to support three major processes: Proposal Development, Project Development and Management and Customer Support. More processes are planned to be included in the future. These processes with examples will be described briefly in the following sections.

(A) Proposal Development

When a new client brief is received, the project team immediately creates a Groove workspace. Relevant and related managers, sales and project leads are invited to the shared workspace. Throughout the brainstorming process, the Groove workspace is the sole repository for all the information, files and data imported from other B2E applications. The workspace is the default virtual meeting place for discussion sessions, research activities and general communication.

Planning & Research

The first phase of proposal development is strategic planning and research. The project management team collects previous project information from the portal and other workspaces, including previously created proposals, analysis and design documents, and case studies. These materials are loaded into the Groove workspace shared by all members. Once all materials are shared, the team can assess the opportunity and determine a conceptual direction for the proposal. Figure 3 depicts a work in progress conceptual plan that the team is developing.

Solution Plan Development

The second phase is to develop solution plans. Team members discuss ideas through virtual meetings, draft solution plans, working on possible solutions until the right idea is achieved through chatting, instant messaging, discussing issues in the topic forum, exploring internet search by co-browsing, etc. For instance, a topic forum is depicted in Figure 4. The workspace essentially allows the team to work together on the development of the proposal, without requiring as much face-to-face time, hence reducing travel.

Proposal Generation

The final phase of the process is to generate the proposal. The sales, project managers, team leads collaborate with each other to generate a cohesive proposal by co-editing the document. Very often, client's inputs are sought at this early stage. Because Groove works easily across firewalls, the team can involve its clients throughout the proposal refinement process. The client will install Groove workspace (a free download). They will be invited to a workspace where KBQuest staff can communicate and clarify issues of the project. Once

the contract is awarded, the proposal workspace becomes the project space, where the team continues working to design and implement the system while keeping constant communication with the client.

(B) Project Development and Management

In the project space, KBQuest uses a variety of applications to manage the project and the relationship with the client. Documents and electronic records generated by B2E applications can be shared through the project space. For example, during the stage of requirements analysis, use cases can be shared and discussed by all related members (Figure 5). Design document such as domain model, data model, sequence diagrams etc can also be shared and discusses. (Figure 6). Indeed, all project-related information is now kept up-to-date automatically via the project space, including specifications document, requirements and analysis document, development documents, source code, and test cases. When a KBQuest team member makes a change, it is automatically sent to the workspace so that all other team members will see the change. Updates of workspace will be synchronized to all participants. For example, a team member can be offline or his internet connection is interrupted. Once he is back online, Groove will synchronize all missing updates, events including chat scripts that took place while the member was offline. This is especially useful in the Asia Pacific region, where Internet connections are frequently lost throughout the day.

(C) Customer Support

Customers invited to join the workspace can monitor the development process and provide instant feedback through the Project Tracking component without delay.

5.3 Results

KBQuest now has a unified B2E software process management and collaborative system that spans all of their cross-countries departments and gives their worldwide customers the ability to effectively monitor the project status. With the simple yet powerful platform supplied by Groove, the previous multiple web-based systems have been replaced or integrated by the B2E workspaces. Teams from the US, Hong Kong and Shanghai offices can communicate with each other via real-time chat, co-browsing and co-editing. All project team members work with the same up-to-date information regardless of their locations and time zones. Groove's P2P platform eliminates the network barriers between departments of KBQuest and also between KBQuest with different customers. Information extracted from the B2E portal can flow more freely. Furthermore, the Groove workspace ensures that both customers and KBQuest personnel can access the project information anywhere anytime; even when there is no Internet connection (Each local Groove workspace retains a copy of the data files). Best of all, the KBQuest staff no longer needs to login onto multiple systems just to access the same project documents.

6. Concluding Remarks

In this paper, the recent trend on B2E applications is discussed. We further identify the desirable features of B2E and the deficiencies of existing B2E systems. We show that, in order to attract and retain people to use B2E, it is essential to provide a good sense of community through real time collaboration. We further propose to implement B2E based on a Peer-to-Peer (P2P) environment that supports real time collaboration. Finally, we presented a case study to illustrate how the system is implemented and used.

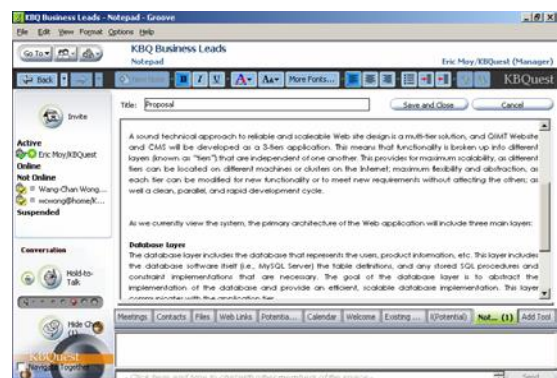


Figure 3: Proposal generation

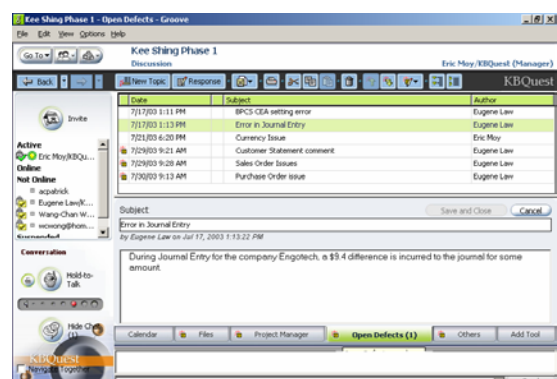


Figure 4: Discussion forum

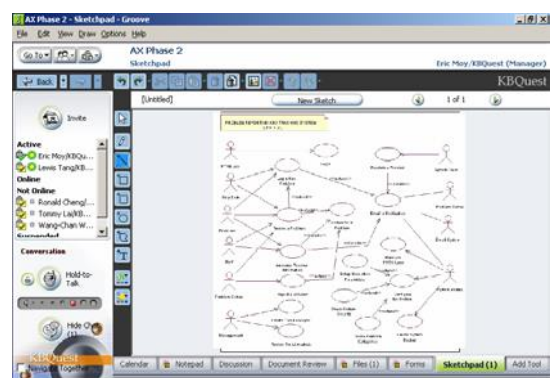


Figure 5: Use-case diagram

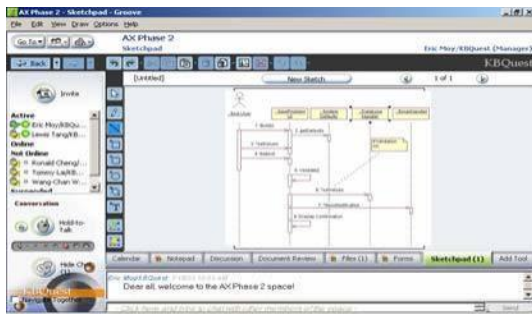


Figure 6: Sequence diagram

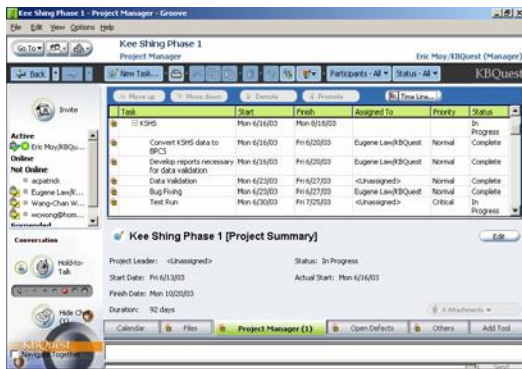


Figure 7: Project management

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Online Real-Time Credit Card Processing Models

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Abstract

Although a variety of payment mechanisms have been developed over the years for online businesses, payment by credit cards remain the leading mechanism for online payments. For real-time online credit card processing, a merchant needs to install a third-party proprietary software in the merchant e-commerce server. However, many issues need to be resolved before integrating a third-party payment solution to a merchant e-commerce system. In this paper, we attempt to address the current state of the online real-time credit card processing models. We also discuss several factors such as cost, complexity and security issues related to implementing such a system.

1. Introduction

Over the past few years, many dot-com companies have failed; however, e-commerce is stabilizing to those companies that streamlined their online business processes [6]. According to a recent report [2], purchase of goods and services over the Internet is expected to increase from \$325 billion in 2001 to nearly \$3.5 trillion in 2006. The consumer spending of e-commerce for the year 2003 is estimated to be at \$110 billion [16]. Despite poor economy in recent years, online consumer shopping has increased from 2001 to 2002 by 43% [7]. During the 2002 holiday season, online consumers spent \$367.05 million on December 8 – an all-time high for one-day shopping; the weekly spending was about \$2 billion [8]. NACHA, the electronic payment association which develops operating rules of the ACH network, the largest network of electronic payment processors in the United States, introduced a new payment category for WEB transactions in 2001 [1]. According to their latest report, WEB transactions increased more than 300% from 2001 to 2002. Consumers are also increasingly embracing electronic methods of payment [18][21].

In the traditional retail business, the display of products, processing of payments, and delivery of goods are handled by merchants in front of the customers. In the e-commerce arena, these processes are typically handled by three different parties, and payment over the Internet is the most common concern for the consumers. Between 40 to 60 percent of Internet purchases are abandoned in the midstream, because customers do not want to compromise privacy or the security of their financial information [12]. To address these issues, various online payment mechanisms have been developed that include:

digital cash, electronic wallet, electronic check, and smart card. Most of these mechanisms have failed due to the complexity of use and implementation as well as poor customer trust. Thus, payments by credit cards remain the most prevalent mechanism for online consumer payments [13] [25].

A complete e-commerce business cycle requires interactions between several hardware and software components physically located in different geographical locations. An electronic merchant usually develops and maintains the merchant processes, while the financial institutions or software companies provide payment services to the merchants. However, in most cases, payments are not processed in real-time. For reasons of security, complexity, and cost, the payment information is typically collected from a consumer but is processed off-line like a physical store. For real-time payment processing, a merchant needs to install a third-party proprietary software in the merchant e-commerce server. However, many issues need to be resolved before integrating a third-party payment solution to a merchant system – the most important is the technical knowledge of the people who are developing the e-commerce system. For large companies, this may not be an issue, but for small companies where resources are limited, it is important to understand the challenges of implementing an online credit card processing system.

This paper attempts to address the current state of the online credit card processing system. First, we provide an overview of the credit card processing mechanism. We then focus on the various models of online, real-time credit card processing system and discuss several factors such as cost, complexity and security issues related to implementing such a system. The results can be extremely valuable to small businesses that are venturing into Internet commerce.

2. Credit Card Processing Mechanism

There are in general six parties involved in a traditional credit card processing cycle: customer, card issuing bank, merchant, merchant's bank, acquirer, and a credit card processor. The card issuing bank issues credit cards to customers and maintains their accounts. The merchant opens an account with a bank to receive payments. In order to accept credit cards, the merchant needs to register with an acquirer – a bank or financial institution that sets up an account for the merchant and provides a terminal to process credit cards. The processor is a large data center maintained by the credit card

network, and it acts as a clearinghouse for all credit card transactions.

There are two stages of transactions for any credit card purchase: payment authorization and fund capture. Authorization refers to checking the account number to see if it is still valid, has sufficient credit, and has not been reported lost or stolen. Capture refers to approval and posting of the transaction and shipment of goods. When a purchase is made by a customer, the merchant uses the terminal to send payment information to the acquirer. The acquirer contacts the card processor for authorization, which in turn contacts the customer's bank for credit availability, and if all goes well, provides a charge authorization number to the acquirer. The acquirer transmits back the authorization to the merchant. All transactions happen in few seconds and no transaction of money takes place yet.

To capture funds, the acquirer accumulates multiple payment authorizations and submits them as a batch to the processor on an hourly or daily basis. After receiving the fund, the acquirer deducts a small fee and credits the rest to the merchant's bank. Thus, all the costs associated with the credit card processing are borne by the merchants. The process of refund follows a similar set of transactions.

The credit card processing mechanism was developed by the financial institutions over a long period of time. The fundamental method of payment authorization and capture of funds are the same whether the purchase is made from a physical store or via Internet. However, the biggest hurdle for an online merchant is to get the credit card and personal information from the customer securely over the Internet.

The online payment processing becomes further complicated due to the introduction of a payment gateway that replaces the acquirer or acts in between the merchant and the acquirer. It is typically a software company or a financial institution that provides necessary software to the merchant for real-time payment processing. Most banks will not set up a merchant account for an online business because online businesses are classified high risk.

3. Methods of Credit Card Processing

A merchant can process credit card payments in a number of ways. These include manual entry through a touch-tone telephone, manual entry using a point-of-sale (POS) terminal, manual or electronic entry via a PC acting like a POS terminal, or electronic entry from a Web site [23]. Many of these mechanisms require physical interaction of the merchant with the customer or a system.

For real-time payment processing, an online merchant needs to integrate a payment processing software to the e-commerce site, so that the communication between the software tools used by the customer, the merchant, and the payment gateway are all automated. There are many variations of real-time payment processing, and recent developments include wireless technology with personal

digital assistants (PDAs), through which customers can swipe credit cards like traditional POS terminals but complete the payment transaction through the Web [3]. Since there is no standard for the Internet payment processing, a merchant needs to invest some time and money to understand various options and to implement a payment solution suitable for the online store.

4. Online Credit Card Processing Models

Several payment solutions are available for online real-time credit card processing that are implemented through technologies such as standard shopping carts, one-click buy, enterprise e-commerce package, and application service provider. These technologies require installation of some software or modification of Web pages in the merchant e-commerce server. These applications can be grouped into two broader categories of merchant-oriented applications and payment gateway-oriented applications [4][5][14][17].

4.1. Merchant-Oriented Applications

In this case, an online merchant collects customer order information including the product, personal, and credit card, from the e-commerce site, and then forwards the payment information to a payment gateway. The payment gateway in turn communicates with the credit card processor, obtains a charge authorization id to charge the customer account, and sends it back to the merchant Web server. The merchant Web server confirms the order by sending a message to the customer. After fulfilling the order, the merchant requests payments to the payment gateway. Thus, all order and payment transaction data are maintained by the merchant. As most of the processing is performed in the merchant server, these systems are sometimes referred to as local-mode. In this case, the collection of the customer information is via the Internet, whereas the sending of information to the payment gateway can be via phone lines, leased lines, or the Internet. For Internet transmissions, the Secure Socket Layer (SSL) protocol is typically used for data encryption as well as Web Server authentication.

The merchant-oriented applications typically employ a client-server approach as shown in Figure 1. The client software or plug-in is installed in the merchant Web server as a library of programs, usually in C or C++, and the server software, termed as payment gateway, resides with the software provider. The client software is a small messaging agent that uses SSL and X.509 digital certificate technology to securely communicate with the server [24]. The merchant e-commerce system typically pass payment transaction data to the client through a set of name/value pairs implemented in a merchant form at the checkout page. Depending on the fields required by the payment gateway, the code will be different. Various other Web pages and program codes are necessary to handle communication between the customer, the merchant and the gateway.

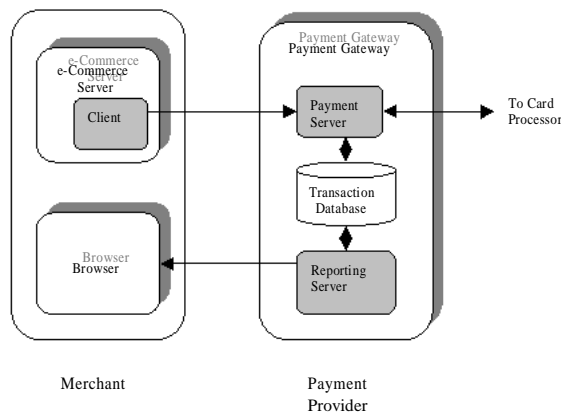


Figure 1: Client-server architecture of Payment Gateway

The payment gateway typically contains a payment server, a transaction database, and a reporting server [10][11]. The payment server accepts encrypted transaction information from multiple clients as well as routes necessary information to the appropriate processing network depending on the credit card. It also performs settlement of transactions. The transaction database contains all transaction-related information for initial orders, payment authorizations, and settlements. The reporting server is used to provide transaction reports such as settled transactions, unsettled transactions, and invalid transactions to the merchant. Thus, in this approach, all order details and some payment information reside in the merchant database, while the payment details reside in the gateway database.

Because most transaction information resides in the merchant's database server, the merchant has more flexibility in the customization of processes and transaction reports, however, strict security protocols must be maintained to protect credit card information in the database. These systems are designed to handle multiple items per transactions, more than 1000 transactions per month, and scalable up to hundreds of millions of transactions. VeriSign's Payflow Pro SDK [24] and Authorize.Net's ADC [3] are examples of merchant-oriented payment applications.

4.2. Payment Gateway-Oriented Applications

These systems are designed for merchants with limited technical capabilities and low transaction volumes. They are typically implemented through a one-click approach and they require minimal changes to the merchant Web pages. The customer usually clicks a link or a button at the checkout page and he or she is directed to a secure page hosted by the payment provider [3][9]. Transaction details (order amount, tax amount, and other parameters) that are encoded in the link are used to initialize the form. The customer then enters credit card details and personal information in the secure form in the gateway Web server.

When the order is submitted, the merchant is notified via e-mail, and the merchant can view specifics of new orders from the Web site maintained by the gateway provider. The processing of payment is same as before; however, all order and payment transactions are maintained by the gateway provider. In this case, the communication between the customer and the merchant is Internet-based, whereas that between the customer and the payment gateway is typically SSL-based. The digital certificate of a single payment gateway serves the customers of all merchants that sign-up with the payment gateway.

The gateway-oriented applications are the simplest payment solutions found in the e-commerce industry, as these systems require less hardware, less technical expertise, and less maintenance for the merchant – these are maintained by the gateway provider. In this case, merchants lose control over the payment transaction data, as they reside with the gateway provider, however, they can view these records through a password-protected Web site hosted by the company providing the payment gateway. A payment gateway provider typically supports many merchants by providing a merchant ID to each merchant and usually helps merchants to open Internet merchant accounts with banks that accept Internet payments by credit cards.

These systems are suitable for merchants processing up to 1000 transactions per month, however, the downside is that only one item can be purchased at a time. VeriSign's Payflow Link [24] and Authorize.Net's WebLink [3] are examples of payment gateway-oriented applications.

5. Issues of Online Credit Card Processing Systems

Selling goods and services on the Internet presents a set of challenges – like how to set up and maintain a secure, reliable, and cost-effective system for payment processing and managing transactions. Several issues need to be resolved before integrating a third-party payment solution to a merchant system – the most important are the security, cost, and complexity.

5.1. Security

The security of financial transactions is of utmost concern when dealing with many parties, especially over the Internet. Consumers must be able to send their financial information to an online merchant without the fear of eavesdropping. They should also be comfortable with the identity of the merchant, that the cyber-merchant is reliable and not bearing a fake identity. The merchant should also be able to send financial information securely to the payment gateway. The technology that addresses these issues is the secure socket layer (SSL) protocol, which uses public- and private-key encryption mechanisms to communicate between a browser and a Web server as well as to authenticate a Web server. If the

merchant is planning for international business, then SSL-encryption key should be 40-bit instead of 128-bit standard for the United States. In order to use SSL, a merchant needs to apply for a digital certificate to a Certification Authority (CA) such as VeriSign [24], get the certificate, and bind it to the IP address of the merchant Web server [20]. The merchant also needs to configure the Web server to accept SSL transmission and develop the payment-related Web pages such that they use HTTPS, the secure version of Hypertext Transfer Protocol.

Fraud prevention such as unauthorized credit card purchase is another important issue for a merchant, because the law provides a consumer liability limit up to \$50 if someone uses his/her credit card fraudulently. The merchant is liable for bad transactions – neither the customer, nor the credit card issuer. Thus it is important to use address verification service (AVS) which verifies key components of a customer's shipping addresses against addresses that the credit card issuer has on record for the customer. Research shows that about 65% of the time, criminals using credit card account numbers fraudulently, do not know the account's related billing address [19]. Various other security measures should be implemented for an online purchase, such as, how many times a customer can enter wrong credit card information before it is rejected. In addition, an upper purchase limit to a single transaction or the number of transactions per day by the same credit card number should be controlled.

According to a very recent report [8], about 8 million account numbers of MasterCard, Visa, and American Express credit cards have been compromised from a third-party payment processor. Thus the merchant needs to safeguard the private key used for SSL encryption as well as the consumer privacy information such as credit card numbers and personal data stored in the merchant database. The private key and the credit card number should be stored in the encrypted form, and access to these information should be highly restricted. All sensitive data should be kept behind a firewall and may be in a different database than the one used for the product catalog. To implement these security protocols and to safeguard data requires technical expertise as well as money, both of which might be limited to a small merchant.

5.2. Cost

There are several costs associated with the development and operation of a payment mechanism, and they are all borne by the merchant. Irrespective of the type of payment mechanism implemented, there is always a cost associated either with the development of the payment-related Web pages or integrating the payment software with the catalog pages. This requires in-house technical expertise or consulting service from a payment provider, where the later might cost about \$200/hour for a merchant [22]. For merchant-oriented applications, there is also a cost associated with the purchase or lease of the software, and often there are monthly or yearly fees

associated with the software license and future upgrades. For payment gateway-oriented applications, commonly there is an application fee, a monthly gateway access fee, and statements fees [15].

There is always an operational cost associated with any credit card processing whether it is performed online or offline. It arises mainly due to the charge placed by the banks and credit card network to process a transaction. Generally, there is a fixed charge for each transaction and a discount rate charged as a percentage of each order-amount. The charges for Internet transactions are often the same as the mail or telephone order transactions, and all of which cost significantly higher than the offline transactions. For example, the discount rate and transaction fee for an Internet transaction are 2.39% and \$0.30 respectively, while those for the standard swipe retail are 1.69% and \$0.20 [19]. The costs are even higher for international transaction, which are about 3.25% and \$0.30, respectively.

The above charges do not significantly vary from one payment provider to another; however, there might be additional charges from a payment gateway if it is not acting as an acquirer. Some payment gateways charge by the volume of transactions, while others provide free transactions up to certain numbers [15]. For merchant-oriented applications, there might be a batch transaction fee and it can run about 10 to 40 cents per batch. There is also a cost for charge back, which is a reversal against a sale that was an error, misunderstanding by the customer, or fraud. It can cost about \$10-\$25 per charge back [19]. For all non-card present situations such as the Internet, there might be an authorization/verification or AVS (Address Verification System) charge, which might cost about 5 to 10 cents per transaction.

5.3. Complexity

The explosive growth of payment gateways provides a variety of real-time credit card processing options available to an online merchant than can be found for a physical store. For example, all large companies such as Authrize.Net, CyberSource, iTransact, LinkPoint, PaymentOnline, and VeriSign, offer at least three different types of such solutions. In the physical store, the integration of a payment system with an existing point-of-sale system is through a standard hardware/software interface. However, in the online business, the integration is through the software and there is no standard used by various payment gateways.

All online payment applications require certain level of coding and merchant-oriented applications use various technologies such as HTML, ActiveX, ASP, JSP, XML, ODBC, JDBC, or JavaBeans to integrate payment gateways with the e-commerce servers. A merchant must have technical capabilities or means to implement these technologies. Some payment systems are also platform dependent. Thus, integration of a payment system with an existing e-commerce system might be an overwhelming effort, unless a particular payment system is considered during the design phase of the e-commerce system.

Furthermore, all payment systems require testing the whole payment cycle, including the authorization, settlement, and refund, using a valid credit card number.

Another complexity might be due to the level and type of service provided by the payment gateway provider, especially in the case of one-click approach where all transaction data resides with the provider. The merchant is limited by the way the company provides access to the database server, type of search for a particular transaction, refund procedure, audit trails, and statements.

6. Conclusion

We have provided an overview of the credit card processing mechanism and some insight into the real-time online credit card processing systems. Critical factors such as cost, complexity, and security associated with the implementation and maintenance of such systems are also discussed. No matter what method of payment processing mechanism is considered, an online merchant must realize that real-time payment processing can be highly complex – there is no one-size-fits-all solution for all merchants. Whatever payment software is chosen, it needs to be integrated with the e-commerce system, unless one can purchase an integrated e-commerce and payment system. Furthermore, choosing the right payment gateway-provider can relieve a lot of headache of handling payments and interacting with other parties of e-business processes. A payment gateway must support all aspects of payment processing – authorization, capture of funds, refunds, and reports. Products offered by selected vendors should be compared according to the factors such as complexity of the system and software, implementation time and cost, software cost and maintenance fees, transaction costs, and security features for consumers and merchants.

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The Framework of Enterprise Information Processing Network for Knowledge Discovery and Sharing

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Abstract

The challenges of the global marketplace are increasingly forcing today's process-centered organizations to utilize the knowledge, capabilities, and resources to be found within their information processing networks. The issue of whether or not companies should exploit their intangible knowledge assets is far more critical than their ability to invest and manage their existing physical assets. Under this paradigm shift, information-oriented productivity depends on the sharing of knowledge and skills among workers, so that enterprise strategies can be driven by the collective intelligence and competence of the group to face today's business challenges and enable organizational learning. Management of organizational knowledge to create business values and competitive advantages is critical towards the organizational development. This paper focuses on the transformation of an enterprise information-processing network into a knowledge network for supply chain co-evolution. 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. A knowledge network is introduced to enhance collaboration, encourage innovation, boost productivity, achieve adaptivity, and increase the information system efficiency. In tomorrow's enterprises, knowledge will be the key to release creative energies that will inspire enormous innovations and great discoveries!

1. The Emerging Business Intelligence

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. Manual workers and mass production schemes are not a predominant factor to today's new business. Functional integration to streamline the flow of business operations is no longer as popular as emerging process-oriented business practices. Information, such as demographics, consumers' behaviors, and numerous other business statistics, and the associated processing power are critical for the survival of organizations in business. With the global deployment of computers, uniform information architecture, and interconnecting networks, participants can work collaboratively, share networked resources, exchange

knowledge, and improve corporate or supply chain performance. Accordingly, corporate and supply chain strategies can be driven by the collective intelligence of groups to better meet today's business challenges. The increasing adaptivity of business practices has led to the role of Business Intelligence (BI) in knowledge management. BI relies heavily on the interpretation of data into useful knowledge for their trading partners within and across the supply chain to gain a competitive advantage. This same business strategy is becoming increasingly adapted by every industry, where successful ventures with a long-term competitive advantage will be characterized by their ability to create new knowledge, quickly disseminate and incorporate it into their production processes, products, and services. As we move this new millennium there will be a fundamental shifts in the prevailing paradigms and knowledge-oriented productivity will present the greatest challenge to management.

2. Knowledge Workers and Empowerment

The 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. 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 [1]. 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. There are several factors needed to consider in order to develop a successful KM system. The first is to recognize the organization's competence.

2.1 Organizational Competence

Whenever a technological innovation is introduced, it brings both new business opportunities and new challenges to organizations. The introduction of Business Process Reengineering (BPR) in the 1990s stressed the importance of Information Technology to business practices. Most BPR issues focused on using "the power of modern Information Technology to radically redesign our business processes in order to achieve dramatic improvements in their performance" [2]. Since then, many organizations recognized IT as a key catalyst for modern business practices, and redesigned their organizational structure and business processes to improve certain critical measures of performance, such as cost, quality, service, and speed. Though IT helps an organization gain a competitive advantages, business strategies should also focus on what "value" might be created for the organization in the marketplace. BPR uses

IT to radically redesign core business processes in response to key competitive factors.

These competitive factors can be derived from the Porter's value chain [3] concept which divides an organization into a set of generic functional areas (Figure 1). According to the value chain concept, everything that a company does can be categorized into primary and support activities. Porter's value chain consists of five types of primary activities: Inbound Logistics, Operations, Outbound Logistics, Marketing and Sales, and Service. Support activities support primary activities and each other by providing purchased input, human resources, and some forms of technology to perform a given function. Porter's version of supply chain management is called a value chain because it focuses on value, where value is measured by the amount that customers are willing to pay for an enterprise'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]. Starting with the resulting generic value chain categories, an organization can further subdivide each into discrete activities, categorizing those activities that best contribute to a firm's competitive advantage. In this way, a value chain is defined and a better organizational structure and business process can then be created around those value activities that can most improve an organization's competitive advantage [5]. Technological innovations usually give companies new ideas for their organizational structure and management. This value chain thinking allows organizations to identify their competitive strengths and weaknesses and therefore

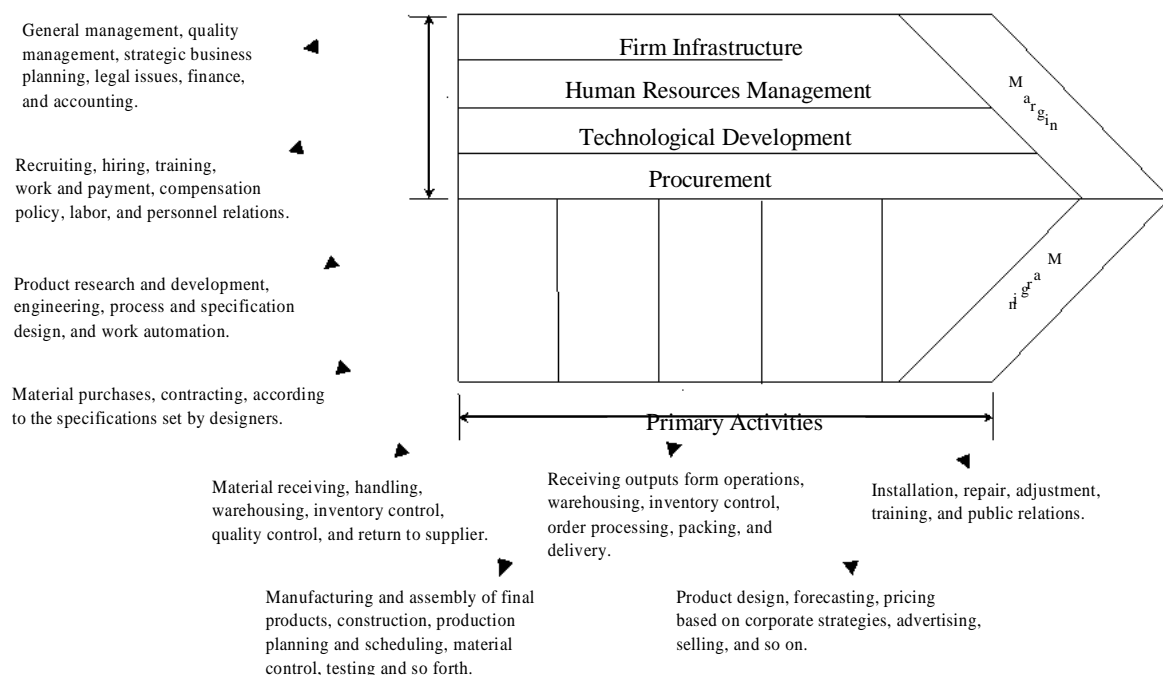


Figure 1 Porter's Value Chain and Value Activities

to reengineer their enterprise performance. All these “value-finding” processes are crucial to the development of a successful KM system. A KM system that fully utilizes an organization or an entire supply chain’s strength to take every business opportunity.

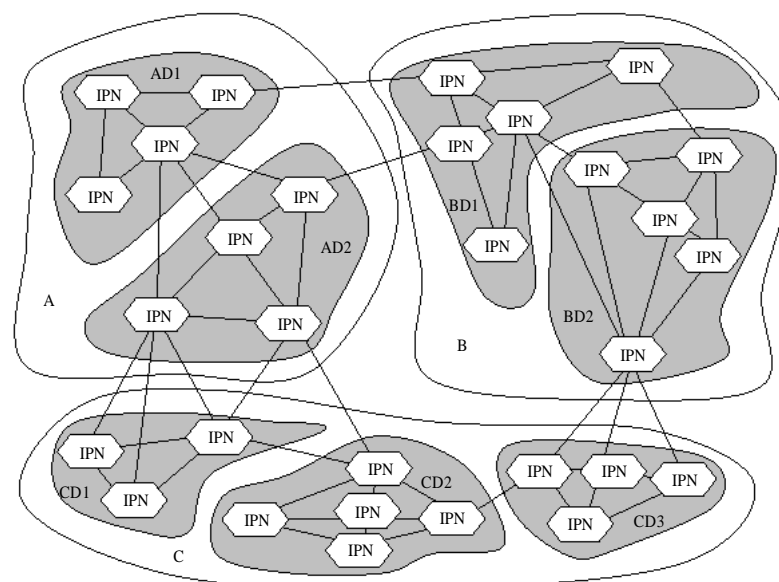
One factor worth mentioning is that value also includes all information that flows through an organization and between an organization and its suppliers, its distributors, and its existing or potential customers. Indeed, information defines business relationships. Having a relationship means that two or more companies have established certain channels of communication based on personal acquaintance, mutual understanding, shared system standards, or synchronized production results. These imply the need for stronger business partnerships, and collaborations have challenged many organizations to extend their organizational boundaries and share their visions with others.

3. The Information Processing Network and Value Chain

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. As a result, the lattice of channels between the various information-processing nodes forms a physical communication infrastructure called an information-processing network.

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 (Figure 2). The information-processing nodes within each network in either organization can work collaboratively to achieve strategic goals in the newly joined network. To this point, we concluded 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



Business components can exist autonomously within an organization, or being shared by trading partners in a global network in an strategic alliance scheme.

Note: Organization A, B, C...
Department A1, A2...B1, B2...C1, C2...
IPN Information Process Node

Figure 2 The Information Processing Networks

system can act like a supply chain that encompass the modern business world, and participating organizations can readily extend their technologies to their partners.

4. 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 boundary-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 [7]. This feature is very important for the every industry, because many participants (contractors, subcontractors, material suppliers, equipment providers, and supervisors) 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. For example, the manufacturing process for raw materials or the production and distribution of equipment is transparent to all members in the supply chain. 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. In the future, the supply chains, rather than the enterprises (contractor, manufacturer, and supplier), will compete with each other. An increase in horizontal integration synchronizes the output of the entire supply chain. There will be no isolated islands of automation, and those who can best define and reengineer their business processes in the supply chain partnership are sure to be more successful in this industry. In today's e-business, competing for knowledge requires either aligning one's strategy to what the organization knows or developing knowledge management (KM) capabilities to support a desired supply chain strategy. The ability of companies to exploit their intangible assets has become far more important than their ability to invest and manage their physical assets. Knowledge requires sharing and corporate strategy can be driven by knowledge. Knowledge management systems must to address the

strategic visions of organization. Knowledge management 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. 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.

5 The KM System Architecture

5.1 Knowledge Utilization

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 and supply chains to remain profitable, competitive, efficient, adaptive, and more intelligent. Organizations that will truly flourish can utilize IT to leverage personnel knowledge in ways that are immediately available. The design of a KM system 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.” In this “knowledge network,” a dedicated knowledge server and a 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 3. In this figure, 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.

Document management is a part of supporting IT, and it includes the ability to automatically develop and

classify document databases. 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 groupware is an integrated collaborative tool 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. 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. Many groupware systems also allow the documents to be posted on the Intranet or the Internet. One of the most dominant groupware systems is Lotus Notes (now incorporated as IBM) which allows groups of users to interact and share information in an organized fashion.

With the growing maturity of Internet technology, the web can become more active. Applications can run on clients' browsers. The technological breakthrough makes the development of future web-based groupware systems (utilizing corporate Intranet) easier, because the traditional groupware and the web-based groupware have some similarities in terms of communications and

collaborations. The groupware and Internet's hypertext scheme can easily profile different categories of business information (such as from specifications and manuals to make hypertext specifications or a TQM manual) 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. One of the differences between the Internet and groupware is its platform-independent advantage 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, 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-

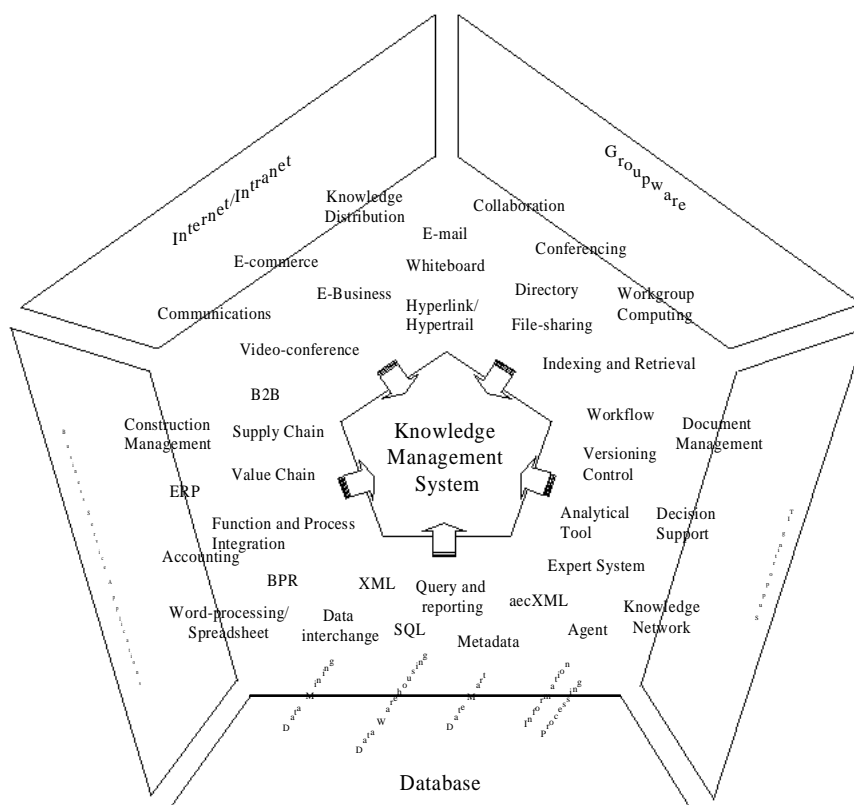


Figure 3 Knowledge Management Technological Framework

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. In addition, 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 almost as if they were one company. The key issue is the inter-enterprise processing. Therefore, knowledge management also includes business processes integration.

5.2 The Learning Organization and Smart Supply Chain

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. This extended learning capability leads to a new definition of supply chain

management and customer relationship management (CRM).

In today’s e-business, companies can achieve a business advantage by leveraging networking technology and the principle of supply chain integration to improve the bottom line by enhancing collaboration between their business and trading partners. 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 (Figure 4). 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]. Therefore, 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.

6. Conclusion

Changing technology is the driving force behind the next wave of economic growth. To take advantage of this growth, organizations will have to apply both new

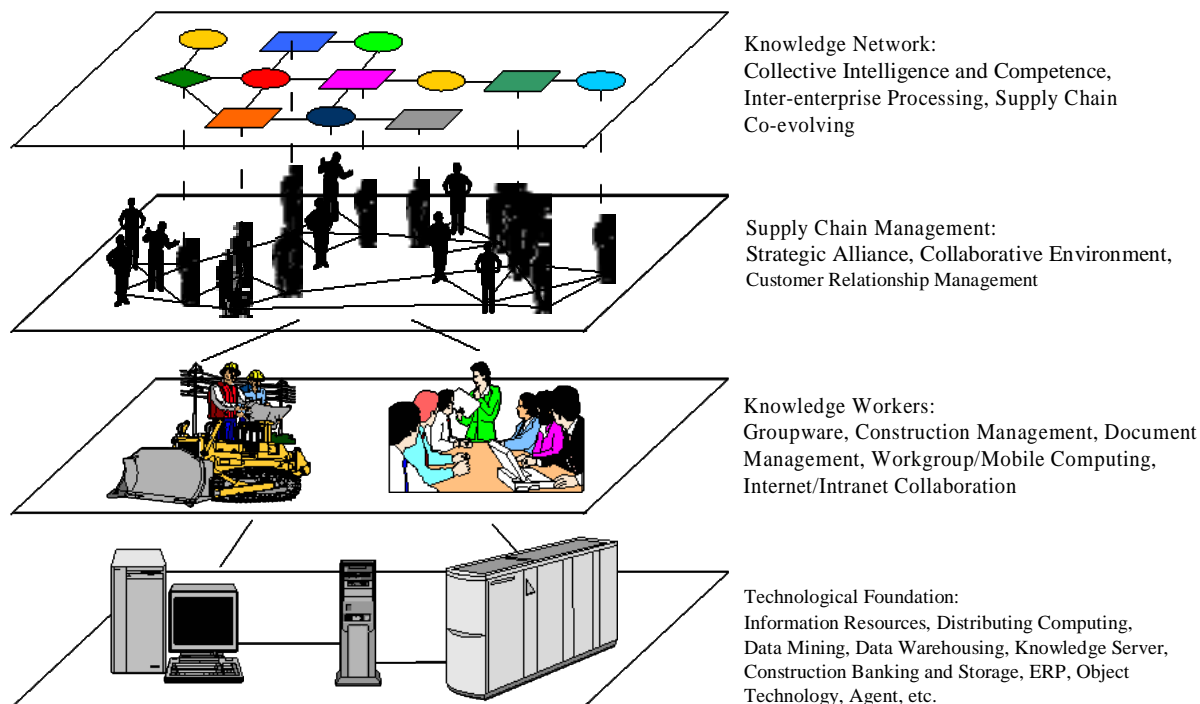


Figure 4 The Knowledge-enabled Supply Chain

technology and new thinking. First and foremost will be the ability to understand the paradigm shift in the economy from data to information and from information to knowledge. Data is the basic building block of information and ultimately of a knowledge-based business. 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. 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. On the other hand, the challenges of the global marketplace are increasingly forcing today's process-centered organizations to utilize more fully the knowledge, competencies, and resources to be found in their supply chain networks. Optimizing parallel, rather than serial, processes is the key to supply chain management. 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.

As a result, a successful knowledge management system for today's new business must provide support for the capture and communication of customer demands, as well as enable these demands to automatically trigger business events and initiate process workflows (such as launching manufacturing runs and issuing purchase requests within the enterprise and across the supply chain). A common data model will also be 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. This new "e-supply chain" offers unlimited business opportunities when enterprises fully integrated their knowledge, processes, and technology. A well-designed and well-integrated supply chain will improve existing cost-intensive processes and provide organizational agility in the event of change.

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Going Wireless: Migrating From E-Business to M-Business

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Abstract

The challenge of globalization—the ability to respond quickly according to changes in market demands and competitions, is the driving force for organizations to optimize their business strategies and operations regularly. Customer preferences and needs change constantly, resulting in pressingly intense competitions. Time sensitive real-time transaction is becoming the common denominator for successful businesses. Information also needs to be available to anyone from anywhere at anytime. As the global economy shifts toward the mobile economy, enterprises need to be progressively more flexible and globalize. Mobile businesses open up new opportunities for innovative enterprises and give them new means of communications with customers and employees. In a changing business landscape, mobile business addresses new customer channels and integration challenges. This paper provides a broad discussion on the changing landscape of business: from e-business to m-business. Several issues will be addressed, such as value chain, the data access of mobile computing, m-business application framework, and the future development of mobile computing (e.g. 4G wireless). All of these efforts attempt to provide an overview and schematics for the integration of modern e-business application strategies into future m-business practices. This paper will show that any innovated business strategy should be built upon target stakeholders. With mobile technologies, enterprise applications will go beyond the four walls of organizations to a workforce on the move.

1. The Emerging Mobile Economy

Internet technology is presently changing communications to the same degree that PC technology reshaped the computing world twenty years ago. Today, e-business is rapidly expanding into a complex web of commercial activities transacted on a global scale between an ever-increasing number of participants, corporate and individual, on global open networks. A successful e-business is concerned with building new kinds of relationships with customers, employees, business partners, investors, regulators, consultants, and all other participants in business life. The most significant economic consequence of this evolution will be increased real-time interaction between organizations and their employees, trading partners, and customers. In the 1990s, a silent paradigm shift affected many business

sectors in the world economy. The emerging mobile technologies with Internet capabilities that connect numerous devices and information portals represent a new phase in enabling intelligent mobile workforces [1]. As a result, a substantial new creative cycle and innovation on the marriage of the Internet, wireless technologies and e-business is another new challenge to today's enterprises. The "mobile business" or "m-business" is an extension of e-business. 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 [2].

Today, enterprises focus on how to use mobile technology to provide customers with rich service experiences and greater satisfactions. Currently, accessing the web through a wireless device is different than accessing the web through wired connections. The mobile Internet business is in its early stages of development, so no real framework has been available to provide a systematic way to explore opportunities or problems. Nevertheless, similar to its predecessor (the e-business infrastructure), the mobile application infrastructure can be laid out easily and also include four different areas: mobile application platform providers, mobile Internet service providers, mobile application service providers, and system integrators. The usefulness of the mobile channel will be largely driven by new applications that enhance the overall customer value.

2. Defining New Market Value

The m-business is facilitated by the integration of the Internet, e-business, and the wireless world where people can go online with any device at anytime from anywhere. To embrace this vision, a new value chain is emerging that focuses on the belongings of mobile devices, wireless access, and contents. However, to create multi-channel and multi-technology solutions in a fast-moving and technologically indefinite mobile environment is difficult and extremely risky. A number of mobile devices, closed networks, disparate carrier/server systems, protocols, and solutions characterize today's wireless landscape. Currently, the fastest way to access the Internet on the move is through the IEEE 802.11b (Wi-Fi) standard. Overall, 802.11 (Wi-Fi) in its various forms (a, b, and g) has emerged as the winner in wireless LAN technology [3]. However, the problem with wireless LAN-based access is that the access points or base stations have a very short range, which means they're restricted to a few "hotspots," such as hotels, conference centers, and

airport. The situation gets more complex when the wireless LAN is mobile.

The fourth-generation (4G) cellular services intend to provide mobile data rates of 100Mbps or more. This 4G is an entirely packet-switched network that all network elements are digital with higher bandwidths to provide multimedia services at lower cost. In 4G mobile IP, each cell phone is assigned a permanent “home” IP address, along with a “care-of” address that represents its actual location. When a computer somewhere on the Internet wants to communicate with the cell phone, it first sends a packet to the phone’s home address. A directory server on the home network forwards this to the care-of address via a tunnel, as in regular mobile IP. The directory server also sends a message to the computer informing it of the correct care-of address, so future packets can be sent directly. This should enable TCP sessions and HTTP downloads to keep going as users move between different types of networks. The ultimate 4G would be full on-demand capability, Wi-Fi to WAN roaming, and have it as a true IP network. Currently, the Japanese government required all of Japan’s ISPs to support IPv6 by 2006, to coincide with the launch of 4G. Countries in Europe and Asia are considering similar regulatory action. NTT DoCoMo (provides i-mode service) also hopes that true mobile broadband will enable them to replace fixed access entirely, and they plan to have a 4G system operational by 2006. A business that creates m-business applications can benefit from the first-to-market advantage. 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.

3 The M-Business System Architecture

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 [4]. 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. The m-business supply chain practices are just like e-business supply chain practices with the exception of mobility. This is a more real picture about business, because business opportunities occur in anywhere at anytime.

With the convergence of B2B, B2C, SCM, CRM, ERP, Business Intelligence, and real-time relationship management, the personalization of customer information is now possible. 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 selling chain management. The fully interactive nature of the Internet changes everything in the world of self-service. The blending of Sales Force Automation (SFA) with customer self-service brings new business opportunities. Relevant information and intelligence support processes all can be aligned and implemented in real-time at anywhere. The application and technological framework of m-business to facilitate these highly interactive communications is summarized in Figure 1.

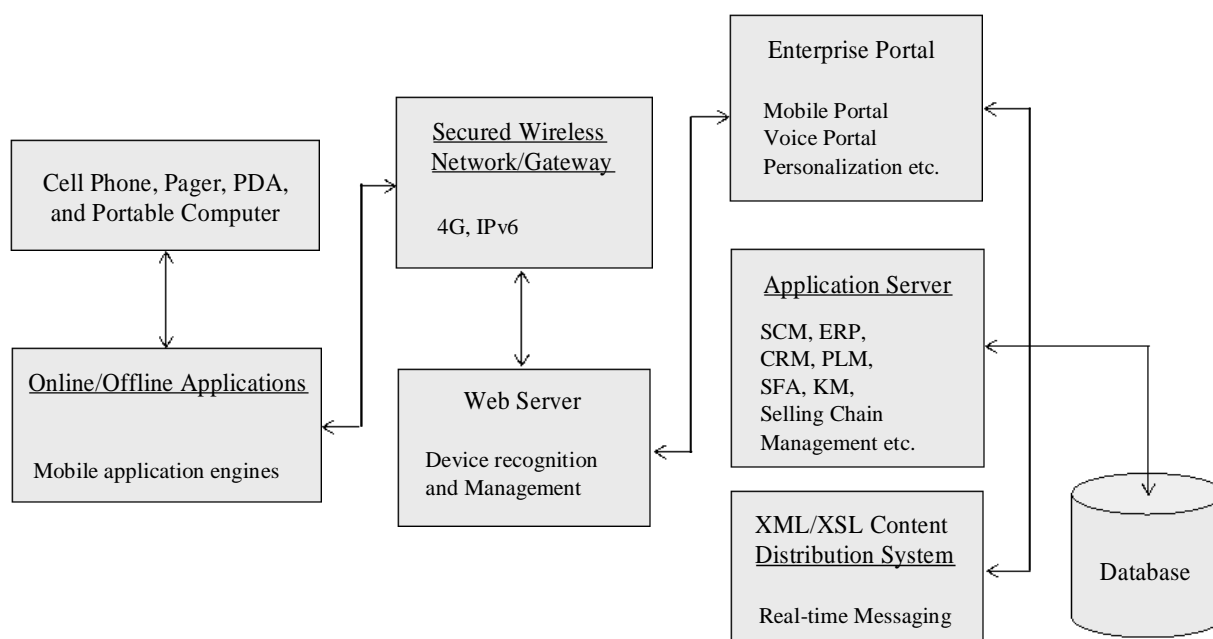


Figure 1 m-Business Application Framework

This framework extends existing business applications such as ERP, CRM, and mobile workforce applications to wireless devices.

In this framework, 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. A selling chain management suite for customer care applications enables new kinds of interactions, new kinds of information, and comprehensive access to all customers and enterprise portals. This customer care can foster joint problem-solving, and convenient self-service. Given the information customers need in the purchasing process. The reasons to stress on 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., (c) the global mobility and service portability, and (d) scalability of mobile networks. 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 to generate profits. As a result, an m-business supply chain solution must provide support for the capture and communication of customer demand, as well as enable this demand to automatically trigger business events and initiate process workflow. This application framework also takes advantage of XML. The XML now supports for developing mobile applications running on multiple devices and platforms [5]. Databases are also working with XML-structured data and tabular relational data. Therefore, the XML/XSL is very promising in m-business practices.

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.

4. Conclusion

Multi-channel and multi-technology strategies represent the next frontier. Being the central platform for mobile applications, the next generation Internet must provide an infrastructure that allows data transfer to be fast and cost-efficient. The mobile Internet will open an important new channel for commerce. With mobile technologies, enterprise applications will go beyond the

four walls of organizations to a workforce on the move. Employees will be able to access the company's mission-critical enterprise applications, such as enterprise resource planning (ERP), customer relationship management (CRM), and supply chain management (SCM). This open enterprise is also extended to suppliers and trading partners so that when customers get in contact with the resources of an organization, they also touch upon the resources of the value chain. The usefulness of the mobile channel will be largely driven by these enterprise applications that enhance the overall customer values. With self-service applications in hand, customers will be able to touch the resource of an enterprise. It is the customers who drive the entire value chain (or supply chain), determining what is to be produced, when, and at what price. They will be able to interact with the entire business ecosystem and not just individual company, and this will mark the era of m-economy.

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Understanding Customer Relationship Management: The Implications of CRM Fit and Customer Orientation

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Abstract

Customer Relationship Management (CRM) has been one of the important managerial issues. The benefits of Relationship Marketing has been well recognized and new information technologies offer amazing possibilities for CRM practice.

The processes of implementing CRM, however, are expensive, and yet the failure rate of the CRM projects is also high. Of the failures, 20% end up even damaging to long-standing customer relationships.

This study focuses on explaining theoretically why huge IT investment on CRM practice does not always generate the successful outcomes to the organizations, what are the critical factors of CRM, and how the factors influence the CRM performance.

Based on the review of the previous frameworks and definitions of CRM, the study proposes an integrated CRM framework. In addition, among others, CRM Fit and Customer Orientation are addressed as critical factors of successful CRM. Although technology has been identified as a main enabler of successful CRM, many CRM experts have claimed that it is not technology in isolation that brings the success to the CRM practice. Adopting Task-Technology Fit (TTF) model, CRM Fit, not Technology, is included in the research model. Therefore, this study proposes that CRM Fit has a positive relationship with CRM performance and Customer orientation moderates the effect of CRM Fit on CRM performance.

1. Introduction

The importance and benefits of customer relationship management has been well recognized [18] [24]. Kotler (1997) [18] mentioned that the cost of acquiring new customers is from 5 to 7 times more than retaining them. Reichheld and Sasser (1990) [24] have suggested that a company can improve profits by anywhere between 25 and 85% by reducing customer defections by a mere 5%.

In addition, Customer Relationship Management (CRM) technologies and other allied information technologies offer amazing possibilities for ideal, highly satisfying customer relationship management [14] [17]. Ives and Mason (1990) [17] have introduced several conceptual tools to use information technology to improve customer service. They point out that information technology can be used to enhance customer satisfaction

by identifying and tracking individual customers; monitoring service levels by company representatives; and assisting customers in specifying, acquiring, fixing, or returning products. It is one of the main reasons why Customer Relationship Management gets substantial attention from researchers as well as practitioners.

The processes of implementing and executing CRM, however, pose difficult challenges for many organizations [1] [26]. According to one Gartner Group study, as many as 55% of all CRM projects are expected to fail during 2002-2006.

CRM systems cost an average of \$35,000 per call-center agent to deploy, and setup and maintenance of CRM sales software typically cost \$28,000 to \$40,000 per salesperson over a three-year cycle [5]. Given such high costs of deployment and maintenance, the drastic failure rates represent huge financial risks for most CRM adopters. Furthermore, It is noted that of these failures 20% lead to damage to long-standing relationships [20].

The study focuses on comprehensive understanding of CRM practice. It attempts to explain theoretically why huge IT investment on CRM practice does not always generate the successful outcomes to the organizations. This study would achieve its goals by drawing from and blending multiple disciplinary perspectives such as the Task-Technology Fit model from Management Information Systems (MIS) and Customer Orientation perspectives from Marketing and Business Strategy literatures. This study identifies factors that are critical for successful CRM implementation, how these factors work and interrelate, and what would be the effects of these factors on customer retention and satisfaction and therefore on the performance of the CRM-implementing organization.

2. What is CRM?

2.1 What/who is Customer?

To answer the question, "What is customer relationship management?" we need to first define the customer. Many different answers exist to these questions, and the broad definition of customer includes suppliers, buyers, consumers, and employees (internal customers) [11]. However in this study, the definition of customer is limited to buyers of the product or service, which a firm provides.

2.2 What is CRM?

Having narrowed the focus of the term “customer” to the product/service buyer, understanding what is CRM and what elements constitute CRM is the next step. Specific buyer-focused CRM projects need to be properly implemented and managed in each organization.

Many researchers and practitioners have attempted to define CRM in various ways. CRM has been seen as different things to different people in the different areas [14] [26] [27]. For some, CRM is understood as computer application and database marketing while for others, business strategy. Even though the definition of CRM is not consistent among researchers, based on the review of previous frameworks of CRM, three core dimensions characterize a buyer-focused CRM system: Customers in the center, Management’s articulation and tracking of customer relationship goals, plans, and metrics, and Technology, which include collaborative, operational, and analytical CRM systems. These key elements of CRM are shown in Figure 1. Each level has to be coordinated for successful CRM implementation and performance outcomes.

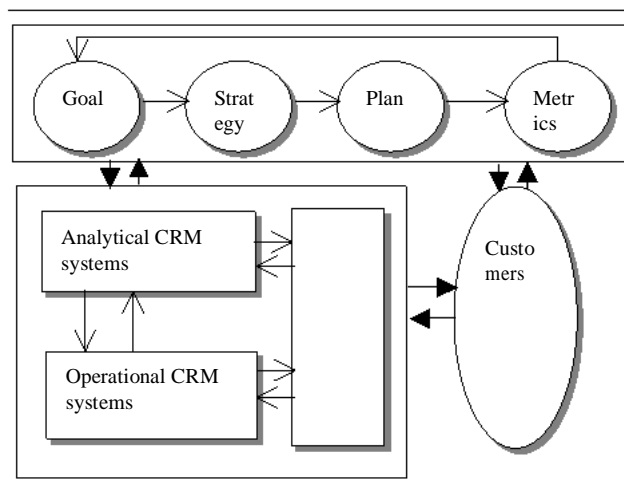


Figure 1. Framework of CRM

First, management level should be included to understand CRM since CRM has been seen as strategy of the organization [2] [7] [25]. Management level should be included in any understanding of CRM. Starting from the corporate level goals, strategies should be established to accomplish such goals. As well, the strategies have to be followed by specific plans and the performance of these plans has to be tracked and evaluated thoroughly. CRM projects have to take organizational level goals and strategy as the starting point because it is these goals, strategies, and plans that reflect the corporate philosophy regarding customer orientation and inculcate a customer-responsive corporate culture.

Second, technological structure contains analytical CRM systems, operational CRM systems, and collaborative CRM systems.

Analytical CRM systems include Knowledge Discovery in Database (KDD) concept and data mining.

KDD is outlined as a process, often iterative, of data selection and sampling, of pre-processing and cleaning, of transformation and dimension reduction, of data mining or analysis, and of visualization and evaluation [19].

Operational CRM systems entail the integration of all the front-end customer-facing functions of the business. For example, since the sales process depends on the cooperation of multiple departments performing different functions, the systems to support the business process must be configurable to meet the needs of each department [10] [15]. Business process reengineering and the integration with the ERP legacy systems [15] are included in the issues of operational CRM. It is important to note that the organization should review its business process before installing the systems.

Collaborative CRM systems refer to CRM functions that provide points of interaction between the customer and the channel [15]. It can be the communication center, the coordination network that provides the neural paths to the customer and his suppliers. It could mean a portal or a customer interaction center (CIC).

Third and finally, the *raison d'être* of any CRM system is the customer. Customer service and related issues must be included in the design, implementation, and operation of any CRM system. CRM software needs to pay attention to not only the users within the implementing organization, but also to the end customer [10]. While enhancing the operational efficiency of the organization is an important goal of using CRM technology, servicing and delighting the customers are the ultimate end-goals as well as the ultimate determinants of success.

With these components in place, CRM is defined as a core business strategy that integrate internal processes and functions and external business networks to interact, create and deliver value with personalized treatment to targeted customers to increase customer retention at a profit. It is grounded on high quality customer data and enabled by information technology [2] [7].

3. How does CRM work?

As the framework of Figure 1 indicates, information technology plays a critical role in the CRM practice. And in fact, huge investments in technology characterize the contemporary practice of CRM.

To explain how CRM systems lead to the increased customer retention and satisfaction, the framework of Task-Technology Fit (TTF) model is adopted and adapted. The TTF model highlights the importance of task-technology fit in explaining how technology leads to performance impacts [12]. TTF assumes that the performance impacts depend upon the fit between three constructs: technology characteristics, task requirements, and individual abilities. Thus it emphasizes that it is not the technology in isolation that affects performance – organizational characteristics also come into play [13]. These notions are appropriate for CRM practice study since many CRM experts have claimed that it is not just

technology that brings the success to the CRM practice, even though technology is the enabler of CRM [6].

Therefore, along with technology, organizational factors play a crucial role in the success of CRM systems. Figure 2 outlines the proposed model of factors that drive CRM performance and success.

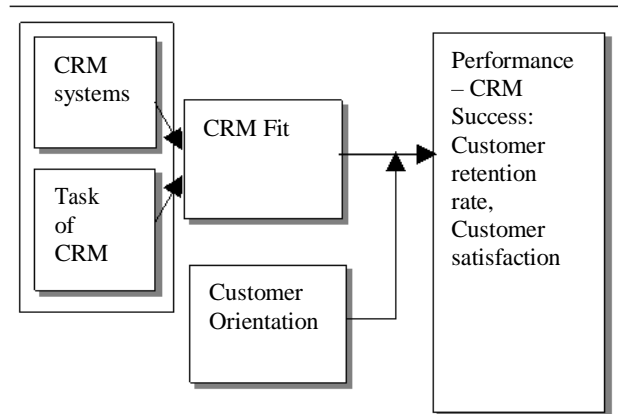


Figure 2. Research Model for CRM Fit

This model contains two main factors for the successful CRM: CRM Fit, not technology, and Customer Orientation. Based on the previous research, CRM Fit is expected to have a positive relationship with CRM success and Customer Orientation moderates the relationship. As antecedents of CRM Fit, both CRM systems, and Tasks and goals of CRM are addressed. The two antecedents are expected to have interaction effect on CRM Fit. Following is the review of each factors.

3.1 Antecedents of CRM Fit: CRM Systems

Technologies (CRM systems) are viewed as tools used in carrying out the tasks in the TTF model [12]. The tools can be computer systems (hardware, software, and data) and user support services (training, help lines, etc.).

The technical architecture of CRM can include multiple applications; performing analytical, operational, and collaborative functions. In the CRM technical structure, on the analytical side, a data warehouse typically maintains historical data that supports generic applications such as reporting, queries, online analytical processing (OLAP), and data mining as well as specific applications such as campaign management, churn analysis, propensity scoring, and customer profitability. On the operational and collaborative sides, data must be captured from the in-bound touch points, including the Web, call centers, stores, and ATMs. As outbound touch points, email, direct mail, telemarketing, and mobile devices [14].

Depending on the situation, however, a firm can choose different set of application packages with the different target. Software packages and systems tend to vary considerably. The decision on the applications and systems a firm chooses is totally dependent on the situation. Therefore, the recognition of all the possible

CRM tools seems not only impossible but also undesirable.

For this reason, the proposed study focuses on overall quality of CRM systems. Like other similar studies on TTF, identifying the quality evaluation criteria, rather than the lists of the tools used in the firm, is more suitable for the purpose of this study.

In this model, CRM systems are measured by system quality and information quality. System quality has been recognized as a measure of the information system itself [8]. For example, system characteristics can be measured by the content of the database, aggregation of details, response time, and system accuracy. Information quality has been studied as a measure of information system product [8], that is, the quality of information that the system produces, primarily in the form of reports.

3.2 Antecedents of CRM Fit: Task of CRM

Task of CRM contains the goals, depth and width of CRM, and business process design. The goals of CRM can be customization, flexibility, recovery, and spontaneous customer delight which can be delivered to the customers and those have been identified as the main drivers of customer satisfaction to be influenced by the infusion of technology [4]. CRM depth is measured by the three different targets of CRM practice [14]. The CRM targets which are applications, infrastructure, and transformation [14]. The authors explained that all those three targets are supposed to be addressed by CRM systems, but in practice, most of the companies can be categorized as focusing primarily on one of these three CRM targets. As well, the Customer Service Life Cycle (CSLC) can be used to identify the width of CRM. CSLC was initially introduced by Ives and Learmonth [16] and described a series of activities that customers would be engaged in as they purchase a product/service. The customers will traverse a life cycle as he/she first learns about it, and then learns how to specify, order, use, repair, and finally discard it. They argued that CSLC provides a powerful tool to assess opportunities to use information technology provide better service. Business process design for customers will be investigated as one of the important CRM tasks, and the focus will be how well the business process is designed to serve customers.

3.3 CRM Fit

Task-Technology Fit is defined as the degree to which a technology assists an individual in performing his/her portfolio of tasks [12]. In line with this definition, CRM Fit is defined as the degree to which CRM systems fit well the tasks and goals of CRM. The antecedents of CRM Fit are the interactions of tasks and goals of CRM and CRM systems. Eight factors were introduced to measure TTF, and the factors are Quality, Locatability, Authorization, Compatibility, Ease of Use/Training, Production Timeliness, Systems reliability, and Relationship with users [12]. These factors are used for CRM Fit in this model. Therefore, in this model, the interaction of task of

CRM and CRM systems is expected to be an antecedent of CRM Fit, and the good CRM Fit is expected to show positive relationship with the CRM performance, which is measured by customer retention rate and satisfaction.

3.4 Customer orientation

Finally in this model, Customer Orientation is included. Customer orientation has been seen as one of the three components of market orientation [21]. To date, the concept of market orientation has long been observed and extended by many researchers from Narver and Slater [21] to Nobel, Sinha, and Kumar [22]. Quite a few studies have found support for the fundamental market orientation and performance relationship [23]. Following Narver and Slater (1990)'s definition, customer orientation is referred to as "the sufficient understanding of one's target buyers to be able to create superior value for them continuously [21, p.21]" in this study. As well, it is broadly recognized that successful organizations need to have a customer-oriented business culture [3] [9]. Therefore, customer orientation is expected to influence the relationship between CRM FIT and performance in the context of CRM practice.

In sum, it is proposed that for successful CRM practice, the technology implemented should have good fit with the tasks and goals of CRM. Just implementing expensive technology is not sufficient. As well, not only the good fit between the technology and the goals and tasks of CRM, but also customer orientation is required.

4. Possible outcomes and contributions

From this study, it is expected to see the positive relationship between good CRM fit and the performance of the organization. Customer orientation is expected to moderate the relationship between the CRM fit and the performance.

This study will provide a comprehensive CRM framework and propose a model of critical factors for CRM success. Following are the theoretical implications of this research. First, the resultant conceptual frame and a model would provide a stronger theoretical basis for understanding the technology aspects of customer and market-focused research in the Marketing discipline. This is because CRM technology is examined based on theories adapted from MIS as well as Marketing. Second, the measures for CRM Fit will be based on scrutiny of CRM practices including technology and CRM business goals. The structure and dimensions of CRM Technology and CRM activities and goals will be a cornerstone for CRM conceptualization. Third, the study will theoretically shed light on the importance of customer centric management as well as information technology in CRM practice. Fourth, the factors identified from the literature will be tested empirically.

The major benefits of this study to the managers would be closer matching of CRM technology and CRM goals, leading to increasing levels of customer satisfaction and customer retention. The results of the study will provide

theoretical explanations about why huge IT investments in CRM practice do not always generate the successful outcomes desired by organizations and what factors other than technology should be focused on. Investments in CRM technology could then be planned based on careful review of business goals. Also, the measures for CRM Fit would help managers diagnose their businesses for CRM readiness and CRM technology investment. Many variables and measures developed in this study should be employable later as analytical tools for evaluating the organizations' CRM adoption, deployment, and management capabilities. In addition, the analyses of the business processes will provide guidance for better services to customers. The results will provide guidelines for using CRM systems to design customized / personalized services that delight the customers. The results of the study will guide for the smart investment to the information technologies since it will investigate the scope (depth and width) of CRM practice.

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E-Commerce Skills Requirements in Online Job Advertisements

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Abstract

This paper presents an ongoing research to determine the most popular skills of the e-commerce workforce based on e-commerce skills requirements present in online job locator websites. A large number of online job ads for e-commerce related positions have been already identified representing different geographical areas of the United States. Data is being collected and analyzed regarding types of positions (IT vs. non-IT), salary offered for positions, required years of experience, educational background requirements, desirable non-technical (personal traits and business) skills, and, technical skills (problem solving, technology, and tools).

1. Introduction

With organizations becoming more adaptive of e-commerce as a viable business solution to augment their traditional business channels, the importance of having a capable mix of IT and non-IT e-commerce staff has become apparent. Depending on a firm's business requirements and the depth of e-commerce solutions results in a varied demand for e-commerce personnel. In line with previous research investigations of skills requirements of IS personnel [3] [4] [10], this study aims to determine the requisite skills for the e-commerce workforce. This study is seen necessary as a result of the many apparent differences that are reported between traditional IS projects and e-commerce projects [5]. Mirza and Chan [6] have identified several challenges with relation to e-business organizations that result in different skills requirements for an e-business IT workforce at different levels of the organization.

With this study we hope to answer three main research questions:

1. How different are the IT skills requirements between traditional IT jobs and e-commerce jobs?
2. How does the importance of non-IT (personal traits and business) skills differ between traditional IT jobs and e-commerce jobs?
3. How are e-commerce curriculums meeting actual skills demands of the e-commerce industry?

Methodology to be used for conducting this study and future work agenda will be described in this paper after a brief literature review of related studies. It is hoped that as a result of this study, e-commerce practitioners and job seekers will be able to determine which skills are most popular. This should help them in better preparing themselves for the e-commerce job market. Additionally, e-commerce curricula will be better developed and fine-tuned to meet the real industry e-commerce skills needs [1].

2. Related Research

Much research has been conducted regarding IS personnel skills requirements. Issues of skills portfolios, traits, training, education, skills development, and, recruitment and retention are major issues that have been extensively investigated [7]. Failure to properly manage a firm's skilled workforce may lead to a high rate of turnover, a costly, and at times, a devastating proposition for organizations [2].

With the growing complexities of organizations and the many new applications, business interactions, and technological advancements, an approach of skills portfolio managements has been recommended [8]. Todd, McKeen, and Gallupe [9] conducted a study of IT skills requirements as found in job ads of popular American newspapers from 1970 to 1990. They studied over 1,400 job ads from five-year intervals during the twenty-year period. They noticed the increase of skills requirements over the years from an average of 4 skills per ad to an average of 9 skills per ad. They also discovered that business skills were becoming more important for technical staff as years progressed. Leitheiser [4] conducted an MIS developer skills study where seven main categories consisting of fifty-four specific developer skills were identified. The seven main identified developer skills categories were: analysis & design, programming, interpersonal, business, environment, language, and application.

3. Research Methodology

This research is being conducted by investigating job ads in a popular online service for job seekers and advertisers. Of special interest are jobs that were specified as "Internet/e-commerce" positions. Eight hundred (800) job ads, posted during a two-month period

in the summer of 2003, have been collected from companies based in American states that include major cities, where a larger demand for e-commerce personnel is expected. Selected states are: California, New York, Illinois, Texas, Georgia, the District of Columbia, and Washington.

Six major categories for representing characteristics of a job ad were identified. These categories include the following:

3.1 Type of Job (IT vs. Non-IT)

Even though e-commerce can be considered as a highly technical profession, e-commerce job ads are not all necessarily looking for technical expertise. Other non-IT jobs may include marketing, sales, and accounting.

3.2 Salary

The salary offered for a certain position may be specified by the advertising company. In other cases, no salary is given. Yet in other cases, the job applicant is expected to specify their salary requirement if he/she decide to seek the position.

3.3 Years of Experience

In the current tough job market, it is interesting to determine if companies are hiring staff without any previous relevant experience.

3.4 Educational Background Requirements

The minimum level of education required from prospective e-commerce employees will be investigated. It is expected that in the current job market, more applicants will be expected to have bachelor's degrees at minimum.

3.5 Non-technical Skills

These include two sub-categories, personal traits, and business skills. Personal traits can be exemplified by "interpersonal skills," and "works well with others." Examples of business skills include "project planning," and "business function."

3.6 Technical skills

Technical skills may be divided into three sub-categories: problem solving skills, technology skills, and tools skills. An example of problem solving skills is "optimizing mathematical solutions." Technology skills include Java, XML, and HTML, while tools include "graphics applications," and "MS Office."

4. Conclusion

This ongoing study aims to determine the requisite skills for e-commerce jobs. It is believed that e-commerce, as a result of its revolutionary nature, demands different skills requirements than more traditional IT positions. An investigation of 800 e-commerce job ads is being conducted. Findings are expected to help improve the path that e-commerce professionals pave for themselves. E-commerce curricula are also expected to benefit from this study, with e-commerce programs being better developed to meet the actual skills requirements of e-commerce companies.

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Mappings between Virtual Community Processes and Business Processes

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Abstract

One of the new business models enabled by the Internet is the community-based model. The aim of this model is to profit from the value created by individuals interacting within a virtual community. While we know that a virtual community can be co-opted for business purposes, we do not know the extent to which a community-based business differs from a conventional one. If we are to systematically build community-based businesses, we ought to know which existing processes in a pure virtual community can be adapted for business purposes and, conversely, which processes are lacking and must be added to the virtual community in order to transform it into a business. This paper analyzes one of the largest teen-advice forums on the Internet, yesnomaybe.com, which is also a profitable, community-based business. The goal is to uncover how virtual community processes map to conventional business processes. Using representational analyses I show that a virtual community contains autonomous supply, production, and consumption processes, while lacking advertising and income processes. I end by discussing how yesnomaybe.com implements its income and advertising processes and in doing so creates a special kind of community-based business known as a programmable autonomous business.

1. Introduction

The Internet has given rise to a number of new business models, whose popular names include the storefront, auction, portal, dynamic-pricing, B2B e-Commerce, and click-and-mortar models [4]. Another emerging business model is the community-based model [16], which aims to profit from the individuals that interact within various kinds of virtual communities like chat rooms, forums, and MUDs [19]. An interesting variant of the community-based business model is the programmable autonomous business model [7] — an unmanned, automated business built entirely in software, which operates profitably and grows its customer base without any employees or managers directing it.

Although we know that virtual communities can be co-opted for business purposes, we do not have process models that describe why they can function as businesses. Existing studies on virtual communities have largely focused on design principles [20] [10] [14] [13], analyzing social interactions within such communities (e.g., [3] [15] [2]) and more recently how to support both

social capital (e.g., [5] [18]) and social processes [6] within virtual communities. There are no studies that systematically compare and contrast the processes in a virtual community with those in a conventional business.

If we are to build businesses that are based on virtual communities, we ought to understand the extant processes in virtual communities that can be adapted for business purposes, as well as those processes that are missing and must be added to the virtual community in order to complete its transformation into a community-based business. The research reported in this paper is a first step towards understanding these processes.

2. A Functional Blueprint for a Conventional Business

Businesses exist to create value for customers [11] in the form of goods—both physical and informational—and services, or products. There are as many different kinds of businesses as there are products. However, although the internal makeup, e.g., employees and equipment, as well as the external environment, e.g., suppliers, promoters, and customers, can vary tremendously across businesses, the creation and operation of most businesses can be described in terms of a very general model that I refer to as the conventional business model, which I have adapted from Flor [7]. This model depicts the main agents that a business interacts with, along with the key physical goods, information, and income exchanged between the agents (refer to Figure 1).

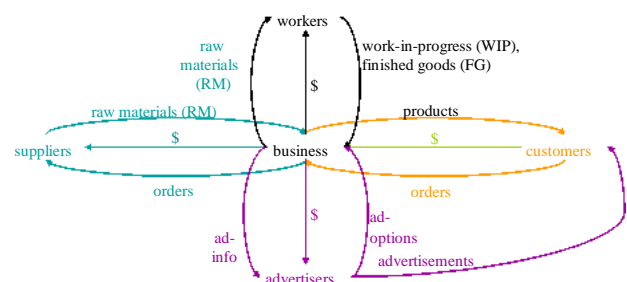


Figure 1. Functional Blueprint for a Conventional Business

Briefly, a business orders raw materials from suppliers who deliver them to the business in exchange for payment (west loop). Workers—both human and machines—take these raw materials and transform them into work-in-progress or finished goods in exchange for wages (north loop). Customers order products from the business,

which delivers them to the customers in exchange for payment (east loop). Finally, one of the major tasks of any business is to "create" customers to purchase its products or services [1]. A business works with various organizations to advertise its products to customers (south loop). These loops correspond to supply, production, consumption, and advertising processes, respectively.

If we build a similar functional blueprint for a virtual community, we can compare and contrast it with that in Figure 1, to uncover existing business processes in a virtual community as well as the processes that are lacking but necessary to make it into a business.

3. Methodology

We apply a representational analysis [8] [9] based on the theoretical framework of distributed cognition [12], to a specific information activity within a community-based business. This is an inductive method where one first charts the movement of information across the individuals and technologies (collectively "agents") that participate in an activity. By abstracting the agents and information in the chart (also known as an information activity map) one can then infer the general processes underlying the observed information activity.

3.1 The community-based business: YNM

The business whose activity is analyzed in this paper was the website YesNoMaybe.com, or simply YNM. YNM is a web-based forum developed by Mental Systems, Inc., which has been in operation since February of 2000. It is the largest teen advice forum in the Open Directory¹ (www.dmoz.org)—for both its own category Kids and Teens : Teen Life : Advice : Romance, as well as its parent category—with over 60,000 registered users who have contributed more than 300,000 postings.

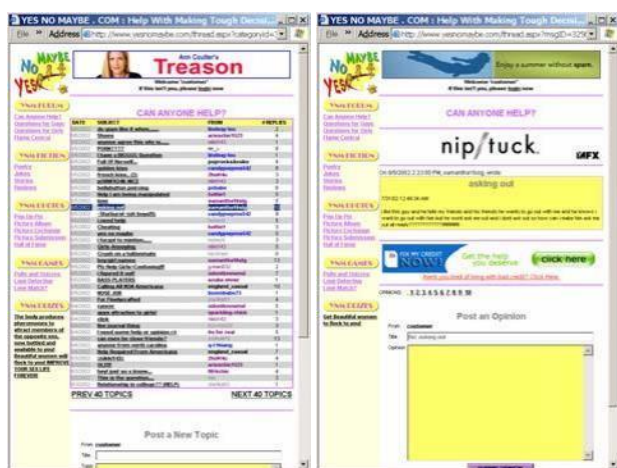


Figure 2. Screen shots: topic list (left) and topic/opinion display (right)

¹ The Open Directory is a hierarchical organization of web sites similar to Yahoo (www.Yahoo.com), but much larger and is outsourced to many of the top search engines, including Google (www.Google.com) and AOL (search.aol.com).

YNM's forum consists of ten different categories, e.g., "Questions for Girls" and "Questions for Guys." Similar to other web forums, users can browse a list of topics (see Figure 2, left screen), read the content of those topics as well as replies (see Figure 2, right screen), or post their own topics and opinions (see Figure 2, bottom of screens).

A poll of over 700 users indicates that 80% are females and 20% are males. 96% of the users are eighteen or under, with 62% below the working age of sixteen. However, YNM is more than just a teen advice forum, it is also a business that has operated profitably since its inception in February of 2000. For example in its first quarter of operation, when companies had large Internet advertising budgets, YNM averaged \$9500 per month in advertising revenues. Since then revenues have been more modest. Over the past year (8/1/2002—7/31/2003, see Figure 3), YNM averaged \$131/month in advertising revenues, with only \$15/month in expenses (fixed web hosting fee)—a simply profitability index of 777%. Besides operating profitably for the past three years, YNM continues to grow its customer base, averaging 1090 new user registrations a month over the past year.

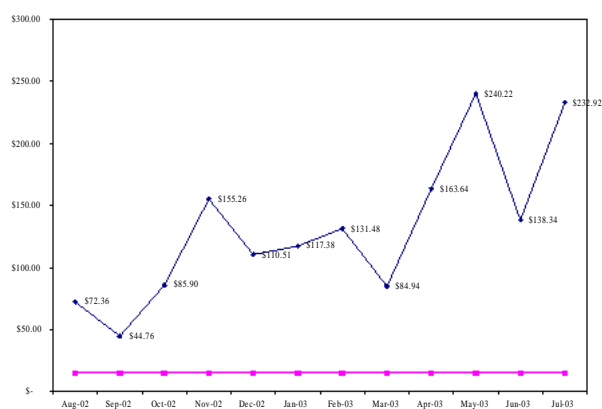


Figure 3. YNM revenues (top line) and expenses (bottom line) from 8/1/2002 to 7/1/2003

3.2 The information activity: A help thread

Table 1 displays a topic posting (index 0) and ten opinion postings (index 1-10). In forum terminology, this is collectively known as a "thread." This particular thread was chosen because it typifies the kinds of messages posted on YNM and that one finds in other virtual community forums.

4. Analysis

The catalyst for the topic posting is some situation in Phoenix's local environment that she is not sure how to handle. Figure 4 graphs the exchange of topics and opinions between the topic poster, Phoenix, and the ten opinion posters over time.

Table 1. The thread to be analyzed

0	phoenix 3/31	I like this guy and he tells my friends and his friends he wants to go out with me and he knows i want to go out with him but he wont ask me out and i dont ask out so how can i make him ask me out all ready????????????!!!!!!
1	lilandra 3/31	..Tell him to ask you out! lol That might work.....guys like it when you take charge!..
2	kitty 3/31	You go up ta him ask him out or why he's not askin you out
3	wolverine 3/31	There's no real way to make someone else ask you out. If he wants to, there is a chance he'll eventually ask you, but there's always the possibility that he's shy, or that he doesn't knwo how you would react. The idea that you don't ask people out strikes me as a strange pne; you can't expect other people to make the first move forever, and some people would never make a move if they didn't have some indication of how you would react. If you're unwilling to ask him out, then the best thing you could do it make it known that you would go out with him if he asked you.
4	colossus 4/03	just go up to him and say 'i think your funny (or somethin like that i mena if he is) and i was just wondering if maybe u wanna go to a movie or something sometime?' and if he sasy no then well he is an ass that doesnt deserve u ne way :) lol hope i helped!
5	jean 4/03	get one of your friends to ask him out for you. hope i was helpful....always works for me.
6	rogue 4/04	u go and ask him if he likes u and then say well do u wanna go catch a movie or something on saturday (or something like that)
7	cyclops 4/05	fuck! just ask him out urself! if u like him so much just ask him out! WHY DO GIRLS HAVE SUCH A HARD TIME WITH IT!!!!!!!!!!!!!!!!!!!!!!
8	nightcrawler 4/05	Why don't you ask out already????????!!!!!! You afraid that at that point, you give him the upper-hand because you were the instigator in this matter? Or maybe you have underlaying insecurities that you haven't dealt with as of yet. You should take some time to think of this matter.
9	Professor Xavier 4/05	If I were you I would flirt as much as possible, or dress really nice for him. And if he still doesn't for awhile then you ask him. I know it's hard to get the courage to, but I have before and it worked. Not all guys are crazy about the old-fashioned saying that the guys have to ask the girls out. XXXXXXX (P.S. Need any more help email me @ xxxxxxxxxxxxxxx@xxxxxxxxxxxxx)
10	storm 4/05	Ok Ive been were you are now. The thing i did worked Ive been with my bfriend for 9 months you just talk to him till you are best friends and then he will relize ok Iam ready to go out with her and Iam just going to warn you know that you need to be careful because once you get to know him you might change your mind abort him so be careful and GOOD LUCK

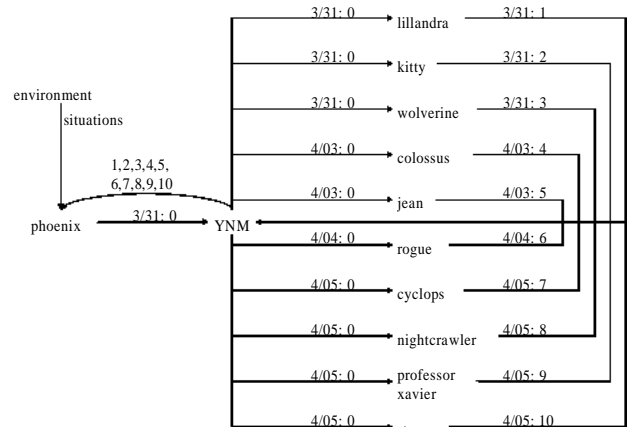


Figure 4. Information activity map for the sample thread

The arrows in the graph are labeled with a number corresponding to the content index from Table 1 and, where known, are prefixed by the date the content exchange occurred, e.g., the label 3/31: 0 denotes a topic posting on March 31st, whereas the label 4/05: 7 denotes the posting of the seventh reply on the fifth of April. She originally posted her topic on 3/31, and over the course of five days, ten other users read and responded with various opinions.

To understand how these processes get co-opted for business purposes. We first simplify the diagram by grouping the ten opinion posters into a single node labeled "opinion posters" (see Figure 5):

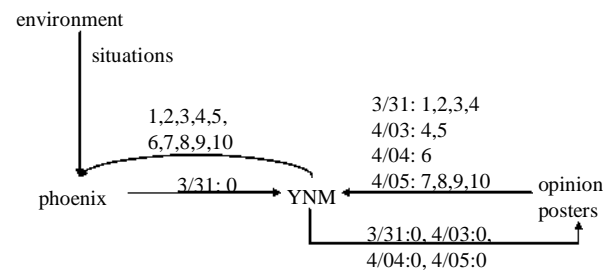


Figure 5. Grouping the 10 opinion posters

Next, we group the information exchanged between agents, as either a "topic" or "opinion" and generalize phoenix as a "topic poster" (see Figure 6)

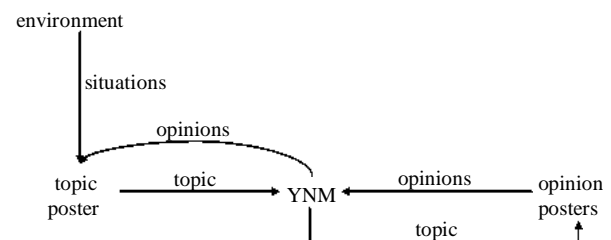


Figure 6. Generalizing the information

Not shown in Figure 6 are the members of YNM that

simply browse and read threads without contributing an opinion or topic of their own. Members refer to this behavior as "lurking," which is best summarized by the following user's posting (see Table 2, emphasis mine).

Table 2. A user posting that describes lurking

Mac y	... aww spanx babe!!! dont worry theres msn for me and you! i might come back i dont know, right now im just lurking around lolz i'll hardly post or reply to anything, like i did before, but it'll be way less, ...
----------	---

Figure 7 depicts the information activity map for YNM with lurkers added:

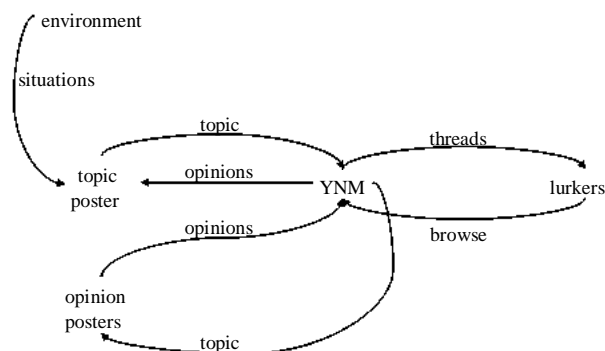


Figure 7. Functional blueprint for the thread

We are in a position now to compare the functional blueprint for the thread (Figure 7), with the functional blueprint for a conventional business (Figure 1).

5. Results

A cursory inspection of the functional blueprint for the thread (Figure 7) may not reveal the underlying business processes. However, by explicitly representing the software scripts that transform the topic and opinions into threads as well as annotating the agents and information with their counterparts in the conventional business model (see Figure 1), the business processes become apparent. Figure 8 depicts a functional blueprint for the thread with these annotations.

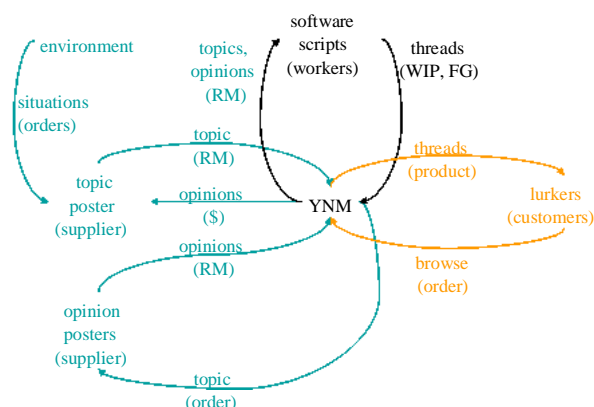


Figure 8. Functional blueprint for the thread with business labels

5.1 Common business processes: Supply, production, consumption

The thread activity, and by extension a virtual community, contains instances of supply, production, and consumption processes. Specifically, the topic and opinion posters play the role of suppliers for YNM. But unlike a conventional business where the raw materials are tangible goods, the raw materials—topic and opinion postings—are information based. Software scripts play the role of the workers in YNM, taking the topics and opinions and formatting them as threads in a database. These threads are YNM's product and are made available online to the lurkers, who correspond to business customers.

The supply process, in particular, differs from that of a conventional business in several interesting ways. First, the suppliers in a virtual community are its members, not some outside agency. Community members can and do shift roles between lurking and posting, viz., between being consumers and being suppliers. Second, they provide raw materials for free without any monetary payment—although one can view the opinions that the topic suppliers receive as a kind of information payment. Finally, the supply process is autonomous. No one within the community orders members to start supplying postings. Rather, situations in the members' environment are the catalyst for the supply process.

5.2 Missing Business Processes: Advertising and Income

The business processes missing from a pure virtual community are more apparent, namely an advertising process and an income process. To transform a virtual community into a community-based business, these processes must be designed into the virtual community. One challenge is to implement them without the virtual community having to pay any money. To do so would result in a true programmable autonomous business—a business built entirely in software that runs itself, generating income and customers, without human workers or managers directing it. In the following section, we discuss the advertising and income processes that make yesnomaybe.com a programmable autonomous business.

6. Discussion

The analysis showed that a virtual community instantiates the supply, production, and consumption processes needed by a business. The missing processes are an advertising process and an income process. While one could copy what conventional businesses do—pay some outside agency to advertise the business and charge customers for accessing content—there are several drawbacks to doing so. One obvious drawback is cost; advertising can be expensive, particularly in the national media needed to reach a mass audience. Second, it is not clear that mechanisms which work for conventional businesses will work for community-based businesses.

For example, customers are used to obtaining community content for free and may be unwilling to pay for it, especially when such content is typically available elsewhere on the Internet.

One possibility is to design low to no-cost advertising processes, as well as income processes that, paradoxically, do not require customers to pay any money to the community-based business. YNM has implemented two such processes. Figure 9 depicts the complete functional blueprint for YNM. To unclutter the diagram, topic and opinion posters have been grouped as "customers" (see west loop in Figure 9). In the following discussion, terms in *italics> reference items in this diagram.*

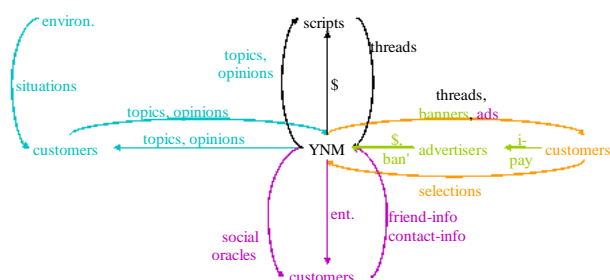


Figure 9. Functional blueprint for YNM as a programmable autonomous business

6.1 Example: YNM's income process

In YNM, customers pay indirectly via advertisers. Specifically, the advertisers give YNM banner code (*ban'*) that allows YNM to display banners along with the thread content in various locations on the web page. In Figure 2, you can see banners at the top of the page, before the thread content, and after the thread content. The advertisers then pay YNM money (\$) in exchange for the users performing some action on the banner. Different advertisers require different actions for payment. The actions include: (a) clicking on a banner; (b) clicking on a banner and then entering contact information into a form, like an e-mail address or telephone number; or (c) simply looking at a banner. The users' actions can be viewed as a kind of information payment (*i-pay*) to the advertiser, who then transforms this information into money for YNM (see Figure 3).

6.2 Example: YNM's Advertising Process

Aside from the listing on DMOZ, YNM does not appear in any of the top search engines for common search terms like "teens" or "teen romance." Moreover, keeping with the goal of autonymity, YNM's owners do not pay companies to advertise the site. As with the supply process, YNM relies on existing customers to promote the site by both word of mouth or by interacting with social oracles. A social oracle is a computer program that provides social information (*ent.*) to customers—entertaining information that users want to share with other friends and associates. YNM has two social oracles: a compatibility program, and the "love

detective" (see Figure 10).



Figure 10. Social oracles for advertising

Generally, social oracles work by taking, as input, information about a user's friends or associates and returning entertaining information about them—information that a user will want to share with others. For example, the compatibility program takes the names of two people and returns three compatibility scores along with an explanation of those scores. This entertaining information is used to construct a direct response advertisement [17]. For instance, in the compatibility game, the user is given the option of e-mailing the compatibility report to a friend. Unbeknownst to the user, only the scores get e-mailed to the friend. To receive the explanations, the recipient is told to click on a link (the direct response mechanism that sends them to YNM), and use the compatibility program.

Matching the e-mails sent out with the registration e-mails in the new-user database, shows the compatibility program has a 14.46% conversion rate. The love detective, operating on similar principles, has a conversion rate of 30.22%. Both social oracles far exceed the 2% response rate that typifies direct mail advertisements.

To summarize, YNM's income and advertising processes when combined with the supply, production, and consumption processes that result from its virtual community, allow it to generate income and grow its customer base without the owners doing any work or paying expenses, aside from the initial development and monthly web hosting costs (see Figure 3). YNM is not only a community-based business, but a programmable autonomous business as well. Future research is needed to discover how to systematically design advertising and income processes for the different kinds of virtual communities on the Internet.

7. Summary

We have seen how a virtual community instantiates supply, production, and consumption processes. To transform virtual communities into businesses, designers ought to focus their efforts on the development of advertising and income processes specific to their types of communities. As YesNoMaybe.com demonstrated, properly designed advertising and income processes can allow community-based businesses to operate autonomously and at low costs.

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A New Thought about Modelling of Bilevel Programming Problems

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Abstract

This paper presents a new mathematical model for bilevel linear programming problems (BLPPs). A new kind of constraint is proposed to emphasize the pre-determined hierarchy in the bilevel decision-making process. The solution to the BLPPs based on this new model is defined. A number of simple examples of BLPPs have been solved using the new model. It has been shown that the new model is able to handle a wider range of BLPPs.

1. Introduction

The origin of the bilevel programming problems can be traced back to 1952 when they had been formulated by H.V. Strackelberg in a monograph on market economy [1]. Dempe [2] defined the BLPPs as mathematical optimization problems where the set of all variables is partitioned between two vectors X and Y , which are controlled by the upper level (leader) and the lower level (follower), respectively, and vector Y is to be chosen as an optimal solution of a second mathematical programming problem parameterized in vector X . According to Dempe, BLPPs turn to be complicated mathematical problems because (a) they are NP-hard; (b) their formulation has inherent difficulties even with respect to the notion of a solution and for many of its reformulations as one-level optimization problems regularity conditions cannot be satisfied at any feasible point. Bard [3] described the linear bilevel programming problems as a mathematical model as follows:

For $x \in X \subset R^n$, $y \in Y \subset R^m$, $F: X \times Y \rightarrow R^1$,
and $f: X \times Y \rightarrow R^1$,

$$\min_{x \in X} F(x, y) = c_1 x + d_1 y \quad (1.1a)$$

$$\text{subject to } A_1 x + B_1 y \leq b \quad (1.1b)$$

$$\min_{y \in Y} f(x, y) = c_2 x + d_2 y \quad (1.1c)$$

$$\text{subject to } A_2 x + B_2 y \leq b \quad (1.1d)$$

where $c_1, c_2 \in R^n$, $d_1, d_2 \in R^m$, $b_1 \in R^p$, $b_2 \in R^q$,
 $A_1 \in R^{p \times n}$, $B_1 \in R^{p \times m}$, $A_2 \in R^{q \times n}$, $B_2 \in R^{q \times m}$.

The solution to the problem (1.1) was described by a set of definitions as follows [3, on P196]:

(a) Constraint region of the BLPP, denoted by S

$$S = \{(x, y): x \in X, y \in Y, A_1 x + B_1 y \leq b, A_2 x + B_2 y \leq b\} \quad (1.2)$$

(b) Feasible set for the follower for each fixed

$$x \in X$$

$$S(x) = \{y \in Y, A_2 x + B_2 y \leq b\} \quad (1.3)$$

(c) Projection of S onto the leader's decision space

$$S(X) = \{x \in X: \exists y \in Y, A_1 x + B_1 y \leq b, A_2 x + B_2 y \leq b\} \quad (1.4)$$

(d) Follower's rational reaction set for $x \in S(X)$

$$P(x) = \{y \in Y: y \in \arg\min_{y \in S(x)} f(x, y)\} \quad (1.5)$$

(e) Inducible region (IR)

$$IR = \{(x, y): (x, y) \in S, y \in P(x)\} \quad (1.6)$$

In terms of the above notation, the BLPP can be written as

$$\min \{ F(x, y) : (x, y) \in IR \} \quad (1.7)$$

It can be seen from (1.7) that the solution to BLPP (1.1) can be found by solving a one-level linear programming problem in which the objective function is $\min F(x, y)$ and the constraint region is IR from pure mathematical point of view. According to Bard [3], the inducible region IR is the intersection of two sets, which are the leader's constraint region S and the region determined by the follower's optimal solution for all $x \in S(X)$, i.e.

$$\{(x, y): x \in S(X), y \in P(x)\}$$

where $P(x)$ is defined in (1.5). So it is obvious that if the leader's constraint region has no intersection with the follower's optimal solution set, i.e., the IR is empty, the problem (1.1) or (1.7) has no solution. However, this is not always the case. For example, one can expect the solution to BLPP (1.1) in a real world situation as the optimal solution for both objective functions over S or the optimal solution for the leader objective function over S . Further more, this model assumes that the information is only perfect for the leader, not the follower. This might lead to a situation in which the solution is not reasonable.

This paper presents a new mathematical model of BLPPs. The new model is developed by modifying the existing model of BLPPs defined by Bard [3] to release the above limitations. The first key point is to relax the problem's constraints by setting the follower's objective function as a reference-to constraint instead of a subject-to constraint. The second key point is to distinguish the two situations: one is when the information is perfect to the leader only and when the information is perfect to both leader and followers. A number of examples of linear BLPPs are depicted and the results show that the new model is able to handle a wider range of BLPPs and produce more reasonable solutions.

The rest of the paper is organized as follows. Section 2 describes development of the new model of BLPPs. Section 3 compares the defined solutions to a number of sample BLPPs using the new and existing models. Section 4 concludes the paper.

2. A New Mathematical Model of Bilevel Programming Problems

Refer to the model of BLPPs (1.1), we separate the problem into the leader's problem or the upper level problem

$$\min_{x \in X} F(x, y) = c_1 x + d_1 y \quad (2.1a)$$

$$\text{subject to } A_1 x + B_1 y \leq b \quad (2.1b)$$

and the follower's problem or the lower level problem

$$\min_{y \in Y} f(x, y) = c_2 x + d_2 y \quad (2.2a)$$

$$\text{subject to } A_2 x + B_2 y \leq b \quad (2.2b)$$

where (2.1b) and (2.2b) are referred as the leader's and the follower's subject-to constraint functions, respectively. Both problems are parametric linear programming problems because each level can only control one variable vector. When these two problems are combined to form a BLPP, there two possible cases: one is that the information is perfect for both levels, which means that both leader and follower know the objective functions and subject to constraints at the other level and the other case is that the information is perfect for the leader only, which means only the leader knows the objective functions and constraints of the follower. In the following sections, these two cases will be discussed separately, then a generalised model will be presented.

2.1 Case 1 -- A BLPP with perfect information for both levels

Given a BLPP with perfect information for both levels, for a possible $x \in S(X)$, the leader knows the follower's response $y(x)$ which satisfies both the leader's and the follower's subject-to constraints and will select a x^* so that the leader's objective function $F(x^*, y(x^*))$ is minimized.

The model can be written as

$$\min_{x \in X} F(x, y) = c_1 x + d_1 y \quad (2.3a)$$

$$\text{subject to } A_1 x + B_1 y \leq b \quad (2.3b)$$

$$A_2 x + B_2 y \leq b \quad (2.3c)$$

$$\min_{y \in Y} f(x, y) = c_2 x + d_2 y \quad (2.3d)$$

$$\text{subject to } A_2 x + B_2 y \leq b \quad (2.3e)$$

$$A_1 x + B_1 y \leq b \quad (2.3f)$$

This model can be simplified to a form that is the same as (1.1) by omitting (2.3c) and (2.3f) because of the perfect information for both sides. The solution to (2.3) is the same as the one to (1.1) except for the follower's feasible set, which should be re-defined as

$$S(x) = \Delta \{y \in Y, A_1 x + B_1 y \leq b_1, A_2 x + B_2 y \leq b\} \quad (2.4)$$

for each fixed $x \in S(X)$.

2.2 Case 2 -- A BLPP with perfect information only for the upper level

Given a BLPP with perfect information only for the upper level, the follower does not know the

leader's objective function and the subject-to constraints. So the follower can only response to a fixed $x \in S(X)$ over its own constraint region which is defined by (2.2b). This might lead to a situation in which the constraint region S is non-empty and compact, but the follower's response to a fixed $x \in S(X)$ does not satisfy the constraint (2.1b). The existing model of BLPPs (1.1) gives no solution in this situation. This is not always reasonable because the solution to a BLPP should be expectable in a real world situation provided that the intersection of the subject-to constraint regions from both levels is non-empty and compact. In order to release this limitation, we modify the existing model of BLPP (1) as follows:

$$\min_{x \in X} (c_1 x + d_1 y) \quad (2.5a)$$

$$\text{subject to } A_1 x + B_1 y \leq b \quad (2.5b)$$

$$\text{reference to } \min_{y \in Y} (c_2 x + d_2 y) \quad (2.5c)$$

$$\text{subject to } A_2 x + B_2 y \leq b \quad (2.5d)$$

where "reference to" is similar to "subject to" but used to combine the upper level problem and the lower level problem to reflect the pre-determined hierarchy in the bilevel decision making process.

Let S_f denote a set formed by a pair of x and y where $x \in S(X)$ and $y \in P(x)$, where $S(X)$ and $P(x)$ are defined in (1.4) and (1.5). If S_f does not belong to S , the leader will ignores the follower's responses and seeks for its own optimal solution over S . Otherwise, the leader will seeks for its own optimal solution over S_f . Consequently, the notation of solution to (2.5) is similar to the one to (1.1) and listed as follows:

(a) Constraint region S

$$S = \{(x, y) : x \in X, y \in Y, A_1 x + B_1 y \leq b, A_2 x + B_2 y \leq b\} \quad (2.6)$$

(b) Projection of S onto the leader's decision space

$$S(X) = \{x \in X : \exists y \in Y, A_1 x + B_1 y \leq b, A_2 x + B_2 y \leq b\} \quad (2.7)$$

(c) Feasible set for the follower for each fixed $x \in S(X)$

$$S_f(x) = \{y \in Y, A_2 x + B_2 y \leq b\} \quad (2.8)$$

(d) Follower's rational reaction set for $x \in S(X)$

$$P(x) = \{y \in Y : y \in \arg \min_{y \in Y} [f(x, y) : y \in S(x)]\} \quad (2.9)$$

(e) Follower's optimal solution constraint region S_f

$$S_f = \{(x, y) : x \geq 0, x \in S(X), y \geq 0, y \in P(x)\} \quad (2.10)$$

(f) Inducible region (IR)

$$IR = \begin{cases} \{(x, y) : (x, y) \in S, y \in P(x)\} & S_f \subseteq S \\ \{(x, y) : (x, y) \in S\} & \text{otherwise} \end{cases} \quad (2.11)$$

2.3 A generalised model of BLPPs

The "reference to" can also be used in the model (2.3), which is for a BLPP with perfect information for both levels, to emphasis the two levels in the problem. Since S_f is always in S in this situation, "reference to" is the same as the "subject to". Under the assumption that the leader's and the follower's constraints implicitly contains the other's subject-to constraints, the notation of solution by (2.6)-(2.11) also can be used for the case 1. Therefore, both the cases presented in section 2.1 and 2.2 can be generalised by the model (2.5) with the notation of solution definition (2.6)-(2.11), this is regarded as the new model in the paper.

3. Comparison of the Existing and New Models by Sample BLPPs

3.1 Sample BLPP 1

Given $x \in \mathbb{R}^1$, $y \in \mathbb{R}^1$ and $X = \{x \geq 0\}$, $Y = \{y \geq 0\}$, the leader's problem is

$$\min_{x \in X} (x - 4y) \quad (3.1.1)$$

and the follower's problem is

$$\min_{y \in Y} (y) \quad (3.1.2a)$$

$$\text{subject to } -x - y \leq -3 \quad (3.1.2b)$$

$$-2x + y \leq 0 \quad (3.1.2c)$$

$$2x + y \leq 12 \quad (3.1.2d)$$

$$-3x + 2y \leq -4 \quad (3.1.2e)$$

i) Case 1

Form a BLPP with perfect information for both sides as

$$\min_{x \in X} (x - 4y) \quad (3.1.3a)$$

$$\text{reference to } \min_{y \in Y} (y) \quad (3.1.3b)$$

$$\text{subject to } -x - y \leq -3 \quad (3.1.3c)$$

$$-2x + y \leq 0 \quad (3.1.3d)$$

$$2x + y \leq 12 \quad (3.1.3e)$$

$$3x + 2y \leq -4 \quad (3.1.3f)$$

The constraint region S can be determined by

$$S = \{(x, y) : x \geq 0, y \geq 0, -x - y \leq -3, -2x + y \leq 0, 2x + y \leq 12, 3x + 2y \leq -4\} \quad (3.1.4)$$

The projection of S onto the leader's decision space S(X) can be determined to be

$$S(X) = \{x : 1 \leq x \leq 4\} \quad (3.1.5)$$

Feasible set for the follower for each fixed $x \in S(X)$

$$S(x) = \{y : y \geq 0, -x - y \leq -3, -2x + y \leq 0, 2x + y \leq 12, 3x + 2y \leq -4\} \quad (3.1.6)$$

The follower's rational reaction set for $x \in S(X)$

$$P(x) = \{y \in Y : y \in \arg \min_{y \in S(x)} [f(x, y)] : y \in S(x)\} \\ = \begin{cases} 3 - x & 1 \leq x \leq 2 \\ 3x/2 - 2 & 2 \leq x \leq 4 \end{cases} \quad (3.1.7)$$

Graphically, S, S(X), S(x) and P(x) can be depicted in Fig.1. It can be seen that the set $S_f = \{(x, y) : x \in S(X), y \in P(x)\}$ depicted as a piece of line AB and BC that belongs to S. Therefore, the inducible region IR should be

$$IR = \{(x, y) : (x, y) \in S, y \in P(x)\} \\ = \begin{cases} 3 - x & 1 \leq x \leq 2 \\ 3x/2 - 2 & 2 \leq x \leq 4 \end{cases} \quad (3.1.8)$$

The problem can then be written as

$$\min \{ F(x, y) = x - 4y : (x, y) \in IR \} \quad (3.1.9)$$

According to the corollary 5.2.3 [1 on P.200], the solution to the problem can be found by comparing the F(x,y) values over the vertices of IR as shown in Table 1.

Table 1 Finding the solution to (3.1.3)

x	y	F(x,y)=x-4y
1	2	-7
2	1	-2
4	4	-12

It can be seen that the optimal solution to (3.1.3) occurs at x=4. The leader selects x=4 and the

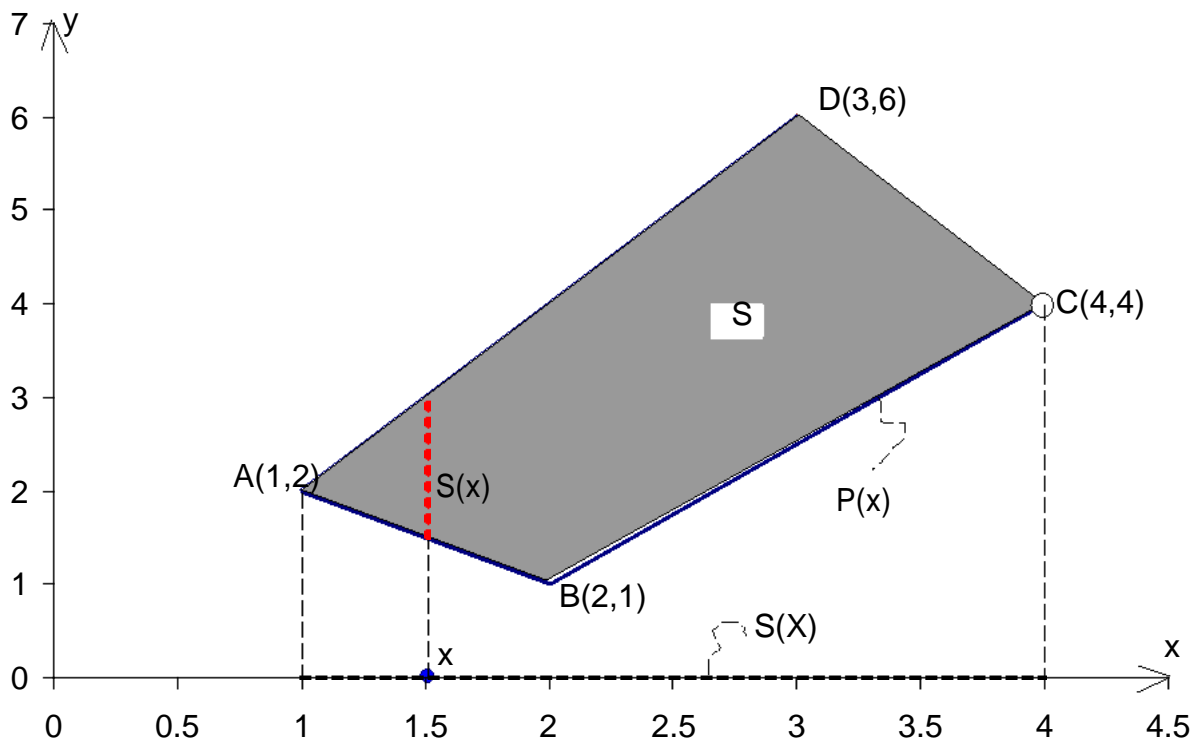


Fig.1 Illustration of S, S(X), S(x) and P(x) for the sample BLPP 1 (case 1)

follower responses $y=4$ to make $F(x,y) = x-4y = -12$.

ii) *Case 2*

Forming a BLPP with perfect information only for the leader side will result in an identical problem as (3.1.3) because the leader has no explicit constraints.

Both cases produce an identical solution to the one obtained by the existing model [3].

3.2 Sample BLPP 2

Given $x \in R^1$, $y \in R^1$ and $X = \{x \geq 0\}$, $Y = \{y \geq 0\}$, find the solution for a BLPP formed by the following two problems: the leader's problem is

$$\min_{x \in X} (x - 2y) \quad (3.2.1a)$$

$$\text{subject to } x - y \leq 0 \quad (3.2.1b)$$

and the follower's problem is

$$\min_{y \in Y} (x + y) \quad (3.2.2a)$$

$$\text{subject to } -x + 3y \leq 4 \quad (3.2.2b)$$

i) *Case 1*

Form a BLPP with perfect information for both sides as

$$\min_{x \in X} (x - 2y) \quad (3.2.3a)$$

$$\text{subject to } x - y \leq 0 \quad (3.2.3b)$$

$$\text{reference to } \min_{y \in Y} (x + y) \quad (3.2.3c)$$

$$\text{subject to } -x + 3y \leq 4 \quad (3.2.3d)$$

$$\begin{aligned} &\text{The constraint region } S \text{ can be determined by} \\ S = \{ (x, y) : x \geq 0, y \geq 0, y \leq \frac{1}{3}x + \frac{4}{3}, y \geq x \} \end{aligned} \quad (3.2.4)$$

The projection of S onto the leader's decision space $S(X)$ can be determined to be

$$S(X) = \{0 \leq x \leq 2\} \quad (3.2.5)$$

Feasible set for the follower for each fixed $x \in X$

$$S(x) = \{y : y \geq 0, y \geq x, -x + 3y \leq 4\} \quad (3.2.6)$$

The follower's rational reaction set for $x \in S(X)$

$$\begin{aligned} P(x) &= \{y \in Y : y \in \arg \min_{\hat{y} \in S(x)} [f(x, \hat{y})]\} \\ &= \{y : y = x\} \end{aligned} \quad (3.2.7)$$

Graphically, S , $S(X)$, $S(x)$ and $P(x)$ can be depicted in Fig.2. It can be seen that S_f is a piece of line AB that is on S . Therefore, the inducible region IR should be

$$\begin{aligned} IR &= \{(x, y) : (x, y) \in S, y \in P(x)\} \\ &= \{(x, y) : 0 \leq x \leq 2, y = x\} \end{aligned} \quad (3.2.8)$$

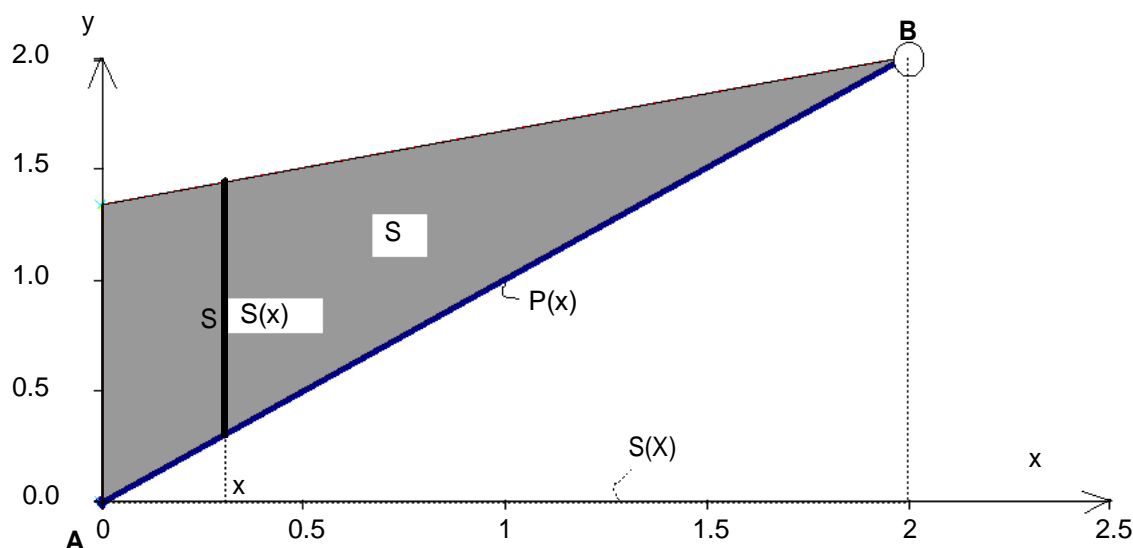


Fig.2 Illustration of S , $S(X)$, $S(x)$ and $P(x)$ for the sample BLPP 2 (case 1)

The problem can then be written as

$$\min\{ F(x, y) = x - 2y : (x, y) \in IR\} \quad (3.2.9)$$

The solution to the problem can be found by comparing the $F(x,y)$ values over the vertexes of IR as shown in Table 2.

Table 2 Finding the solution to (3.2.3)

x	y	$F(x,y)=x-2y$
0	0	0
2	2	-2

It can be seen that the optimal solution to (3.2.3) occurs at $x=2$. The leader selects $x=2$ and the follower responses $y=2$ to make $F(x,y) = -2$.

ii) Case 2

Form a BLPP with perfect information only for the leader side as

$$\min_{x \in X} (x - 2y) \quad (3.2.10a)$$

$$\text{subject to } x - y \leq 0 \quad (3.2.10b)$$

$$\text{reference to } \min_{y \in Y} (x + y) \quad (3.2.10c)$$

$$\text{subject to } -x + 3y \leq 4 \quad (3.2.10d)$$

The feasible set for the follower for each fixed $x \in X$

$$S(x) = \{ y : y \geq 0, -x + 3y \leq 4 \} \quad (3.2.11)$$

The follower's rational reaction set for

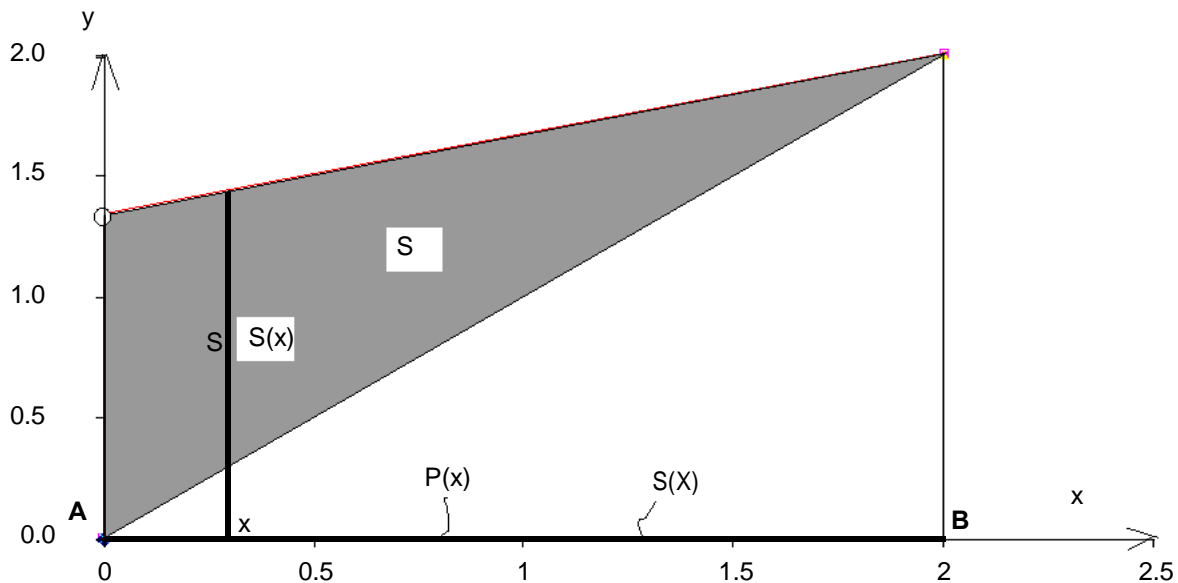


Fig.3 Illustration of S, S(X), S(x) and P(x) in the sample BLPP 2 (case 2)

$$x \in S(X)$$

$$P(x) = \{ y \in Y : y \in \arg \min_{y \in S(x)} [f(x, y)] \} \\ = \{ y : y = 0 \} \quad (3.2.12)$$

Graphically, S, S(X), S(x) and P(x) can be depicted in Fig.3. It can be seen that S_f is a piece of line AB that is not entirely in or on S. Therefore, the inducible region IR should be

$$IR = \{(x, y) : (x, y) \in S\} = S \quad (3.2.13)$$

The problem can then be written as

$$\min\{ F(x, y) = x - 2y : (x, y) \in IR\} \quad (3.2.14)$$

The solution to the problem can be found by comparing the $F(x,y)$ values over the vertexes of IR as shown in Table 3.

Table 3 Finding the solution to (3.2.10)

x	y	$F(x,y)=x-2y$
0	0	0
2	2	-2
0	4/3	-8/3

It can be seen that the optimal solution to (3.2.10) occurs at $x=0$. The leader selects $x=0$ and the follower responses $y=4/3$ to make $F(x,y) = x-2y = -8/3$.

Table 4 tabulates the solutions to the sample BLPP 2 using the new model for the cases 1 and 2 and the existing model. It can be seen that the

solution using the new model with perfect information for the leader gives the most reasonable result.

Table 4 Comparison of solutions to sample problem2 using different models

	x	y	f(x,y)	F(x,y)
New model (case 1)	2	2	4	-2
New model (case 2)	0	4/3	4/3	-8/3
Existing model	0	0	0	0

3.3 Sample BLPP 3

Given $x \in R^1$, $y \in R^1$ and $X = \{x \geq 0\}$, $Y = \{y \geq 0\}$, find the solution for the a LBLPP formed with the following two problems: the leader's problem is

$$\min_{x \in X} F(x, y) = x - 4y \quad (3.3.1a)$$

$$\text{subject to } -x - y \leq -3 \quad (3.3.1b)$$

$$-3x + 2y \geq -4 \quad (3.3.1c)$$

and the follower's problem is

$$\min_{y \in Y} f(x, y) = x + y \quad (3.3.2a)$$

$$\text{subject to } -2x + y \leq 0 \quad (3.3.2b)$$

$$2x + y \leq 12 \quad (3.3.2c)$$

i) Case 1

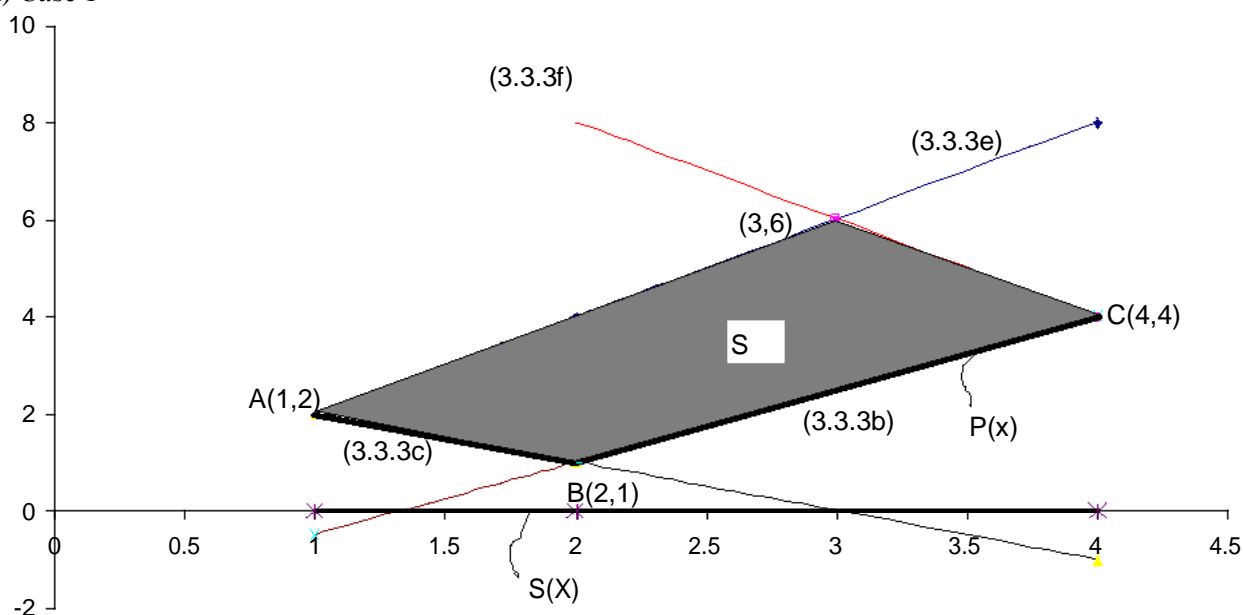


Fig.4 Illustration of S, S(x), S(X) and P(x) for sample BLPP 3 (case 1)

Form a BLPP with perfect information for both sides as

$$\min_{x \in X} F(x, y) = x - 4y \quad (3.3.3a)$$

$$\text{subject to } -x - y \leq -3 \quad (3.3.3b)$$

$$-3x + 2y \geq -4 \quad (3.3.3c)$$

$$\text{reference to } \min_{y \in Y} f(x, y) = x + y \quad (3.3.3d)$$

$$\text{subject to } -2x + y \leq 0 \quad (3.3.3e)$$

$$2x + y \leq 12 \quad (3.3.3f)$$

The constraint region S can be determined by

$$S = \{(x, y) : x \geq 0, y \geq 0, -x - y \leq -3, -x + 2y \geq -4, -2x + y \leq 0, 2x + y \leq 12\} \quad (3.3.4)$$

The projection of S onto the leader's decision space S(X) can be determined to be

$$S(X) = \{1 \leq x \leq 4\} \quad (3.3.5)$$

Feasible set for the follower for each fixed $x \in S(X)$ is

$$S(x) = \{y : y \geq 0, -x + y \leq 0, 2x + y \leq 12, -x - y \leq -3, -3x + 2y \geq -4\} \quad (3.3.6)$$

The follower's rational reaction set for $x \in S(X)$ is

$$P(x) = \{y \in Y: y \in \arg \min_{\hat{y}} [f(x, \hat{y}): \hat{y} \in S(x)]\} \\ = \begin{cases} \{y: y = \frac{3x}{2} - 2, 1 \leq x < 2\} \\ \{y: y = 3 - x, 2 \leq x \leq 4\} \end{cases} \quad (3.3.7)$$

$$S_f = \{(x, y): 1 \leq x \leq 2, -3x + 2y = -4\} \cup \{(x, y): 2 \leq x \leq 4, -x - y = -3\} \quad (3.3.8)$$

Graphically, S , $S(X)$, $S(x)$ and $P(x)$ can be depicted in Fig.4. It can be seen that S_f is the piece-wise line AB and BC which are on the S . Therefore, the inducible region IR should be S_f .

$$IR = \{(x, y) : (x, y) \in S, y \in P(x)\} = S_f \quad (3.3.9)$$

The problem can then be written as $\min\{F(x, y) = x - 4y : (x, y) \in IR\}$

The solution to the problem (3.3.3) can be found by comparing the $F(x, y)$ values over the vertexes of IR as shown in Table 5.

Table.5 Finding the solution to (3.3.3)

x	y	$F(x, y) = x - 4y$
1	2	-7
2	1	-2
4	4	-12

It can be seen that the optimal solution for (3.3.3) occurs at $x=4$. The leader selects $x=4$ and the

follower responds $y=4$ to make $F(x, y) = -12$.
ii) Case 2

Form a BLPP with perfect information for the leader only as

$$\min_{x \in X} F(x, y) = x - 4y \quad (3.3.10a)$$

$$\text{subject to } -x - y \leq -3 \quad (3.3.10b)$$

$$-3x + 2y \geq -4 \quad (3.3.10c)$$

$$\text{reference to } \min_{y \in Y} f(x, y) = x + y \quad (3.3.10d)$$

$$\text{subject to } -2x + y \leq 0 \quad (3.3.10e)$$

$$2x + y \leq 12 \quad (3.3.10f)$$

Feasible set for the follower for each fixed $x \in S(X)$

$$S(x) = \{y: y \geq 0, -2x + y \leq 0, 2x + y \leq 12\} \quad (3.3.11)$$

The follower's rational reaction set for $x \in S(X)$

$$P(x) = \{y \in Y: y \in \arg \min_{\hat{y}} [f(x, \hat{y}): \hat{y} \in S(x)]\} \\ = \{y: y = 0\} \quad (3.3.12)$$

$$S_f = \{(x, y): 1 \leq x \leq 4, y = 0\} \quad (3.3.13)$$

Graphically, S , $S(X)$, $S(x)$ and $P(x)$ can be depicted in Fig.5. It can be seen that S_f is a piece of line AB that is out of S . Therefore, the inducible

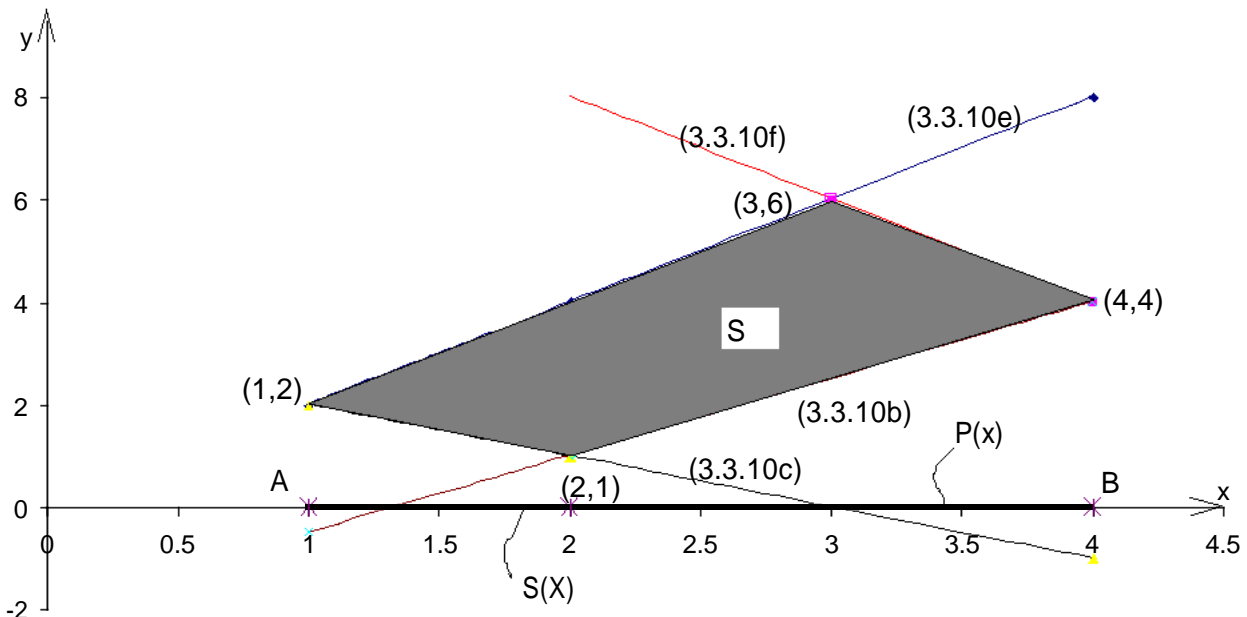


Fig.5 Illustration of S , $S(x)$, $S(X)$ and $P(x)$ for sample BLPP 3 (case 2)

region IR should be S.

$$IR = \{(x, y) : (x, y) \in S\} \quad (3.3.14)$$

The problem can then be written as

$$\min\{F(x, y) = x - 4y : (x, y) \in IR\} \quad (3.3.15)$$

The solution to the problem (3.3.10) can be found by comparing the $F(x, y)$ values over the vertexes of IR as shown in Table 6.

Table 6 Finding the solution to (3.3.10)

x	y	$F(x, y) = x - 4y$
1	2	-7
2	1	-2
3	6	-21
4	4	-12

It can be seen that the optimal solution to (3.3.10) occurs at $x=3$. The leader selects $x=3$ and the follower responses $y=6$ to make $F(x, y) = -21$.

Table 7 tabulates the solutions to the sample BLPP 3 using the new model for the cases 1 and 2 and the existing model. It can be seen that the solution to the sample BLPP 2 using the new model with perfect information for the leader gives the most reasonable result.

Table 7 Comparison of solutions to sample BLPP3 using different models

	x	y	$F(x, y) = x - 2y$
New model (case 1)	4	4	-12
New model (case 2)	3	6	-21
Existing model	No solution		

4. Conclusion

The follower's objective function is modelled by a new kind of constraint, *reference to*, in the BLPPs to reflect the predetermined hierarchy of the bilevel decision making process. The newly introduced constraint is the same as the one in the existing model if the set $S_f = \{(x, y) : x \in S(X), y \in P(x)\}$ belongs to S. When S_f does not belong to S, the follower's objective function will be ignored. The new model of BLPPs can lead to a reasonable solution when S_f is out of S. Three typical sample BLPPs have been

solved by using the new model and the results have been compared against the results gained from the existing model. It has been shown that the new model can be expected to be suitable for a wider range of BLPPs and be able to produce more reasonable solutions.

5. Acknowledgement

The author would like to thank Dr Guangquan Zhang and Mr Chenggen Shi for constructive discussions.

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Logistics – A Pathway Towards ‘Sustainable’ Competitive Advantage for the Multinational Enterprise

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Abstract

The Internet is significantly changing the strategic behaviour of many businesses that operate in the global arena. Today, many multinational enterprises (MNEs) work closely with their logistics providers to enhance their competitive positions. They increasingly outsource their non-strategic business functions, with logistics providers picking up this new source of business. The MNE is moving more towards a ‘front-end’ or customer focused operation, with their key logistics providers aligning themselves as supply chain integrators. Logistics providers may be classified as 1st to 4th party logistics providers. A 4th party logistics provider provides complete supply side solutions for the MNE, plus a degree of demand side service. It becomes an integral part of the MNEs competitive solution set. This paper proposes that integrated, fully activated, demand-supply (FADS) chains provide a mechanism to move beyond 4th party logistics provider (4PLP) solutions. It elucidates the key clusters of skills levels that must be activated by the logistics provider to operate at the 5th party logistics provider (5PLP) FADS level of outsourcing and service. The 5PLP FADS logistics provider brings a vast array of ‘added-value skills’ to the MNE, and a key innovative, flexible and highly agile partnership results, whereby pathways towards ‘sustainable’ competitive advantage may be developed. The 5PLP FADS logistics model is the next step in the progression to total logistics integration.

1. Introduction

The Internet has emerged as a powerful global force that is influencing, and sometimes significantly changing the strategic behaviour of many businesses. Some [25] [31] suggest the Internet is a new communications tool, building closer relationships with customers, suppliers, and employees. Others suggest the Internet is creating a new way to conduct business – often termed e-business [7]. The global marketplace has changed. The large MNE of the past is experiencing a dramatic change in competition from a diverse array of new global entrants [29]. Some businesses such as the book portal - Amazon.com, the auction house - eBay.com, or the automotive portal - SmartSearch.com.au, offer only an ‘on-line’ presence, yet each trades successfully. On-line Marketplaces like netbuy.com, offer extensive virtual inventories. NetBuy’s virtual inventory is four times the

size of the largest electronics components market distributor [26]. NetBuy cuts the long catalogue searching to seconds, removes inefficiencies, and links buyers with sellers. Such skilled niche operators focus on their ‘front-end’ or ‘web interface’ connectivity with the customer. Many incorporate aspects of the 8C’s of the customer web interface design - context, content, connection, communication, community, commerce, customization and characterization [15] into their business strategies. These focused, ‘on-line’ solutions are reducing both the uniqueness and the competitive advantage of the large MNE, by exploiting the unique features of the Internet [21]. This tough environment has invoked MNEs to seek lower cost solutions, whilst maintaining or improving quality [13]. Sustainability has now become a key function of cost management [26], and of strategy [7] [17] [25]. Competitive advantage has also become a key focus [12] [35].

2. Competitive Advantage

Porter, [24] proposed that 5 forces could be used to develop a company’s competitive position. These forces

1. the intensity of rivalry among existing competitors,
2. the barriers to entry for new competitors,
3. the threat of substitute products or services,
4. the bargaining power of suppliers, and
5. the bargaining power of buyers

present a key starting point from which MNEs may shape their unique competitive position. Porter’s original model displayed in Figure 1, whilst still valid, no longer covers the current global and networked environment.

Porter, [25] recognised the impact of the Internet on the business environment. He suggested new ways to create distinctive strategic positionings. Size is no longer the determining factor in success, but speed is a vital success factor. He identified two underlying drivers of profitability that transcend any technology or type of business:

- Industry structure, which determines the profitability of the average competitor, and
- Sustainable competitive advantage, which allows a company to outperform the average competitor.

Porter linked these drivers to his five forces model of competition and added the key negative (-) and positive (+) effects applicable to a specific ‘on-line’ industry. The bracketed sign indicated whether the relevant factor has a negative, or positive, effect on the competitiveness and

profitability of this industry. This Porter model, displayed in Figure 2, differs for each specific industry may exhibit different effects, and to different degrees.

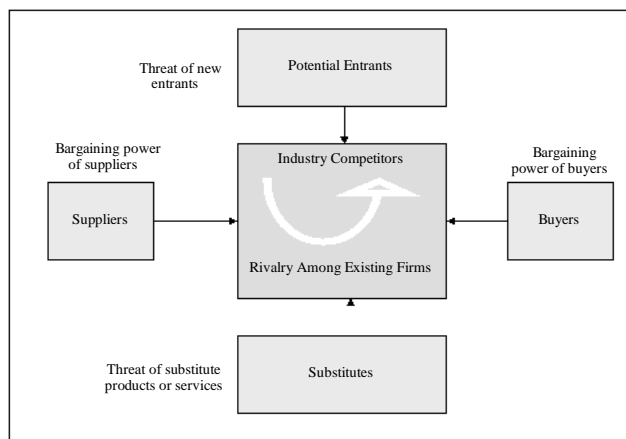


Figure 1: Porter's Five Forces Model (Source Porter, [24])

Porter suggests that, in general, Internet technologies will continue to erode profitability by shifting power to customers. This implies the MNE must move into this space and work closely with its customer base. Positive and negative effects on profitability, as a result of the impact of the Internet on the MNEs structure, can be subsequently looked at for each of the five competitive forces.

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Porter believes that cost and price advantages (profitability drivers) are developed by either improving 'operational effectiveness' or 'strategic positioning'. 'Operational effectiveness' refers to 'doing the same things your competitors do but doing them better'. Here, the MNE only gains advantages if it is 'able to achieve and sustain higher levels of operational effectiveness than its competitors'. Porter concludes that 'the nature of Internet applications makes it more difficult to sustain operational advantages than ever'. As such, strategic positioning becomes all the more important, gaining cost advantages or price premiums by competing in a distinctive way. This requires a 'strong focus on profitability rather than just growth, an ability to define a unique value proposition, and a willingness to make tough trade-offs in choosing what 'to do' and 'not to do'. It involves the configuration of a 'tailored' value chain that enables a company to offer unique value. Porter states that 'when it comes to reinforcing a distinctive strategy, tailoring activities, and enhancing fit, the Internet actually provides a better technological platform than previous generations of IT'. Multinational Enterprises (MNEs) and other large firms operating in the

global arena, need to tailor their deployment of Internet technology to their particular strategies'.

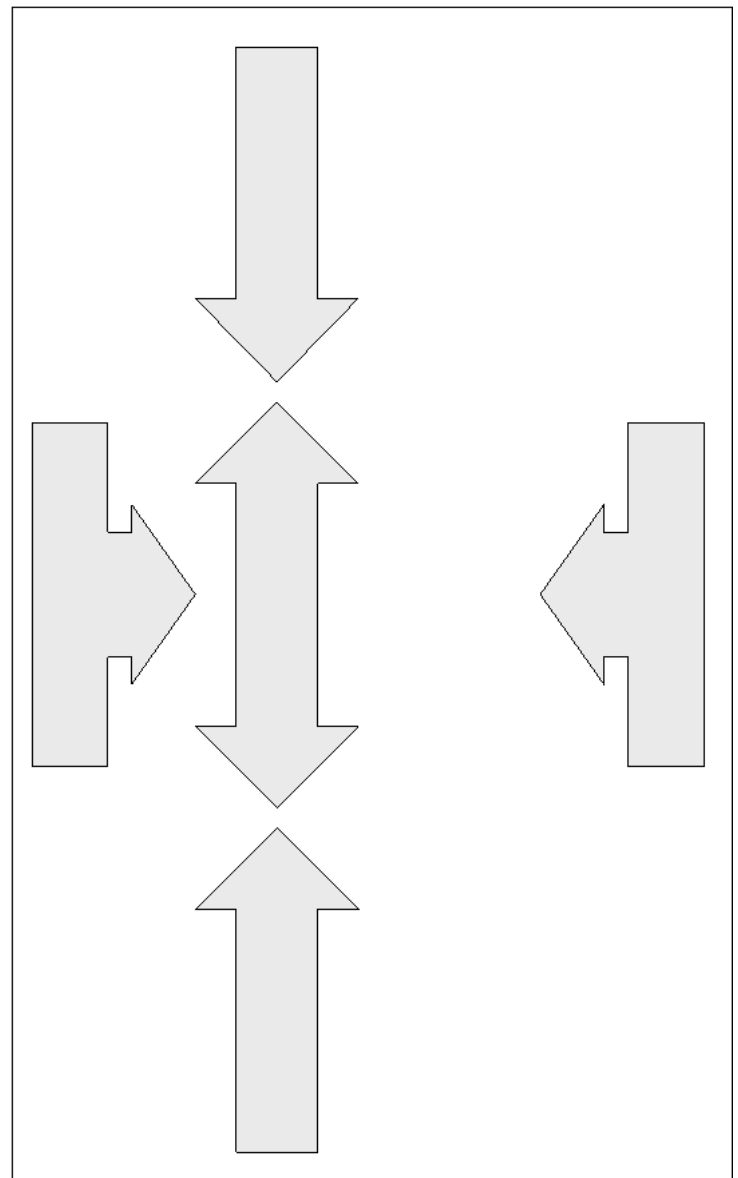


Figure 2 - How the Internet Influences Industry Structure (Source Porter, [25])

Porter suggests six principles exist for establishing and maintaining a distinctive strategic positioning:

- 1.start with the right goal, which is superior long-term return on investment,
- 2.deliver a value proposition different from those that competitors offer,
- 3.operate a distinctive value chain, performing either different activities than rivals or performing similar activities in different ways,
- 4.abandon or forgo some product features, services, or activities in order to be unique at others, in other words looking at trade-offs,
- 5.strategy defines how all elements of what a company does fit together; all a company's activities must be mutually reinforcing, and

6. maintain continuity of direction, in order to develop unique skills and assets or build strong reputations with customers.

To establish and maintain a distinctive strategic positioning, and to respond to competitive pressures from start-up businesses, substitute products, new initiatives, and the like, many MNEs have moved down the outsourcing path, outsourcing commodity like areas such as transport, warehousing and the like, and then have concentrated on their core functions and competencies. [23] [34] support these ideals from both economic and price viewpoints.

3. Outsourcing

The reason(s) why a MNE decides to outsource can vary widely. Greaver 2nd, [14] offered the following reasons why an MNE may outsource an entire business function, or some elements of its business:

- Organizational driven reasons
 - Enhance effectiveness - concentrating on what you do best
 - Increase flexibility to meet changing conditions, demand for products and services, and technologies
 - Transform the organisation
 - Increase product and service value, customer satisfaction, and shareholder value
- Improvement driven reasons
 - Improve operating performance (increase quality and productivity, shorten cycle times, and the like)
 - Obtain expertise, skills, and technologies that were not otherwise available
 - Improve management and control
 - Improve risk management
 - Acquire innovative ideas
 - Improve credibility and image by associating with superior providers
- Financially driven reasons
 - Reduce investments in assets and free up these resources for other purposes
 - Generate cash by transferring assets to the provider
- Revenue driven reasons
 - Gain market access and business opportunities through the provider's network
 - Accelerate expansion by tapping into the provider's developed capacity, processes, and systems
 - Expand sales and production capacity during periods when such expansion cannot be financed
 - Commercially exploit existing skills
- Cost driven reasons
 - Reduce costs through superior provider performance and the provider's lower cost structure
 - Turn fixed costs into variable costs
- Employee driven reasons
 - Give employees a stronger career path
 - Increase commitment and energy in non-core areas.

Almost always the MNEs driving forces to outsource are to satisfy its strategic aims, to respond to global

competition, to utilize technology, to focus on 'sustainable' competitive advantage, and/or to drive down costs. [13] [19] [25].

3.1 Levels of Outsourcing

Initially, legal firms and others outsourced single functions like the mail room to first party logistics providers (1PLPs). In the early 1990's large second party logistics network players (2PLP) like TNT and UPS, commenced global operations, and in the late 1990's third party logistics providers (3PLPs) like FedEx, emerged offering added value full web tracking services. In 1999, the US logistics industry was estimated to be USD 920 billion, whilst globally the logistics industry was estimated at over USD 2 trillion globally. Significantly, less than 5% of this industry was outsourced worldwide [32]. A skilled logistics provider, capable and experienced in operating within the global arena, has genuine new opportunities to successfully enter this broad area.

For example, the software MNE Oracle, now offers a wide range of computer packages to support the transport industry. These software solutions include: load tendering, ratings (TL, ocean, air and rail), transportation infrastructure (route, carrier and vehicle definitions), intelligence and reports (flexible shipping document generation), inbound freight management, freight payment and audit. Many unexpected players (for example, integrated IT suppliers, management consultants, financial services) have also entered the logistics market. Today, many integrated functional areas, especially those deemed non-core, are outsourced to 3PLPs including: transportation, sub-assembly, and the like. These 3PLPs share resources between their network members, sometimes outsourcing certain activities to second or third tier providers, (who join the value adding process as complementary providers). Thus, both horizontal and vertical integration develops between these optimized 3PLPs and their value chains. These value chains find new ways to generate efficiencies and profits. They utilize their innovative on-line and marketing talents, incorporate latest information and communication technologies, and create new drivers in their service delivery. In addition, the MNE, with its supply chain efficiently managed (and costs controlled) by its 3PLPs, can divert its attention to developing its own internal core business efficiencies, increasing its sales and revenues, and delivering its quality assured products to the marketplace in a rapid, reliable manner [4]. The Internet, along with its off-shoots - Intranets (communication and electronic links throughout and across the MNEs functions) and Extranets (communication and electronic links between and across the MNEs supply network), provides a new medium for detailed information sharing and collaboration throughout the MNEs partnership network. As such, the Internet is a key enabler of outsourcing processes.

3.2 The Affect of the Internet

The Internet has moved outsourcing processes into a new dimension. It has allowed the MNE and its supply chain partners to share information, rationalize components, 'stock-in-process', and stock holdings. Most of the large logistics companies have acquired software, such as warehouse management systems and transport management systems, to manage their warehouses, transportation and other activities.

More recently electronic data interchange and the Internet have allowed 3PLPs to provide higher value added services for their clients through the ability to support software systems like 'Vendor Managed Inventories', 'Supply Hubs' and 'E-fulfillment'. It has also enabled 3PLPs to bridge the gap between the private and the public sector, in areas such as customs procedures.

Services such as Profit Zone's GPS tracking, NetRaker's tracing, PeopleSoft's efficiency programs, and Vodafone's 'churn-rate' (loss of customer to another competitor) programs, deliver definite value to customers in planning their operations better and reducing their working capital locked up in unused inventory and work-in-progress.

The MNE may determine which functions may be treated like commodities and outsourced. The MNEs decision makers may choose to dissect each function into its components, and then decide which activities are strategic, and/or critical. Such activities normally remain 'in-house'. Other non-core options may then be defined and possibly outsourced to logistics providers.

3.3 The Two Clusters of Logistics Outsourcing Skills Model

A rich aggregation of desirable skills has emerged for international logistics outsourcing. Voss [33] termed these 'logistics improvement skill levers' and divided them into two clusters. Voss's clusters are displayed in Table 1. These clusters encompass the outsourcing levers developed by others including [18] [35]. The 'technical' cluster encompassed the areas of supply chain management along with its recent interconnective developments. Whilst the need to enable powerful information technology and communication infrastructures (technical equipment), and technical skills has now become indispensable [6], technologies and technical skills on their own are not sufficient to attain economic success [3]. Consequently, Voss defined a second cluster – the 'soft skills' cluster. This 'soft skills' lever set is more complex than the technical lever set due to its immateriality [33] but it delivers hard results. For example, in logistics services, there is a need to interact and manage relationships, and for 3PLP's this requires the use of a broad range of soft skills [1], as reflected in areas such as the criteria (and requirements) for job candidates Voss's lever set clusters link to many of the Greaver 2nd [14] outsourcing drivers. For example, organization, improvement and employee drivers occur at both the technical level and the soft skills level, whilst

revenue, finance and cost drivers are embedded in the use and management of knowledge.

Today, MNEs and their associated 3PLP's, still primarily focus on the 'technical' levers, but the importance of soft skill levers is undeniable, [1] [28]. The world market is heavily intercultural [11] [28], stresses the importance clearly: 'while the technological advances allow an instantaneous global communication across enormous distances, there has been no comparable breakthrough in bridging psycho-cultural distance between people with different cultural frames of reference'. To reach such this market the 3PLP must acquire all the skills and abilities necessary to build bridges between people of different cultures [6]. This soft skill set uses personal, communicative, psychological and cultural sensitivity in conjunction with mental flexibility and corporate agility, thereby enabling intercultural encounters to be successfully negotiated. The MNE and its globally operating 3PLPs may then utilize these two clusters of outsourcing levers to enhance their competitive position.

Table 1: The Two Clusters of Logistics Outsourcing Skills Model (Adapted from Voss, [33])

Cluster 1: Technical Levers	Cluster 2: Soft-Skill Levers
<ul style="list-style-type: none"> • Information Technologies • Communication Technologies • DSS Technologies • Organization Technologies • IT-Infrastructure • Logistics Assets • Technical Ability • Logistics Knowledge / Know-how • SCM Knowledge • IT-Knowledge 	<ul style="list-style-type: none"> • Social Competency • Intercultural Competency • Interpersonal Competency • Communication Skills • Organizational Skills • Problem-Solving Skills • Leadership Skills • Team Orientation • Empathy • Integrity • Self-Assurance / Self-Awareness • Motivation / Creativity • Politeness / Diplomacy • Mobility / Flexibility

3.4 The Three Clusters of Logistics Outsourcing Skills Model

Voss's two clusters of logistics outsourcing skills may be further enhanced to include a third cluster with its own set of levers - the Institutional levers. The three clusters of logistics outsourcing skills model is displayed in Table 2. These additional levers encompass the drivers required to incorporate the rigorous business management, the Internet and its competitiveness into the logistics framework. The Institutional cluster of skills encompasses the legislative and governance frameworks within which the MNE operates. The logistics provider then integrates these into its operational frameworks, ensuring all external compliance related areas (financial, legal, operational,

regulatory and the like) are incorporated within its solutions.

The Institutional levers are important logistics considerations. For example, US MNEs wishing to trade in China must understand that the Chinese government and its sanctioned trading companies have blocked third-party foreign trading companies and distributors from direct participation in the Chinese market, and from providing a complete range of trading and distribution services [5]. This Chinese legislation greatly inhibits a logistical competitive advantage for non Chinese MNEs. Thus, a 3PLP company, working in China for a US MNE, must have detailed knowledge of the specific Institutional levers that apply, and must establish (or have) a mechanism within which it may operate competitively.

Table 2: The Three Clusters of Logistics Outsourcing Skills Model (© Gunesh and Hamilton, 2003)

Cluster 1: Technical Levers	Cluster 2: Soft-Skill Levers	Cluster 3: Institutional levers
<ul style="list-style-type: none"> • Information Technologies • Communication Technologies • DSS Technologies • Organization Technologies • IT-Infrastructure • Logistics Assets • Technical Ability • Logistics Knowledge / Know-how • SCM Knowledge • IT Knowledge 	<ul style="list-style-type: none"> • Social Competency • Intercultural Competency • Interpersonal Competency • Communication Skills • Organizational Skills • Problem-Solving Skills • Leadership Skills • Team Orientation • Empathy • Integrity • Self-Assurance / Self-Awareness • Motivation / Creativity • Politeness / Diplomacy • Mobility / Flexibility 	<ul style="list-style-type: none"> • Government Legislation • Industrial Policies • Company Laws • Financial Services regulation • Intellectual Property and Copyrighting Policies • Competition and Antitrust legislation • Corporate Governance and Transparency • Transport Policies (Road, sea, air & Rail) • Political Stability • Economic Growth

3.5 The 3PLP Model and Sustainability

The third party logistics provider absorbs all the three clusters of levers into their logistics solution(s) for the MNE. They then use their specialist skills to enhance the overall operations of the MNE and themselves. The 3PLP aims to position itself with a unique set of competitive and reverse logistics skills [22], thereby allowing an avenue towards sustainable competitive advantage. Companies like, Menlo worldwide (www.menloworldwide.com), Ryder (www.ryder.com), SmartSearch (www.SmartSearch.com.au), and Schneider (www.apldirectlogistics.com) each utilize combinations of technical, soft-skill, and institutional levels to develop their unique competitive solutions[2] [12].

3.6 The 4PLP Model

Over the past few years, key MNEs have sought to outsource some (or all) non-core supply chain areas of their business to a series of 3PLPs or even to one master PLP, termed a 4PL™ by Andersen Consulting. Andersen Consulting's model [10] for the evolution from a single function MNE outsourced task, such as the mail room (to a 1PLP), up to complex, fully integrated MNE outsourced solution delivered by a 4PLP is displayed in Figure 3.

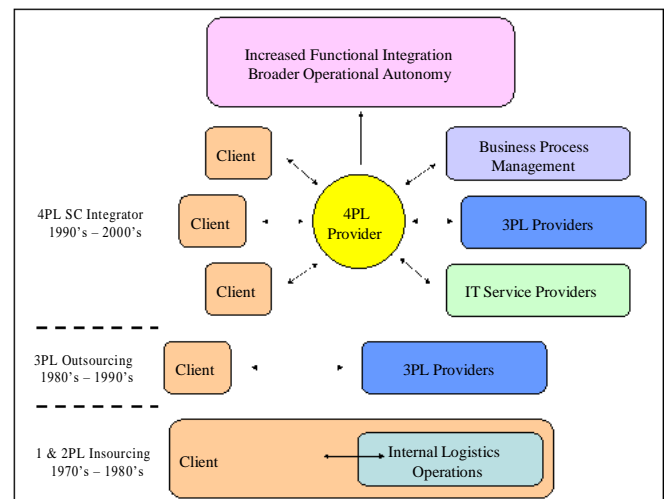


Figure 3: Evolution from First to Fourth Party Logistics Providers (Adapted from Docherty [10])

The range of activities undertaken by the 4PLP is almost identical to the role of a consultant on a long-term contract. In addition to business process reengineering; systems support and supply chain management planning; relationship management between 3PLPs and the client; and design, implementation, management and operation of the logistics facilities; the 4PLP can assist the MNE with entry into unfamiliar markets, especially those where it has extensive expertise. The 4PLP also offers a one-stop shopping experience for supply chain planning, systems selection/integration, project management, operational expertise, combined with the very latest in solutions and execution technologies. The 4PLP often works with a series of MNEs. In this environment it learns from its various MNEs and incorporates these skills into its knowledge base. It then applies this acquired knowledge to create and enhance the competitive positioning of itself and its MNEs.

In 2000, Andersen Consulting applied its 4PL™ model to Sears Roebuck's US equipment repair centres [10]. They utilized GIS, Simulation, and other tools to study the supply chain. They developed iso-cost curves, and determined regions of high and low total service cost and profitability. They used these graphic displays to establish the best US locations for the Sears Roebuck repair facilities. This model has since been adapted to many leading organizations.

The true 4PLP provider is really a super-service, cyber-corporation. For example, Nistevo (www.nistevo.com) sources and delivers the world's best items or pre-assembled component blocks. These globally

sourced items are then assembled by the MNE, and efficiently delivered to the customer. This allows the MNE to retain its competitive advantage. The UPS Logistics Group (www.ups.com/bussol/logistics) can also deliver a similar service, (and not just ship the MNEs products). Ian Chong, UPS Logistics Group's Business Development Manager estimated over 50% of CISCO's product was never touched by its employees in 2002. Thus, the MNEs 4PLP provider coordinates the timely component sourcing, manufacture, and delivery. The 4PLP functions like a virtual enterprise. It uses the global communications networks to minimize the barriers developed by geography, and sources world's best practice ingredients for the MNE, and delivers competitive advantage. [27] explains the uptake of outsourcing. In 2002, 75% of the Fortune 100 companies and approximately 45% of the Fortune 500 companies in the US used a 4PLP solution.

Currently, many MNEs like IBM, Phillips, Newscorp, and Sears Roebuck, use 3PLPs or 4PLPs, to innovate, and revolutionise their business solutions. Innovation is encapsulated via the seamless, vertical and horizontal integration of processes, and generally involves several players. This has led to increased competitiveness, particularly production, service and response speeds.

Many 4PLP 'end-to-end' management issues are related to time reductions [9]. An on-line business approach assists these improvements. For example, rapid electronic fund transfers speed-up the 'cash-to-cash' cycle [13] [30]. If interconnected with a demand-chain driven, fully networked, supply-chain enabled, integrated, on-line e-business system, a faster, more flexible, efficient service may be provided. The utilization of the embedded ordering and office automation systems facilitates a more economical, 'continuous' replacement system, where small, frequent orders permit supply chain members to hold reduced inventory levels. In addition there is direct, quick, efficient interaction between suppliers, the 4PLP, and the MNE. By analysing and connecting additional customers, appropriate 4PLPs. and appropriate suppliers, dedicated, service-related e-business sites including, www.epiphany.com, www.peoplesoft.com, www.seibel.com www.oracle.com, www.salesforce.com, and www.commerceone.com, can provide additional value to the on-line service business system. Thus, the web enabled 4PLP has several key competitive tools - time, flexibility, efficiency, cost, inventory, connectivity, customer analysis, and the like, by which it may enhance its value creation and positioning – and each is related to its on-line presence via the Internet.

3.6.2 Profitability

MNEs competing in the global environment face pressures to improve value and profitability. Investors expect MNEs to adopt value-based management frameworks where its activities and resources focus on increasing shareholder value. The MNE may identify and improve their key 'services and facilities' value drivers by enhancing operating performance (to increase quality

and productivity, shorten cycle times, and the like). The MNE may incorporate revenue management and dynamic pricing strategies, as well as development of new services (reverse logistics, service chain management and design for logistics). It may develop new expertise, skills, and technologies that were not otherwise available. It may develop new cost management, control and risk management systems, or it may outsource non strategic functions to 3PLPs or to a 4PLP [32].

3.6.3 Lean Supply Networks

The 3PLPs and 4PLP endeavour to maximize efficiencies throughout the MNEs supply chain. This has led to a shift towards leaner supply networks [13]. It has made MNEs more vulnerable. With fewer inventories in the system to 'buffer' against interruptions in supply, any disruption can have significant impact on the supply chain. For example, outsourced logistics services such as cargo delivery and postal services (which generate tangible savings of at least 10%), are possible terrorism targets. Other types of disruptions include external factors like the Kobe earthquake or foot and mouth disease, or business related factors like employee strikes, or operational breakdowns. These risks must be assessed and minimized. Thus the MNE may require logistics service providers to have special certification as 'secure' deliverers. Hence, when outsourcing the MNE must consider, the robustness of the supply chain to handle disruptions, risk management capabilities, particularly those relating to public health and safety [32]. In developing such 'risk' strategies the MNE may require the logistics providers to incorporate its latest innovative ideas in a cost conscious manner, and to create relationships with credible and sometimes superior providers.

3.6.4 Value

Without value, sales and market share don't happen [8] [19]. As businesses become more and more connected through the Internet customers may buy from anyone around the globe. Price differentials begin to disappear, with many buyers aware of the 'best' prices. Product quality differentials disappear and those with inferior products often lose market share. Customers talk to each other via chat rooms, email and bulletin boards, and the like. They are well informed as to which products and services offer the best value. Geographical location doesn't matter in today's globally connected world, as the next service provider is only one 'click' or phone call away, and global shipping networks are able to move items rapidly. Hence, the market consists of businesses with similar prices, and products, trying to differentiate themselves through whatever value attributes remain for differentiation. For many businesses this difference is their 'service' component, and the processes their customers must go through to obtain their desired outcomes [17].

3.6.5 Supplier Relationships

[20] recognises the relationship focussed customer does not engender the supplier to be stringently price conscious, whilst the price conscious customer, who does not readily perceive product value, may leave the supplier feeling abused, resentful and less focused on product quality. He links customer cooperation and a commitment to lower prices, suggesting the ‘balanced sourcing’ (high-high) quadrant should be the key target area. Thus, for maximum competitiveness, a 4PLP and its MNE’s should position themselves within this area. This requires high levels of collaboration between all parties. The 4PLP must seek to maximize the capabilities of each component of the supply chain, whilst minimizing overall ‘end-to-end’ risk. Laseter [20] suggests the ‘balanced sourcing’ (high-high) quadrant, as displayed in Figure 4, offers the best option in today’s highly competitive market.

Today, the MNE and its logistics partner(s) increasingly concentrate on delivering customer satisfaction. The MNE is acting more as a service organization with its core functions shifting from full manufacturing towards final assembly, sales, strategic positioning, and research and development conceptualization. It has generally outsourced its logistics costs (normally around 15% of the finished product cost) to 3PLPs or a master 4PLP. The logistics provider then instils innovation throughout sections of the supply chain. The vested interests throughout this virtual corporation act together chasing competitive advantage for the entire alliance team.

	Trust Based Partnerships	Balanced Sourcing
High	Supplier dominated Unclear rationale for improvement Assumes congruence of supplier goals Supplier may capture all of the value creation	Uses supplier capabilities fully Drives improvement at customer and supplier Requires high capability customer
Low	Unleveraged Purchasing Unmotivated, unstructured Traditional ‘clerical’ mentality of purchasing ‘Price taker’ Leaves lots of money on the table	Darwinian Rivalry Adversarial Customer dominated Requires purchasing clout Eliminates lethargy, but may cause resentment Does not result in improvement
	Low	High
	Commitment to competitive pricing	

Source: Laseter, 1998

Figure 4 Supplier Relationship Matrix (Adapted from Lasseter [20])

Today, the MNE and its logistics partner(s) increasingly concentrate on delivering customer satisfaction. The MNE is acting more as a service organization with its core functions shifting from full manufacturing towards final assembly, sales, strategic positioning, and research and development conceptualization. It has generally outsourced its logistics costs (normally around 15% of the finished product cost) to 3PLPs or a master 4PLP. The logistics provider then instils innovation throughout sections of the supply chain. The vested interests

throughout this virtual corporation act together chasing competitive advantage for the entire alliance team.

3.7 The 5PLP Model

Hai and Yirong [16] present the Morgan Stanley Consulting Co. Ltd. China Logistics 5PLP model as the apex of a logistics relationship with the MNE. This model is displayed in Figure 5. They believe the 5PLP model focuses on providing overall logistics solutions for the entire supply chain. They further define the supply chains management (SCM) as a truly integrated approach managing flow and transforming goods in respective logistics networks. This supply chain management hinges on a common collaborative performance measurement framework that yields close, collaborative and well coordinated network relationships. The aim is to establish a competitive advantage across the supply (and demand chain) by constantly exchanging information with alliance partners, and driving further reductions in cycle times, life-cycle turns, and the like[1]. Hai and Yirong assert this delivers what consumers want, where and when they want it, and it does so in an efficient manner. They, like Morgan Stanley believe that by linking outsourcing to strategic alliances ‘win-win’ productivity situations (encapsulating faster running loops) arise for supply chain members.

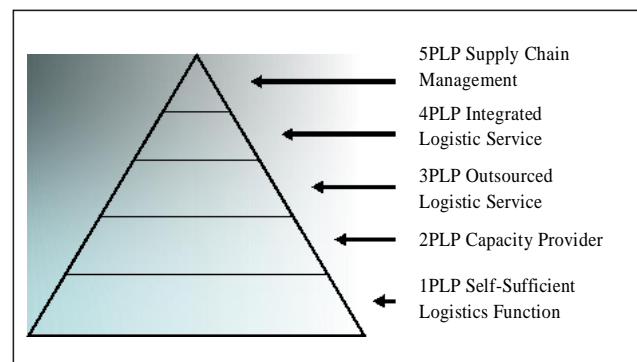


Figure 5 – The Morgan Stanley 5PLP Model (Adapted from Hai and Yirong, [16])

The Morgan Stanley’s 5PLP model is merely a re-badged 4PLP. It is not a ‘customerized’ or ‘characterized’ logistics solution. It does not provide targeting to specific individual customers needs. Thus the demand chain is not seen as a key logistics driver. For example, a current 4PLP model offers a complete set of supply side solutions for the MNE. It covers the logistics of entire supply chain, and even some basic demand chain parameters. This is the same as the Morgan Stanley 5PLP model. Without the full integration of both the demand and supply chain, and this structure being both highly flexible and agile, the apex of a logistics relationship cannot be reached. Hence the Morgan Stanley model does not represent the ultimate logistics solution, and it cannot be conceived as the apex of the logistics relationship with the MNE.

3.8 The Four Clusters of Logistics Outsourcing Skills Model

The three Cluster model developed from Voss, and incorporated into the previous (1PLP to 5PLP) models can be further expanded to include a final cluster with its associated set of levers. This additional cluster is termed the ‘characterized’ cluster. Here, for example, the web site’s ability to adapt and modify itself (based on tracking information and business intelligence software) is used to provide the customer with the impression of a made-to-order site that targets the customer’s requirements. This allows a new set of levers to be activated. This set of levers specifically targets the individual customer in an approximate ‘one-on-one’ relationship. The four clusters of logistics outsourcing skills model is displayed below in Table 3.

Table 3: The Four Clusters of Logistics Outsourcing Skills Model (© Gunesh and Hamilton, 2003)

Cluster 1: Technical Levers	Cluster 2: Soft-Skill Levers	Cluster 3: Institutional Levers	Cluster 4: Characterization Levers
<ul style="list-style-type: none"> • Information Technologies • Communication Technologies • DSS Technologies • Organization Technologies • IT-Infrastructure Assets • Technical Ability • Logistics Knowledge / Know-how • SCM Knowledge • IT Knowledge 	<ul style="list-style-type: none"> • Social Competency • Intercultural Competency • Interpersonal Competency • Communication Skills • Organizational Skills • Problem-Solving Skills • Leadership Skills • Team Orientation • Empathy • Integrity • Self-Assurance / Self-Awareness • Motivation / Creativity • Politeness / Diplomacy • Mobility / Flexibility 	<ul style="list-style-type: none"> • Government Legislation • Industrial Policies • Company Laws • Financial Services regulation • Intellectual Property and Copyrighting Policies • Competition and Antitrust legislation • Corporate Governance and Transparency • Transport Policies • (Road, sea, air & Rail) • Political Stability • Economic Growth 	<ul style="list-style-type: none"> • Agile Customer Relationship Management • Reliable Communication Technologies • Integrated Organizational Technologies • Database, Web Interface and Knowledge Management Technologies • Responsive Database, Web Interface and Activated Business Intelligence • On-line ‘Customization’ and Management • Responsive Flexible Demand Chain

By incorporating the four sets of levels into a MNE and its 4PLP supply chain, a flexible, agile, demand chain driven, supply chain supported, system may be developed. Here sets of ‘fully activated demand-supply’ chains, termed ‘FADS’ chains offer a means to sustainable competitive advantage.

FADS offer a means to move beyond the current proposed models to a 5PLP level. They incorporate improvement levers, competencies or skills, and important new achievements concerning ‘sustainable’ competitive advantages [18] [24]. They can absorb the current reasons for outsourcing as proposed by many authors including [13] [14] [32] [33].

4. The 5PLP FADS Logistics Model

To develop sustainable competitive advantage the MNE and its 4PLP must acquire and utilize unique intelligence. They derive this sophisticated intelligence by concentrating on the customer and tracking their interactions. For example, by tracking a customer’s activities, weaknesses in communication, understanding, time wastage, and the like, better communication solutions may be developed. Provided this rectification is rapid a reduction in ‘churn’ rate (loss of customer) may be achieved. These changes require the 4PLP to move into a new relationship across the entire demand–supply chain, and to work intelligently with ‘fully activated demand-supply 5PLP FADS chains.

A new logistics model – the 5PLP FADS logistics model, is proposed. The 5PLP FADS logistics model incorporates the four clusters of logistics outsourcing skills into the current ‘state-of-the-art’, or ‘revised’ 4PLP Model. This new logistics model is displayed in Figure 6. The current 4PLP brings its own specific values and skills to the business equation, thus providing a new competitive edge to the MNE. For example, the 4PLP may be a highly skilled on-line web operator with outstanding IT innovation, network skills, and on-line marketing skills. This may add an entirely new dimension to the MNEs operational skills set, or it may be a superb financial negotiations house that seeks to expand its sphere of influence. The combination of these specific skills, along with an agile, flexible, individual customer activated sensory system, opens new pathways for possible ‘sustainable’ competitive advantage. Such a mix of skills provides reduced scope for direct competition. This solution is delivered by a 5PLP FADS logistics provider.

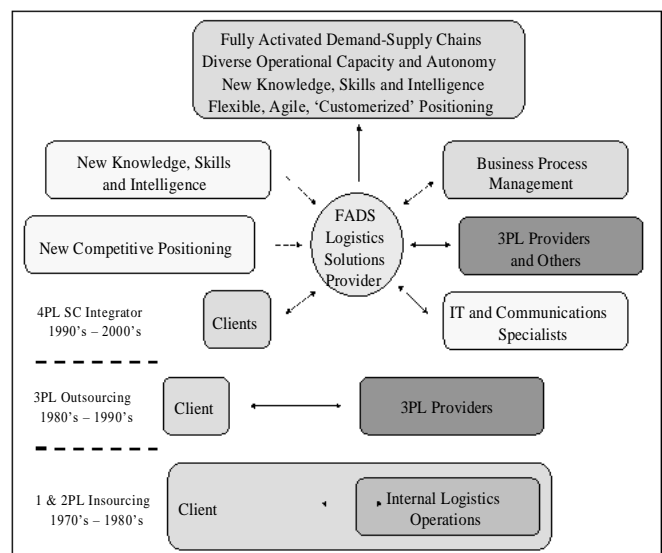


Figure 6: The 5PLP FADS Logistics Provider Model (© Gunesh and Hamilton, 2003)

The 5PLP FADS logistics provider and its MNEs are singularly focused to deliver ‘customerized’ (one-on-one) products such as a uniquely combined or ‘customerized’

set of web site pages, and helpful hints, combined with intelligent expert system software support to adapt to the customer's changing views.

To attain 5PLP FADS level logistics support the 'characterization' [15] cluster, must be fully incorporated. This fourth cluster of skills levers occurs when the MNE and its FADS logistics team are directly connected to the customer. Here the demand-driven customer-focused MNE combined with its logistics partner becomes instantly and highly responsive (agile and flexible) to the specific need of its individual customers. It requires its 5PLP FADS logistics partner to develop features specifically targeting 'what' each customer wants, along with the 'when's', the 'how's', and the 'specific' product personalization of 'where' and 'for whom'. This new economic focus has positive implications and demands across the entire demand-supply chain. In contrast, a 4PLP and its supply chain can capably deliver tangible products in a tightly managed way. Indeed, with MNEs moving more to a final assembly and a front-end, or customer sales focus this has been achieved – consider firms like UPS (www.ups.com). However, such a structure only partly satisfies the customer's demands. In addition, in the service related, or intangibles area there is great benefit, and competitive positioning possibilities, if a logistics provider can deliver a true 5PLP FADS logistics system. To deliver a 5PLP FADS logistics system the 4PLP must move to a higher level of logistics provision. It must master each of the four clusters. It must have a broad skills base and must overcome its own inadequacies including - knowledge and understanding deficiencies; appropriate IT, software and communication integration; web interface 'customerization', and the like. A 5PLP FADS logistics provider must bring new knowledge to the partnership, and the partnership must be lean, efficient and profitable for all parties.

In the future, logistics and outsourcing will approach the total logistics provider solution. The authors suggest this to be a 5PLP FADS model that delivers all the MNEs non-strategic (and even some strategic) requirements. In Australia, the major airline Qantas is one of many businesses that is segmenting their MNE, with each strategic business unit (SBU) capable of being outsourced, or being a logistics provider in itself. The 5PLP FADS model offers a new model applicable to such a move. It offers a future integrative and development path for logistics.

5. XYZ.com.au – An Example of a FADS Logistics Solution

The Australian company, termed XYZ.com.au for confidentiality reasons is a highly skilled Australian web portal company, founded in 1998. It is currently producing a leading edge FADS logistics solution for a major printing firm. It is now offering a new solution to an Australia-wide magazine. This on-line company has taken on all aspects of the magazine, and has added 'value' by combining it with its own leading edge web infrastructure and knowledge, on-line marketing and

distribution network and innovative flair. It now runs all aspects of this magazine, providing both the printing firm and the magazine shareholders with their required returns. XYZ.com.au is using its great skills mix to enhance the magazine, its reach and its on-line presence, and the shareholder body is seeing the benefits of a greatly enhanced, focused product.

6. Conclusion

A new age of global competition confronts the MNE and other large global businesses. MNEs must find new avenues to maintain competitive advantage. Past outsourcing moves have generated savings, but, as more and more businesses move along this path, opportunities for sustainable competitive advantage appear to diminish. There will always be logistics outsourcing improvements, especially in international settings, and by reviewing and clustering related skills levers, and relating these to logistics models, further advances to the development of logistics may be defined. The current 3PLP and 4PLP models alone will not provide 'sustainable' global competitiveness, as such options are readily copied. A new model is required. This paper suggests that development of a four cluster set of skills levers, and the combination of these levers into an enhanced 4PLP model for logistics outsourcing – may allow the development of a fully activated demand-supply 5PLP FADS chain logistics model to be realized.

The 5PLP FADS logistics provider must bring a unique, comprehensive skills-set (covering the four clusters of skills levers) to the MNE. A pathway towards 'sustainable' competitive advantage may then be forged between the 5PLP FADS logistics provider and its MNE partners. The 5PLP FADS logistics model is the next step in the progression to total logistics integration.

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Delivery in Online Sales: The Role of Communicating Quality and Price Positions

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Abstract

E-retailing, though growing rapidly, is still a very small proportion of total retail sales. One issue inhibiting sales over the internet is delivery. Many customers are not happy paying what they often perceive to be excessive delivery charges. However, the average customer on the internet is not highly price oriented, so resistance to paying delivery charges may occur because customers do not believe that they are receiving any value for this additional cost. Our research looks at the impact on willingness to pay delivery charges of different price levels and a message informing the customer that the delivery time specified is considered good service by industry standards. This simple message seems to focus customer thinking on value received (better quality service), and lowers resistance to paying delivery charges. Thus, explicit reference to the quality of the delivery service, where companies actually have good delivery, seems to be a useful message to include when customers are considering information about delivery charges.

1. Introduction

E-retailing (B2C) is growing rapidly, but the proportion of on-line retail sales still constitutes only a small percentage of total retail sales, and is likely to remain a small part of the total for some time. Frequently services, particularly delivery, are a problem. Some observers claim that e-retailers offer consumers better service than stores, but they may be talking mainly about “service” in terms of using customer information to get the sale [22], rather than more traditional after-sales service elements such as delivery, returns, etc. Anecdotal evidence indicates that many consumers are quite unhappy with service by many e-retailers [6].

Some observers have begun to point out that this service element may be a critical issue in adoption of interactive shopping [5, 11, 17]. Certainly, in other distance shopping formats, service plays an important role. For example, catalog purchasers typically report that they are concerned about service attributes such as delivery time, handling of complaints and problems, and order placement [4, 9, 15]. Clearly, understanding consumer views about service issues such as delivery will

be important as e-retailers work at improving sales over the internet [7, 12, 13].

Although delivery is a critical element of B2C retail services, only a few studies look at delivery issues in much detail. One survey shows that Dutch consumers are more likely to use the internet for product reservation than for purchase of products which require delivery, even though all the products in the study could be delivered digitally over the internet [21]. For physical products which require delivery, the tendency against actual purchase is even stronger [14]. Price may be an issue, since generally, once delivery charges are included, stores are cheaper than online retailers [1].

This study in Singapore looks at customer willingness to pay for delivery of products available on-line. As a managerial issue, this is important, because internet B2C suppliers have not yet found ways to make delivery cheap. They either have to charge customers a relatively high delivery price, or absorb a lowered margin. Which strategy works better depends on customer willingness to pay – if customers are highly price sensitive, as some discussions on e-retailing claim, then charging customers higher delivery prices will not work very well. However, some work indicates that consumers on the internet do not seem to be highly price sensitive [e.g., 3]. Then a proper strategy would be to demonstrate to them why the high prices are worth paying – if they see value, they are more willing to pay.

2. Delivery, Value, and Price Sensitivity

Service is a key element in consumer choice in retail buying, and much modern retailing is based upon the concept that consumers buy service as much as products when they purchase from a retailer [2]. Certainly, consumer demand for better service has played an important role in development of the modern retail sector in the more advanced economies of East Asia [e.g., 8, 20]), as well as in developing economies [e.g., 19]. Thus, one important reason for dissatisfaction among consumers who have tried buying over the web, and for discouraging non-buyers from trying, is the service component.

Frequently, service on the web is not up to standards that consumers expect from fixed stores, and consumers who want good service as a component of what they buy may not choose to shop online because of this. For

example, Van den Poel & Leunis [21] showed that consumers reported much higher likelihood to purchase either a small radio or a TV in specialty stores, which provide high service levels. Supermarkets and internet came out about equally, far behind specialty store, and catalog sales were very unlikely to be used for these products. Specialty stores (first) and catalog sales (last) did not change their relative positions among heavy vs. light internet users.

In Singapore, some studies indicate that consumers generally expect fairly low service performance from internet retailing, including poor perceptions of the delivery service component [17]. For example, one survey showed that prompt delivery of books and CDs ordered over the internet was not considered very likely. Of course, this would not be very critical if it was not important to consumers, but prompt delivery scored moderately highly in their list of concerns. Another survey cited in that report showed that delivery was a top concern for clothing ordered over the internet. Asked about whether better services would encourage more on-line purchase, most consumers said yes [17].

Eastlick & Lotz [5] demonstrate that attitudes toward service are one element which influences adoption of interactive shopping. Karlsson and Rosen [7] note many cases of internet stores that have failed primarily because of inability to meet customer expectations about delivery. In Singapore, Speece [17] shows that perceptions of delivery, among other service issues, differs strongly among respondents who bought books / CDs on the internet and those who did not. Shoppers who did not order over the internet had lower expectations of prompt delivery than those who did, but were more strongly concerned about delivery.

Given that consumers want high quality delivery if they buy over the internet, would they be willing to pay for it? Generally, Asian middle class consumers are strongly value oriented [e.g., 16, 18], which means they are willing to pay reasonable prices if they perceive that they have received some benefit. In other words, "Value (unlike quality) involves a tradeoff of give and get components" [23, p. 14; parentheses in the original]. Components of value include intrinsic product or service attributes, as well the extrinsic attribute price. Discussing value segments, Lichtenstein, Ridgway, and Netemeyer [10] note that price plays a negative role, but is not the most important thing considered.

In value oriented service evaluation, a buyer may set an acceptable quality level, then look for the best price within that level. Or, buyers may decide a budget, based on their ideas of price points representing required quality, then look for the best quality at that price. On the surface, it may sometimes be difficult to distinguish value orientation from either strong quality or strong price orientations. When value consumers have a large budget, the weight of price seems to decline. People buy higher quality and are willing to pay more. With smaller budgets, price assumes a correspondingly larger role. Nevertheless, value oriented consumers are still making the tradeoff, not simply choosing highest quality or

lowest price. In addition, when consumers perceive several options to be very similar, price may be the only criteria on which they can distinguish. They do not insist on lower prices because they are highly price conscious, but rather, because they do not perceive it at they are gaining any value for the higher prices.

The profile of customers on the internet is usually strongly middle class and above, making it unlikely that most such consumers are truly strongly price oriented. Rather, they are probably value oriented, but may not like to pay much for delivery because they perceive delivery service quality on the internet to be poor. Karlsson and Rosen [7], for example, show that customers of online grocery stores are not willing to pay much for delivery alternatives which they perceive as being unattractive, but they are willing to pay more for preferred delivery modes.

Delivery time is one key issue. For example, Persson and Wikstrom [13] quote a customer in an in-depth interviews as saying "the delay is the biggest drawback with the internet ..." (p. 4). Many customers expect lower prices to compensate for the perceived poor service: "... for a good price, I am willing to accept a wait of a couple of days or more" [13 p. 4]. Noack [12] cites examples showing that customers are willing to pay for what they perceive as good delivery service. Frequently commentators on internet delivery view such data and recommend that internet companies should minimize delivery time [e.g., 13], and one strategy is to set up logistics to get very rapid delivery [12].

However, simple communication with customers during the ordering process may have some impact on their perceptions of delivery service quality, and thus, on their willingness to pay delivery charges. If consumers compare access to products in a physical store, when they get it right away, to purchase over the internet, delivery quality may be perceived as poor, because they do not get the product immediately. Pointing out the quality of delivery time relative to most other internet sellers may be able to shift the comparison, so that consumers feel that they are getting some value (additional quality in delivery) compared to most internet stores. To demonstrate that simple communications may indeed be able to influence willingness to pay in this way, we looked at this issue in a consumer survey in Singapore.

3. Methodology

While developing the survey instrument, we conducted in-depth interviews with three consumer stores selling common consumer goods on the internet in Singapore. Each had online sales which managers considered to be growing well, but which still constituted only a few percent of total retail sales for the store. They all stressed that delivery costs were relatively high, and considered that prices were probably higher online once delivery costs were factored in. These stores talked about delivery times ranging from 1 to 3 days normally, but more likely to be around 3 days rather than quicker. Thus, the time which was considered pretty good by

industry standards in the experimental manipulation was determined in this consultation with online retailers.

The key elements affecting consumer decisions to buy online were developed from the literature, as noted above. One questionnaire section asked respondents to rate the importance on a 1 to 5 scale of a number of elements including delivery, price, and other service elements. Another section asked about willingness to buy given a delivery time and a delivery charge. Respondents were asked this for both local and overseas orders, taking 2 days and 1 – 2 weeks, respectively. Delivery prices were stated at three different price levels, each one in a separate questionnaire, so that any one respondent only ever saw a single price for local and a corresponding single price for overseas delivery. (E.g., the low local delivery charge was listed with the corresponding low overseas delivery charge.)

Half of the questionnaires at each price level included a message informing the respondent that the stated delivery time is considered fast by industry standards, vs. a control with no comment about delivery time. Thus, there were six questionnaire versions (Table 1). Each had a quota of 50, so that a total sample of 300 was obtained by mall intercept at several locations in Singapore. A screening question eliminated anyone who was not an internet user. The sample is relatively young, mostly under 30, with high education on average, and is fairly consistent with the characteristics of heavy users of the internet according to other surveys.

Table 1: Six Questionnaire Versions

	delivery charges		
	low	medium	high
local purchase	S\$ 3	S\$ 4 – 8	> S\$ 8
overseas purchase	S\$ 15	S\$ 16 – 20	> S\$ 20
no message version: Assuming that for local delivery a product costs S\$ 50, and takes 2 days to deliver. How willing are you to pay S\$ 3 for delivery charge?			
with message: Assuming that for local delivery a product costs S\$ 50, and takes 2 days to deliver, which is considered fast by industry standards. How willing are you to pay S\$ 3 for delivery charge?			
the overseas versions say 1 – 2 weeks delivery.			

Consistent with the profile of internet users usually cited in most Asian countries, the sample was predominately young and male. Sixty percent of the

respondents were men. The age group from 18 – 24 accounts for two thirds of the sample, and another twenty percent were between 25 – 30. Ninety-five percent of the sample was ethnic Chinese, which under-represents other ethnic groups in Singapore, but is perhaps consistent with strong internet usage.

4. Results

Security of the transaction, delivery reliability, and convenience were considered the most important issues. Delivery time was of mid-level importance, not much different from a set of issues also including return policies, reputation of online stores, low price, and modes of payment. Physical viewing of products was considered the least important of the issues listed in the questionnaire, but even this was considered somewhat important, scoring above the midpoint of the 1 to 5 scale toward the important (Table 2).

Table 2: Importance of Elements in Decision to Purchase Online

	mean	standard deviation
security of transaction	1.52	.87
delivery reliability	1.61	.84
convenience	1.68	.85
return policies	1.90	1.01
reputation of online stores	1.92	.98
delivery time	2.01	.96
low price	2.09	1.04
modes of payment	2.22	1.00
physical viewing of goods	2.43	1.19

scale: 1 = very important; 5 = not important at all

notes: differences of approximately .14 are significant ($p = 0.05$). A blank line separates means which are significantly lower than the mean above ($p = 0.05$).

Table 3 indicates that the means of willingness to pay for delivery of orders from overseas follows a standard demand curve. There is more resistance when delivery charges are higher. However, resistance to the charges is significantly reduced for high and medium level delivery charges when the message is included pointing out to customers that the delivery time is considered good by industry standards. In other words, the message seems to focus customer attention on the value that they receive for the price, and they are more willing to pay when they explicitly see the value.

Table 3: Mean Willingness to Pay Overseas Delivery at Three Price Levels, by Message about Delivery Quality or Control

delivery prices	no message		with message		row sig (no-with)
	mean	std dev	mean	std dev	
low	3.00	1.20	2.88	1.26	.626
medium	3.90	1.07	3.20	1.05	.001
high	4.02	.98	3.44	1.21	.010
column sig. (low-med)	.000		.176		
(low-high)	.000		.019		
(med-high)	.582		.310		

scale: 1 = very willing, 5 = not willing at all.

Table 4 shows similar results for local delivery charges. The same downward sloping demand curve is evident, with more resistance to higher prices. Here, since local charges are lower, resistance only becomes large for the high level of delivery charges, but again, at this high level, including the message reduces resistance to paying. Clearly, willingness to pay, at least at higher price levels, depends on customers explicitly recognizing that they gain some value for what they pay. When it is explicitly pointed out to them that the delivery service is high quality, they are more willing to pay.

Table 4: Mean Willingness to Pay Local Delivery at Three Price Levels, by Message about Delivery Quality or Control

delivery prices	no message		with message		row sig (no-with)
	mean	std dev	mean	std dev	
low	2.50	1.13	2.48	1.18	.931
medium	3.16	1.06	2.98	1.08	.401
high	4.10	1.07	3.46	1.01	.003
column sig. (low-med)	.003		.024		
(low-high)	.000		.000		
(med-high)	.000		.030		

scale: 1 = very willing, 5 = not willing at all.

To test the joint impact of message and price level, as well as to control for price sensitivity, ANOVA was run, with willingness to buy as the dependent variable. Price level, message, and the importance of price (noted in Table 2) were the independent variables. Results indicate that price level for delivery charges is significant ($p = .000$, and $p = .000$) for both local company delivery and foreign company delivery, respectively. In each case, the results show a standard downward sloping demand curve, consistent with basic economic theory. The parameters indicate more willingness to pay as delivery charges decline, and more willingness to pay local charges, where the amount is lower than for overseas (Table 5).

Price importance was also significant ($p = .037$ and $.011$ for local and overseas delivery, respectively). The similar negative coefficients in each case indicate that more price sensitive customers are less willing to pay the delivery charges. This, of course, is consistent with the definition of price sensitivity and most other research.

The key issue here is that the message about delivery quality was also significant in each case ($p = .029$ and $p = .000$, respectively, for local and overseas delivery). The positive coefficient for no message indicates less willingness to pay. Thus, a simple message pointing out that the delivery time is considered high quality in the industry was able to reduce resistance to paying delivery charges.

Table 5: ANOVA Results of Joint Impact of Message, Price Level, and Price Importance on Willingness to Buy

	local		overseas	
	sig.	parameter	sig.	parameter
model	.000		.000	
message none	.029	.602	.000	.532
message		0 *		0 *
delivery price level	.000		.000	
low		-1.005		-.592
medium		-.518		-.288
high		0 *		0 *
price importance	.037	-.127	.011	-.159
R squared	.225		.147	
adjusted R- sq	.209		.129	

* signifies the statistical base category; other categories are relative to the base.

5. Conclusion

Although delivery is a critical element of B2C retail services, only a few studies look at delivery issues on the internet in much detail. This study in Singapore focuses customer willingness to pay for delivery of products available on-line. It examines three different price levels, each one in a separate questionnaire, and information informing the respondent that the stated delivery time is considered fast by industry standards, vs. a control with no comment about delivery time. Results clearly show that customer willingness to pay can be influenced by the message that they see at the time they consider the delivery charges.

These simple results have important implications for e-retailers. Delivery has been a barrier to the development of ecommerce, partly because customers frequently resist paying extra delivery charges. However, this resistance is frequently misinterpreted as strong price sensitivity. It is not. Rather, the resistance to delivery charges seems to represent unwillingness to pay when customers see no value in what they are paying for. They are willing to pay when they see some value received in exchange for the price. This is characteristic of value oriented middle class consumers throughout Asia.

Thus, the e-retailer's task is to shift the customer's focus when they consider delivery charges. Frequently, the comparison may be: "slow if ordered online, compared to fast if bought in a store." Resistance to delivery charges is bound to be high in such a comparison. The consumer is being asked to pay more for worse service. A simple message about the quality of delivery time can apparently shift the focus more toward "faster delivery at this site, compared to slower delivery at other sites." Here, the consumer is being asked to pay for better quality, something which many value oriented consumers are quite willing to do. In fact, given that delivery charges might be similar for various delivery times on different sites, the consumer may perceive this as similar price for better service – a very attractive proposition to value oriented customers.

Of course, additional research is needed to confirm that such results would hold in a variety of e-retailing situations. And it would be very useful to examine how to best present messages to get the customer to shift focus from the web – store delivery time comparison to the better quality web – worse quality web contrast. Nevertheless, these results do suggest that one relatively simple way to help reduce resistance to delivery charges in e-retailing is to include a message about the quality of services at the time when consumers consider the delivery charges.

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An Adaptive e-KANBAN System and Its Characteristics

-Controlling the numbers of KANBAN by monitoring demand fluctuation-

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Abstract

This paper discusses methods to revise the numbers of e-KANBAN for parts procurement operations from supplier factories. Three policies, i.e. Fixed Interval Review (FIR) Policy, Demand Average-monitored Review (DAR) Policy and Demand Average & Variance-monitored Review (DAVR) Policy are proposed to absorb the fluctuation of parts consumption level, which is created by the downstream shop floor of the production line. The performance of each policy is evaluated by simulation experiments and quantitative trade-off relations between criteria, i.e. Ratio of Line Stops (RLS) and Frequency of e-KANBAN Resetting (FKR), are clarified. Obtained characteristics suggest that DAVR and DAR Policies dominate FIR Policy but each of the former two policies do not hold superiority from the other.

1. Introduction

These years, because of rapid progress of globalisation and information technology in every sector of industry, assets of operations management are transferred among companies without serious obstacles. The same phenomenon also happens in each business function such as in supply chain.

Looking at Just-In-Time technology born in a Japanese car manufacturer some decades ago, many competitors utilize this toolset as so-called lean technology. In addition, information infrastructure starts to absorb this engineering asset into its own domain and modifies it. An example of such diversification is electronic version of KANBAN system called e-KANBAN system. However, according to such a drastic change, traditional know-how becomes obsolete and necessity of new technological development emerges. In this paper, based on the above argument, a new problem on a powerful engineering tool for supply chain

management, called KANBAN system, is focused to study.

A contemporary problem surrounds this technology is how to determine the numbers of KANBAN in the recent volatile demand environment. Generally, the numbers of KANBAN are quite sensitive for performance of production-logistics system, e.g. manufacturing system often stops if numbers of KANBAN are not enough, and contrary, work-in-progress inventory will exceed the capacity of buffer space if it is too much.

As both globalisation and information infrastructure are the major causes of demand instability, operations managers and researchers in this area have to cope with this problem. One effective way to overcome this difficulty is to revise the numbers of KANBAN more often than before. And, ironically, e-technology can contribute this subject as it provides quick repetitive response with low cost.

As a matter of research contribution, this paper discusses the way to revise the numbers of KANBAN for parts procurement operations from supplier factories and proposes some policies for reviewing the numbers of KANBAN to absorb the fluctuation of parts consumption level created by the downstream shop floor of the production line.

2. KANBAN System and Its e-version

The mechanism of typical KANBAN system between final assembly factory and parts supplier factory is illustrated in Figure 1. For simple explanation, let us suppose the lot size of parts transportation is one. Each part is transported from supplier factory with its KANBAN, which describes part specification, supplier site, frequency of transportation etc. Then this is qualified and accepted by quality assurance (QA) division of final assembly factory followed by transfer to line side. When each part is required by assembly line, the part and attached KANBAN are separated and assembly operation proceeds for the former.

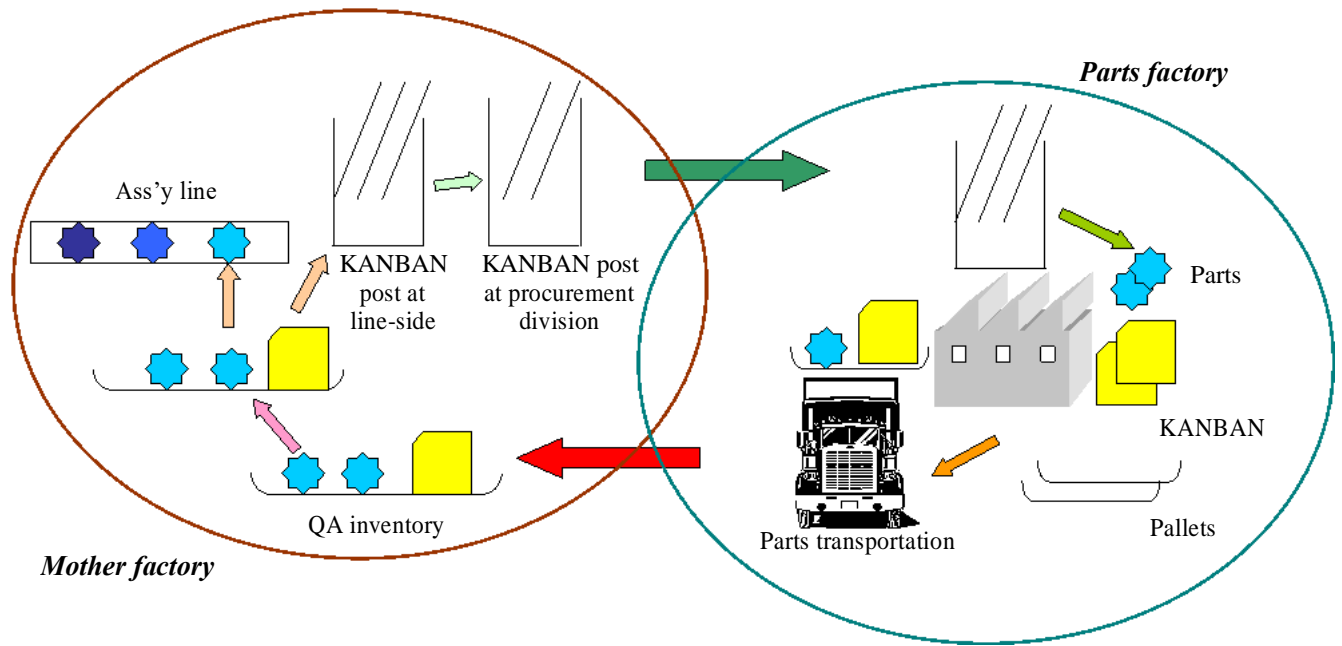


Figure 1. Mechanism of KANBAN system

The latter is thrown in KANBAN post at line-side and assorted into every supplier sites to prepare procurement operation at the division in charge.

KANBANs in the KANBAN post at procurement division are periodically transferred to appropriate suppliers and attached to the parts ready to deliver at supplier factories. Then, these are transported to QA division of assembly factory again through periodic delivery operation.

During the entire operation cycle, quick response or lead-time reduction is one of the key subjects for better performance of the production logistics system and substantial efforts have been made on this matter by launching continuous improvement activities as well as information technology implementation.

Typical example of the latter activities is electronisation of KANBAN system called e-KANBAN that is quite simple and natural attempt. Essential idea is to realise zero transfer lead-time of KANBANs in every operation phase such as their separation from parts at line-side, assortment, transfer to suppliers and coupling with deliverable parts. Concerned technologies for actualise this idea include parts database system, low cost peripheral facilities for data capturing in each phase of operation, infrastructure for data transfer such as web-based systems, monitoring and analysing systems of demand or requirement data from downstream function (assembly line in this case) etc.

Some of these technical issues have been developed, revised and implemented in some extent by the companies operated based on KANBAN systems and all of these attempts indicated that information technologies were relevant for KANBAN system refinement.

Recognising the above fact, in this paper, the last issue is focused to discuss in terms of consideration of way to revise the numbers of KANBAN.

3. Related Research and Consideration

Traditional way to determine the numbers of KANBAN is described by formula (1) [2].

$$N_t = [(\mu_t^D L + K \sqrt{L} \sigma_t^D) / M] \quad (1)$$

Where,

N_t : The numbers of KANBAN determined at the end of t -th day

μ_t^D : The average demand quantity per day estimated at the end of t -th day

L : Lead time of parts procurement (days)

K : Parameter of safety inventory

σ_t^D : The standard deviation of demand quantity per day estimated at the end of t -th day

M : Capacity of pallet (Numbers of KANBAN to be installed on it)

The essential idea of this expression is that KANBAN must care entire demand quantity and additional quantity due to its fluctuation during procurement lead-time. For the latter issue, policy of 3-sigma guarantee is quite usual and, therefore, $K=3$ might be very agreeable. The most important point here is that numbers of KANBAN derived by this way strongly affect the performance of entire system.

It is obviously noticed from this method that numbers of KANBAN depend on every variables and parameters defined above. Parameters, i.e. parts procurement lead-time, safety inventory parameter and pallet capacity, are controllable in some extent by KANBAN system manager and they made efforts to determine or improve these values properly for many years. Especially,

procurement lead-time consists of parts transportation and/or transfer time and KANBAN management time, and substantial contribution to eliminate the latter portion of lead-time have been realised through e-KANBAN implementation.

On the other hand, variables, i.e. demand average and variance must be the target variables to estimate because these concern uncontrollable business environment issue. A traditional way adopted in some factories is periodic consideration on whether numbers of KANBAN should be changed or not. For instance, some factory in Toyota Motor Co. used to consider its modification by monthly basis. The mind behind such policy is that demand statistics, e.g. average and variance, are basically stable and downstream activities such as sales division make efforts to guarantee this steadiness. And if it does work successfully, efforts on demand monitoring can be minimised as a by-product of this attitude.

However, as the business situation has been getting volatile gradually during this decade, the above argument became tough to emphasize for many companies. And consideration on how to monitor, estimate the demand statistics and feedback such information to revision of numbers of KANBAN become an emerging subject to cope with.

As a related study on this subject, Katayama et al [1] considered two types of revision models of numbers of KANBAN described below and analysed their performance under auto-correlated demand arrivals from downstream function.

- 1) FIR (Fixed Interval Review) Policy: This policy performs reviewing procedure every predetermined interval. Key parameter of this method is length of interval (days).
- 2) AR (Adaptive Review) Policy: This policy launches reviewing procedure based on the following flow chart (Figure 2), which includes statistical test procedure for detecting the change of demand average.

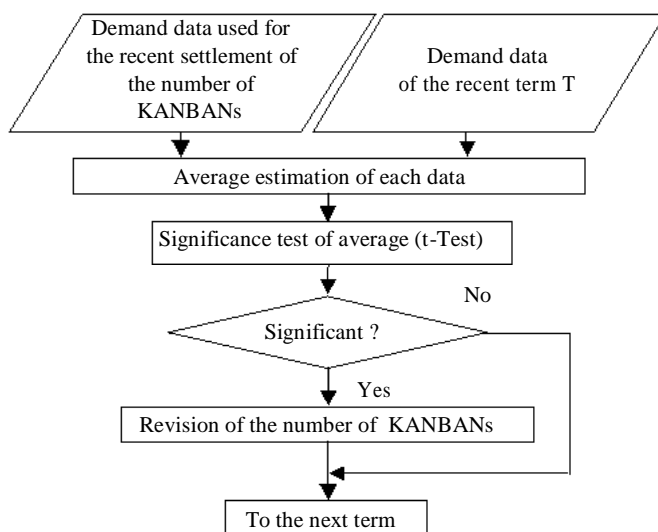


Figure 2. Flowchart of AR Policy

However, considered situations in simulation-based experiment in this study were quite limited, i.e. drastic change of average demand such as step function model and/or change of demand variance was not treated. Study on such more complicated cases is remained for further research.

4. Model Construction

Based on the arguments described in the former sections, analytical model is constructed in this section, where demand model, and some policies for revising the numbers of KANBAN and performance criteria are proposed.

4.1. Demand Arrival Model

First order autoregressive model described in formula (2) is adopted as demand arrival model.

$$D_t = \lambda D_{t-1} + (1 - \lambda) X_t \quad (2)$$

Where,

D_t : Interval of the t-th and t-1-th demand arrival

X_t : Statistically independent element of interval of demand arrival D_t . Its probability density function is supposed to be a Normal Distribution $N(\mu_t, \sigma_t^2)$.

λ : Autocorrelation coefficient of adjacent interval data of demand arrival, i.e. D_t and D_{t-1} .

From this expression, it is noticed that mean and variance of D_t are μ_t and $\frac{1-\lambda}{1+\lambda} \sigma_t^2$ respectively.

The cases to analyse include changes of mean and variance of D_t by step functions.

4.2. Structure of Lead-time

As mentioned in section 3, structure of lead-time is very important in KANBAN system, which consists of parts transportation and/or transfer time and KANBAN management time.

Based on some case investigation of car factory that operates under e-KANBAN system, certain fixed lead-time is assumed for the former portion, i.e. physical transportation lead-time of parts. For the latter portion, i.e. KANBAN management time, the ultimate ideal case, i.e. zero lead-time, is supposed because of e-KANBAN.

4.3. System Criteria

Two criteria, i.e. RLS (Ratio of Line Stops) and FKR (Frequency of the numbers of e-KANBAN Revisions) are considered as key performance indicators, which were also examined in the past study [1]. Namely, the first

criterion RLS is a reliability measure of the system that evaluates risks of line stoppage or malfunction. On the other hand, the second one, i.e. FKR, is an efficiency measure that evaluates necessary operational efforts to manage KANBAN system. Where, some man-hours for indirect work such as redefinition of e-KANBANs have to be consumed if revision is launched.

$$RLS = \frac{\text{Overall line stoppage time}}{\text{Overall available time of the line}} \times 100(\%) \quad (3)$$

$$FKR = \frac{\text{Number of revisions of number of e-KANBAN}}{\text{Total production terms}} \quad (\text{Times/Term}) \quad (4)$$

4.4. Proposal of Revision Policies of The Numbers of KANBAN

In the past research discussed about AR Policy [1], only demand average was focused to estimate and its variance was ignored despite of the σ_t^D in expression (1). This means that AR Policy cannot adapt the structural change of demand fluctuation, which tends to become large due to volatility increase of the market.

Therefore, as a new revision policy of the numbers of KANBAN, variance test procedure for detecting the change of demand variance is added to the flowchart given in Figure 2. Detail of this logic named Demand Average & Variance-monitored Review (DAVR) Policy is described in Figure 3.

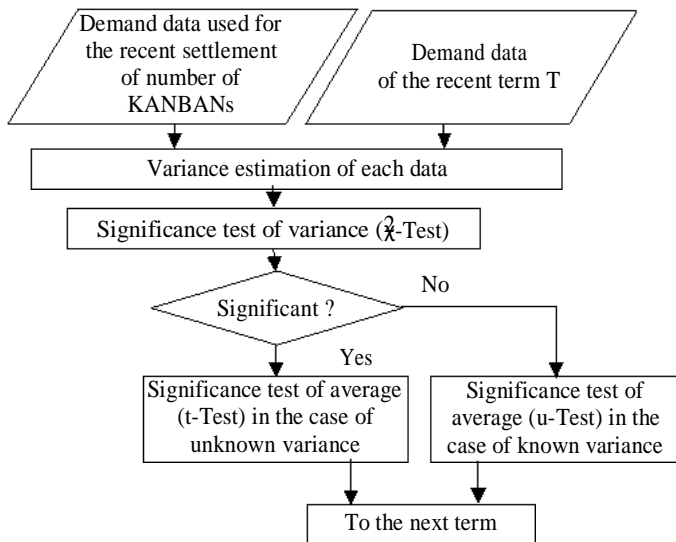


Figure 3. Flowchart of DAVR Policy

Based on demand arrival data, i.e. interval of the adjacent demand arrivals, used for setting current numbers of KANBAN and that of recent term T, e.g. interval data of demands in recent 10 days, each variance is evaluated by using the formula of definition of variance.

From this procedure, their point estimates are obtained.

Then, these point estimates are examined whether these are significantly different or not. The logic of the significant test of variance, which is performed in terms of χ^2 -Test, is applied for this procedure.

If the result is significant, demand average is checked whether it changed or not. This procedure, the followed step of variance test, can be performed by t-Test of average as same as Figure 2 because this is the case of unknown variance. On the other hand, if the result is not significant, checking procedure of demand average is performed by ordinary u-Test of average because this is the case of known variance.

When entire procedure is executed, the same procedure is iterated again after the shift of unit time.

As the summary of this section, following three revision policies are considered to examine in this paper. Where, FIR Policy and DAR Policy is the same policy as the policies in the former research [1]. Especially, DAR Policy is the same policy as AR Policy (See Figure 2) and is renamed for easier distinction from DAVR, the proposed policy.

- 1) Fixed Interval Review (FIR) Policy
- 2) Demand Average-monitored Review (DAR) Policy
- 3) Demand Average & Variance-monitored Review (DAVR) Policy

5. Performance Analysis by Simulation

The mission of this section is to analyse the chain relation between accuracy of demand monitoring, revision policy of numbers of KANBAN and system performance. This analysis is performed through simulation experiment in which simulator developed by C++ language is used. Summary of some relevant characteristics is also given based on the obtained result.

5.1. Simulation Condition

Some assumed conditions for simulation experiment are summarised as follows.

- 1) Simulation horizon: 150 days
- 2) Working hours of production line: 16 hours/day
- 3) Parts procurement lead-time L : 0.125 day
- 4) Parameter of safety inventory K : 3.0
- 5) Capacity of pallet M : 1
- 6) Autocorrelation coefficient of adjacent interval data of demand arrival λ : 0.8
- 7) Cases of demand parameters: Following five cases are considered.
 - a) μ_t ; 12→8, σ_t^2 ; 1
 - b) μ_t ; 12→8, σ_t^2 ; 2.5
 - c) μ_t ; 12, σ_t^2 ; 1→2.5
 - d) μ_t ; 8, σ_t^2 ; 1→2.5
 - e) μ_t ; 12→8, σ_t^2 ; 1→2.5

For instance, case a) means that μ_t changes 12 to 8 by step function. Where, timing of parameter

change is determined randomly and total numbers of simulation for each case are 148 patterns. On the other hand, σ_t^2 is fixed to 1

- 8) Revision interval of the numbers of KANBAN R for FIR Policy: 29 cases, i.e. 2~30 days
- 9) Length of the term T for statistics calculation regarding DAR and DAVR Policies: Three cases, i.e. 3, 5 and 10 days
- 10) Necessary time to remove or attach KANBAN from or to appropriate parts: Immediate (zero)
- 11) Time interval of collection of KANBANs from KANBAN posts: Immediate (zero)
- 12) Revision point of the numbers of KANBAN: KANBAN post. This means that necessary numbers of KANBAN are added to KANBAN post when revised numbers are bigger than the current amount. Otherwise, appropriate numbers of KANBAN are removed from there. If there are not enough KANBANs in the post, KANBANs are waited to arrive to remove.

5.2. Results and Consideration

Obtained results through simulation experiment are summarised in Figure 4 and 5. These figures represent the relationship between two criteria, i.e. Average RLS and Average FKR, in terms of trade-off charts, which are obtained by 148 iterations of simulation.

Figure 4 illustrates comparative performance of three revision policies considered in this paper, i.e. FIR, DAR and DAVR, for specified parameter conditions. Where, μ_t changes from 12 to 8 and σ_t^2 is stable as 1.

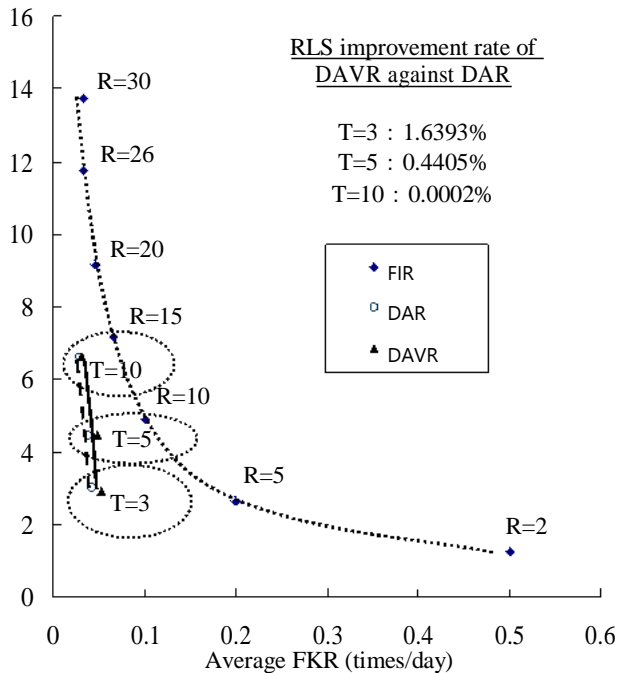


Figure 4. Performance comparison of three policies (in the case that μ_t ; 12→8, σ_t^2 ; 1)

In case of FIR Policy, FKR becomes small whereas RLS gets large according to longer revision interval and it is observed there is an inverse proportion between two measures. Looking at the performance of DAR and DAVR Policies, both show quite superior performance to FIR Policy and do not hold superiority from the counterpart. Namely, both of these policies have quite close but different trade-off characteristics. According to decrease of T, i.e. length of the term for statistics calculation, RLS values of both policies are improved substantially but FKR values are not sacrificed very much. In comparison with DAR Policy, DAVR Policy indicates its strength on reduction of RLS whereas weakness on FKR. Improvement rates of average RLS of DAVR from that of DAR are positive and smaller T values create better improvement. These might be because of the effect of its variance test procedure.

In case that both of demand parameters are changed, i.e. μ_t change from 12 to 8 and σ_t^2 change from 1 to 2.5 by step function, characteristics illustrated in Figure 5 was obtained. This figure just focuses on the performance of DAR and DAVR Policies and illustrates that superiority of DAVR Policy against DAR Policy becomes bigger for small T, which is the same trend as Figure 4. However, the improvement rates indicate better scores. This feature is quite reasonable as DAVR Policy tries to detect the change of variance σ_t^2 in the supposed situation. On the other hand, FKR measure gets worse as DAVR tries to revise the numbers of KANBAN more frequently in this case.

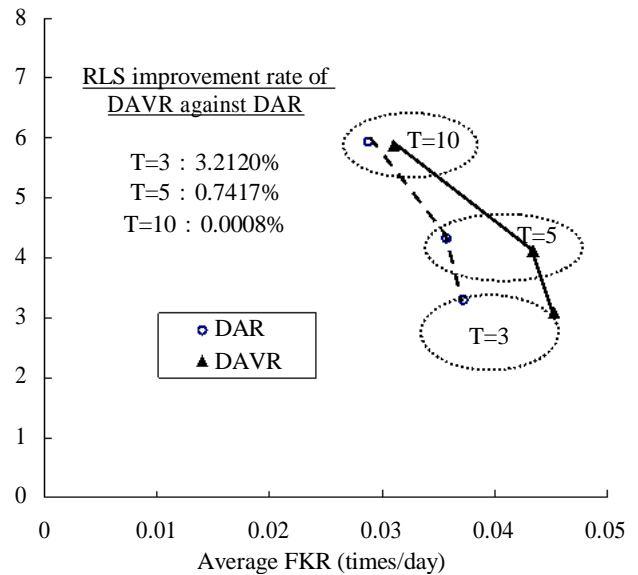


Figure 5. Performance comparison of DAR and DAVR policies (in the case that μ_t ; 12→8, σ_t^2 ; 1→2.5)

For more detail in the case of μ_t ; 12→8 and σ_t^2 ; 1, Table 1 summarises the joint characteristics of both FKR and RLS measures of FIR and DAVR Policies. Here, average FKR values are the points read from each

performance graphs that attain the same RLS performance.

It is noticed from this Table that DAVR Policy provides smaller average and variance of RLS than FIR Policy. That is, DAVR adaptive estimate/control offers more servile characteristics than static FIR Policy.

Table 1. RLS performance comparison of FIR Policy and DAVR Policy (μ_i ; 12→8, σ_i^2 ; 1)

Average FKR	Policy	Average RLS	Variance of RLS
0.051 or 0.053	FIR	7.169	5.443
	DAVR	2.933	0.451
0.046 or 0.047	FIR	9.169	13.43
	DAVR	4.459	1.203
0.031 or 0.033	FIR	11.74	21.62
	DAVR	6.601	4.069

6. Concluding Remarks

This paper argued about three revision methods of the numbers of KANBAN for robust and efficient parts procurement operations in some volatile demand environments. The performance of each policy is evaluated by simulation experiments and quantitative trade-off relations between considered criteria are obtained. These characteristics indicate that proposed policy in this paper (DAVR) dominate traditional simple method (FIR) in terms of both criteria and provide more reliable feature than the other semi-advanced method

(DAR).

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An Exploratory Study of Critical Issues in Online Securities Trading: The Hong Kong Perspective

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Abstract

The advancement of technology enables more and more people to do their business activities online. This has threatened the businesses of the traditional intermediaries. Among the various form of electronic commerce, online securities trading is one that will stand a better chance for wide adoption and success. Online securities trading penetration rate has remained on a steady upward trend [39].

The development and adoption of online securities trading have been slow in Hong Kong as compared to other Asian counter parts such as South Korea, Japan and Singapore. Past research on online securities trading in Hong Kong has been lacking. The objectives of this study are to explore the critical issues, impacts, problems and barriers of online securities trading in Hong Kong, and what can be done to facilitate local online securities trading.

This paper will first provide the background of online securities trading in Hong Kong, followed by literature review on online securities trading, self-service technology, electronic commerce, and review of studies of online securities trading in other countries.

In-depth interviews were also conducted with senior personnel in local brokerage firms that offer online trading to gather their expert opinion and to explore the critical issues, attributes, benefits and barriers of online securities trading in Hong Kong.

Recommendations to managers and future research of an empirical study will be discussed in the last section.

1. Introduction

The term 'Online Securities Trading' is the same as 'Online Trading', 'Electronic Trading' or 'Internet Trading'. It refers to any use of electronic means of sending orders (bids and offers) to the market, electronic order routing, automated centralized execution and subsequent dissemination of price and volume information [13].

We will use the term 'Online Trading' as a short form of 'Online Securities Trading' through out this paper.

One of the fastest growing online businesses is Online Trading. It is inexpensive, convenient, and supported by a tremendous amount of financial and advisory information. Trading is very fast and efficient, almost fully automated, and it is moving towards 24 hours of global trading. Day trading is rising rapidly and the traditional brokers are

disappearing slowly [37].

In recent years many companies have adopted the Electronic Commerce model in their businesses, but many of them have failed. Online trading is one of the successful Business-to-Consumer models of Electronic Commerce. Putting a securities brokerage online is a very smart move, since the business itself is simply an information-based business, and there is no logistic problem related to physical delivery. There is no better way to pass information through other channels than the Internet [3]. Online securities trading will be one of the potential winners of the Internet. The arrival of wireless application protocol (WAP), third-generation mobile phones and WAP-enabled personal digital assistants will mean even more flexibility and access.

The aim of this research is to investigate the reasons behind such low penetration rate and to find out the barriers, benefits, issues and impacts arising from the adoption of online securities trading in Hong Kong. The management of this industry can make use of such studies to strengthen and improve their business. The government and regulatory bodies can make use of such studies for policy making and amendment to existing policies so as to provide a better environment for suppliers and consumers to participate in such business. The key factors that affect the Hong Kong consumer adoption and consumer barriers of online securities trading will be investigated. These factors could be used as variables for empirical studies of consumer behavior, adoption and diffusion of online securities trading in Hong Kong.

2. Literature Review

Literature on online trading is very limited; however we may review the literature in the following related areas to gather the attributes and issues that are associated with online securities trading.

2.1 Characteristics of Online Trading

Online trading has the following characteristics [6]:

- directly connect buyers and sellers;
- support fully digital information exchange between them;
- suppress time and place limits;
- support interactivity and therefore can dynamically adapt to customer behavior;
- can be updated in real-time, therefore always

up-to-date.

2.2 Self-service Technology and Online Trading

Traditionally, securities trading were done by broker, but the new online technology allows customers to perform securities by themselves. Therefore it is worthwhile to do a review of literature on self-service technology.

There are five attributes associated with the technology-based self-service option, namely, speed of delivery, ease of use, reliability, enjoyment and control [15].

Electronic Data Interchange (EDI) is an inter-organizational system, which transmits standard business documents electronically between trading partners. EDI is quite similar to online trading in nature. Ratnasingam [33] states that the driving factors to adopt EDI are:

- cost savings (increase productivity and profitability by reducing costs);
- simplification of business processes (via automation) that eliminated the use of paper;
- speed from savings in time;
- increase productivity.

2.3 Electronic Commerce and Online Trading

Some of the issues in Electronic Commerce may also be applied to Online Securities Trading since Online Securities Trading is a form of Business to Consumer Electronic Commerce. Turban et al. [37] have made a detailed study on issues in Electronic Commerce, and now we summarize those issues that are applicable to online securities trading:

Benefits to Organizations

- Globalize and borderless markets
- Reduced cycle time
- Reduced production cost
- Reduced number of employee
- Improved brand or corporate image
- Improved customer service

Benefits to Consumers

- Round the clock trading
- More choices offer
- Lower commission rate
- Quick delivery
- Attract lower income group customers

Limitations and Barriers

- Technical Limitations
- Developing cost
- Security and privacy
- Lack of trust and user resistance
- Legal issues: Many legal issues such as consumer

protection, content control, taxation, encryption policies, cross-border transactions, intellectual property enforcement, privacy and code of ethics are as yet unresolved, and government regulations and standards are not refined enough for many circumstances.

A survey conducted by Deloitte & Touche LLP [4] asked online trading executives on what they consider to be their biggest work-related worries, and the results are listed as follows:

- concerns about system outages and mistakes;
- inability to handle a rapidly growing transaction volume;
- possibility of a bear market;
- formation of alliances between discount brokers and larger institutions.

Among the listed worries, brokerage executives find outages a top worry.

The Critical Success Factors

A study by Jones et al. [26] states that there are eight 'C' for a successful online retail business: Community, Concern (trust and confidence), Connectivity, Content, Convenience, Customer care, Communication, and Customization:

- Community: Rheingold [34] and Turban et al. [37] believe that the Web is being transformed into a social Web of communities. They think that every Web site should incorporate a place for people to chat. With millions of members, such communities could have significant effects on markets. The community brings together consumers of specific demographics and interests. This presents opportunities for transacting business and communicating messages about products and services.
- Concern (trust and confidence): customers have a wide range of doubts, worries and reservations about online retailing. Trust and confidence are central to all business relationships. Fears about the security of credit card transactions and about releasing personal and financial details are regularly cited as major reasons why consumers are reluctant to trade online.
- Connectivity: Connectivity problem such as not enough bandwidth and system outage are limiting the growth of online businesses.
- Content: Content is concerned with providing consumers with rich & up-to-date information, expert insights, lots of products to choose from, and providing it with an entertaining, visually appealing, informative and easy to use interface.
- Convenience: Convenience focuses upon the critical importance of an easy to use, easy to navigate, and logically organized site and the ability to make quick transactions.
- Customer care: Customer care is seen to be about

providing online customer support at all stages of the retail relationship.

- **Communication:** Many communication channels such as chat room, e-mail, discussion forum, etc are provided by online businesses, to facilitate communication with their customers.
- **Customization:** Products are produced in a large quantity but are customized to fit the desires of each customer. Electronic Commerce is an ideal facilitator of mass customization.

Some of the above critical success factors seem to coincide with the studies by Ghosh [17] and Turban et al. [37], who have identified the critical success factors for starting an online business as follows:

- Specific products or services traded
- Top management support
- Project team reflecting various functional areas
- Technical infrastructure
- Customer acceptance
- User-friendly Web interface
- Integration with corporate legacy systems (combine traditional and online method)
- Security and control of the online business system
- Competition and market situation
- Pilot project and corporate knowledge
- Promotion and internal communication
- Cost of the online business project
- Level of trust between buyers and sellers

2.4 Comparative Online Trading Developments

Since Online Trading is still in its infancy in Hong Kong, so it is worthwhile to have a survey on this topic in other mature countries.

In general, the use of computers and mobile phones, and access to the Internet, is in line with income, and the online trading development follows a similar pattern. From Table 2.1 you can see that the adoption rate of online trading in countries with higher income such as United States, Sweden and Germany is higher than India, China and Brazil. Even among the high-income economies, differences are evident. High ownership of personal computers, and especially high usage of mobile phones, has meant that the Scandinavian countries lead in online banking and online trading. The long-standing stock-owning culture in the United States and wide computer ownership has seen online trading become particularly popular there [12].

In Asia Pacific Region, the adoption rate of Korea, Japan and Singapore is higher than Hong Kong. Korea is Asia's fastest-growing country in online trading, with 65 per cent of trades conducted online. A number of factors, such as government support, deregulation of commissions, the rise in Internet companies and creative entrepreneurs as well as the creation of a Korean "Silicon Valley"

contributed to the explosive growth in online trading in the country [23].

From Table 2.1 it can be seen that the adoption rate of online trading in Hong Kong is very slow, approximately 1 per cent of the total trading volume. This figure is close to the survey done by HKSFC [23] in April 2000, which found that only 1.3 per cent of total trading volume is online trading.

Table 2.1: Comparative online trading developments

Source from BIS estimates based on data from the World Bank, Central Banks and Claessens, Glaessner & Klingebiel [11][12].

	Real GNP per capita (US = 100)	Internet users as % of inhabitants	Mobile phones per 100 inhabitants	Bank customers using online banking (%)	Electronic brokerage transactions: % of total
Australia	75	32	34	4	22
Finland	71	41	65		
Germany	74	18	29	12	32
Japan	79	21	45		32
Sweden	69	41	58	31	55
United Kingdom	70	21	46	6	26
United States	100	27	31	6	56
Hong Kong	71	36	64	2	1
Korea	49	23	50		65
Singapore	70	24	42	5	10
Argentina	37	2	12		
Brazil	21	2	9	4	6
China	11	1	3		3
Czech Republic	40	7	19	3	
India	7	0	0		2
Malaysia	24	7	14	<1	
Mexico	25	2	8	4	41
Nigeria	2	0	0		
Poland	26	5	10	<1	
South Africa	27	4	12		
Thailand	19	1	4		

3. Research Methodology

Senior personnel from five well-known securities houses that offer online securities trading were selected for the in depth interviews. The objectives of these interviews were to identify the benefits and problems, the issues and impacts associated with online trading.

Each interview session started with an introduction which emphasized that the participants should give their honest opinions and discuss how they 'really feel'. The interviews were carried out in a relaxed atmosphere, and to enable an open and free exchange of ideas, detailed notes were taken during the interviews instead of tape.

4. Findings and Analysis

The results reported are based upon the synthesis of the interview transcripts. Common themes that emerged have been identified.

4.1 Limitations and Barriers in Online Trading

The statistics [23] show that the number of brokerages with current online operations is relatively small as a percentage of the industry (less than 4%). The use of online trading facilities is still in its infancy and there is plenty of room for development. Online trading constituted only 1.3% of the total market volume for Hong

Kong securities in April 2000. The interviewees pointed out that the key factors for such low adoption rate were:

- geographical environment;
- social habit;
- limitation from the work place;
- connection cost and problems;
- security and privacy;
- access to computer and computer illiteracy;
- broker and client relationship;
- increased risks;
- confidence and trust;
- account settlement flexibility and margin finance; and
- regulatory policies and account opening.

The limitation factors from these findings are quite different from the studies done by Williams [41] in USA markets; which are mainly execution and technical problems. USA is the first country to adopt online trading and it is therefore worthwhile to take a look at the problems of online trading in USA. In response to numerous complaints from online investors, USA congress asked the General Accounting Office (GAO) to launch an investigation into online trading practices. They talked with 12 online brokers, who, even though they represented less than 10% of the number of firms that offered online trading, accounted for about 90% of the online trading volume during early 1999. Below is the report from this investigation. The top 10 complaints from USA consumers in descending order were:

- difficulty accessing accounts;
- failures/delays in processing orders;
- errors in processing orders;
- best execution problems;
- errors/omissions in account records of documents;
- transfer-of-account problems;
- margin position sellouts;
- problems with opening accounts;
- problems with executing cancellation orders;
- inaccurate quotes/pricing information.

Most of our findings of key factors from the interviewees are consistent with our literature review except geographical environment, social habit, and limitation from the work place; these factors are peculiar to Hong Kong. Notice that system failure is not a problem in most online brokerages in Hong Kong as the interviewees expressed that their system has been developed for quite a while and it is stable, also good contingency plan and backup are installed. Let us discuss these limitation factors in detail as follows.

Geographical Environment

The interviewees pointed out that Hong Kong is a very densely populated city and the number of securities houses is very high as compared to other cities. People are

reluctant to use online trading since it is very easy to access a securities house in their neighborhood.

Social Habit

Hong Kong people like to go to the securities house where they can meet their friends and brokers to exchange the tips for stocks; also the crowd, the noise and the atmosphere are conducive to trade. This is a similar habit for Hong Kong people where they like to go to the noisy restaurant for 'dim sum', a Hong Kong style of lunch. In contrast to online trading, they are on their own and it is sometimes lonely.

Limitation from the Work Place

Many companies in Hong Kong restrict their employees from visiting certain Web sites using filtering software. In particular, they restrict their employees from online trading during office hours.

Connection Cost and Problems

The Broadband usage is relatively low in Hong Kong due to high connection cost and dispute between property developers and service providers in cable laying. According to the report in Hong Kong Economic Journal [25], currently there are seven hundred and ninety thousand broadband households, which is about 10% of Hong Kong population. The connection cost becomes the switching cost, which limits the adoption of online trading.

Security and Privacy

There is a great deal of concern regarding the security of financial information transmitted over the Internet. If brokers' systems did not have sufficient security measures, hackers would break in and steal clients' information or assets. The security measures used by local online trading brokerages are user IDs and passwords, SSL security standards, encryption and firewalls. Online brokerages in Hong Kong generally use 128 bits SSL encryption method to secure and protect all personal information contained in online transactions between the online brokerage and customers.

Thirty-four percent of those participating in the Dataquest surveys claimed that privacy and security concerns kept their trading down [28]. Security is a critical issue, which limits the mass adoption of the Web, especially since surveys of Web users indicate that vendor reliability and security of financial transactions are important to users [19].

Access to Computer and Computer Illiteracy

Senior citizens may not know how to use a computer to do the online trading. Low-income people may not afford to possess a computer to do the online trading. Interviewees revealed that, quite a number of local investors are housewives and retired people. They do not have computers at home.

Interviewees also revealed that the customer profiles

of online trader are mostly young and educated people. Although Hong Kong is considered a developed country, the Internet penetration rate is relatively low compared to other developed countries. This is partly due to the immigration of people from China who are mostly lower income and computer illiterate. Currently the quota for China immigration is 150 people per day. A report in Hong Kong Economic Journal [24] stated that from 1982 to 1997 there were many well-educated middle class families migrated out of Hong Kong because of losing confidence in handing over of Hong Kong sovereignty to China.

Online trading would encourage the participation of younger players, as they would generally be more IT savvy. However, they may lack the funds to trade in significant volumes as compared to more established and older business people who may be more 'IT illiterate' [27].

Broker and Client Relationship

No specific broker is assigned to online client, only general customer support and hotline is available. In the traditional stock broking world, much of the value offered by brokers has been in the quality of the working relationships they developed with their clients. Brokers won their business not only by executing orders, and earning a commission in the process, but also by helping guide clients to investments that were both profitable and within the client's so-called risk tolerance profile. Whereas it is impossible to maintain such a close relation in the online trading world. This observation is consistent with the study by Wheelwright [40].

Increase Risks

The interviewees expressed the same view as Yiu [43] in that online trading has enabled investors to invest directly in the market; it has also made it easier for fraudsters to make profits. One of the most common types of online trading fraud is "pump and dump". He might, perhaps, claim on a bulletin board that the company in question was about to release news of a new product, service or alliance. His hope would be that other readers would buy the stock and pump the price. New regulations should be issued to prevent fraud and manipulation in online trading.

Financial markets are becoming more volatile as investors act on impulse or are tempted by how easy it is now to execute trades [32]. Online trading certainly has enabled millions of punters to change their minds easily and several times a day [21].

Risk assessment is the duty of stockbrokers or financial planners, who question clients to gauge their comfort level for volatility and potential losses. But with the explosion of online trading, investors have taken control of their own finances [31].

Confidence and Trust

The interviewees revealed that the loss of confidence by customers in online trading were partially due to the

dot com crisis and the closing down of many online brokerages such as 2CUBE.com and Charles Schwab (Hong Kong). Also customers do not trust a faceless broker.

Account Settlement Flexibility and Margin Finance

Interviewees expressed that customers preferred traditional trading because of the flexibility in account settlement and the availability of margin finance whereas customers need to deposit enough money before trading online.

Regulatory Policies and Account Opening

Interviewees pointed out that the requirement of 'face-to-face' account opening policy by the regulator had hindered some customers from opening the online trading account. They also revealed that the regulator is going to tighten online trading policy even further such as the minimum capital size, margin finance and system integrity.

4.2 Benefits in Online Trading

It has been suggested in our literature review that the benefits for online retail business were lower commission rate, speed of delivery, round the clock trading, global and borderless markets, control, ease of use, enjoyment, more choices, attractive to cost conscious customers, reduced number of brokers, lower production cost, improved brand or corporate image, and improved customer service. The interviewees also mentioned availability of most of these benefits in the local market and these are described in detail below:

Lower Commission Rate

Hong Kong government is going to deregulate the minimum commission rate on April 1, 2003. Currently, Hong Kong regulator requires a minimum 0.25% commission rate charged by registered online brokers. With better competition, commission rate will be lowered after the deregulation. Some interviewees revealed that they will not compete on commission rates but they will aim at middle range of commission rates in the market and compete using value added services.

Speed of Delivery and Increased Trading Volume

The interviewees pointed out that AMS/3, an Internet-based trading system that eliminates the need for orders to be input manually, should allow online brokerages to offer faster service to its clients, and increase reliability, speed and trading volume.

Online trading is foreseen to encourage more trading volume, as the facility eases the ability to buy and sell [7] [27].

Convenience, Round the Clock Trading

With online trading, you can trade any time, anywhere or any place, when you can get hold of a PC or WAP phone with Internet connection.

Global and Borderless Markets

In the past, Asian investors who wished to buy securities in other regional countries had to do so through a broker. With Internet, online trading company can reach customers around the globe. At the moment cross-border trading is not easy, the Hong Kong Stock Exchange is planning to introduce the CCASS/3 system, which will allow cross-border trading, cross-market trading, and prolong settlement period [22]. Most interviewees revealed that they had facilities, which allowed their customers to do online trading in other markets such as USA and Europe.

More Client Control, Easier to Set a Price Limit for your Stock

The interviewees shared the following views with Burton [9] and Bien [5]. One reason why retail investors have adopted online trading is that it gives them more control over their stock portfolios. Traditional stockbrokers were often suspected to buy and sell a client's securities frequently without client permission, especially in order to increase their commissions. Online trading sites allow you to set a price limit at which you buy or sell the stock. This is useful if you have an exact price in mind but haven't got the time to monitor the stock all day. You can even place orders when the market is shut, so you can make decisions in the evening or at weekends.

No Mark Up by Middleman

Online trading is system automated and no manual manipulation is necessary and thus prevents mark up by middleman. Based on information provided by brokerages as well as from actual trades, online brokers aren't marking up the prices of stocks to investors as much as done by the offline brokers [18].

Ease of Use and Enjoyment

Ease of use will improve as more Internet access channels such as digital television, personal organizers and mobile phones, become available. User-friendly Web page design and software tools had made online trading both easy to use and enjoyable.

Attract Small Investors and More Customers

The interviewees, Schroeder [36] and Bien [5] agreed that the growth of online trading opened the markets to individual investors as never before, making markets fairer for small investors. Online trading enables small investors equal access with anybody else. They don't have to rely on being a client of the right broker to find out about an issue. Strong retail demand by small investors, in turn, attracts more institutional and overseas investors to a market. Online trading could allow them to access and maintain more customers than their current offline resources allow.

Lower Production Cost and Reduced Number of Broker

Online brokerages are able to charge less than traditional brokerages because of lower expenses in terms of staff, space and other resources [10]. As with most of the businesses that migrate online, the first benefit is to reach a broader market and reduce operating costs through the disintermediation process [3]. Lower costs have caused online trading to expand rapidly in countries like South Korea and USA. Interviewees revealed that they would not lay off their existing brokers but allow them to resign naturally.

Improved Customer Service, Improved Brand or Corporate Image

Online trading makes it easier to reach and educate investors. The online trading site is full of information to educate investors on how to invest and pick a stock. Online brokerages are now competing to attract customers with the quality of the information provided. Such competition has allowed online investors to obtain stock news and analyst briefings similar to the information traditional traders possess. Online trading site serves as a forum for discussion, with topics including tips on stocks to invest in, useful investment books and government economic policies.

Information Transparency

The interviewees agreed with Lee [27] that the information provided via online trading facilities helps trader make better judgment. Investors can view the volume of buyers and sellers of any counter. This gives investors an idea of current buying patterns, and to some extent, the amount of speculation or substance a certain stock would have. In short, online trading indirectly reduces investors' risk by allowing them to be better informed and the wealth of information helps investors make better judgment.

Distribute other Financial Products, More Choices Offered

The interviewees agreed with Lo [29] that online trading company has the advantage of using the Internet platform as an efficient way to complete transactions and distribute other products to customers. Besides stock broking, online trading firms can offer other financial products, such as mortgages, personal loans, investment funds, insurance and credit cards to their clients using their existing trading sites.

4.3 Issues and Impacts of Online Trading

The interviewees also revealed the following critical issues and impacts arising from online trading:

Greater Competition

The major impact of online trading is greater competition, resulting from deregulation of commission rate, lower product cost and increased transparency. Small and foreign brokerages, which previously competed in their local markets, are now operating globally. Some

brokerages even sell below cost. This intensifies competition even further. Brokerages need to offer larger differentiation and product customization. It becomes more difficult to sustain competitive advantage in many cases. Traditional securities houses will have a better chance to survive the competition if they have an established brand name, good resources and global reach.

Threats from Online Banking

The launching of online banking (e-banking) by the local banks will boost the growth of online trading even more. The interviewees are worried about the threats from online banking, banks have the advantage of attracting their existing customers to enroll in their online trading system with the convenience of settlement and funds transfer with the customers' existing bank account. Banks have advantage over securities houses when the new regulation regarding minimum capital base is imposed, since banks have a bigger capital base.

Market Consolidation and Strategic Alliance

The interviewees expressed that there are too many small to medium-sized brokerages in Hong Kong, and they predicted that after the deregulation of commission rates more small brokerages will either close down or merge with other bigger brokerages. This is consistent with the study by HKSFC [23] which stated that more local brokerages, in particular, the small to medium-sized firms, are planning to form strategic alliances in offering online trading facilities in securities to remain competitive in the market.

Those alliances may well have been forced upon brokerages by increased competition and, they are to be welcomed, as it will strengthen the industry. The exact shape of the alliances is yet to emerge and it is unclear whether the traditional concerns about sharing client details will be overcome. There may be some regulatory and supervisory issues that arise out of these alliances and the HKSFC will monitor the development.

Disintermediation and the Changing Roles of Traditional Brokers

Direct marketing will eliminate many types of intermediaries. Online trading enables customers to place their orders without the intermediation by the brokers. The survivors will basically be providers of value-added services ranging from acting as a trusted third-party intermediary to matching special customers' requirements with brokerages' capabilities. This is also consistent with the study conducted by Bailey, Bakos [2] and Turban et al. [37].

Customer Profiles

The interviewees revealed that most online traders are young, educated and adventurous males.

Lee [27] observed that online trading would encourage the participation of younger players, as they would generally be more IT savvies. However, they may lack the funds to trade in significant volumes as compared to more

established and older business people who may be more 'IT illiterate'. Online trading is most beneficial to analytical share players who can make their own judgment from the information online.

A study by Libbon [28] showed that fifty-seven percent of online traders were less than 45 years old and 30 percent were under 35. Just 14 percent were 55 or older. Men outnumber women in online trading by two to one.

Hoffman, Novak and Schlosser [20] stated that key demographic variables like income and education drive the policy questions surrounding the Internet because they are the most likely to differentially impact the consequences of interactive electronic media for different segments in our society.

Sanchez [35] observed that online trading attracts 'shy' investors. Customers do not always prefer personal intervention to technology. Information available on stock trading sites limits the necessity for interaction with brokers. In addition, online trading sites allow investors more independence in their decision-making, while the traditional manner of investing would involve lengthy discussions with brokers.

Day-Trading Increased

The interviewees revealed that day-trading activity had increased in online trading. This is consistent with Yiu [43] which stated that the introduction of online trading services is likely to lead to a surge in day-trading, and can increase market volatility, where regulators may need to consider establishing new day-trading rules.

Best Model -- Brick and Click

The interviewees pointed out that the main reason for the recent shut down of 2CUBE.com and Charles Schwab (Hong Kong) is due to competition and lack of branch support. Therefore they think that the best model for online trading is to combine the virtual trading with the physical branch support, the so-called 'brick and click' model. This is consistent with study conducted by Committee on the Global Financial System [13] and Turban et al [37].

Expand Customer Base to China

There is a great demand from people in China to trade Hong Kong stocks because of its good regulation and mature system. Online trading is very suitable for these people because they can trade remotely from China once they have opened their accounts. Interviewees expressed that there is great potential in expanding online trading customers from China and they had done many road shows in China.

Value Added Services

All interviewees agreed that the offering of value added services is the best way to fight against competition and to differentiate themselves from competitors. They have suggested many value added services such as the followings:

Discussion Forum for Investors: Online trading site

serves as a forum for discussion, with information on tips on stocks to invest in, useful investment books and government economic policies.

Track Share Price Movements: Most online trading sites will provide function to track share price movements.

24-Hours Help lines: If you are unsure about something, you can call a 24-hour help lines without having to approach a broker.

Personalize Web: New online trading system enables customers to personalize their Web start pages and control how they view their information.

Stock-Screening: There exists stock-screening system, which will sort and filter stocks according to a set of criteria the trader enters. For instance, the trader can ask the program to show only stocks that have a certain price, volume, or P/E ratio, among other factors, and the investor can then select stocks to trade based on the results. The system can filter stocks according to specifications in many categories [38].

Real-Time Prices, Breaking News, Performance Measurement and Charting: Most online trading sites these days offer real-time prices, breaking news, performance measurement and charting. More cutting-edge are services like financial-planning tools that allow you to assess your savings needs, and tailored news. For example, if you have a portfolio of ten stocks, the system will deliver only the news that affects those stocks [8].

Portfolio Analysis and Risk Tolerance: SmartMoney is a sophisticated online asset allocation and portfolio management tool. It will ask you questions about your risk tolerance, view of the economy and the income you want at retirement. It then produces a chart that shows, in percentage terms, the categories of stocks you should consider investing in: foreign, large cap, small cap, bonds and so on [1].

Advisory Broker: Some online brokerages provide an advisory broker to give you professional advice before you place your order online.

Other Value Added Services: Free education seminars, research analysis and free use of computer facilities in the branch.

Communicating Media

The commonly used media to receive client orders are Internet and phones. Interviewees indicated that they are planning to allow customers to place their orders through wireless phone and Personal Data Assistant (PDA).

Regulatory Issues

For better customer protection and stable online trading market, government is going to tighten control for online brokerages in margin finance business, minimum capital size, system integrity and contingency plan, but it may relax the account opening policy.

System Integrity and Contingency Plans: Most of the interviewees reported that they had emergency back up for systems, power source, staffing, monitoring and technical support. Also customers may use phone to place their

orders in case of system failure. They encountered some system failures when they first offered their online trading service. However, they claimed that the problems were fixed within a short period of time. These questions of the robustness of systems, the capacity to meet demand generated by very aggressive marketing and the adequacy of contingency plans are being reviewed in the special round of Hong Kong Securities and Futures Commission (HKSFC) inspections and it indicates that the industry will need to do more to address risks in these areas.

Account Opening: The interviewees pointed out that the requirement of 'face-to-face' account opening policy had limited the number of online trading customers, but they also pointed out the government is going to relax this policy. Yeung [42] stated on 29th June 2002 (South China Morning Post Hong Kong) that the Hong Kong Securities and Futures Commission (HKSFC) had amended its code of conduct with immediate effect to allow investors to open online trading accounts without a face-to-face meeting. Those online brokerages that allow clients to open accounts without attending in person generally require clients to provide proof of identity, address and bank account details. For better control, some brokerages require their clients to have account opening documents endorsed by lawyers, accountants or a notary public or contact the clients by phone to confirm the details. However, we noted that some brokerages merely require clients to submit a copy of proof of identity without third party endorsement.

Suitability of financial products offered to clients: Almost all online brokerages rely on prior disclosure in the client agreement in relation to the risk of dealing in the products involved. HKSFC is looking into this issue by requiring clients to pass a qualification test before permitting clients to trade online in their selected products.

Impacts on Market

Online trading is more cost-efficient, accelerates trade execution and potentially expands the price information available to investors. As a result, online brokerages are finding their profit margins under pressure. Some of them may try to respond by chasing volume, others may concentrate on certain niches such as advice and research. The interviewees observed that two impacts on market are market fragmentation and market volatility. This is consistent with the study by Crockett [14]. Lower barriers to entry may mean that new online trading systems proliferate, and markets may therefore become more fragmented. Online trading leads to tighter pricing (i.e. lower bid-ask spreads) in securities markets by decreasing transaction costs. By reducing bid-ask spreads, online trading will tend to reduce the profit of active market, markets may become shallower, resulting in increased intra-day volatility. A study by research group Tempest Consultants [16] shows that 60 per cent of fund managers believed online trading had exaggerated price swings and market volatility in the UK stocks, despite having little net impact on market liquidity or company valuations.

5. Recommendations

5.1 Recommendations to Regulatory Authorities

The interviewees have recommended the following policies so as to make the online trading more conducive and healthier:

- fraud & manipulation policies;
- day-trading rules;
- systems failure and contingency policies;
- alliances, mergers and acquisitions policies;
- account opening and digital signature;
- establishment of the true and full identity of a client; and
- suitability of financial products offered to clients.

Williams [41] suggested that the regulatory authority should ensure that online trading systems include accurate and complete information on their websites in the key investor protection areas of risk disclosure, margin requirements, privacy considerations, and trade executions. This is to protect investors who are unfamiliar with online trading.

There is a trend where residents in Mainland China are using the online trading system to trade the China stocks listed in Hong Kong Stock Exchange, because of their relatively low P/E ratio. The problem for them is that they need to open a trading account personally in the local banks; they also need to deposit money into this account before they can start trading. At the moment China has strict regulation in foreign exchange and it is difficult for China residents to bring large sum of Chinese currency to Hong Kong. The large transaction volume certainly worth the regulators in Hong Kong and China to take a closer look to facilitate such trading.

5.2 Recommendations to Organizations

Interviewees have also made the following recommendations to organizations so as to promote online trading in Hong Kong. Some of these recommendations are consistent with the critical success factors in the literature review, such as methods to increase confidence & trust, communication, user-friendly Web interface, customization, customer care, etc.

Insurance for Online Trading: This is a good way to increase the consumer's confidence to trade online. Charles Schwab has introduced an insurance scheme to protect investors in case of system collapse; each client with a US stock-trading account with it would get compensation for their assets held by the broker of up to US\$100 million [44].

Celebrity Brokers in Charge: This is an effective way to attract customers as they have more confidence and trust in the well-known analysts or brokers.

Distribute other Financial Products: Online trading company has the advantage of using the Internet platform

as an efficient way to complete transactions and distribute other products to customers. Besides stock broking, online trading firms can offer other financial products, such as mortgages, personal loans, investment funds, insurance and credit cards to their clients using their existing trading sites [29].

Alliance of Online Brokerage with Online Banking: Since the biggest threat of online trading comes from online banking, the merging of online brokerage and online banking firm provides consumers the convenience of switching between the two services and freely transfer funds between the bank account and trading account. The Merger of E*Trade and Telebank is an example of such strategy [30].

Best Model -- Brick and Click (Multi-Channel Distribution): As mentioned earlier, the failure of 2CUBE.com and Charles Schwab (Hong Kong) indicated that pure online trading without physical branch support has not been successful in Hong Kong. Physical branches serve the function as 'relationship enhancers' and public trust. Combine the virtual trading with the physical branch support; the so-called 'brick and click' model will have the ultimate advantage.

6. Conclusions

In Hong Kong the population density is very high and in just about any street corner or shopping mall you can find a branch office of bank, securities agency, travel agency or property agency. The current penetration of online trading in Hong Kong is low. Due to the convenience, efficiency and cost saving of online trading, there is room for growth in Hong Kong. This paper has identified the variables and factors related to the issues, impacts, barriers and benefits of online trading in Hong Kong. These variables can be used for further empirical studies of why Hong Kong people refuse to trade online and what can be done to facilitate online trading in Hong Kong. This may also help future researchers to build an online trading consumer behavior model.

Greater competition that leads to consolidation and alliance is expected when the government deregulates the commission rate this year. The offering of value added services is the best way to counteract the competition. Other recommendations to online trading organizations have also been suggested in this paper.

In view of the developments in online services, more guidance to brokerages and increased investor education on using online trading facilities will be necessary; this paper has also made some recommendations to the regulatory authorities.

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Development of Web-based Vietnamese Pronunciation Training System

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Abstract

We developed a web-based Vietnamese language learning system. A learner can hear the standard pronunciation of a Vietnamese word by inputting the corresponding word to the keyboard of the system in the Internet environment. Then the system checks the learner's pronunciation with the standard one and the score is shown on the display monitor immediately. We used the Visual C++ language to describe the system in order to provide a GUI (Graphical User Interface) environment for the users. From the results of the experiments, we confirmed that the learner could be trained to improve his pronunciation of the Vietnamese words by using our system.

1. Introduction

Vietnamese is the official language of Vietnam that is spoken by over 80 million people in Vietnam and other countries. This language is a mono-syllabic tonal language, which means that all words are only one syllable long. Each syllable of the words can be pronounced in six different tones and those tones confer different meanings on the words. If the learner pronounces a word with a wrong tone by mistake, then the meaning of the word will change completely. Therefore, the learner has to pay attention to not only pronunciation but also the tones.

We developed the Vietnamese pronunciation training system for the purpose of helping a learner of this language to enhance his skills in pronunciation. Our system gives the standard sound files by native Vietnamese speaker to the learner and compares his pronunciation to the standard one by using record-and-playback. From the results of the experiments, it is shown that the learner can be trained to improve his pronunciation of the Vietnamese words by using the system.

2. System design

We designed the system in consideration of the following conditions:

(1) For the purpose that the system can be used by many people, the system is constituted of some common elements, such as a personal computer, a microphone and an earphone.

(2) The system provides a GUI (Graphical User In-

terface) environment for users.

(3) The size of the system software has to be sufficiently small for the purpose that it can be distributed to the users through the Internet.

In order to satisfy above conditions, we used Visual C++ language to describe the system. The system works normally under following environment:

OS : Windows 98SE/2000/XP.

RAM : more than 64 MB.

CPU : more than 500 MHz.

2.1 Constitution of the system

Our system is constituted of two modules, that is, the input module and the recognition module. The former module acquires the pronunciation of a Vietnamese word which is pronounced by a user, and then analyzes this word to generate the standard pronunciation of the word. The latter module analyzes both the acquired pronunciation and the standard one, and computes the degree of a similarity between that two pronunciations by using a pattern matching technique. Figure.1 shows the constitution of the system.

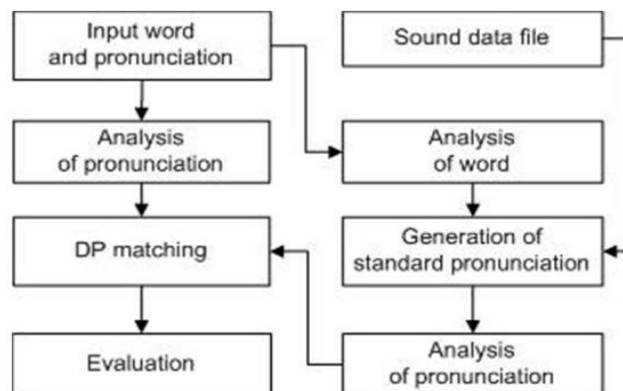


Figure 1: System construction.

2.2 Process of learning by using the system

At first, a user inputs a Vietnamese word to the system from the keyboard. Secondly, he pronounces this word toward the microphone after the standard pronunciation of the word is sounded by the speaker. Then, the system computes the correctness of user's pronunciation by comparing with the standard one,

and displays that correctness by points. The user can master the correct pronunciation of the Vietnamese word by repeating above procedure. Figure.2 shows the user interface window of the system.

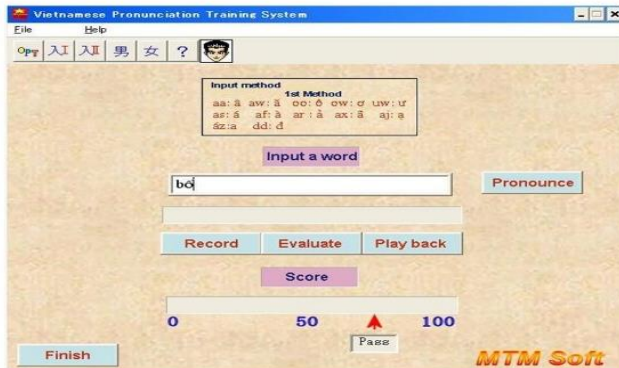


Figure 2: System interface window.

3. Making of the system

3.1 Input module

3.1.1 Speech data file

The sound data of the standard pronunciation of some Vietnamese words is stored in the speech data file. Since actual sound data size of the pronunciation is very large, that data is stored after being decomposed into vowel sounds, consonant sounds and tunes of voice.

In order to generate the pronunciation of almost all of the Vietnamese words, it is needed to store several hundred phonemes in the data file. Since the data size of a phoneme is about 10 to 15 kB when the sound data is sampled at 11025 Hz in the 16 bit monaural Wave form, the speech data file requires about the size of 10 MB.

In practice, we used two files as the speech data file, that is, wordsound.dat and wordpos.dat. The sound data of all of the phonemes are stored in the former file. In the latter file, the size and the position of each phoneme in the wordsound.dat are stored. To state how these files are used, first the size and position of a phoneme is taken out from wordpos.dat, then the sound data can be obtained from wordsound.dat by using acquired information. The construction of speech data file is shown in Figure. 3.

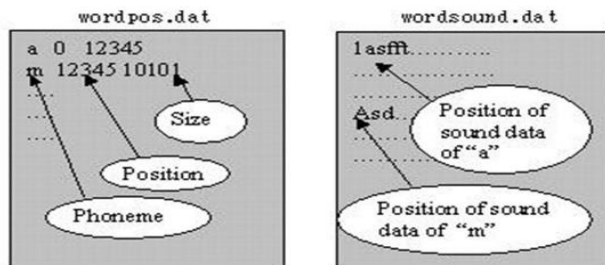


Figure 3: Speech data file.

3.1.2 Word acquisition process

As the Vietnamese words have six different tones, so we provided two sorts of ways to input the tones. The user can input the tones by using combinations of the alphabets and the numerals as a way. As another way, only the alphabets are used to denote the tones. Figure.4 and Figure. 5 show these ways. When a word is acquired from the keyboard by using those ways, then the system shows the word by Vietnamese letters on the display.

2nd input 1st input	1	2	3	4	5	6	7	8	9
a	á	â	ã	ä	å	â		ã	
e	é	ê	ë	ẽ	ē	ē			
i	í	î	ï	ĩ	ī				
o	ó	ô	õ	ö	ø	ô	ø		
u	ú	ù	û	ü	ū				
y	ý	ÿ	ÿ	ÿ	ÿ				
d									đ

Figure 4: One of the means of inputting a Vietnamese letter.

2nd input 1st input	a	e	o	u	d	w	s	f	r	x	j
a	â					ã	á	à	ã	ã	ä
e		ê					é	è	ẽ	ẽ	ē
i							í	î	ï	ĩ	ī
o			ô			ø	ó	ò	õ	õ	ø
u				û		ū	ú	ù	û	û	ū
y							ý	ÿ	ÿ	ÿ	ÿ
d					đ						

Figure 5: Another means of inputting a Vietnamese letter.

3.1.3 Pronunciation acquisition process

The user of the system inputs the pronunciation of the word through the microphone after he saw that word in the display. Then, the user can hear his own pronunciation any times, and he can also pronounce the same word again.

Since it is needed about 1 to 2 seconds to pronounce a Vietnamese word for the user in general, we set a time for recording a word as 3 seconds. The recorded pronunciation data is stored after being sampled in the similar way to the case of the standard pronunciation data (11025Hz, 16 bit monaural Wave format). We used the API (Application Programming Interface) functions of the Windows to describe a program for the recording and the playing back processes.

3.2 Generation of standard pronunciation

Figure. 6 shows the procedure of a generation of the standard pronunciation for the input Vietnamese word. The obtained standard pronunciation can be repeated any times in order that the user can check his own pronunciation with that one.

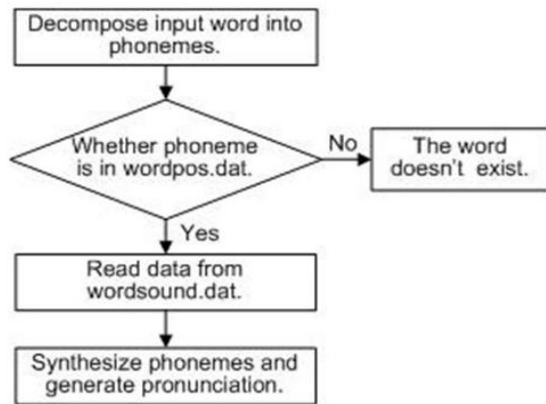


Figure 6: Overview of standard pronunciation generation process.

3.2.1 Decomposition of input word into phonemes

The Vietnamese language has following features:

- (1) Every word can be decomposed into one or two phonemes. The words which begin with a consonant are divided into two phonemes, and the other words become a phoneme themselves. There are no words which have more than three phonemes.
- (2) There are 26 combinations of consonants to appear in the beginning of a word.

The system decompose the input words into phonemes by exploiting those characters according to the algorithm below:

- (1) The system prepares a set of the 26 combinations of consonants.
- (2) In case the beginning of the word is a vowel, the word is a phoneme itself. The procedure is finished at this step.
- (3) In another case the beginning of the word is a consonant, the system inspects a part of the word from the beginning to the consonant just prior to a first vowel of the word whether that part is in the set of consonants or not. If this part is in the set, then the procedure is finished with informing the user that there is no word like such a word in the Vietnamese.

Otherwise, the accorded combination of consonants in the set is a phoneme and the rest part is another phoneme respectively, so that the word is decomposed into two phonemes. The procedure is completed in this step.

3.2.2 Synthesis of standard pronunciation

After the phonemes are obtained by above procedure, the system read the size and the position of those phonemes in wordsound.dat from wordpos.dat. By us-

ing this information, the sound data of the phonemes can be read from wordsound.dat.

In case of one-phoneme-words, the sound data can be used immediately as a standard pronunciation, the other case, two corresponding sound data of phonemes are combined to form a standard pronunciation. In the latter case, obtained standard pronunciation might sound unnaturally for a difference of each pitch of the phonemes. So we adjust the pitches of two phonemes to the pitch of the second phoneme, because the pitch of a two-phonemes-word depends on that of the second phoneme. The fast algorithm in the reference [1] is adopted as a way to adjust those pitches. The following Figure. 7 shows above procedure, and Figure. 8 demonstrates an example of which the pronunciation of the Vietnamese word [ma] is synthesized from the phonemes [m] and [a].

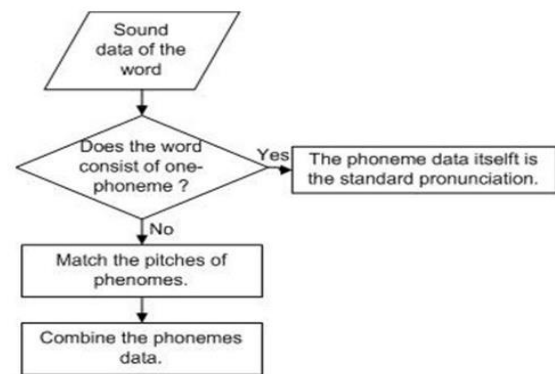


Figure 7: Segmentation and synthesis of pronunciation data.

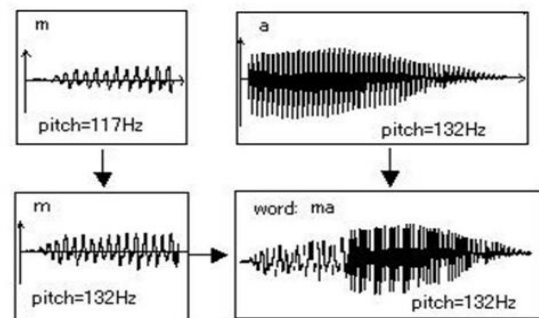


Figure 8: Example of synthesized pronunciation data.

The obtained standard pronunciation can be heard any times for the user by pressing the button from the keyboard.

3.3 Recognition module

In the recognition module, the degree how the input pronunciation of the word corrects in comparison with the standard pronunciation of that word

is computed. As the means to evaluate that degree, the cepstrum analysis [2] and the DP (Dynamic Programming) matching method [3] are exploited.

3.3.1 Detection of voice segment

At first, the section in which the voice signal of input pronunciation is exist has to be detected in order to compare with the standard pronunciation waveform. Although it is difficult to detect this voice segment exactly, we tried to do by using the energy and the number of zero cross of the voice waveform [4].

The waveform is divided into a number of frames at the period of 10 ms, and then the energy $E(n)$ and the number of zero cross $N_z(n)$ are computed for each frame, where n denotes the number of a frame. By using two threshold levels E_1 and E_2 ($E_1 > E_2$) determined from the energies, a conjectural voice segment (n_1, n_2) is detected in all of the extent as following way. That is, the beginning point of the segment n_1 is determined to the first point where the energy is greater than E_1 and besides the energy never drops below E_2 after that point. The terminal point of the segment n_2 is also determined by the same way as the case of n_1 .

The conjectural segment (n_1, n_2) is extended toward the outside of this segment by using $N_z(n)$ of each frame. The beginning point n_1 can be moved to the point where the number of frames whose $N_z(n)$ is greater than some value N_0 is more than 3 in the extent of (n_1-25, n_1) . By the same way, the terminal point n_2 can be moved too. By the means mentioned above, the voice segment (n_1, n_2) can be detected, provided that E_1, E_2 and N_0 are determined experimentally. Figure. 9 demonstrates an example of the detection. In this example, the beginning point n_1 is moved to n_1' , and n_1' is newly denoted as n_1 . On the other hand, the terminal point n_2 is not moved.

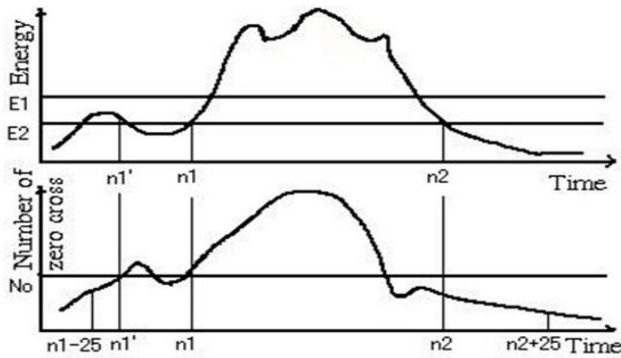


Figure 9: Detection of voice segment.

3.3.2 Cepstrum analysis

The cepstrum is obtained as a result of the inverse Fourier transformation of a logarithm of the power spectrum of a voice waveform. By using the cepstrum, we can calculate the pitch and the envelope of the

spectrum of a voice waveform.

Firstly, the voice waveform is analyzed by means of the short time spectrum analysis. That is, the frame of 20 ms long is picked out from the voice waveform, analyzing by the spectrum analysis. This analysis is performed many times to the frame which is picked out from another position in the waveform by shifting the frame 14 ms successively. Since the beginning and the terminal parts of the frame exert an influence to the spectrum, the frame is multiplied by the Hamming window function [5]. In this way, we determined the length of a frame 20 ms and the interval of the shifting 14 ms experimentally. The obtained cepstrums is treated as vector numbers and stored in arrays. Figure.10 shows the procedure of cepstrum analysis.

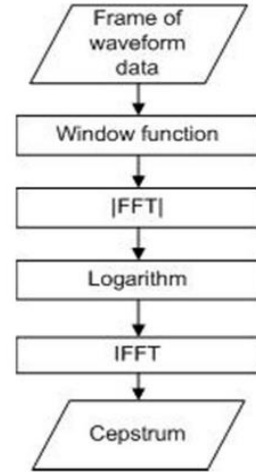


Figure 10: Procedure of cepstrum analysis.

3.3.3 Pattern recognition by DP matching method

In order to regularize some time series of cepstrums relating the time axis nonlinearly, the DP matching method is usually adopted.

By using this method, the distance between the cepstrums of the input pronunciation and the corresponding standard pronunciation is calculated.

Above two time series of the cepstrum which are obtained in 3.3.2 are denoted respectively as

$$A = a_1, a_2, a_3, \dots, a_i, \dots, a_N$$

$$B = b_1, b_2, b_3, \dots, b_i, \dots, b_M$$

where the vector a_i and b_i is the cepstrum of a frame. The distance between the cepstrum a_i and b_i is given by addtoresetequationsubsection

$$d(i, j) = \sum_k d(a_i[k], b_j[k]) \quad (1)$$

$$d(a_i[k], b_j[k]) = \|a_i[k] - b_j[k]\|^2 \quad (2)$$

where $a_i[k]$ and $b_j[k]$ are the k -th elements of each vectors. By using the equation (1) and (2), the distance between A and B is defined as

$$D(A, B) = \frac{G(N, M)}{N + M} \quad (3)$$

$$g(i, j) = \min \left(\begin{array}{l} g(i, j-1) + d(i, j) \\ g(i-1, j-1) + 2d(i, j) \\ g(i-1, j) + d(i, j) \end{array} \right) \quad (4)$$

$$i=1..N, j=1..M$$

where $g(1,1) = 2d(1,1)$, and we use the constant r under the condition of $|i-j| \leq r$.

By using this distance, the system can evaluate the pronunciation of a user. For instance, the smaller the distance becomes, the better the learner can improve his pronunciation.

4. Experimental results

To evaluate our system, experiments are performed on the following conditions:

- (1) Arrange a quiet room to avoid an influence of a noise.
- (2) A personal computer (CPU : Celeron 800 MHz, RAM : 128 MB, OS : Windows 2000), a microphone and speakers are used to make up the system.
- (3) The learners practice Vietnamese pronunciation time and again according to the way that is described in section 2.2.

Table 1 shows the scores of the experiments which are carried out to three subjects. Each subject pronounces a one-phoneme-word and a two-phonemes-word (shown in Figure. 11) five times respectively.

One-phoneme word	Two-phonemes word
a : letter "a"	na : custard-apple
o : aunt	ma : ghost
ô : stain	bô : father

Figure 11: Vietnamese words which is used for the experiments and their meanings.

Table 1. Experimental result.

Subject	A		B		C	
Word	o	na	a	ma	ô	bô
1 st time	50	30	50	80	60	55
2 nd time	70	70	40	100	70	60
3 rd time	100	60	60	90	90	80
4 th time	90	100	70	100	80	75
5 th time	100	85	100	100	95	80
Average score	82	69	64	94	79	70

From the table, we can find that the score doesn't increase monotonously, because of both the influence of the subjects' breathing sound mixed in the pronunciations and the insufficient accuracy

of the recognition process. It can be seen also that the fifth score is higher than the first one in all the experiments. This means that subjects had made progressed considerably in Vietnamese pronunciation. On the other hand, we can see that the subject could not advance his score easily for the vowels which don't exist in the Japanese language.

5. Conclusion

In this paper, we made description of our Vietnamese pronunciation training system. From the results of the experiments, we showed that the subjects' pronunciations approach to the standard pronunciations gradually by repeating a practice, while there are some room for improvement about the influence of a noise and the accuracy of the recognition process.

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The Influence of Customized Internet Banner Ad On Attitude-Ad-Brand-Behavioral Relationship

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Abstract

This paper examines the influence of customizing banner ads to entice higher users' interactivity and sequentially builds not only positive attitudes toward the ad and the brand but also positive behavioral outcomes. It also attempts to introduce a new profiling-targeting parameter based on psychographics for customizing banner ad based on Internet user's individual differences according to their personality, types of goal-directed motives and preferred information processing strategies. Data was gathered through an online survey with a sample of 385 respondents. The Covariance Structural Modeling results supported a positive attitude-ad-brand-behavioral relationship. Positive attitude towards the ad generates more positive behavioral outcomes. Contrary to expectations, the results did not support the proposition that a positive brand attitude produces more positive behavioral outcomes. The findings provide evidence to support the proposition that customization of banner ads' creative and appeals (in terms of presentation modality, verbal versus visual presentation and information-rational versus entertainment-emotional appeals) based on users' individual differences in need for cognition, goal-directed motives and preferred information processing strategies effects positive attitudes toward the ad and the brand.

Introduction

The existing decision support systems and computer network literature have revealed that the Internet has created significant opportunity for customisation, one-to-one marketing and Internet advertising. It has also put an enormous pressure for acquiring customer information needed for such customisation.

Even though there are existing technologies to serve different and customized bundles of advertising messages to customers as they enter web sites, Raghu, Kannan, Rao and Whinston [27] argue that both profiling of the entering customers in real time and selecting the customized mix of offerings are a challenge. This is because the customer base for such customized advertisements is dynamic. That is, in order to provide individual users a customized offering, the profiling of customer preference requires a continuing basis of high level tracking of an individual customer's level of interaction when he/she surfs Web sites. Although there is a large amount of current and historical customer information available to assist the profiling a customized offering, the underlying behaviour of how Internet users process and use information from the Web remains largely unexplained.

Roehm and Haugtvedt [29] and Nowak, Shamp, Hollander and Cameron [22] have suggested the customisation of advertising messages presented to match consumers' responses. Customisation, from an advertising perspective, can be referred to as the extent of responsiveness to the consumer and the potential to facilitate interpersonal communication [13]. According to Heeter [13], the benefit of customisation involves simply personalising messages by inserting the customer's name at various appropriate points in the web page presentation. Many Internet advertising researchers highly recommend customisation or personalisation. However, there is little attention given to how customisation can be operationalised.

Several recent studies also show that changes in the nature of information communicable by Web advertising alters both consumer information search strategies and their decision-making processes [31] [14] [15]. Several studies indicate the moderating effect in the attitude-behavior relationship depends on the amount of cognitive effort required to form or change attitudes [12]. The next question is what types of

information are most attractive to Internet users, and what compels them to elaborate on particular information while discarding the remainder? In addition, what are the appropriate levels of exposure needed to impact consumer cognition, attitudes toward the ad and the brand? To address these issues, we propose a research model employing individual's need for cognition, goal-directed motives and preferred information processing strategy as a psychological mechanism to customise a banner ad design in order to understand how Internet banner advertising can lead to attitude change.

The Research Model

The model proposed assumes that customisation depends on segmenting consumers by profiling their individual differences in terms of their need for cognition, goal-directed motives and their preferred information processing strategies (known as behavioral variables). The customisation of the advertising message embraces their preference for informative and/or entertainment banner ads.

In Figure 1, the model begins with identifying antecedents that effect attitudinal and behavioral changes. The antecedents include need for cognition, goal-directed motives, information-processing strategies and personal involvement. The framework proposes a psychographics mechanism as a basis of customising a banner ad by segmenting Internet users based on their individual differences in need for cognition. Personality has been identified as one of the variables which moderates the strength of relationship between attitude and behavioral [9]. A motivational construct (goal-directed motives) is included as one of the important antecedents to explain both the direction of behaviour and in the context of brand information processing. Goal-directed motive is defined as Internet users' desire, willingness, interest or readiness to process brand information in a persuasive communication presented in a form of an Internet ad. An Internet ad with content that can satisfy a Internet user's goal-directed motive will be relatively easy to process, therefore elaboration of message may be enhanced. Bettman, Payne and Luce [4] have made a similar suggestion about ad message processing and elaboration in a non-Internet environment. Besides the type of Internet ad that an Internet user will be attracted to, an individual's reaction to an ad (e.g. ad/brand attitude) is also a function of his/her motivation.

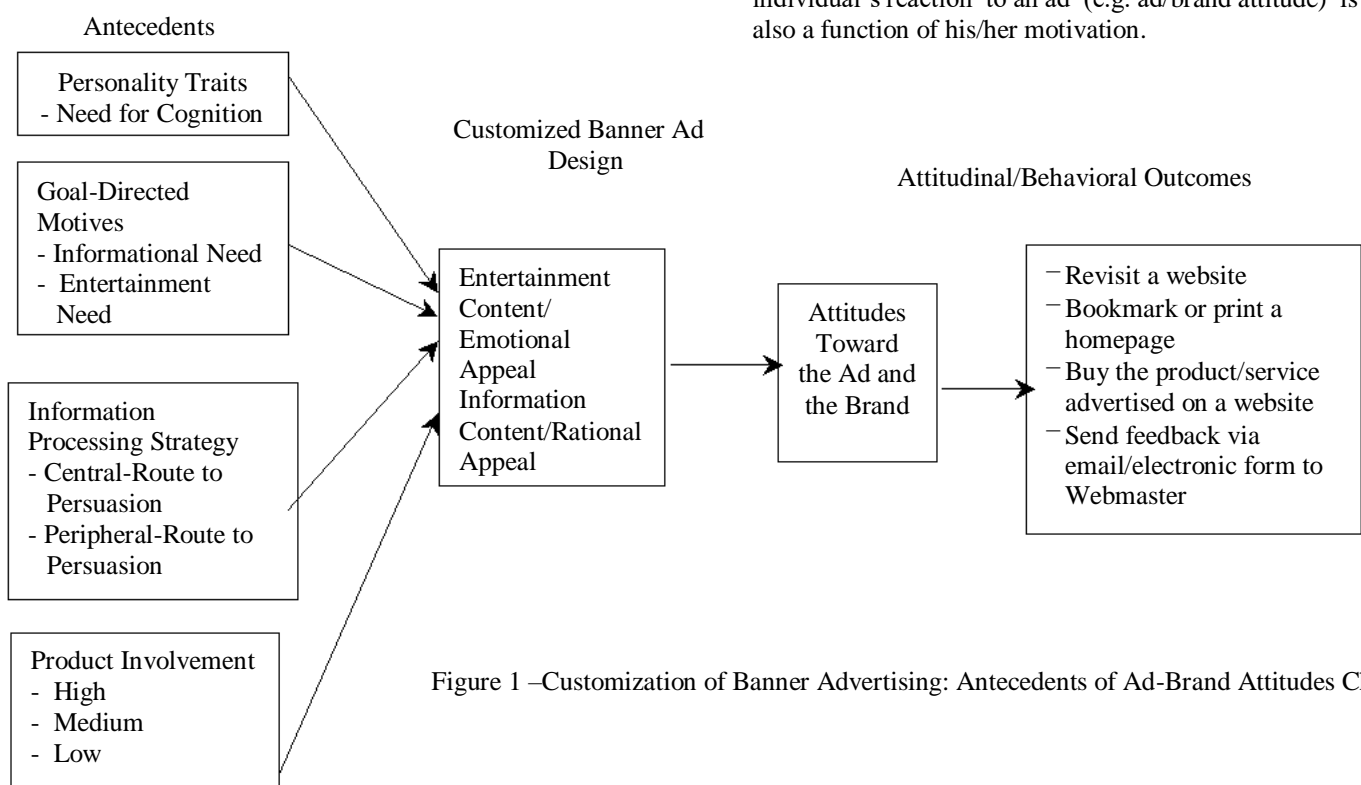


Figure 1 –Customization of Banner Advertising: Antecedents of Ad-Brand Attitudes Change

As opposed to the traditional method of customised banner advertising using demographics, the study presents a model that uses psychographics and behavioral variables to deliver the interactive advertising message and/or web site content that is tailored to the target audience.

For example, Rodgers and Sheldon [28] suggest that individuals who are driven to use the Internet for a particular reason such as searching or browsing are more likely to express favourable attitudes toward banner ads that correspond with that motive.

Cialdini, Petty and Cacioppo [7] and Petty and Cacioppo [25] have provided an explanation of the

moderating effects in the attitude-behaviour relation. These authors suggest that the moderating effects are related to the amount of cognitive effort an individual has been willing and/or able to expend in forming or changing attitudes. That is, attitudes that are formed or changed with greater cognitive effort are more predictive of future behaviour as compared to attitudes which are formed with less cognitive effort. The Elaboration Likelihood Model of Persuasion (ELM) developed by Petty and Cacioppo [23] [25] will be used as a general framework for organising and understanding the basic processes responsible for attitude change. According to ELM [25], there are two information processing strategies for attitude change - central and peripheral route processing. For example, in some circumstances, attitude formation and change results from a consumer's careful attempts to comprehend and evaluate the relevant content of an ad and to integrate this new information with his/her prior knowledge into a coherent and reasoned opinion about the brand. In other situations, consumers use peripheral factors such as their feelings about the quality of the ad, the source of the ad or their current mood state as cues to assist them to decide how they feel about the advertised brand. A motivated individual tends to engage in central processing. The persuasiveness of the message basically depends on careful and in-depth consideration of the merits of the advertised product. In this case, informational aspects of the message play an important role in persuasion and peripheral cues (animated images, graphics, music or video) are less important. On the other hand, an individual who has little motivation tends to disregard the informational aspects of the message and is likely to be persuaded by peripheral cues.

Previous studies have suggested that there is a link between product category and message strategies [8] [19]. Petty, Cacioppo and Schumann [24] and Petty and Cacioppo [25] suggest that involvement (personal relevance) with an issue was directly or indirectly related to the extensiveness of the cognitive effort that consumers expend in forming or changing attitudes. The study conducted by Verplanken [32] reported the moderating effects of involvement and need for cognition in attitude-behaviour consistency. Laurent and Kapferer [17] suggest that consumer involvement effected the extent of the decision process and information search, which in turn effected the types of media to be chosen, the numbers of repetitions of ad messages as well as the quantity of information provided by the ad.

Empirical study provided by Cho [5] claimed that Internet users who are in high involvement situations, are more likely to click ads in order to request more information than those in low involvement situations. On the other hand, those who are in low involvement situations are more likely to click a banner when it has a larger than average size banner ads. These

individuals are also more likely to click on a banner ad when it has dynamic animation. However, the study showed that there was no difference in clicking of banner ad for Internet users in the high involvement situations, regardless of the size or dynamic animation. Cho also concludes that the effect of advertising is maximized when the contents of the advertising vehicle are relevant to the product category. The effects of banner ads will be minimal where the contents of the Web site are irrelevant to the product category. Hence, a banner ad with higher relevance to the product category and the contents of the site where the banner ad is placed will generate more clicking of the banner. The study conducted by Roehm [30] confirmed that where there was matching of the tone and content of message to some aspect of a consumer then product evaluations and attitudes were enhanced and were more positive. In addition, the recent research conducted by Petty and Wegener [26] has shown that matching a communication to the functional base of an attitude that is relevant or important to a participant, can increase message scrutiny.

Recent evidence provided by Cho and Leckenby [6] suggest that simple exposure to a banner ad without clicking did not change Internet users' initial brand attitude and purchase. Furthermore, the brand attitude changes (either in the positive or negative direction) in line with their likeability of the corporate Web site, as a result of users clicking of banner ad in order to link and be exposed to the respective target ad. Furthermore, a recent study conducted by Lee and Miller [18] concluded that brand attitude would be a better measure of Internet advertising effectiveness.

Thus, in this paper, we emphasize that it is not just message content but the important combination of the message and the audience for the achievement of maximum persuasiveness. That is, the extent to which the advertising message is customised according to personality, goal-directed motives and information processing strategies of Internet users is a critical determinant of the strength of the message persuasiveness and formation/creation of attitudinal-behavioural changes. In this study, behavioural outcomes includes longer duration visit; higher frequency of repeat visit; bookmarking the web site; searching for more information about the brand; and providing feedback to advertisers or providing personal information to advertisers. This paper tests the following hypotheses, as illustrated in Figure 2.

- H₁: The greater extent of perceived customisation of a banner ad, the greater extent of change in attitude towards a banner ad.
- H₂: The greater extent of perceived customisation of a banner ad, the greater extent of change in brand attitude.
- H₃: The greater extent of perceived customisation of a banner ad, the greater extent of change in behaviour outcomes.

- H₄: The greater extent of change in attitude towards a banner ad, the greater extent of change in behaviour outcome.
- H₅: The greater extent of change in attitude towards a banner ad, the greater extent of change in brand attitude.
- H₆: The greater extent of change in brand attitude, the greater extent of change in behaviour outcomes.

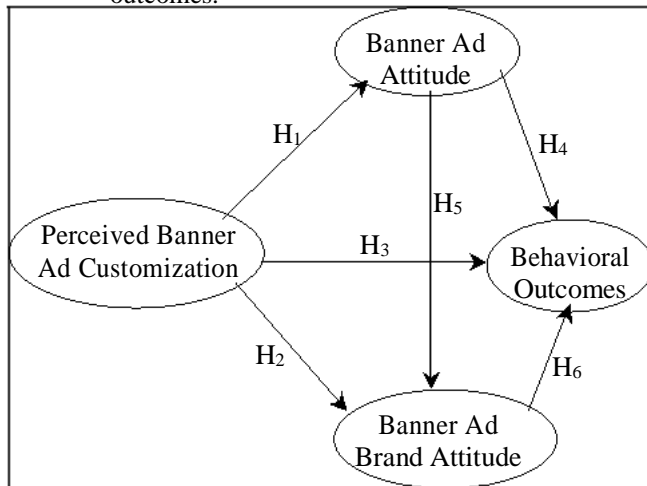


Figure 2 – Hypothesized Relationship of Perceived Banner Ad Customisation and Ad-Attitude-Brand Behavioural Relationship

In this study, familiar brands are used. A familiar brand will tend to be favored. In a previous empirical study by Ward and Lee [33], Internet users were found to be reacting more favourably to familiar brands since they prefer well-known brands. In addition, the expected click-through rate for a familiar brand was ten times higher than an unfamiliar brand. Empirical results provided by Dahlen [10] have shown that a familiar brand has a positive effect on brand attitude when exposed once or twice but wears out on multiple exposures. The author also suggests that the banner ads of familiar brands perform best on a short-term basis with relatively good initial click-through rates, but decrease rapidly after repeated exposure. The diminishing returns would likely to affect brand attitude rather than brand awareness given that in such high familiarity of the brands, brand awareness would not be expected to change. In particular, the framework showed in Table 1 was employed as guideline when designing the banner ads.

Three standard size banner ads of 460 x 55 pixels were created for this study. Each banner ad was created with different advertising theme and interactive features. The advertising objective was to determine the differences in attitudes towards the banner ad and the brand as a result of two forced exposures: first is to view and second is to click on the preferred banner ad.

Research Design And Methodology

Familiar Product/Brand	Level of Product Involvement	Goal-directed Motives	Personality Traits	Information Processing Strategies	Ad Design Principles	
					Advertising Appeal	Banner Ad
Soft drink	Low	Entertainment	Low NC	Peripheral route information processing (visual processing)	Entertainment Oriented	<u>Image site</u> Contains More Visuals and Interactive Features
Computer	High	Information	High NC	Central route information processing (verbal processing)	Informational Oriented	<u>Informational site</u> Contains More Verbal Content and Less Interactive Features
Fashion Apparel	Medium	Information and Entertainment	Medium NC	A combination of central and peripheral route information processing (Both verbal and visual processing)	More Informational and Less Entertainment Oriented	<u>Combined Informational and Image site</u> Contains More Verbal Content and Interactive Features

NC – Need for Cognition

Table 1 – Classification of Stimuli Employed In Design of Banner Ads

All banner ads contained two identical design properties with the actual company logo on the left side of the banner space and an animated actual (current) company slogan or message flashed across the centre of the banner to trigger respondent's brand familiarity. The basic structural design of the experimental banner ads was shown in Figure 3.

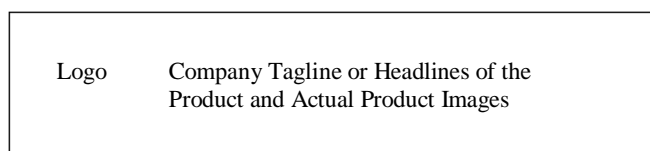


Figure 3— Design of Banner Ad

The background colour used for all banner ads (or dominant colour of the banner) was white. The exception was allowed for the soft drink banner ad because the background colour (red) used was the exact colour of the actual brand to project the psychological effect of warm, sense of novelty and entertainment. In addition, interactive features such as animated images were included in the soft drink banner ad to catalyst and initiate immediate reaction (clicking on the banner ad). Even though the computer banner ad was purposively designed as an informative banner, a blue animated butterfly was built-in as a means of instructing the respondent's attention of the product benefits. Similarly, as for fashion apparel banner, blinking words of the product attributes were flashed to ensure users' attention.

Operationalisation of Research Variables

The measurement scales used in this study were adapted from various sources to suit the specific context of Internet advertising. These measurement scales were based on valid and reliable measures found in previous research. In this study, for measuring attitudinal responses, this research utilised the scales developed by Gardner [11], Mitchell [21], Maheswaran and Sternthal [20], and Cho [5]. Since these scales developed by Gardner [11], Mitchell [21], Maheswaran and Sternthal [20] were originally administered to measure attitudes toward the ad and brand for traditional media, they were modified to apply in the context of Internet advertising. Cho's [5] scales were directly applied in this research to measure attitudes toward the target ad. As for behavioral responses, measurement scales developed by Baker and Churchill [3] was considered and compared to Cho's scale [5]. Modification was then made to tailor the scales to measure the purchase intent. A 7-point Likert scale measures all scales.

Sample Characteristics

The population for this study is Internet users. As such, there were no boundaries placed on the potential

respondents since the Internet can be connected anywhere and at anytime. Two samples were drawn. Data was gathered through an online survey with a sample size totalled 385 respondents who have more than one-year Internet experience. Two samples including a working adult group and a commercial online panel were used. The first sample was recruited by using advertising flyers and emails to undergraduate business students. A professional marketing research firm, AMR Interactive Australia, using their existing online panel, provided the second sample. The panel was invited via email to participate in the study. A Web URL address was then sent to those who showed interest and willingness to participate in this study in return for a cash draw incentive.

Results

The assessment of the measurement models by the means of the exploratory and confirmatory approaches. Table 2 shows that there are 4 constructs in total. Each construct is tested for its convergent validity and discriminant validity and unidimensionality is achieved. The findings indicate that the dimensions of these constructs are conceptually and empirically acceptable with multiple goodness-of-fit indices (GFI, CFI, TLI and NFI) above the 0.90 recommended level. All variance extracted for the latent constructs are equal or greater than the conventional standard of 50 per cent. The average factor loadings on these constructs are all equal or greater than 0.70. For those factor loadings of less than 0.50 were removed, the measurement is re-specified and similar CFA are conducted for level of model fit, within construct convergent validity and within construct discriminant validity including the composite reliability and the average variance extracted. Lastly, the composite reliabilities (CR) were computed. The CR results show that all constructs have reasonably acceptable reliability. Not all CR have similar reliability Cronbach's alphas. These findings confirm that the underestimation of Cronbach's alphas is insignificant [2] and therefore it is not likely to cause any practical consequences [1].

Previous research has recommended the use of multiple indices to assess the fit of the model to the data [16]. In judging the adequacy of model fit, larger CFI, TLI and NFI values (greater than 0.90) indicate good model fit. The normed Chi-square should not be greater than 5.0 [34] to indicate a good fit. Finally, the RMSEA value of less than or equal to 0.08 indicates a good fit.

In evaluating goodness of fit, the model receives a good fit to the data. The standardised regression coefficients estimated by ML estimation together with the significance tests and the structural paths are shown in Figure 3. For absolute fit measures, the model has achieved a good fit (GFI = 0.952, normed Chi-square = 2.901 and RMSEA = 0.070).

			Reliability Tests		Validity Tests			
1	Perceived Banner Ad Customization	3	0.8632	0.8690	0.6913	0.8260	Satisfactory	Satisfactory
2	Attitude Towards A Banner Ad	2	0.8629	N.A	N.A	N.A	N.A	N.A
3	Banner Ad Brand Attitude	3	0.9224	0.9232	0.8006	0.8914	Satisfactory	Satisfactory
4	Behavioral Outcomes	3	0.9066	0.9100	0.7725	0.8757	Satisfactory	Satisfactory

Table 2 – Summary of Psychometric Properties of Measures

Absolute Fit Measures

λ^2 / df	2.901
RMR	0.067
GFI	0.952
RMSEA	0.07

Incremental Fit Measures

Normed fit index	0.967
Relative fit index	0.952
Incremental fit index	0.978
Tucker-Lewis index	0.968
Comparative fit index	0.978

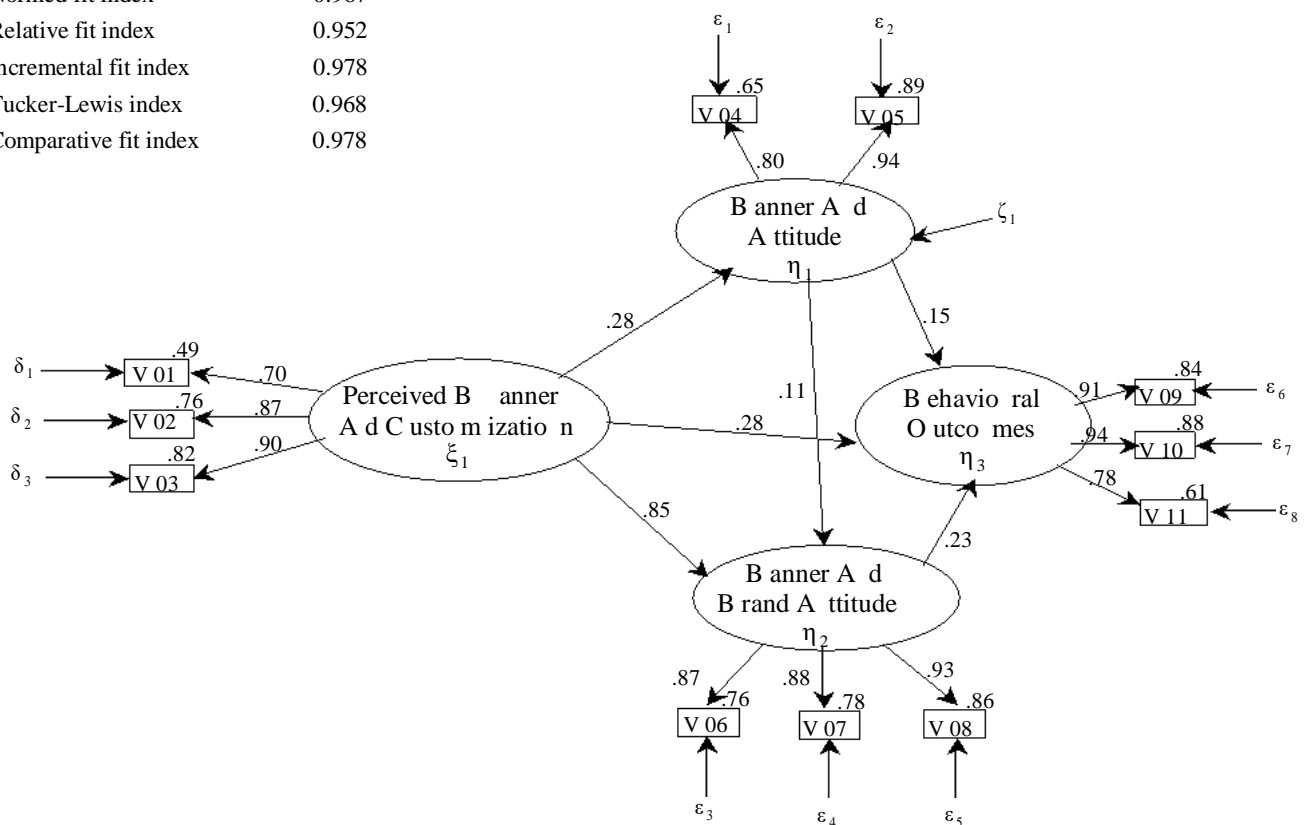


Figure 4 – The CSM Results of Estimates of Banner Ad Customisation, Attitude Towards A Banner Ad and Brand Attitude

The incremental fit measures are above the 0.90 recommended levels (NFI = 0.967, TLI = 0.968 and CFI = 0.978), therefore confirming that the model has acceptable level of goodness-of-fit.

In Figure 4, the results of the CSM show that the standardized regression coefficients of all structural paths are significant except the hypothesized relationship between banner ad brand attitude and behaviour outcomes. The extent of perceived banner ad customisation has positive and significant impact on attitude towards a banner ad ($\beta = 0.284$, SE = 0.059, p-value = 0.000), banner ad brand attitude ($\beta = 0.853$, SE = 0.051, p-value = 0.000) and behavioral outcomes ($\beta = 0.280$, SE = 0.147, p-value = 0.031). Therefore, H₁, H₂ and H₃ are supported.

The relationships between the attitude towards a banner ad and banner ad brand attitude ($\beta = 0.109$, SE = 0.043, p-value = 0.002) and between attitude towards a banner ad and behavioral outcomes ($\beta = 0.154$, SE = 0.060, p-value = 0.003) are both positive and significant. Therefore, these results support H₄ and H₅. Contrary to expectation, the findings showed insignificant but positive impact of banner ad brand attitude on behavioral outcomes ($\beta = 0.226$, SE = 0.123, p-value = 0.086). H₆ is not supported.

Discussion and Conclusion

The results show that the perceived banner ad customisation is important to effect positive attitudinal and behavioral changes. The banner ad design differs in terms of either verbal or visual representations or variation of both, and is customized based on psychographic segmentation according to personality (need for cognition), goal-directed motives, level of product involvement and preferred information processing strategy to boost interactivity and enhance elaboration, persuasion and attitudinal/behavioral changes. The perceived ad customisation and ad-attitude-brand relationship were found to be significant for banner ads. These findings support the proposition made by Roehm and Haugtvedt [29] who recommended customisation of advertising messages based on consumers' personality.

This study recommends a connection between message strategy and users characteristics. The results provide evidence to support that matching the message strategy in terms of presentation modality (verbal versus visual presentation), message appeal (information-rational versus entertainment-emotional) and inclusion of interactive features (static versus dynamic animation) with users individual differences in their need for cognition, goal-directed motives and preferred information processing strategies produces positive attitudinal responses. For example, the banner ad and its respective Web sites were designed with different creative techniques so that each layout was distinctive

according to its appeal. A rational-informational appeal (information site) with persuasive argument on the product attributes was used for computer brand. While the soft drink Web site incorporated an emotional-entertainment appeal (image site) in which celebrity video clips and news were peripheral cues, the fashion apparel used a combination of both rational-informational and emotional-entertainment appeals (text and animated images) was a more persuasive than celebrity source peripheral cues presented.

The main objective of this paper is to explore and to provide evidence relevant to the debate over whether Internet advertising works well as a branding medium. This study also aims to suggest a framework to measure Internet advertising effectiveness via brand attitude change. It includes the proposition of 'customisation of a Web site design based on Web content and form in accordance to individual differences in need for cognition, goal-directed motives and information processing strategies to the functional base of an attitude (brand attitude) to increase message scrutiny, persuasion and attitude change.

Practical Implications and Future Research

The current approach for personalised ad selection is based on the demographic information, browsing and interaction history of a particular user. The research model offers advertisers and advertising agencies a new profiling and targeting parameters for automated personalised Internet advertising. The model suggests that information about user's personal differences in terms of personality traits, types of goal-directed motives and preferred information processing strategies are better-quality user information for profiling and creating automated customized and personalised ads. User information can be requested via filling out a registration form or survey. Alternatively, the ad-server (via neural network or proprietary learning methods) can analyse the user's browsing and interaction history. Cluster technique is used to classify users into need for cognition, goal-directed motives, personal relevance or preferred information processing strategy segments. Customized ads are then selected and placed to match the relevant user.

This study also offers a comprehensive model that advertisers and advertising agencies can apply when they develop an Internet advertising plan. The research model can be employed at each development stage of a plan. For example, when defining target audiences, this model offers an alternative psychographics variables such as individual differences in need for cognition and users' goal-directed motives and preference in information-processing style as segmentation variable.

This study also recommends the use of psychographic segmentation to Internet ad design. For example, message design in terms of its 'content' and 'form' are

based on need for cognition (high or low in need for cognition), types of goal-directed motives (information versus entertainment), type of involvement (high, medium or low), type of personal relevance (high, medium or low) and information processing strategies (central-route information processing versus peripheral-route information processing). Content' embraces the variations in the ad creative based on the product category and product involvement customized according to Internet users' need for cognition, goal-directed motives (information, entertainment) and information processing strategy (central-route, peripheral route) while 'form' refers to the inclusion of interactive ad features. For example, high involvement products and services require an informational ad/site with less animation features, verbal-oriented content with textual links to satisfy information needs. Low involvement products and services require an emotional-entertainment oriented ad/site with more colourful background, graphics and images, animations, interactive features (such as chat community group and/or feedback services) to create a positive impact on Internet users' attitudes toward the ad, product and brand.

This study can be considered as an initial stage of investigation rather than a complete explanation of the phenomenon under study. The model needs further replication, extension and critical evaluation using similar product category and/or unfamiliar brands.

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An Association Rule-Based Inference System for Customer Need Recognition

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Abstract

Facing intensive competition in the marketplace, manufacturing companies are forced to react to the growing individualization of demands. To meet this challenge, more and more companies have realized the importance of understanding the voice of customers and recognizing customer needs. Customer needs are inherently implicit and ambiguous, resulting in barriers for customers, marketers and the designers to communicate one another and cooperate throughout the product development process. This paper studies the mapping mechanism between the customer domain and the functional domain of design. An Association Rule-Based Inference System (ARIS) is presented for the recognition of customer needs.

1. Introduction

Manufacturing companies are facing the intensive competition in the marketplace. Under such a competitive environment, more and more companies shift to the customer needs. Product definition has been considered as one of the key factors in the early stage of the product design. The success or failure of the product definition directly influences the whole product development.

Based on the Axiomatic Design theory [18], the products are specified by several functional requirements (*FRs*); and for each *FR*, there are different value options (*FRVs*). The class-member relationships for variety representation theory [12] has illuminated that for each type of product alternative (class) with a specific set of *FRs* (class attributes), product variety can further result from different *FRVs* (members). The class-member relationship for variety representation is shown as Fig. 1.

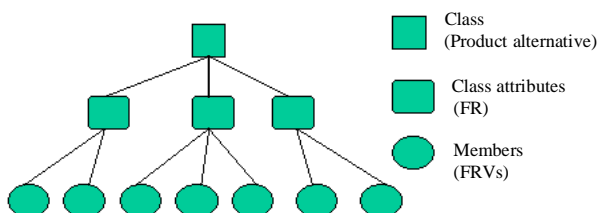


Fig. 1. Class-member relationship for variety representation

Axiomatic Design theory also indicates that the design

world is composed of four distinct domains. The customer needs and product specifications are stated in *CN* domain (customer needs domain) and functional domain [18] respectively. The customer domain and the functional domain comprise the product definition phase, from the abstract customer needs to the concrete product requirement specifications [15]. Under the philosophy of “design for customers”, the product specifications (*FRs*) should be evolved from the real needs of customers (*CNs*).

There are many difficulties when translate the genuine customer needs (*CNs*) into *FRs* because *CNs* are always originated in a verbatim format and possess the non-technical nature. On the contrary, *FRs* are always expressed with the explicit technical parameters which can be easily understood by the design engineers. Traditionally, design engineers use their experience and intuition to translate imprecise customer requirements into a clearly defined design specification, but this is a less than ideal approach, as it leads to imperfect designs, which satisfy a design engineer’s interpretation of customer requirements, rather than satisfying the genuine customer requirements [1].

Data mining is a rapidly evolving area of data analysis that attempts to identify trends or unexpected pattern in large pools of data by using mathematical tools. It could help extract useful information from large database. Association rule mining is a data mining technique that discovers strong associations or correlation relationships among data without constraining the data type and is very suited to mine the mapping relationships between the customers’ needs with the linguistic expression and functional requirements specified by the technical parameters.

This paper presents an association rule-based inference system to provide the mapping mechanism between customer domain and functional domain. Section 2 describes related research work in the field of requirement management. In section 3, an association rule-based inference methodology is represented. Section 4 represents a case study and section 5 summarizes the research work in this paper.

2. Literature review

The voice of customers (*VoC*) has received amount of interest of both academicians and practitioners [8]. The

traditional method to translate the customer needs into the corresponding functional requirement is Quality Function Deployment (QFD) [3] [7] [12]. Though QFD can help improve the product quality by providing the information about the customers [16], it is a document with a list of customer needs and functional requirements rather than a mapping tool to recognize the relationship pattern between the two.

From a design perspective, Hauge and Stauffer develop a taxonomy method of product requirements as a way to organize information [7]. Though the taxonomy method does recognize the topology of the functional requirements by classifying large bodies of information, it is too general to be a domain-independent framework. Also, because the taxonomy method starts from the engineering design perspective, it can't provide the pattern information about the customer domain and the functional domain.

In recent years, several researchers have gained achievement in the field of requirement management. Fung establishes an intelligent inference model in which the customer needs, the product specifications are both expressed in Fuzzy Sets characterized by their relevant membership functions, and the relationship between them is represented in the form of Fuzzy Propositions [5]. Though Fuzzy Set Theory excels in treating the notions that can't be clearly defined, it is not good at solving the quantitative variables because the variables must be fuzzified before they enter the inference process. It is not appropriate to translate the quantitative variables into fuzzy values.

Tseng and Jiao adopt Computer-Aided Requirement Management methodology for product definition noted as PDR [19]. This method adopts functional requirement (FR) patterns from previous product designs to map FR into desired value (FR instance). The values of FR variables are characterized by the representative center vectors. Their work focus on the FR domain, but the mapping between the customer domain and functional domain is still not recognized. A mapping mechanism to recognize the relationship between the customers' needs and product functional specifications is needed to be established to help companies provide the products to meet the customers' needs.

3. Mapping mechanism between customer needs and functional requirements

3.1 Product definition

Supposing $P = \{FRV_{jz_j}\} (j = 1, 2, \dots, m; z_j = 1, 2, \dots, n_j)$ as the generic representation of a product definition, where the product definition (P) is embodied by $FRV_{jz_j} (j = 1, 2, \dots, m; z_j = 1, 2, \dots, n_j)$ and it refers to the j^{th} FR taken with the z_j^{th} value; j refers to the numbers of FRs that the product alternatives consist of; and n_j refers to the numbers of FRVs for each FR_j .

The recognition of the mapping mechanism between

CNs and FRs to help develop the product definition then is identical to the mapping recognition problem between CNs and FRVs.

This paper proposes an ARIS system to establish the mapping mechanism between CNs and FRVs. A vivid model of customers' needs recognition is shown as Fig. 2. The FRVs are clustered and then the mapping mechanism is established between the customers' needs and FRVs. The definitions of products are described by the combinations of FRVs.

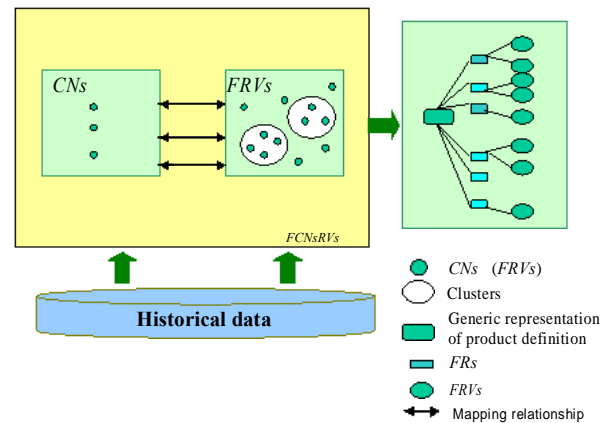


Fig.2. A vivid model of customers' needs recognition

3.2 ARIS architecture

The ARIS system consists of three parts: the user interface, the knowledge base and the inference engine. The knowledge base captures the data of CNs and FRVs. It can be partitioned into two parts:

1. $K - CN$: The knowledge about customer needs;
2. $K - FRV$: The knowledge about functional requirement values.

The architecture of ARIS is showed as Fig. 3.

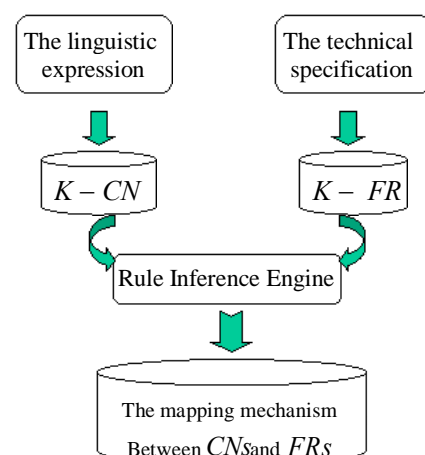


Fig. 3. Illustration of the ARIS architecture

The relational database can be established, in which CNs and FRVs are stored in two tables which are related by means of a common file. In this system, the common file

is the customer ID.

CNs are represented as $CN_{ip_i} (\forall i = 1, 2, \dots, n; p_i = 1, 2, \dots, k_i)$, which denotes the i^{th} customer's the p_i^{th} needs, where i refers to the numbers of the customers and k_i refers to the numbers of the needs of the i^{th} customer. Similarly, FRV_{ijz_j} denotes the z_j^{th} value of the j^{th} FR ($\forall j = 1, 2, \dots, m; z_j = 1, 2, \dots, n_j$), and these are what the designers design in order to meet the requirement of the i^{th} customer, where j refers to the numbers of FRs, and n_j refers to the numbers of the FRVs candidates for the j^{th} FR.

The schematic representation of ARIS can be shown as Fig. 4.

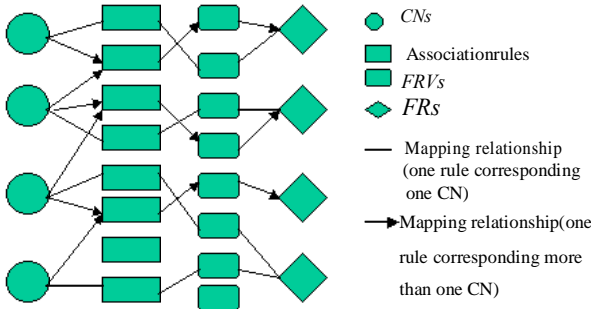


Fig. 4. The schematic representation of ARIS

3.3 Methodology

The methodology to establish the mapping pattern between CNs and FRVs by using association rules will be illustrated as following. The whole process involves two steps: data clustering and mining association rules.

3.3.1 Data clustering

Clustering is the process of grouping a set of physical or abstract objects into classes of similar objects. A cluster is a collection of data objects that are similar to one another within the same cluster and are dissimilar to the objects in other clusters. Different customers desire various FRVs. For almost all the manufacturing companies, it is impossible to meet every individual need because of the high cost. Based on the Chamberlin-Dixit-Stiglitz (CDS) Model [13], the products close together on the spectrum are better substitutes than those further apart. That is, the customers are willing to choose those products that have FRVs which are closest to their desired values if they can't find the products with their desired values are on the markets. It is wise to cluster the customers' desired values and provide the product family not only to meet the needs of customers but also reduce the cost and design time.

1. Measuring Distance

There are three types of the FRVs variables: the numerical variables, the binary variables and the nominal variables [9] [10]. The methods to measure the distances of

different types of variables are different.

1. Numerical variables distance measure

The distance measures of the numerical variables are not single. In general, the clustering methods for numerical variables include Euclidean distance, Manhattan distance, Minkowski distance and weighted Euclidean distance measure. In this paper, the weighted Euclidean distance measure is adopted:

$$d(i, v)_{\text{NUMERICAL}} = \sqrt{\sum_{j=1}^m W_j (FRV_{ijz_j} - FRV_{vjz_j})^2} \quad (1)$$

subject to

$$FRV_{ijz_j} = \frac{FRV_{ijz_j} - \min FRV_{ijz_j}}{\max FRV_{ijz_j} - \min FRV_{ijz_j}}, \quad (2)$$

where $d(i, v)_{\text{NUMERICAL}}$: the distance between customer i and customer v based on the numerical variables;

FRV_{ijz_j} : the standardized z_j^{th} value for the j^{th} FR ($\forall j = 1, 2, \dots, m; z_j = 1, 2, \dots, n_j$) held by the i^{th} customer;

W_j : the relative importance of the j^{th} FR.

Equation (2) aims at normalize the FRV variables to eliminate the effect of the unit difference.

2. Binary variables distance measure

A binary variable has only two states: 0 or 1, where 0 means that the variable is absent and 1 means that it is present. The binary variables can be grouped into two types: the symmetric and asymmetric binary variables. A binary variable is symmetric if both of its states are equally valuable and carry the same weight. The most well-known coefficient for assessing the distance measure of symmetric binary variables is the simple matching coefficient. A binary variable is asymmetric if the outcomes of the states are not equally important. For the distance measure of the asymmetric binary variables, the most well-known coefficient is the Jaccard coefficient. In this research, the binary variables in FRVs are treated as symmetric variables and thus a simple matching coefficient is adopted:

$$d(i, v)_{\text{BINARY}} = (r + s) / (q + r + s + t) \quad (3)$$

where $d(i, v)_{\text{BINARY}}$: the distance between customer i and customer v based on the binary variables;

q : the total numbers of binary variables that equal to 1 for both customer i and v ;

r : the numbers of variables that equal to 1 for customer i but equal to 0 for customer v ;

s : the numbers of variables that equal to 0 for customer i but equal to 1 for customer v ; and

t : the numbers of variables that equal to 0 for both customer i and v .

3. Nominal variable distance measure

A nominal variable is a generalization of the binary variables in that it can take on more than two states. A discrete ordinal variable resembles a nominal variable, except that the states of the ordinal value are ordered in a meaning sequence. In this paper, the ordering sequence doesn't exist, so the simple matching approach is employed to measure the distance of the nominal

variables:

$$d(i, v)_{NOMINAL} = (p - m) / p \quad (4)$$

where $d(i, v)_{NOMINAL}$: the distance between customer i and customer v based on the nominal variables;

m : the numbers of variables for customer i and v that are in the same state; and

p : the total numbers of variables.

2. Fuzzy Clustering Analysis

② Forming a fuzzy similar matrix

$$z(i, v) = \{d(i, v) - \min d(i, v)\} / \{\max d(i, v) - \min d(i, v)\} \quad (5)$$

$$d(i, v)' = W_{NUMERICAL} z(i, v)_{NUMERICAL} + W_{BINARY} z(i, v)_{BINARY} + W_{NOMINAL} z(i, v)_{NOMINAL} \quad (6)$$

$$R = [r(i, v)]_{n \times n} \quad (i, v = 1, 2, \dots, n) \quad (7)$$

$$r(i, v) = 1 - d(i, v)' \quad (8)$$

where $R = [r(i, v)]_{n \times n} (i, v = 1, 2, \dots, n)$: the similarity matrix;

$r(i, v)$: the degree of similarity between customer i and customer v ;

$W_{NUMERICAL}$: the relative importance of the numerical values;

W_{BINARY} : the relative importance of the binary values;

$W_{NOMINAL}$: the relative importance of the nominal values; and

$d(i, v)'$: the dissimilarity between customer i and customer v based on all the types of variables.

Equation (5) is used to normalize the FRV variables because the values in the similarity matrix are within the interval 0 and 1 and it is applicable to each type of $FRVs$. Equation (6) calculates the distance between customer i and customer v with the consideration of all types of $FRVs$.

③ Getting the fuzzy equivalent matrix

Equivalent matrix has the following characteristics:

- Reflexive: $r_{ii} = 1 (i, v = 1, 2, \dots, n)$;
- Symmetrical: $r_{iv} = r_{vi} (i, v = 1, 2, \dots, n)$; and
- Transitive: $R \circ R = R$

The similarity matrix generally meets the first two requests. To meet the third, convert it into an equivalent matrix by using the “continuous multiplication” method.

Multiplication in fuzzy relations is also known as the maxmin composition. Let $R(i, v), (i, v) I * V$ and $R(i, v), (i, v) I * V$ be two fuzzy relations, then $R \circ R = \{[(i, v), \max\{\min_k (i, v)_k, (i, v)\}]/i, I, V\}$ is also a fuzzy relation where r_R is an element in a fuzzy relation.

④ Choosing a threshold and perform clustering

After the equivalent matrix has been obtained, a threshold is chosen noted as l_n above which the $r(i, v)$ values validate that the customer i and customer v hold the similarity and can be classified into the same cluster. Based on the equivalent matrix, given different thresholds, different clustering results can be obtained. The clustering graph is shown as Fig. 5.

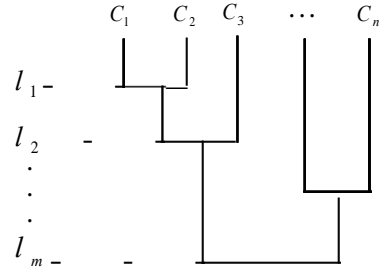
Denoting l as the l^{th} cluster ($l = 1, 2, \dots, s$) where $l[(i, v) \setminus i, v, (r_{iv} > l_n)] (i, v = 1, 2, \dots, n)$, then we have:

$$FRV_{jl} = \sum_i FRV_{ijl} / N_l \quad (9)$$

where N_l : the customers' numbers that fall into l ; and

FRV_{ijl} : the FRV for the j^{th} FR that falls into the l^{th} cluster desired by customer i .

Equation (9) calculates the average values of j^{th} FR desired by those customers falling into the same cluster. And FRV_{ijl} are then stored into the database [2].



j^{th} item in l_i where l_i refers to the i^{th} member in A_{k-1} , then members l_1 and l_2 of A_{k-1} are joined if
 $(l_1[1] = l_2[2]) \wedge (l_1[2] = l_2[2]) \wedge \dots \wedge (l_1[k-2] = l_2[k-2])$
 $= l_2[k-2]) \wedge (l_1[k-1] \neq l_2[k-1])$

In the first iteration, each item is a member of the set of candidate 1-itemsets, C_1 . Then the frequent itemset A_1 can be determined by scanning all the C_1 and selecting those items that reach the min_sup. The second candidate C_2 then is evolved by joining A_1 with A_1 and thus A_2 is determined by scanning all the C_2 and selecting those items that reach the min_sup. The iteration terminates until $C_{k+1} = \Phi$ and A_k is determined.

3. Generating Association Rules from Frequent Itemsets

Once the frequent itemsets from the database have been found, it is straightforward to generate strong association rules from them [14] [20].

7 The format of association rule

Association rules are displayed by using the following format:

$CN_{ip_i} \rightarrow FRV_{jl}$ [Coverage=value; Support=value; Strength=value; Lift=value; Leverage=value]

The left-hand-side of this rule - CN_{ip_i} is presented before the \rightarrow arrow. The right-hand-side- FRV_{jl} follows the arrow and precedes the opening bracket. It indicates that item CN_{ip_i} associates with item FRV_{jl} . That is, if item CN_{ip_i} exists, item FRV_{jl} also occurs.

7 Criteria

Only when the criteria have been met, it validates there are strong associations between the items. There are five criteria are needed to be met during the association rule inference process. They are shown as the following.

1. Coverage

Coverage is the proportion of transactions covered by CN_{ip_i} :

$$\text{Coverage} = P(CN_{ip_i}) \quad (10)$$

2. Support

Support is the proportion of transactions covered by both the CN_{ip_i} and the FRV_{jl} :

$$\text{Support} = P(CN_{ip_i} \cap FRV_{jl}) \quad (11)$$

3. Strength

Strength is the proportion of transactions covered by the CN_{ip_i} that are also covered by the FRV_{jl} :

$$\text{Strength} = P(FRV_{jl} / CN_{ip_i}) \quad (12)$$

4. Lift

Lift is the strength divided by the proportion of all transactions that are covered by the FRV_{jl} . Lift provides an indication of how much more likely is the right hand given the left hand than normal:

$$\text{Lift} = P(FRV_{jl}) \setminus P(FRV_{jl} / CN_{ip_i}) \quad (13)$$

5. Leverage

Leverage is the proportion of additional transactions

covered by both the CN_{ip_i} and FRV_{jl} above those expected if the CN_{ip_i} and FRV_{jl} were independent of each other:

$$\text{Leverage} = P(FRV_{jl} \cap CN_{ip_i}) - P(FRV_{jl}) \times P(CN_{ip_i}) \quad (14)$$

4. Case study

4.1 Background

So far, the ARIS system representation, the mathematical formulation and the algorithm have been discussed. This section presents one case that is greatly related to the above aspects to present the application of the proposed methodology. The case adopts the high variety product – the vibrating motor used as the absolutely necessary accessory of mobilephones - as an example. This is because (1) The motor products are not complex for the customers and it is easy to understand the customers' requirements for the motor products expressed in nature language; and (2) The motor products are standardized customization products which can reflect the customers' different individual needs so as to reveal the nature of ARIS system.

Since different customers have their own requirements for the mobilephone products, the motor products matched with these different mobilephones are typical customized products under mass customization. The difference in motor product design requirements results in the products characterized by a number of variations including the customers' requirements which expressed in their nature language and the functional requirement values.

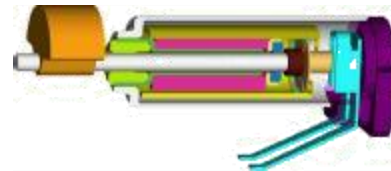


Fig.6. Illustration of a motor product

The motor product is a collection of nine FRs . These nine FRs are current, pbfree, length, diameter, coating, angle, strength, weight and hardness respectively. The illustration of the real motor product is shown in Fig. 6. The description of FR_j is shown in Tab. 2.

Tab.2. Description of FR_j

FR_j	Description
FR_1	Current
FR_2	Pbfree
FR_3	Length
FR_4	Diameter
FR_5	Coating
FR_6	Angle
FR_7	Strength
FR_8	Weight
FR_9	Hardness

Tab. 3(a) Description of FRVijz_j

FR_j	FR_j Description	FRV_{ijz_j} (Encoded with jz_j)	FRV_{ijz_j} Description
FR_1	Current	11	100
		12	80
		13	60
FR_2	Pbfree	21	Y
		22	N
FR_3	Length	31	8
		32	12
		33	10
FR_4	Diameter	41	5
		42	4
		43	6
FR_5	Coating	51	Au
		52	Alloy
		53	None
FR_6	Angle	61	40
		62	55
		71	7
FR_7	Strength	72	4
		81	2
FR_8	Weight	82	3
		91	40
FR_9	Hardness	92	70

Tab. 3(b) Description of CNs

CN No.	CN Description
1	Feel the vibration very strongly
2	Alarmed by the vibration without vibrating suddenly
3	Sensitive to the vibration
4	Buy the expensive mobilphone to use for a long time
5	Change the style of the mobilephone occasionally at a lower price
6	Try other style of mobilephones every now and then with a moderate price
7	Portable
8	Comfortable to hold
9	Not easy to lose
10	Little noise
11	Alarmed when can't depend on vibration
12	Alarmed by both vibration and sound
13	Green environment
14	Light

4.2 Applying ARIS for the mapping mechanism

4.2.1 The data list about CN and FRV

It has been mentioned above that the motor product is a collection of nine FRs . Among these FRs , FR -pbfree is of binary type, FR -coating is of nominal type and the remaining seven FRs are of numerical types. There are 30 customers' needs derived from the company's database.

It is not surprising that there are different requirements for each FR . The historical data are composed of both customers' requirements expressed in their language and the corresponding FR values (FRV_{ijz_j}) which meet their requirements. The requirements and values bound with each customer differ from each other and are stored in the database identified by an identifier – the customer No. The description of the customer requirements (CN) and FRV are partly shown as Tab. 3.

4.2.2 Weight determination

Analytical Hierarchy Process (AHP) is used to calculate the relative importance of each FR . The pairwise

comparison scale is shown as Tab. 4. The weights (W_j) for FRs are shown as Tab. 5.

Tab. 4 The scale for pairwise comparison

Verbal judgement of preference	Numerical rating
Extremely preferred	1
Very strong to extremely	2
Very strongly preferred	3
Strongly to very strongly	4
Strongly preferred	5
Moderately to strongly	6
Moderately preferred	7
Equally to moderately	8
Equally preferred	9

Tab. 5 The preferences for FR_j

FR_j	W_j
Current	0.219
Pbfree	0.304
Length	0.046
Diameter	0.031
Coating	0.019
Angle	0.066
Strength	0.157
Weight	0.095
Hardness	0.083

4.2.3 Customer clustering

1. Distance Measurement

② The numerical FRs distance measurement

There are seven numerical FRs including current, length, diameter, angle, strength, weight and hardness. The first three FRs have three levels of $FRVs$, the last four FRs have two levels of $FRVs$. That is:

$$FR_1 = \{FRV_{11}, FRV_{12}, FRV_{13}\},$$

$$FR_2 = \{FRV_{21}, FRV_{22}, FRV_{23}\},$$

...

$$FR_7 = \{FRV_{71}, FRV_{72}\}.$$

The weighted Eluclidean distance measure is adopted. The original data are input into SPSS software to be processed during which the original data are normalized automatically by computer and then the results are calculated.

The distance between customer i and customer v , i.e., $d(i, v)_{NUMERICAL}$, ($\forall i, v = 1, 2, \dots, 30$), is presented as a 30×30 matrix whose elements represent the distance between two customers measured based on numerical variables. The result is shown as Tab. 6.

② The binary FRs distance measure

There is only one binary FR namely pbfree function. It has only two states: 0 or 1, where 0 means that pbfree function is required and 1 means that it is not required. The simple matching coefficient is adopted. The distance

between customer i and customer v , $d(i,v)_{BINARY}, (\forall i,v = 1,2,...30)$, is presented as a 30×30 matrix and the result is shown as Tab. 7.

Tab. 6 Result of numerical variables distance measure

0	0.076	0.534	.	.	.	0.273	0.296	0.252
0.076	0	0.557	.	.	.	0.197	0.235	0.191
0.534	0.557	0	.	.	.	0.36	0.238	0.282
.
.
.
0.273	0.197	0.36	.	.	.	0	0.114	0.313
0.296	0.235	0.238	.	.	.	0.114	0	0.274
0.252	0.191	0.282	.	.	.	0.313	0.274	0

Tab. 7 The result of binary variables distance measure

0	0	0	.	.	.	0	0	0
0	0	0	.	.	.	0	0	0
0	0	0	.	.	.	0	0	0
.
.
.
0	0	0	.	.	.	0	0	0
0	0	0	.	.	.	0	0	0
0	0	0	.	.	.	0	0	0

7 The nominal FRs distance measure

There is only one nominal FR namely coating. It has three states: Au, Alloy and None. The simple matching approach is adopted to measure the distance of the nominal variables. The distance between customer i and customer v , $d(i,v)_{NOMINAL}, (\forall i,v = 1,2,...30)$, is presented as a 30×30 matrix and the result is shown as Tab. 8.

Tab. 8 The result of nominal variables distance measure

0	0	1	.	.	.	1	0	1
0	0	1	.	.	.	1	0	1
1	1	0	.	.	.	1	0	1
.
.
.
1	1	0	.	.	.	0	0	0
0	0	1	.	.	.	0	0	1
1	1	0	.	.	.	0	1	0

2. Fuzzy Clustering

The similarity matrix is represented as R . The elements in R represent the similarity between every two customers. The result of R is shown as Tab. 9 and the equivalent matrix R^2 is shown as Tab. 10.

Because R^2 doesn't equal to R , the R^2 is not fuzzy equivalent matrix. The algorithm is required to iterate again. The result of R^4 is shown as Tab. 11.

As $R^4 = R$, R^4 is fuzzy equivalent matrix. Setting the threshold l_n as 0.84, the clustering graph is derived. It is shown as Fig. 7. Based on the clustering graph, the customers are clustered into three clusters. That is:

$$l_1 = \{1,2,7,8,11,12,14,15,24,29\},$$

$$l_2 = \{3,4,5,9,10,13,17,19,20,23,26,30\},$$

$$l_3 = \{6,16,18,21,22,25,27,28\}$$

Then the $FRV_{\mu}(j = 1,2,...9; l = 1,2,3)$ are shown in Tab. 12.

Tab. 9 The result of R

1	0.924	0.446	.	.	.	0.71	0.7	0.73
0.924	1	0.42	.	.	.	0.78	0.76	0.79
0.446	0.42	1	.	.	.	0.64	0.74	0.72
.
.
.
0.71	0.78	0.64	.	.	.	1	0.87	0.69
0.7	0.76	0.74	.	.	.	0.87	1	0.71
0.73	0.79	0.72	.	.	.	0.69	0.71	1

Tab. 10 The result of R^2

1	0.7	0.64	.	.	.	0.78	0.84	0.83
0.7	1	0.74	.	.	.	0.83	0.76	0.82
0.64	0.74	1	.	.	.	0.8	0.75	0.85
.
.
.
0.78	0.83	0.8	.	.	.	1	0.86	0.78
0.84	0.76	0.75	.	.	.	0.86	1	0.76
0.83	0.82	0.85	.	.	.	0.78	0.76	1

Tab. 11 The result of R^4

1	0.924	0.446	.	.	.	0.71	0.7	0.73
0.924	1	0.42	.	.	.	0.78	0.76	0.79
0.446	0.42	1	.	.	.	0.64	0.74	0.72
.
.
.
0.71	0.78	0.64	.	.	.	1	0.87	0.69
0.7	0.76	0.74	.	.	.	0.87	1	0.71
0.73	0.79	0.72	.	.	.	0.69	0.71	1

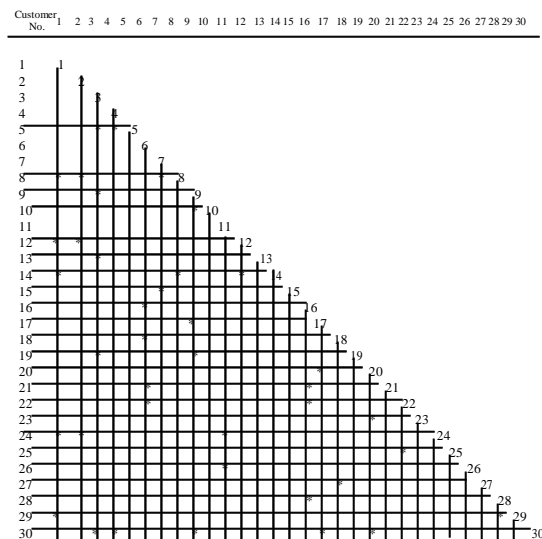


Fig.7. Clustering graph

Tab. 12 List of FR_j and FRV_{jl}

FR_j	FR_j Description	FRV_{jl} (Encoded with jl)	FRV_{jl} Description
FR_1	Current	11	100
		12	78.3
		13	67.5
FR_2	Pbfree	21	Y
FR_3	Length	31	9.2
		32	11.17
		33	10.75
FR_4	Diameter	41	4.5
		42	5.5
		43	5.13
FR_5	Coating	51	Au
		52	Alloy
		53	None
FR_6	Angle	61	44.5
		62	47
		63	42.5
FR_7	Strength	71	6.7
		72	4.5
		73	5.13
FR_8	Weight	81	2.4
		82	2.42
		83	2.38
FR_9	Hardness	91	49
		92	57.5
		93	47.5

4.2.4 Mapping mechanism between CN and FRV

Since the customer requirements CN_{ip_i} and FRV_{jl} ($j = 1,2,...,9; l = 1,2,3$) have been obtained as above, the data list about the CN_{ip_i} and the corresponding FRV_{jl}^i are shown as Tab. 13.

CN_{ip_i} and FRV_{jl}^i are input as identifier-item file which is a text file that lists customers' information which is to be analyzed in identifier-item format.

Each customer has a unique identifier within which are at least two columns, one for the identifier and one for the items.

Tab. 13 The data list of CN_{ip_i} and FRV_{jl}^i

Customer ID	CN_{ip_i} (Represented by CN No)	FRV_{jl}^i (Encoded as jl ⁽ⁱ⁾)
001	1,4,7,8,12,13,14	21 ⁽¹⁾ ,11 ⁽¹⁾ ,31 ⁽¹⁾ ,71 ⁽¹⁾ ,93 ⁽¹⁾ ,63 ⁽¹⁾ ...
002	1,4,7,8,9,12,13	21 ⁽²⁾ ,11 ⁽²⁾ ,31 ⁽²⁾ ,41 ⁽²⁾ ,71 ⁽²⁾ ,51 ⁽²⁾ ...
003	2,5,9,11,13	21 ⁽³⁾ ,12 ⁽³⁾ ,33 ⁽³⁾ ,43 ⁽³⁾ ,73 ⁽³⁾ ,52 ⁽³⁾ ...
.	.	.
.	.	.
.	.	.
028	3,5,9,10,13	21 ⁽²⁸⁾ ,13 ⁽²⁸⁾ ,32 ⁽²⁸⁾ ,42 ⁽²⁸⁾ ,72 ⁽²⁸⁾ ...
029	1,4,7,12,13,14	11 ⁽²⁹⁾ ,31 ⁽²⁹⁾ ,41 ⁽²⁹⁾ ,71 ⁽²⁹⁾ ,51 ⁽²⁹⁾ ...
030	2,5,9,11,13	12 ⁽³⁰⁾ ,21 ⁽³⁰⁾ ,32 ⁽³⁰⁾ ,43 ⁽³⁰⁾ ,52 ⁽³⁰⁾ ...

In this case, the search mode is set as searching for strength, that is, the association rules are generated according to the strength value as a descendent order. The maximum number of association is set to 10000 so that the association rules can be derived completely. The minimum leverage, minimum lift, minimum strength, minimum coverage and minimum support are set as 0.001, 1.0, 0.1, 0.2 and 0.2 respectively. There are 37 rules generated. The results for the associations between CN_{ip_i} and FRV_{jl} ($j = 1,2,...,9; l = 1,2,3$) are partly shown as Tab. 14 (For illustrative simplicity, only 7 rules are listed in the Table).

Tab. 14 Association rules between CN_{ip_i} and FRV_{jl}

Rule 1: green environment\par -> pf_y\par [Coverage=0.882 ; Support=0.882 ; Strength=1.000; Lift=1.13; Leverage=0.1038]
Rule 2: alarmed when can't depend on vibration\par & not easy to lose\par & change the style of the mobilephone occasionally at a lower price\par -> h_57.5\par [Coverage=0.294 ; Support=0.265 ; Strength=0.900; Lift=2.55; Leverage=0.1609]
Rule 3: alarmed when can't depend on vibration\par & change the style of the mobilephone occasionally at a lower price\par & not easy to lose\par -> c_78.3\par [Coverage=0.294 ; Support=0.265 ; Strength=0.900; Lift=2.55; Leverage=0.1609]
Rule 4: alarmed when can't depend on vibration\par & change the style of the mobilephone occasionally at a lower price\par -> l_11.17\par [Coverage=0.294 ; Support=0.265 ; Strength=0.900; Lift=2.55; Leverage=0.1609]
Rule 5: alarmed when can't depend on vibration\par -> h_57.5 [Coverage=0.353 ; Support=0.294 ; Strength=0.833; Lift=2.36; Leverage=0.1696]
Rule 6: not easy to lose\par & alarmed when can't depend on vibration\par -> a_47\par [Coverage=0.294 ; Support=0.265 ; Strength=0.900; Lift=2.55; Leverage=0.1609]
Rule 7: not easy to lose\par & comfortable to hold & change the style of the mobilephone occasionally at a lower price\par -> w_2.42\par [Coverage=0.353 ; Support=0.265 ; Strength=0.750; Lift=1.96; Leverage=0.1298]
.
.
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5. Summary

This paper proposes the ARIS system to facilitate communications between customers, marketers and designers. In evolutionary design, the historical data about the customers' needs and the functional specifications can be used to mine valuable information. The ARIS system can improve design efficiency and quality by providing the clear mapping mechanism between the customers' requirements and product specifications and enabling the design of products based on customers' needs. It also establishes a coherent framework for cooperation among marketers, designers and customers.

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Virtual Supply Chain Management in Hong Kong and China

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Abstract

Intensifying global competitions and rapid advancement of technology have promoted the needs for companies to work collaboratively with their supply chain partners in the form of a virtual enterprise, giving rise to virtual supply chain. However, given the concept was originated from the West, how to promote the application of virtual supply management concept in Asia has become an important issue to be addressed. As Hong Kong and China are leading logistics centers in the world, it is critical to identify their current situations regarding virtual supply chain management and to identify the best ways to direct companies in this region to embrace the highly collaborative Virtual Enterprise. This paper describes the different forms of enterprise collaborations and presents the result of a preliminary study on the current status of supply chain management in Hong Kong and Mainland China.

1. Introduction

Today's business environment is becoming more competitive than ever before and the global competition occurs increasingly between networks of firms [Thoreli, 1986]. Many visionary companies have been increasingly concerned with managing the business processes and activities within and between companies [Hoffner, Field, Grefen & Ludwig 2001] in order to achieve superior supply chain performance. The advancement in information and communication technology further slashes the coordination costs and enables different organizations to build up partnerships where separate firms specialize, and activities are coordinated by decentralized information systems [Strader, Lin & Shaw, 1998]. The mainstream adoption of technologies has blurred the boundaries between business organizations and it gives rise to the virtual enterprise.

Virtual Enterprise (VE) is a single business entity of globally distributed independent enterprises that participate in the different phases of the life cycle of the product or service, and work to share resources, skills, and costs, supported by Information and Communication Technologies (ICT), in order to enhance its customer value proposition and timely create and exploit complex market opportunities [Bernus and Nemes, 1999][V-Chain Project D2.2.]. The term Virtual Enterprise was originated

from a US Congress Report in 1989 on the competitiveness of the US manufacturing sector in this Century [V-Chain Project D2.2]. Strader et al. (1998) claimed virtual organizations could enjoy the agility and speed of small companies and resources of large company, in addition to better adaptation to globalization and better focus of core competence.

Though many enterprises in US and Europe have taken the lead to transform themselves into an integrative enterprise, the success of creating a single enterprise still relies on the harmonious and synergistic integration of all its capitals [Hawa 2002]. Given Hong Kong and China have dominant positions in regional logistics and manufacturing activities and their management cultures are believed to be substantially different from those in the West, it is essential to investigate the current status of supply chain management and to explore how companies in this region can migrate from existing loosely organization to highly collaborative Virtual Enterprise.

2. Collaboration in a Virtual Supply Chain

Being a virtual enterprise, all participating members in the virtual supply chain environment seek to use technology and management collaboratively in order to enhance business operations in relative to speed, agility, real-time control, and customer response [Manthou, Vlachopoulou, & Folinas 2003].

Collaboration can be viewed as the cornerstone of the success in creating a virtual enterprise and it involves two key elements: information sharing and commitment. Moving from traditional supply chains to a collaborative virtual chain networks requires the seamless flow of information amongst supply chain partners, resulting in high degree of information symmetry. Because information is power, information sharing within the supply chain promotes the shift of the power structure to high degree of interdependence. Besides, all participating organizations in the virtual supply chain environment are required to share the capitals with each other, giving rise to higher state of commitment.

3. Different Forms of Enterprises

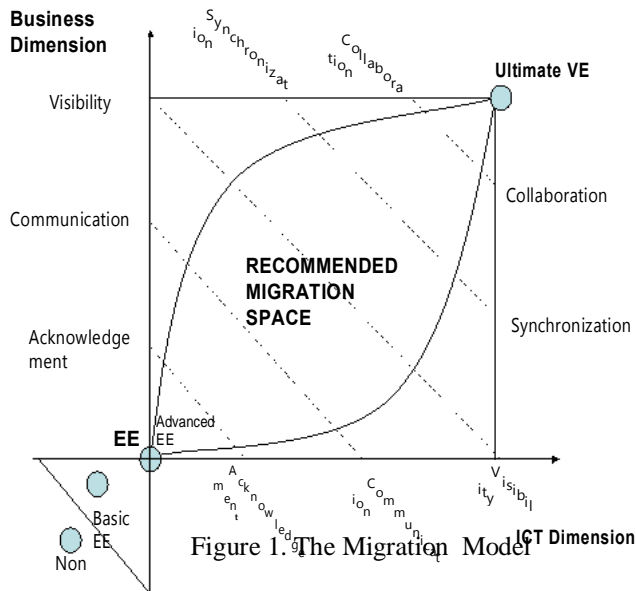
Organizations can be categorized into different forms in the migration journey toward virtual enterprise. Higher

forms of enterprise collaboration start from Extended Enterprises (EE). Extended enterprises span organizational boundaries and possess complicated relationships between a company, its partners, customers, suppliers and market [Browne et al., 1994] [Caskey, 1995]. It is a view of an organization that takes into account of partnership and can be depicted as a globalization of exchanges, subcontracting and partnership [Martinez, 2001]. Member in the extended enterprise is required to co-ordinate its internal systems (intra-organizational activities) with other systems in the supply chain and further needs to be flexible and ready for adapting to changes [Martinez, 2001].

Extended Enterprise (EE) is better characterized as one that embodies varying network of a “dominant” company and its supporting companies (or any type of actors). Meanwhile, a virtual enterprise (VE) is a higher form of extended enterprises that has embraced the notion of inter-enterprise flow in order to sustain the agile and dynamic relationships. Both EE and VE are usually defined as virtual organizations, in contrast to those traditional organizations (called “non-EE”).

4. From Extended to Virtual Enterprise

The obvious challenge to many existing extended enterprises is how to make the successful transition from extended (EE) to virtual enterprise (VE) provided that virtual enterprise is an emergent concept with varying characteristics. According to the Report: From Extended Enterprise to Virtual Enterprise Report [V-Chain Project D2.3], migrations from the extended enterprise to virtual



enterprise will go through five stages: acknowledgement, communication, visibility, synchronization and collaboration. In migrating from EE to VE, companies need to make improve along two dimensions: Information and Communication Technology (ICT) dimension and Business Dimension. These ideas are brought together in

the migration model shown in Fig 1.

Acknowledgment can be considered the fundamental of all transformation. In order for the company to make the migration, the company must believe that VE is the future direction and acknowledge the need for moving towards the VE. This is the first stage of the transformation. This first stage needs the changes in the thinking of management and thus the improvement is mainly along the business dimension. The second stage of the transformation is labeled as **communication**. To reach this stage, the company needs to build the capability to share information and communicate with other trading partners within the supply chain. Therefore, companies mainly need to make improvement along the ICT dimension. Through this stage, companies in the supply chain are transformed from “**the knowledge islands**” to the “**the knowledge highways**”. The third stage of the transformation is called **visibility**, companies need to build trust and decide to share important information with their trading partners. The improvement needed to reach this stage is mainly along the business dimension. Through this stage, companies are transformed from “**the opaque company**” to “**the transparent company**”. The next stage of the transformation is referred to **synchronization**. Through this stage, companies within the supply chain will use the shared information to synchronize different activities through coordination and thus be able to achieve additional cost savings while enhancing service level and improving speed. A good analogy for this transformation is the change from “**the track of a discotheque**” to “**the choreography of a ballet**”. The last stage of the transformation is labelled as **collaboration**. Through this stage of transformation, the relationships between the companies within the supply chain are changed from “**the Win - Lose relationship**” to “**the Win - Win relationship**”. At this stage, companies are collaborating closely to utilize their combined capitals to explore market opportunities and provide better values to the customers. They formulate strategies jointly and share the risks and rewards with the objectives of maximizing the returns for all partners. The combined entity work like a single enterprise and finally the migration to virtual enterprise is completed.

5. Current Status of Supply Chain Management in HK & Mainland China

A field research in manufacturing companies in Pearl River Region (HK and Southern China) was conducted in Spring and Summer, 2003 to investigate the supply chain collaboration and virtual migration in this region. Manufacturing sector is appropriate for this study because based on literature reviews, manufacturing industries are keen to use SCM technology to enhance its business operations. Pearl River Region is a conducive environment where it has over 480,000 factories and 50,000 workers. Most Hong Kong manufacturing firms have moved to Southern China since 1980s. The region

contributes 40% of export values annually to China.

The field research began in Spring 2003. Data were collected through face-to-face interview and a total of 10 Hong Kong companies and 3 Chinese companies were successfully interviewed. Based on the analysis, three categories were identified – they are advanced EE (highly integrated), basic EE (partially integrated) and non-EE (non-integrated). These categories was shown in Fig 2.

Supply Chain Structure – Sharing information & Integrating Process				
	With Customer		With Supplier	
	Information Sharing	Processes Integrated	Information Sharing	Processes Integrated
Category 1	<ul style="list-style-type: none"> Supply Plan, Resultant Inventory, 18 - 24 mth sales plan, cross enterprise mater planning, EDI documents, demand forecast. 	<ul style="list-style-type: none"> VMI program, allow assessment on master sales order status inventory, integrated ordering system 	<ul style="list-style-type: none"> Future ordering plan Plan, Forecast, Production Schedule, purchase order information 	<ul style="list-style-type: none"> VMI program, out standing order status on-hand inventory status, invoice settlement, intranet shared with supplier
Category 2	<ul style="list-style-type: none"> Inventory Demand forecast 	<ul style="list-style-type: none"> Receive Purchase order through system, 	<ul style="list-style-type: none"> Demand forecast 	Upload information for material planning
Category 3	<ul style="list-style-type: none"> Shipment information Monthly Outstanding order 	<ul style="list-style-type: none"> Nil 	<ul style="list-style-type: none"> Demand forecast 	Nil

Figure 2. Key Result of the Survey

Our findings showed that most responding companies in category 1 are Multinational Corporations (MNCs). Hong Kong and Chinese owned manufacturers tend to belong to category 2 while companies at category 3 are mainly Chinese-based. Since MNCs have more resources and are more receptive to the ideas of information sharing and coordination due to the influence of their parents, these companies have higher level of information sharing and coordination with their suppliers and customers and they are closer to the VE. Meanwhile, Chinese companies are less receptive to information sharing and coordination and this they have lower degree of information sharing and coordination in the supply chain. Because the central theme of virtual supply chain is collaboration, it is therefore recommended the Hong Kong and Chinese managers to focus on developing trust and building relationships with their partners so that they can share more information with each other. With the shared information, they can also coordinate many activities with each other. These types of information sharing and coordination activities are fundamental requirements for moving towards the VE. Furthermore, companies also need to enhance their information systems so that they can link up with their suppliers and customers. The IT

infrastructure is also an essential for moving to the VE state.

6. Conclusions

The results of our preliminary study has shown that most companies in Hong Kong and Mainland China have not adopted the concept of virtual enterprise management. Migration from the current status to the Virtual Enterprise is a long journey for these companies. Companies need to carefully plan out the steps that they will have to take to migrate to the VE state. Though this subject has drawn enough attention from both academicians and industry players, virtual enterprise should not be considered as cure-for-all. Managers with the vision to embrace the adoption of virtual enterprises may follow the suggested path to migrate from the current state to the VE state. However, some companies may choose not to go through this path and decide to enhance the performance of their supply chain through other means.

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Intelligent Optimisation Agents in Supply Networks

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Abstract

This paper describes a model of intelligent supply network that improves efficiency within the supply chain. We argue that intelligence creates efficiency and results in chain optimisation. In particular, intelligent agents technology is used to optimise performance of a beverage logistics network. Optimisation agents can help solve specific problems of supply network: reduce inventories and lessen bullwhip effect, improve communication, and enable chain coordination without adverse risk sharing. We model the beer supply network to demonstrate that products can acquire intelligence to direct themselves throughout the distribution network. Further, they gain a capability to be purchased and sold while in transit. Overviews of the supporting technologies that make intelligent supply network a reality are fully discussed. In particular, optimisation agents have the characteristics of autonomous action, being proactive, reactive, and able to communicate. We demonstrate that agents enhance the flexibility, information visibility, and efficiency of the supply chain management. Suggestions and recommendations for further research are provided.

1. Introduction

This paper presents the design of a new intelligent software system that integrates information systems developed for relationships between enterprises and the final consumer (Business to Consumer or B2C) and between suppliers (Business to Business or B2B). The proposed theoretical model uses Agent Technology and will assist both the producing firm and the customer to look automatically for an increase in the data exchange rate.

Agent technology has successfully been used in the past for in managing business processes, as described in ADEPT (Advanced Decision Environment for Process Tasks) from Jennings [10]. Based on the functionality of decision making from the company managers, the business process involves a combination of judgement and information from marketing, sales, research, development, and manufacturing and finance departments. Ideally all relevant information should be brought together before judgement is exercised. The ADEPT solves problems related to this process by

viewing it as a community of negotiating, service-providing agents. Each agent represents a distinct role or department and is capable of providing one or more services.

Within this paper the term 'agent' corresponds to the software problem-solving entities, which are situated in a particular environment, with specified functions, in order to process the inputs received related to the problem domain. The agents have the ability to control their internal state and their behaviour, to exhibit flexible problem-solving techniques in pursuit of their design objectives. The intelligent agent software system is designed to fulfil the specific purpose of analysing the information about the customers that is available currently at the retailers' databases.

Usually each software agent is a different specialist, able to accomplish certain tasks, thus providing co-operative members in a society. In this work, the scenario of knowledge co-operation on our study based on [10] will illustrate how certain components (i.e. supply agents) can be monitored from a multi-agent software system, by using intelligent specialized software agents, which will simulate the procedure of data analysis to extract useful information for the relationships between commercial partners [19]. The key aspects of this work, based on the previous research in the field [4], are:

- The identification of possible market relationships has been mapped to a 'communication' problem where different kinds of agents seek to exchange messages to satisfy and interpret data on an on-line basis.
- The agents are autonomous entities and they either work on their own or co-operate with others.
- Every aspect of the scheduling process (from initial data acquisition to the relationships' interpretation) must be available to the user, in order to understand the internal process of the software.

This study illustrates how agent technology can be used to solve real supply chain inefficiencies and optimise the logistics network. For instance, we explain how companies can use agent technology to collect data from retailers, group them into meaningful categories, and then perform different functions. As a result, the distribution chain can be managed more efficiently. Intelligent agents also make available timely data to inventory management resulting in reducing stocks and

tied capital. Intelligent agents are adoptive to changes so they are valuable in a dynamic environment where new products or partners have entered into the supply network. This flexibility gives agent technology a relative advantage which, for pioneer companies, can be a competitive advantage. The study concludes with recommendations and directions for further research.

The following sections of this paper describe intelligent agent technology, and discuss the need to re-engineer the supply network in association of technical needs and the solution of the agent-based information system is analysed. chain optimisation & re-engineering. A multi-agent architecture is described at a subsequent section and the paper concludes with recommendations and directions for future research.

2. Intelligent Agent Technology

“An intelligent agent is an encapsulated computer system that is situated in some environment, and that is capable of flexible and autonomous action in that environment in order to meet its design objectives” [22]. Agent technology has successfully been used in the past for in managing business processes, as described in ADEPT (Advanced Decision Environment for Process Tasks) [10]. Based on the functionality of decision making from the company managers, the business process involves a combination of judgment and information from marketing, sales, research, development, and manufacturing and finance departments. Ideally all relevant information should be brought together before judgment is exercised. The ADEPT solves problems related to this process by viewing it as a community of negotiating, service-providing agents. Each agent represents a distinct role or department and is capable of providing one or more services.

Within this paper the term 'agent' corresponds to the software problem-solving entities, which are situated in a particular environment, with specified functions, in order to process the inputs received related to the problem domain. The agents have the ability to control their internal state and their behaviour, to exhibit flexible problem-solving techniques in pursuit of their design objectives. The intelligent agent software system is designed to fulfil the specific purpose of analysing the information about the customers that is available currently at the retailers' databases.

In a more general way as in [22], the term 'agent' can be used, as a software-based computer system, which has the properties:

- **Autonomy:** It means simply that an agent is a computer system, which is situated in some environment, and it is able to act without the intervention of humans (or other agents), and should have control over its own actions and internal state and have some kind of control over their actions and internal state.

- **Social ability:** Agents can interact with other agents (or humans) via agent communication language (ACL).
- **Reactivity:** agents perceive their environment and respond in a timely fashion to changes that occur in it.
- **Pro-activeness:** Agents do not simply act in their environment, but they can also take initiatives. The application domain of applying agent technology is crucial as we always have to balance between risk and trust when working with software-based systems.

Usually each software agent is a different specialist, able to accomplish certain tasks, thus providing co-operative members in a society. In this work, the scenario of knowledge co-operation will illustrate how certain components (i.e. chain requirements) can be monitored from a multi-agent software system, by using intelligent specialised software agents, which will simulate the procedure of data analysis to extract useful information for the logistics network and send the appropriate messages to each level as described in the next section.

The general architecture of each individual intelligent software agent, as shown in Figure 1 includes the body, head and the communication abilities (grey box). The body contains all the centralised processes, tasks given to each agent to accomplish which can be different, depending on their role. The head includes the information provided either from the user or the other software agents and the grey box includes all the functions required in order for the agents to be able to communicate and as a result co-operate with other members of the agent society. This successful combination of several autonomous intelligent agents working together is called multi-agent systems.

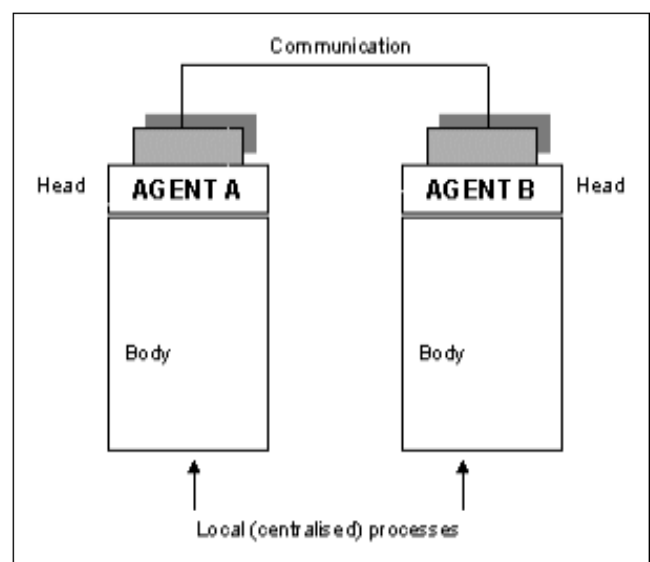


Figure 1: Intelligent Agents

3. Chain Optimisation via Intelligent Agents Technology

A large array of software applications for planning and optimizing performance of supply chain is currently on market. These applications include Materials Requirement Planning (MRP), Manufacturing Resources Planning (MRPII), Enterprise Resource Planning (ERP), and Advanced Planning and Scheduling (APS). Most of these applications are focused internally within an enterprise. Inter-organisational communication is usually effected by mail, phone, fax, email, or electronic data interchange (EDI). However, EDI systems are expensive for small and medium enterprises. As a result, information flow in supply chain is normally pipelined sequentially, paused to each chain echelon, while human intervention imposes costs, delays, and errors.

The advent of the Internet has led to the emergence of new business models. Companies can now collaborate closely with all partners in the supply network. Collaboration can take place in different levels: share forecasts, manage inventories, schedule labour, or optimize deliveries. Software for Business Process Optimization (BPO) and Collaborative Planning, Forecasting and Replenishment (CPFR), is correspondingly evolving to optimise end-to-end supply networks.

Agents technology has been usefully used in automated electronic third party mediation (or brokering) mechanisms in various commerce transactions and marketplaces [18]. Agent brokers can be a non-obstructive, external dimension of existing buyer-seller relations and may only serve as a go-between and gatherer of pricing information, other service provider. Neubert et al. propose an intelligent negotiation agent, capable to assist human decision-maker supply contract negotiations, thus resolving conflict through the harmonisation of individual interests [14]. Vulkan and Jennings found that autonomous, automated agents give promising results in auction negotiations of the supply of services within the context of a BT British Telecom project [21].

Nissen explored the application of agents technology in supply chain integration of a medium-sized US government facility and found that it may have better results than web-based supply chain technologies [15]. Kimbrough et al. simulated the Beer Game having artificial agents instead of human to manage an electronic supply chain [11]. They found that agents were able to track demand, eliminate the Bullwhip effect, discover the optimal policies (where they are known), find optimal policies under complex scenarios, and add adoptability of the supply chain to business environment fluctuations. Gerber et al. presented an agent-based information and trading network (ITN) for dynamic production and sales of timber and found that simulated trading mechanism as well as matrix auction mechanisms were especially suitable for supply web co-ordination and optimization tasks [8].

4. Re-engineering supply chain using intelligent agents' technology

The main concepts of this work appear to be similar with the main concepts of the multi-agent-based technology introduced by Ferber [5]. The key aspects of this, based on the previous discussions concerning the nature of the problem are:

- The identification of certain relationships within an electronic marketplace has been mapped to a 'communication' problem where different kinds of agents seek to exchange messages to satisfy and interpret data on an on-line basis.
- The agents are autonomous entities and they either work on their own or co-operate with others under certain conditions and based on certain relationships.

The philosophy of this work is based on a dynamic multi-agent software system, which employs communication skills, with decision-making functions for data interpretation in supply chain management. The information environment within any large organisation is extremely complex. Describing who holds what information, how it is used and from where, how it can be better interpreted to derive meaningful conclusions, are very complex tasks but their importance has been accepted from all the companies in the market. Systems that can help aid the process of data interpretation and recognition of the types of information within a retailer and its value in relation to the supply chain management are therefore extremely important. In order to explore the importance of the multi-agent system development, a theoretical framework is being proposed. Specialised software agents will be able to automatically process the data and give information about the different levels of the supply network, based on certain attributes (i.e. cost, quality, safety, trace-ability, competitive advantage etc.). These will be the results from identification of the main characteristics of a well-managed process:

- Defined ownership
- Defined boundaries of each level within the chain
- Defined flow of information between the different levels
- Established control points within the whole marketplace
- Established measurements

The proposed software system overcomes today's problems, as it supports the use of more than one computational intelligence technique through agents' technology. The key function is the application area of interpretation of the available data. Considering a software system responsible for data interpretation, there can be distinguished a number of interesting characteristics as shown in Figure 2:

- The process is distributed. There can be distinguished a number of autonomous processes (data gathering from retailers, data grouping etc.), which interact with each other to end up with a meaningful conclusion.

- The distributed problem domain denotes the development of a hierarchical layered software system, which results in the construction of a structured society of agents, with different groups, each one specialised and with different functionality.
- The software system as a whole has to be easily maintained, as new agents might be included, if new products or manufacturers have entered the market.
- Finally, the requirements of such an automatic system for data interpretation in marketing are high, as it deals within a dynamic environment, where any change is possible, and the system has to be accurate.

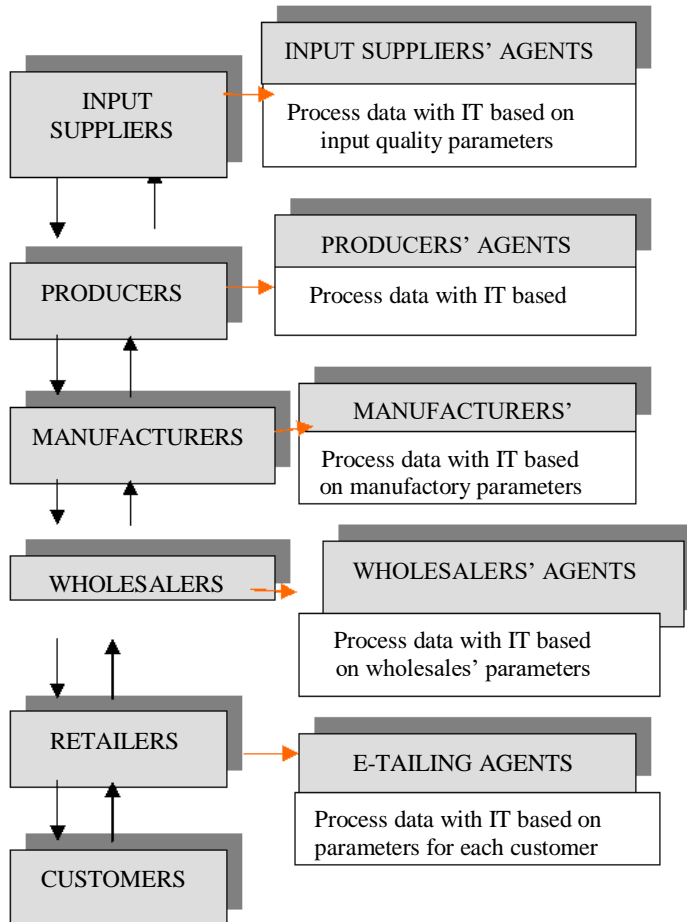


Figure 2: E-marketplace towards a multi-agent system for supply chain management

The novel idea of this framework is the construction of an agent society, in groups, based on the hierarchical reasoning during the interpretation procedure, which benefits from the agent technology in terms of decentralisation of execution, decentralisation of control and existence of co-operation. Every software component within a multi agent system has to carry out problem solving actions in order to achieve its goals. When acting on their own, their functionality determines the right actions to perform in certain situations. Within a multi-agent system though it has to consider the actions of the other software components as well, based on the principle of social rationality as given in [9]: “Within an agent-

based society, if a socially rational agent can perform an action so that agents’ joint benefit is greater than their joint loss then it may select that action”.

Based on that the expected utility of an action is given from the equation:

$$EU(a) = f(IU(a), SU(a))$$

where $EU(a)$ is the expected utility of an action “a”, which is given from the combination (based on some function f , depending on the application) of the individual utility (IU) and the social utility (SU). It means that in order for an agent to perform an action it has to consider both its own and the society’s loss (or gain). Rationality refers to the successful performance of an action. The only assumption within this theory is that the intelligent agent requires complete information and sufficient time to carry out the necessary reasoning.

The whole procedure of communication between these different kinds of agents also offers at the end the positive result of improved interpretation, a flexible architecture and adaptability.

5. Communication

In order that agents achieve their goal, they have to communicate their knowledge, which can be accomplished through the Agent Communication Languages (ACL) in a standardised way, by using communication protocols including TCP/IP, SMTP and HTTP to exchange any type of knowledge needed.

The best known ACL is that of the DARPA knowledge sharing effort, which led to the successful development of the Knowledge Query Manipulation Language (KQML) [6] and the Knowledge Interchange Format (KIF) [7]. Much research is being performed by the Foundation for Intelligent Physical Agents (FIPA), an international body that aims to set general standards for agent interoperability. FIPA have defined an ACL (FIPA ACL), which includes basic communicative actions (such as inform, request, propose and accept) together with a number of interaction protocols including the contract-net protocol.

In distributed multi-agent systems the agents themselves may be transmitted across a computer network and executed remotely. Such agents are called mobile agents. In these architectures the agent software is transmitted to the host computer, the data are processed and the final result is communicated back.

5.1.KQML

KQML is both a message format and a message-handling protocol to support run-time knowledge sharing among agents for co-operative problem solving. It employs a layered architecture of communication, where at the bottom the functionality for message transport or communication occurs and at the top the content is specified by the application. Consequently, it provides the agent designers with a standard syntax for messages, and a number of performatives that define the force of a message, while letting them decide the content of the messages. Examples of performatives include tell, inform, perform, reply and each one is associated with a

set of parameters indicated by “:”. The inspiration for these message types comes largely from speech act theory, in order to cope with problems associated with large-scale knowledge bases, which are sharable and reusable.

The performatives support the development of higher-level models of inter-agent interaction such as contract nets and negotiation. KQML provides a basic architecture for knowledge sharing and the underlying communication is asynchronous, because it assumes the message transport is reliable and preserves the order of messages, but may not guarantee delivery always.

5.2.KIF

Apart from the communication language, agents need to have an understanding and parse the content of the messages they receive. This is facilitated by Knowledge Interchange Format (KIF), which provides a syntax for message content, which is essentially first order predicate calculus with declarative semantics. This empowers the agents to understand the meaning of expressions in the representation without the help of an interpreter for manipulating those expressions. KIF is logically comprehensive, as it includes mechanisms to support the expression of arbitrary sentences in first-order predicate calculus. It also provides methods for the representation of knowledge about the representation of knowledge (meta-knowledge) and plays the role of mediator for declarative knowledge bases and knowledge representation languages (i.e. PROLOG, LISP and XML). The language description includes both a specification for its syntax and one for its semantics. For example, in order for an agent to reason based on salaries of different employees it needs to have knowledge of the employees’ id, the department they are working for and the amount of their salary:

(salary ?id ?department ?salary)

and the representation of the agent’s interest in different salaries:

(interested agent (salary ?x ?y ?z))

5.3.Ontology

Based on the domain experts’ reasoning for solving complex problems, the requirement for a domain specific vocabulary has been identified, as traditional representation languages are domain independent. Ontologies have been developed in order to provide a domain specific vocabulary for inter-agent communication. In the context of knowledge sharing the term “ontology” is used as a description of the concepts and relationships that can exist for an agent or a group of agents in a defined set of formal vocabulary. This means that in order for the agents to communicate in an efficient way, they have to use a formal context of knowledge representation so that they infer the same meaning for the same concepts referenced. The set of objects and the relationships between them are represented in a logical formalism of a vocabulary. There are certain definitions associated with the names of the different entities within the problem domain (types of entities, their attributes and

their properties, the entities’ relations and functions and any of their possible constraints) in a human readable text describing what these names mean and certain axioms that constrain their interpretation. In a multi-agent system the agents share the same vocabulary, but this doesn’t mean that they share a knowledge base. Each agent might have different knowledge to that of the others, but a shared vocabulary is essential in order to achieve their communication in a coherent and consistent manner.

6. Multi-agents architecture for chain optimisation

This section introduces the novel idea of a hierarchical decentralised multi-agent architecture developed for data interpretation and monitoring supply chain management. It employs different groups of intelligent agents to cope with the variety of application functions by using distributed problem solving. The design and functionality of the diversity of agents, along with the key issues behind the multi-agent system as a whole, are described.

The establishment of the application requirements has firstly to be considered before the software development. During the analysis of the supply chain management process, there are a number of functions specified, which indicate the need for heterogeneous groups of autonomous software entities as described in the previous section. In order to avoid any complexity issues concerning the development of the multi-agent system, the problem has been viewed from a high level of abstraction at the first stage, which as a consequence will lead to the individual agents’ specification and functionality.

The role modelling procedure is similar to the one of the GAIA methodology [22], according to which abstract roles are identified. In each one there might be other sub-roles defined depending on the specified application. As a consequence, during the design process, the roles and interactions between all the agents are identified and will be used to implement the multi agent system for supply chain management.

Within the supply chain management, the agents can be used to monitor the business units or facilities that purchase the raw material, and how these can be converted into intermediate goods and final products, which then are being delivered to the customers. The supply chain then can be efficiently co-ordinated, to ensure that the products pass through the chain in the shortest time and at the lowest cost, as agents can be used for sharing information on the network of different companies and negotiate about product prices [20].

For reasons of brevity we omit the details of the described case study and focus on the analysis and design of the software components instead. The particular application is providing customers with certain quantities of beverages. This activity involves the understanding of the system’s organisation, while viewing it as a collection of roles that stand in certain relationships to one another

and have certain interaction patterns. Figure 3 denotes the architecture of a multi-agent system for the supply chain for beverages, where the interaction between certain type of agents is predefined and the users depending on their profile have access to certain information at any time.

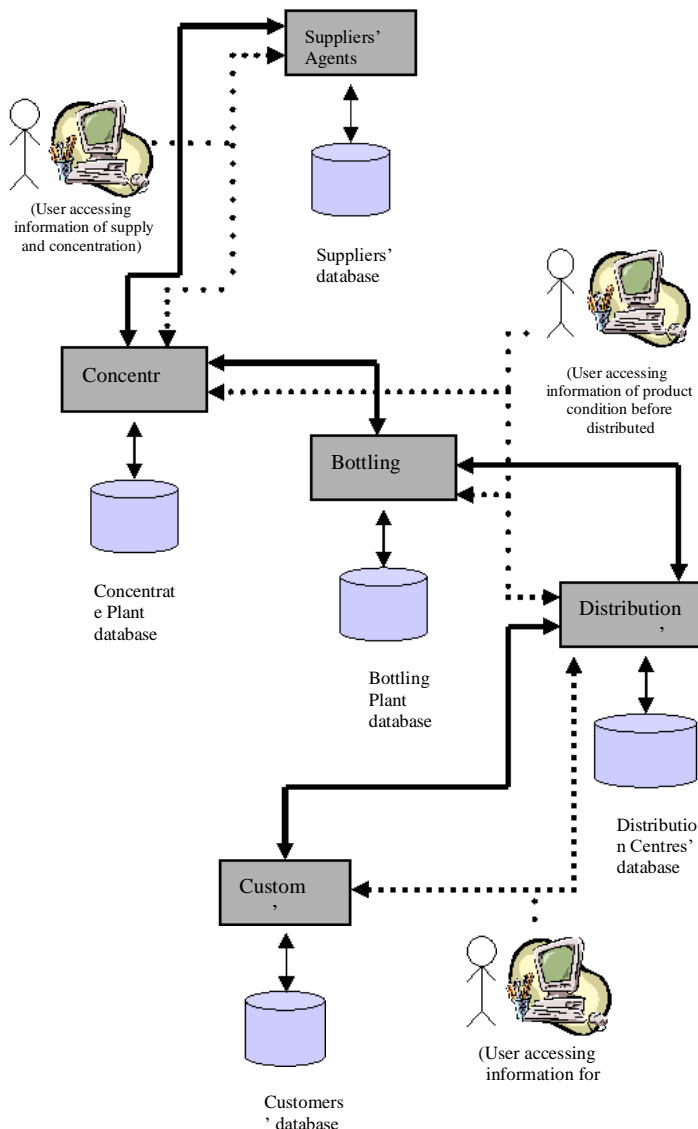


Figure 3: Agent-based supply network

Table 1 illustrates the key roles for a supply chain management multi-agent system and how these are used within the specific supply chain for beverages. The different protocol activities, permissions and responsibilities associated with each role are given, which will assist the different software components to achieve the mission of the logistics, which is to get the right goods or services to the right place and the right desired time and the right condition, while making the greatest contribution to the firm. At the same time the intelligent agents' functionality will provide one more advantage, which is to deliver the right information to the right user the right time.

Table 1: Schemata for agent roles

Role Schema: InputSupplier	
Description: Receives quote request from the producers' agents and ensures that the appropriate input quote is sent.	
Protocol and Activities: WaitForRequest, CheckQuote, InformSupplier	
Permissions:	
read incomingRequest	supplierInput
Responsibilities:	
Trust, Negotiation with supplier	
Role Schema: Producer	
Description: Receives quote request from the manufacturers' agents (Concentration Plants in our case study) and ensures that the appropriate quote is sent to the input suppliers.	
Protocol and Activities: WaitForRequest, CheckQuote, InformProducer	
Permissions:	
read incomingRequest	manufacturersInput
Responsibilities:	
Trust, Negotiation with producers	
Role Schema: Manufacturers	
Description: Receives quote request from the wholesalers and ensures that the appropriate information is sent to the producers.	
Protocol and Activities: WaitForRequest, CheckQuote, InformManufacturers	
Permissions:	
read incomingRequest	producersInput
Responsibilities:	
Trust, Negotiation with manufacturers	
Role Schema: E-tailing	
Description: Receives quote request from the customers electronically and ensures that the appropriate quote is sent to the manufacturers.	
Protocol and Activities: WaitForRequest, CheckQuote, InformDistributors, InformCustomers	
Permissions:	
read customersInput	distributorsInput incomingRequest
Responsibilities:	
Trust, Negotiation with distributors	

An example of an agents' dialogue, based on the different roles and the given ontologies is illustrated in Table 2, where a customer posts its order and two different distributors reply. At the end the customer's agent will select the distributor with the best price and time delivery. This can be specified by evaluation functions, predefined within the agents' knowledge. Based on the latter mentioned roles, the software system will be able to monitor on-line the supply chain management of beverages, which can be on-line evaluated based on the Inventory Model.

7. Discussion

There are great general benefits and savings to be gained by the use of intelligent agents for supply chain management. Initially, optimisation agents can be the building block of a correct designed simulation for an accurate representation of a supply system. The monitored supply chain can be driven temporarily beyond its maximum capacity through the knowledge of the multi agent system based on the behavior of the different layers of the supply network. Additionally the efficiency of the supply chain may be increased through the elimination of unexpected mistakes. Potential supply errors will be identified while they are still in the incipient stages.

Table 2: Example of KQML dialogue for MAS

```
Dialogue:
(orderFromCustomer
  : sender CustomerA
  : language KQML: ontology E-tailingForBeverages
  : content
    (stream-about
      : language KIF : ontology beer
      : content c1
    ))
(replyToOrder
  : sender DistributorX : receiver CustomerA
  : reply-with d1
  : content
    (stream-about
      : language KIF : ontology beerDistibution
    ))
(replyToOrder
  : sender DistributorY : receiver CustomerA
  : reply-with d2
  : content
    (stream-about
      : language KIF : ontology beerDistibution
    ))
(tell
  : sender DistributorX : receiver CustomerA
  : in-reply-to c1 : content (= (beer 500) (deliver
15.00)))
(tell
  : sender DistributorY : receiver CustomerA
  : in-reply-to c1 : content (= (beer 400) (deliver
16.00)))
```

While not directly preventing the occurrence of the system error, the unexpected element of a mistake may be eliminated and the supply can succeed with minimum losses at each layer of the chain. Some of the main contributions of the system proposed in this paper include:

- **Flexibility:** Agents technology can be non-obstructive of existing buyer-seller relationships. Trust, mostly the lack of it, has been repeatedly found to moderate of buyer-seller relationships [2] [12] [17] [16]. Typically, the application of Information Technologies alters the trade relations. Empirical studies suggest that

powerful partners take advantage of IT technologies to gain more power or impose their strategy to smaller partners. However, IT applications don't necessarily have to be obstructive in order to be effective. For example, Bakos and Dellarocas describe online reputation mechanisms as an emerging alternative to more established mechanisms for promoting trust and cooperative behaviour, such as legally enforceable contracts [1]. Das and Malek, who defined supply chain flexibility as the robustness of the buyer-supplier relationship under changing supply conditions, found that order quantities and supply lead-times are the two most common factors associated to flexibility [3]. Intelligent agents can manage orders effectively and reduce lead times thus the flexibility of the chain increases. These advantages are attributed to the following abilities of the multi-agent system:

- ¾ The analysis and design of the layered architecture has been defined and the different roles of groups of intelligent agents have been specified to map the procedure of supply chain management.
- ¾ The advanced web-based graphical user interface called the Supply Assistant Agent (SAA) will assist the users of the software depending on their user profiles to view certain information of the system and to control and if necessary interfere by sending the appropriate message to the intelligent agents of certain layers.
- ¾ A number of different intelligent agents will be able to derive information relating to the state of a product, within the supply chain from measurement data and from communication with the user and between different layers of the supply chain.
- ¾ The multi-agent system will be easily extensible due to its object-oriented design and development, which also means that it can be reused for different kind of supply chains.
- **Information visibility:** visibility of appropriate information into a distribution network is necessary in order to optimize scheduling and planning costs. Information visibility means having the right data at the right time. As a consequence, the success of any technological improvement depends on delivering information visibility into the system. Agents' technology has this advantage of having access to the different layers of information, even in cases where information has been processed from different techniques.
- **Efficiency:** Forestalling the Bullwhip effect fire-fights the explosion of many supply problems such as: excessive inventory, severe delays, poor product forecasts, unbalanced capacities, poor customer service, uncertain production plans, high backlog costs, and lost sales.

Despite the obvious advantages, there are a number of issues to be considered associated with the analysis and design of such a software system at the operational,

tactical and strategic level. We found that (a) there are data-related concerns at the operational level. Data & information sources need identification and filtering prior to processing. Problems we expect to find here are incomplete or missing data, data handling difficulties, or unreliable and inaccurate data sources. Specified security mechanisms have to be predefined as well, so that different end users have access to specific information. (b) Process-related concerns at the tactical level. In particular, process complexity, which is the speed of negotiation among the agents and the distribution of functionality to the different layer of software components, has to be specified. (c) Partner-related concerns at the strategic level. Partners should be willing to share information at tactical and operational level. Although a minimum level of trust should be expected, using optimisation agents, it is not prerequisite for business partners to share or expose strategic information (i.e. demand forecasts).

Additionally, a number of issues should be taken into account, during the software development that are of high importance for future research within the area of intelligent agents' application in supply management:

- Trust: in a web-based marketplace, it might be difficult for consumers and producers to know who is reliable and secure.
- Privacy and Security: there must be predefined access to certain type of users to certain information and there is a high concern from the consumers and producers of the security of their personal information when using e-commerce systems
- Billing/Revenue: there are no billing mechanisms so far developed for similar applications and it must be implemented over the basic web structure
- Reliability: data and connections must be reliable and with predictable performance.

It should be emphasised that agent-based systems are not a panacea for solving every type of problem. They suffer from all the problems associated with the process of gathering human expertise and converting it into a reusable knowledge base. However, the MAS development has proved to be efficient, especially in cases where there is an environment that changes over time, different distributed processes need to take place, and their results need to be correlated, like this one of supply chain management.

Future research should aim to quantify the advantages of agent technology as discussed above. We suggest the simulation of the optimisation agents effect on beverages supply network, measuring and comparing specific indicators such as inventory level, distribution costs, total logistics cost savings, life cycle time, etc. Optimisation agents can be used in supply networks with time, cost, and efficiency as critical elements. In this respect, optimisation agents can be successfully applied to sectors such as electronics and machinery, including agricultural machinery.

8. References

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