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A Position Model in Evaluating the Levels of Information Technology Adoption for SMEs in the Business Network

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Abstract

Information Technology (IT) is computer application and infrastructure that leverage intra and inter firm process and systems integration [Pant and Ravichandran, 2001]. There are many solutions provided by vendors and different levels of implementations for firms to adopt. Nevertheless, few strategic decision making and categorising models have been developed for managers and industrial practitioners. Based on previous literature, this research is designed to propose a level of IT adoption model by categorising factors. With the empirical data of Taiwanese Small and Medium Enterprises (SMEs), the authors discuss the proposed model in terms of its applicability, limitation, and future research. Moreover, factors such as business network positions and firm sizes are drawn in to enhance current researches on Supply Chain Integration and B2B eCommerce implementation.

Keywords

Levels of IT adoption, B2B eCommerce, Business Network, Supply Chain Integration, and SMEs.

1. INTRODUCTION

The adoption of information technology (IT) has often been cited as a significant factor in sustaining competitive advantage [Ferratt, et al., 1996; Loebbecke & Powell, 1998]. Motivations for firms adopting IT include improvement of efficiencies, protecting market share, assisting in innovative activities, and increasing productivity and profitability. The

usage of IT is also a key dependent variable in Information Systems (IS) research [DeLong & McLean, 1992] and many of its studies have shown empirically the determinants [e.g., Adams et al, 1992, Davis, 1989&1993, Mathiesons, 1991].

For IT adoption and its impact, several models have been developed in the past. Most research concentrate in IT adoption at certain levels, sectors, or groups. For examples, Daniel and Wilson [2002] have compared the intension and benefits of eCommerce adoption by SMEs in the UK; Coombs at al [1999] survey the three areas of best practice of adoption, level of organisational impact, and performance of the system; Karahanna et al [1999], study the pre-adoption and post-adoption of IT process and conclude that the belief and attitude of IT usage and benefits are limited. Also, researches on the technology acceptance model (TAM) [Davis et al, 1989; Venkatesh and Davis, 1996] also developed to further strength a complete idea of IT usage [Taylor & Todd, 1995]. Following this stream, there are more empirical data to support TAM [e.g. Chau, 1996; Hu et al 1999, Keil et al, 1995] and critical reviews about why to use IT [Legris et al, 2003].

It is difficult to evaluate what direct impact and benefits the adoption of IT has on business performance. The performance of a business is a complex result originating from many varying influences brought about by internal effort and changing business surroundings. Within certain types of IT adoption, researchers have recently noticed the adoption levels, impacts, and factors associated with its decision makings [Sohn & Wang, 1998]. Similarly, Mehrtens et al [2001] note the level of IT use in the organisation is a part of organisational readiness, which is also a very important factor of IT adoption in recent studies. More research findings can be seen by Iacovou et al [1995]'s Electronic Data Interchange (EDI) adoption by SMEs, Sohn and Wang [1998]'s adoption levels of Internet Market for computer retailing companies, and Daniel and Wilson [2002]'s eCommerce adoption in British SMEs which differentiate intentions and benefits affecting the level of the IT utilisation.

Comparing large firms which have greater resources, SMEs are sometimes struggling with survivals rather than peacefully planning long-term strategies. It results in the caution and conservativeness of investment activities. Based on the previous literatures, this research is aimed to propose a model of IT adoption levels by categorising factors. With the analyses of empirical data of Taiwanese Small and Medium Enterprises (SMEs), the authors further discuss the proposed model in its applicability, limitation, and suggestions for future researches. Moreover, factors such as business network positions and firm sizes are drawn in to enhance current researches on Supply Chain Integration and B2B eCommerce implementation.

2. RESEARCH INITIATIVES

With their relatively small scale, SMEs are significantly affected by overall economic environment. In Taiwan, most firms are SMEs. There are 1,078 million SMEs, 98.18% of the total numbers of firms. Between them, they have 7.4 million employees, and account for 77.67% of the total work force (*Small and Medium Enterprises White Pages 2000, the Ministry of Economic Affairs, Taiwan*). Those SMEs have their own business networks and vertical integration channels that rely on supply chain management to cooperate with suppliers, buyers, and collaborative manufacturers so as to integrate their resources and gain competitive advantages. Nevertheless, many of them recently face fierce competitions from the neighbouring countries such as Mainland China, Singapore, Malaysia, and South Korea, especially after joining WTO. Some of these countries have cheaper labour forces and the rest have good product quality and advanced technologies. Added to this are the problems of reduced overseas orders and investment associated with worldwide economic recession.

2-1 Barriers of SMEs in Information Technology Adoption

To meet the new challenges, SMEs, given their scant resources, will need to form strategic alliance and gain competitiveness through IT adoption. Their problems represent an attractive market. Hence, Application Service Providers such as IBM, Epson, and HP in Taiwan have targeted this market since 2000. From a government survey data in Taiwanese SMEs by the Ministry of Economic Affairs, Small and Medium Enterprises Administration (see Table 1), shows that SMEs need more help in computer-based management and eCommerce (which stand for 45.04%) than the rest.

Table 1: Survey of SMEs’ Needs for guidance from government

Needs for Government Guidance	Numbers	Percentage	
Computer-based Management	843	27.82	} 45.04%
ECommerce	522	17.22	
General Management	1043	34.42	
Financing & Business Loan	476	15.7	
Quality Improvement	57	1.88	
Assisting Strategic Alliances	89	2.93	

Sources: Ministry of Economic Affairs, Small and Medium Enterprises Administration, Taiwan
 Surveying period: 1/7/2002 ~ 31/12/02

From the two sources above, it is clear that SMEs do face certain difficulties in adopting IT compared with large firms. They are as following:

- 1) Huge sunk costs need to be invested. Unless used for reducing transaction cost only, IT adoption such as B2B eCommerce might not be able to help SMEs to establish brand name in the e-marketplace. They still need to spend money to build up reputations like other large firms.
- 2) IT adoption can increase the efficiency of business processes. Nevertheless, it raises the performance requirements of the physical business processes such as distribution, inventory control, and other after sales service. Once higher level of IT investment had been implemented, SMEs might not have the capabilities to fulfil these requirements compared to large firms or core firms in the business networks [Wang & Heng, 2002a].
- 3) SMEs have less resources and funds to invest in related information systems. For SMEs have fewer resources to train their staffs or recruit people to implement it, they eventually find it difficult to install and upgrade the information systems needed to link up with large firms.
- 4) SMEs are unwilling to share their internal information while larger firms normally differentiate confidential and public information carefully. This would discourage SMEs from constructing some IT infrastructures such as Electronic Data Interchange (EDI) and Business-to-Business Integration (B2Bi), which have potentials to leak unsecured information. This matter is of grave concern to many small firms because they may only possess a few key business processes or products as their competitive advantages.
- 5) There are more varieties of databases, platforms and applications among SMEs. It results in lack of standard interfaces and information formats which are needed to avoid data redundancy and system errors. It also indicates that the internal information systems development in SMEs varies, which may affect the absorptive capabilities [Cohen & Levithal 1990] for B2B processes.
- 6) From business network point of view, linkages among SMEs are not in stable collaborative mode. SMEs are pragmatists [Liu & Brookfield, 2000] and they shy away from new investment of interorganisational systems especially when there is not short-term return of investment. Besides, core firms and the business network members (SMEs) might not have similar appreciation of the same level of IT adoption to implement B2Bi or collaborative commerce since the switching costs and business opportunities in the network centre and its edge may be different. Though SMEs have less resources and capabilities, they are more flexible in terms of their core competency – they are more prepared to change their product line, business process, or other partners.

IT systems providers have struggled to penetrate SMEs market where beneath the stable surface there is still turmoil. Taiwanese SMEs have found barriers to set up and choose adequate IT systems to achieve strategic positions in the business networks of complete

supply chains. While short-term advantages have allowed SMEs to thrive, the trend of informatisation, the needs for collaboration, and governance of core firms would eventually force them to opt for certain level of IT solution. After all, the questions will be, what to choose, how to do it, and when to implement it.

2-2 Taiwanese A/B plans in Supply Chain Integration: Difficulties Encountered within Business Network Boundaries

Another initiative is a famous Taiwanese government project which focuses on Supply Chain Integration for B2B eCommerce - "Informatisation Promotion Projects for Information Industry". Widely known in Taiwan as another name "A/B Plans" (Table 2), it was designed by Department of Industrial Technology, Ministry of Economic Affairs, and again completely implemented in 2001 by Institute of Information Industry. There are 15 large firms currently building up systems such as ASUS, Inventec, Mitac, MSI, and Twinhead which link up with 3,948 IT components manufacturers so as to implement B2B eCommerce from procuring to manufacturing processes [Din, 2002a].

Table 2, Contents of A/B plans in IT supply chain Integration

Project Items	Description	Firms Involved
Plan A	Bridging the supply chains in between Taiwanese IT suppliers and International Buyers.	IBM (with 20 suppliers), Compaq (with 10 suppliers), and Hewlet Packet (with 12 suppliers) etc.
Plan B	Linking collaborative supply chains for large firms (core firms in business network) which have annual revenues more than 10 billions NT dollars. It targets the goal to further bridging domestic SMEs in IT supply chain.	There are 15 large firms currently building up systems such as ASUS, Inventec, Mitac, MSI, and Twinhead which respectively link with 3,948 IT components manufacturers so as to implementing B2B eCommerce from procuring to manufacturing processes.

Source: Department of Technology Development, Ministry of Economic Affairs

Although the above plans have brought clear benefits to the large firms involved [Ding, 2002b], there are still criticisms from those firms involved – especially those SMEs linking with large firms. They are in the business network boundaries of an entire supply chain which have less resources and business capabilities [Wang and Heng, 2002a]. Difficulties have been discussed above which deter enterprises from bridging their collaborative SMEs because of the deferent level of IT adoption. Hence, there is a need to further develop a conceptual model for evaluating the current situation of those SMEs.

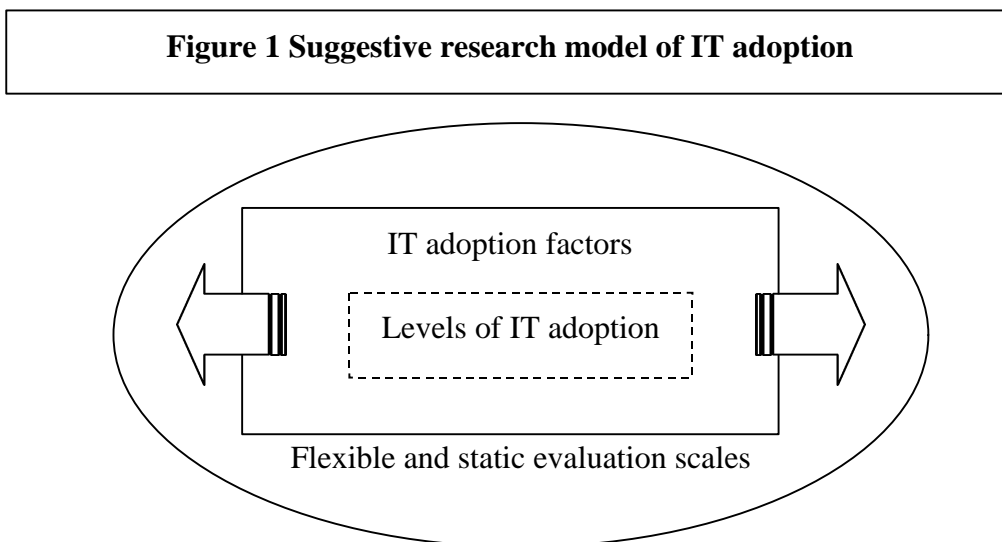
2-3 Knowledge niche from previous literature

Iacovou et al [1995] reflecting on the previous works of IT adoption levels, say that the major impediment of EDI implementation for SMEs is inability. This reason makes SMEs reluctant to join EDI community [Ahin, 1991, Banerjee & Golhar, 1994, Smith, 1990]. Iacovou et al [1995] further propose EDI adoption model for small business with three factors – perceived benefits, organisational readiness, and external pressure. In their work, empirical data has been collected from different levels of adopters namely unprepared adopter, ready adopter, coerced adopter, unmotivated adopter, and non-adopter. Similar to their work, Mehrtens et al [2001] further define the three factors created earlier and also note the level of IT use in the organisation affecting organisational readiness in the Internet adoption by SMEs. In interfirm level of IT adoption, recent works have added trust and power in IT adoption [Hart & Saunders, 1999, Wang & Heng, 2002b]. Another stream of IT adoption research is the successful factors of ERP systems, for example, Nah et al [2001] survey the literatures and identify 11 factors for this level of IT adoption. However, those factors are mostly related to organisational readiness only. In fact, perceived benefits and beliefs have also been pointed out as determinants affecting the attitudes of adopters, which influence the outcome of implementation [Karahanna et al, 1999].

In an empirical analysis of the computer retailing firms [Sohn & Wang, 1998], a model for the levels of Internet Market adoption has been developed. It differentiates those targeted firms into non-adopters, made adoption decision, low level implementation, and sophisticated implementation. The interesting parts are that they add cost incentive and institutional support as major factors based upon the previous literatures. However, all the above researches have ignored certain aspects of the real situations in reflecting of IT adoption by SMEs. First, cost is a concern of relative factor but not absolute factor since large firms and SMEs probably have different resources to support IT implementation. Second, to divide firms into only low and sophisticate implementation can not fully correspond to the real situations of levels of IT adoption. Last but not the least, to access Internet market and Internet adoption are not expensive when even broad band networking has become very cheap nowadays. If a firm can afford to buy a computer, it is nearly not be a problem to adopt Internet at all by technical and cost perspectives. Therefore, there is no need to consider much on those adopters for Internet. Utilising Internet market or other technology can only cost a lot if firms construct and maintain their own infrastructures such as fixed extranet, expensive databases (for instance, Oracle 9i), and marketing website with many IT professionals. Consequently, we propose five levels to form a position model for evaluate current status of IT adoption for SMEs within the business network of supply chains [Wang & Heng, 2002a], namely essential functions (Documentation), single department/ operation process, cross departments / multi-process integration, Enterprise Integration Process (EIP) (i.e. ERP), and B2B Integration / Collaborative Business.

3. LEVELS OF INFORMATION TECHNOLOGY ADOPTION AND THE INFLUENTIAL FACTORS

Previous literature in IT adoption has developed more and more factors that their correlations have been also calculated to create formulas (i.e. a cross-country study of e-business adoption by Zhu et al, [2002]). In some respects, those researches provide in-depth views for analysis in future study. Yet in absence of these research suggestions have limited practical relevance into real situations in different levels of IT adoption. For example, one of Zhu et al, [2002]’s hypothesis is ‘Larger firms are more likely to adopt ebusiness’. If people look at the galaxy of Internet, they will find out all types of ebusiness activities created by small firms. A clever idea can make small firm successful with little investments of IT infrastructure, such as the inaugurator of search engine ‘Yahoo.com!’ and the famous Taiwanese cosmetic online retailer “eBeauty”. They both started with very few resources and capitals. Without cautiously differentiating the levels of IT adoption so as to map those factors, models might be hardly used. As a result, we suggest the factors identified to be compounded into those practical levels as portrayed in figure 1 with flexible scales to adjust the comparing method or static scales for a set of similar firms. Furthermore, we have also created a pilot model for evaluating SMEs’ positions of IT adoption by in network relationships of supply chains. Those influential factors are as follows:



Resource: proposed theoretical framework

Firm Size / Capital (Resources)

As early as Zaltman, et al [1973], literature has found that more formalised and centralised

organizations (often the larger firms) are less likely to initiate innovation adoption decisions, but are better equipped to actually adopt innovations [Kennedy 1983]. It has been considered as an adoption factor facilitator consistently [i.e. Damanpour, 1992] and used in IT adoption since researchers believe larger firm tend to have abundant resources, be more capable in bearing risks, and possess more power to urge trading partners to adopt IT [Zhu et al, 2002]. In the pilot position model, capital asset is the scale for this factor.

System Support Readiness

System support readiness is a factor often divided into many sub determinants - for example, Premkumar et al., [1994]'s system capability for EDI adoption and Sohn and Wang [1998]'s existence of IT champion, top management support, and absorptive capacity for Internet Market adoption. Considering a firm as a complete entity, Iacovou et al, [1995] and Mehrtens' works use system support readiness in organizational level as a major factor which affect the levels of IT adoption fro SMEs. In the pilot test, numbers of IT staffs, existence of IT championship, and existence of IT division are sub-constructs to form the scale.

Perceived Benefits

Perceived benefit is an important incentive [Saunders & Clark, 1992, Son, Narasimhan, & Riggins, 1999] for B2B Commerce. In this issue, large firms indeed enjoy more efficiency in their business processes after project implementing. However, to those SMEs, their environments and business opportunities have undergone more changes than expected, thereby creating uncertainty after the huge investment. IT adoption might not bring equal perceived benefits to firms to those SMEs. It weakens the resolve of many SMEs in going ahead with future plans. Hence, the perceptual amount of money and other potential benefits is recognised as the scale for the preliminary test.

Product Life Cycle (Industries)

Information technology has been considered an important tool to create efficiency and effectiveness. In some industries, product life cycles are relatively short. Superficially, the two statements seem to have no relationships. Interfacially, since the shorter product life cycles generate the needs of supply chain visibility and quick interfirm transactions, IT adoptions become a vital issue for firms within those industries such financial and IT industries. By this factor, time scale by months has been used in the pilot test.

Network Position of a Supply Chain

Considering the business network formation [Liu, R. J. & Brookfield J., 2000] in a supply chain, core firms normally deal with orders from outside the network boundaries [Wang & Heng, 2002b]. The closer to the core of the business network, the more collaborative activities take place. It is not necessary that core firms must be larger firms than those in the middle area

and this can be found in Taiwanese machine tool industry when those firms cooperate to compete with overseas large firms [Liu, R. J. & Brookfield J., 2000]. Thus, network position is considered to be a factor here and more advanced studies align with this direction is expected in the future [Christiannse & Markus, 2002, Wang & Heng, 2002b].

Business Network Linkage (i.e. market, partnership, and customer)

Dynamic (loosen) or stable (fixed) interfirm linkage [Wang & Heng, 2002b] in the supply chain is also a consideration here. This area is explored in both business from the angles of markets, partnership, and brand recognition as well as social aspects such as power, trust, resources interdependency [Saunders & Clark, 1992; Son et al, 1999]. Combining with the previous factor, it is expected to modify current IT adoption models from the business network structure to test the dynamic degrees of linkages. This idea is similar to Fan et al [2000] who note that the information systems solutions are affected by the dynamic degrees of business environment

Levels of IT adoption

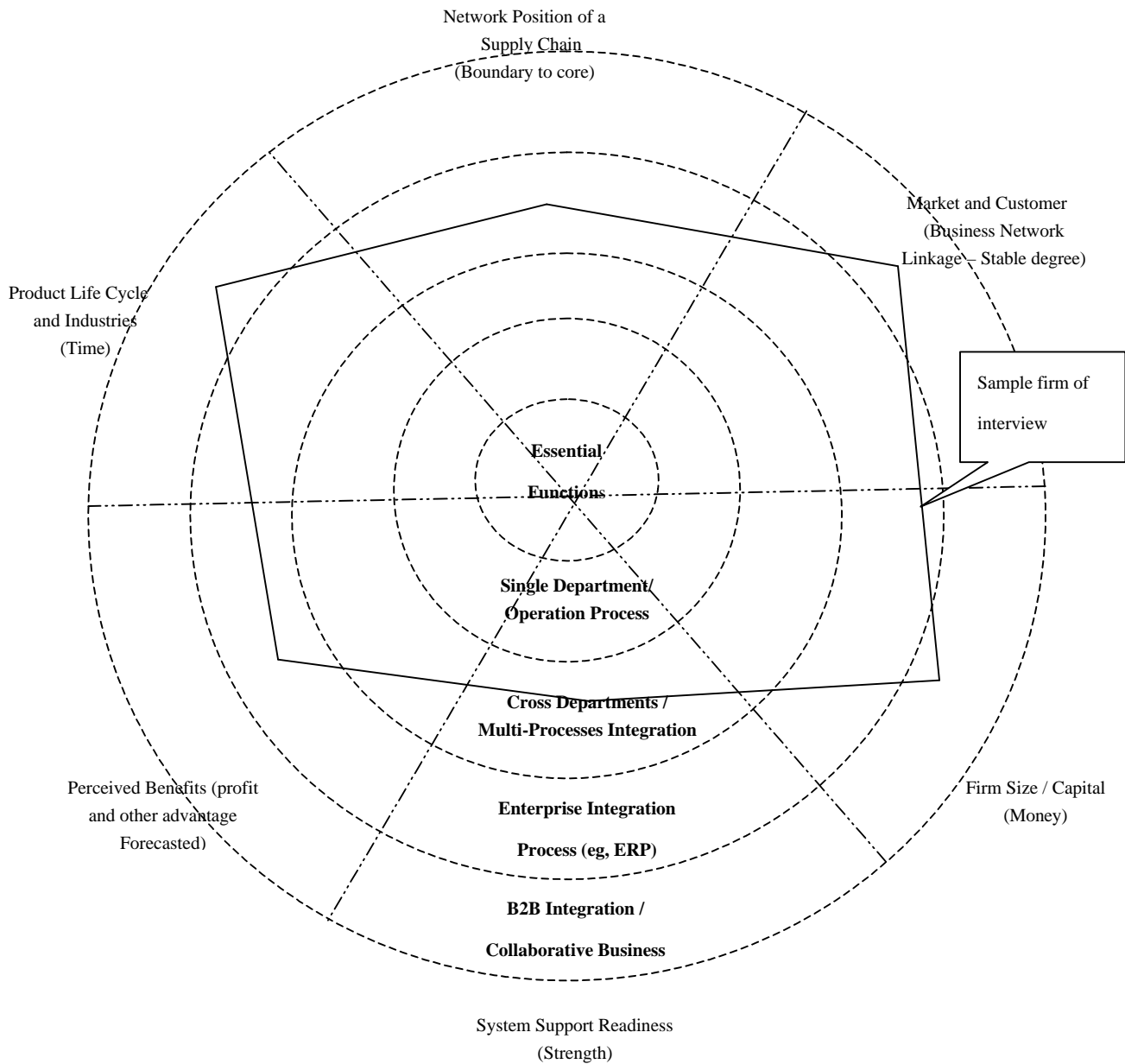
With the above 6 factors, the levels of IT adoption are divided into five levels as 1) Eessential Functions (Documentation) – computers with basic softwares like MS-Office and MS-Windows; 2) Single Department/ Operation Process – computer-based information systems for one type of operation process (i.e. accounting information systems); 3) Cross Departments / Multi-Processes Integration – several modules of computer-based information systems have implemented to fit multi-processes needs among departments. (i.e. logistics, finance, and sales departments); 4) Enterprise Integration Process (EIP) – systems like Enterprise Resource Planning systems are developed to support organisational wide business activities; 5) B2B Integration / Collaborative Business – systems have interfirm links with other collaborative manufacturer, designer, suppliers, and customers. This highest level IT adoption used for interfirm communication and transaction is also named as Inter-Organisational Systems (IOS) [i.e. Grover, 1993], Electronic Data Interchange (EDI) [i.e. Lim & Palvia, 2001], or Business-to-Business integration (B2Bi) [i.e. Lee et al, 1999].

4. A POSITION MODEL FOR THE EVALUATION OF IT ADOPTION

Based on the previous discussion of factors which affect the levels of IT adoption and the suggestive research model, we further propose a conceptual model (Figure 1) to evaluate the current positions of firms within the business network of supply chains. It is a multi-dimensional diagram which consists of six phases that are the influential factors for IT adoption by SEMs. Ideally, it can be used to posit all type of firms but practically many giant enterprises might already implement B2B integration since they have abundant resources to

back up and they have needs in linking with their strategic alliances. Nevertheless, this diagram can still be utilised by large firms or core firms of business networks to target capable partners if certain level of IT adoptions are required on them.

Figure 2 Position Model for the evaluation of IT adoption in Supply Chain



Resource: proposed position model for evaluation

In order to put a sample line on this diagram, an interview has been conducted in a middle size firm which is one of the members in Taiwanese semiconductor industry. We interviewed its CIO, senior account officer, and a senior IT engineer to find out where the target firm belongs. Some interesting results have been identified through the interviews. For instance, the semiconductor industry is part of IT industry which normally has very short product life

cycles. In order to gain supply chain visibility, firms in this industry exert a stronger pressure in adopting B2B integration / collaborative commerce. The firm which is interviewed is no exception though it only has several IT staff as a team to support its IT systems. Through the perceived benefits of it are not highest in this diagram and it is not a core firm or boundary firm [Wang & Heng, 2002b], because the network linkage is very strong/stable (its customers are HP, TSMC, Intel etc.) it is forced to adopt B2B integration.

The results here are derived by comparing the factors described in previous section, and should be viewed only as a guide so as to show the position of a firm's current IT adoption status. However, from this model we have started in doing surveys in order to find out patterns of several industries. The model aims to provide an evaluating tool for industries to reflect its current IT investment and budgets. For the IT planners, they can adjust their IT strategies with the reflection and comparison by plotting their competitors, customers, and suppliers position line.

5. DISCUSSION AND LIMITATIONS

In the past years, industries have been assaulted by a new catch phrase: "Optimise supply chains by eliminating constraints." A constraint occurs when a supply chain does not have enough capital, people, equipment, or space to acquire, transport, manufacture, and/or sell product. Many information systems providers are promoting optimisation B2Bi to help firms eliminate the constraints. From a business network perspective, the constraint is generated not only from the internal level but from external factors. Researches have identified many determinates for IT adoption in the past, but few of position models are developed in order to anchor those strategy and supply chain theories. We hope to continue the research with greater breadth and depth in the future.

With the commencing of our surveys, some of the questions have been presented in front of our desks such as the length of being a member of the supply chain, what is the co-ownership structure (resource interdependency [Galuti, 1999], and the success of adjusting firms' strategies by utilising this model. For the purpose of extending this model, cross-countries studies by collaborating with the authors are welcome. The preliminary result may provide some insights to the managers who intend to participate or already participated in the IT adoption in supply chain. Our study can help them prioritise the important factors in establishing strategies. Factors identified in this study are from the literature review and empirical data. It is possible that some important factors for the model can be added on. In addition, the levels of the IT adoption would vary as firms grow and environment changes.

In this paper, we have reflected on relevant research literature and combined theories of business network, levels of IT adoption, and the adoption determinants into a position model as it applies to strategic evaluations. Both theoretical and industrial aspects have been explored to suggest promising directions for future research.

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