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The adoption behaviour of information technology industry in increasing business-to-business integration sophistication

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Abstract. *A supply chain is not a linear type of inter-firm structure but is often considered as a network. Business networks are underpinned by the firms' resources, social legitimacy and associated power, which are also seen in the adoption theories of business-to-business integration (B2Bi) in the supply chain. However, there appears to be scarcity of the discussion on the theoretical relationship between them. This paper aims to enrich the previous findings of technology adoption theories in a business-to-business context by proposing a structural model and using Structural Equation Modelling approach to test it. It focuses on the integrated supply chain to test, analyse and extend the adoption factors to the use of computer-based information systems (IS). The survey data were collected in the Taiwanese Information Technology Industry. The path analyses indicate the answers for three issues raised from the research framework and confirm the associations between a firm's existing system support readiness and the network determinants outside organizational boundaries. Further, it identifies the interrelationships among these factors and indicates that some of them mediate the enterprises' behaviour on investments to increase current IS for B2Bi purposes.*

Keywords: business-to-business integration, business network, B2B eCommerce, IT adoption

1. INTRODUCTION

Supply Chain Management (SCM) has been an important topic in recent years and its development has a significant relation with utilizing information technology (IT) across the boundaries of firms. Management of IT can be an important remedy for inventory control and

supply chain collaboration problems; it increases the visibility of demand throughout the physical supply chain, as well as the electronic linkages, and creates transparency of outsourced productions and operations (Lee *et al.*, 1999). Nevertheless, firms along the entire supply chain have various intentions and perceived benefits associated with IT investments, resulting in different degrees of information systems (IS) readiness. Consequently, understanding the intrinsic factors of the adoption of IT becomes essential and critical for those firms trying to extend and maximize the capability and utilization of IT systems in facilitating logistics, collaborative designs, subcontracting and other inter-firm business activities. There are many solutions provided by IS vendors and different levels of IT implementations corresponding to the complexity of networks for firms to adopt. Few strategic decision-making and categorizing models have been developed for managers and industrial practitioners. IT-based IS integration in B2B eCommerce is actually a case of IT adoption and is named as business-to-business integration (B2Bi) (Oslen, 2000).

Implementing SCM requires a higher-level adoption of business applications and infrastructures to leverage intra- and inter-firm transactions via systems integration. It also involves both the initiators and adopters in the business network environment that links to management studies. Another concern relates to the various solutions provided by IS vendors and the different levels of implementation by the B2Bi adopters. Previous literature explains only a portion of the adoption of B2Bi decision-making and related impacts from the business network aspects. Particularly, extant research focuses more on the adoption decision rather than the strengthening processes of current infrastructure. Thus, this research tests a proposed structural model by investigating this issue based on a survey conducted in the industrial parks of Northern Taiwan and discusses the proposed model by its applicability, limitation and future research. Factors such as business network and firms' governance capability are drawn in to enhance previous studies on B2Bi adoption.

2. LITERATURE OF BUSINESS NETWORK AND B2Bi

B2Bi

Barrett & Konsynski (1982) described computer-based IS used in inter-firm transactions as the inter-organization information sharing systems providing one of the first models of infrastructure from the perspectives of organizational impacts, which widely influenced subsequent studies and the development of inter-organization IS. IS that are applied to inter-firm communication and transactions are called inter-organizational systems (IOS) (e.g. Premkumar, 2000; Gallivan & Depledge, 2003; Ibbott & O'Keefe, 2004), electronic data interchange (e.g. Lim & Palvia, 2001), or B2Bi (e.g. Oslen, 2000).

This research examines the recent business activities involved in adopting B2Bi, which has been defined as the interconnection and integration of the business processes of two or more independent organizations to collaborate through information technology (IT) applications (Zaheer & Venkatraman, 1994). It can better represent the concept of IOS as business-to-

business (B2B) means inter-firm transactions and trading activities across firms' boundaries, while integration indicates collaborative processes for business goals.

B2Bi research from a business network perspective

While the previous literature explains a portion of B2Bi adoption and the related impacts, the complexity of inter-organizational and structural levels are beyond the individual technology adoption level, and B2Bi adoption is an organizational-level decision within the dyadic inter-firm context. Recent literature in the web-based technology adoption highlights the importance of non-technology factors such as the external pressures and management supports (Chan & Ngai, 2007). Hence, some aspects of B2Bi adoption are missed if viewed only from a technological perspective. This has been partly addressed by recent research using an organizational approach in considering intra-/inter-firm characteristics as well as the inherent features of B2Bi technology.

Dynamic groups in industry have been traditionally named as 'business networks' or 'networks' based on management literature. The term was initially adopted for marketing and exploring relationships between suppliers and customers, leading to its entrenchment within entire industries as reference to an industrial network (Johansson & Mattson, 1987). Researchers have anticipated the vertical and horizontal integration along the entire supply chain with the new technologies. Consequently, a management perspective developed into issues of B2Bi from the dyadic inter-firm level (Son & *et al.*, 1999; Damsgaard & Truex, 2000), business network level (Johansson & Mattson, 1987; Kambil & Short, 1994; Venkatraman, 1994; Zaheer & Zaheer, 1997), and supply chain level (Kim & Umanath, 1999; Premkumar, 2000; Lim & Palvia, 2001).

The electronic integration usage has been approached from a business network context. This level focuses on using a network as an entity to investigate the interactions and dynamics among network members and thus to identify the mutual benefits and constraints by using IS for B2Bi. Kambil & Short (1994) study the use of information technology to re-engineer key business processes and business relationships, and to analyse the effects of electronic integration on organization structure and competitive process at the level of business networks. The roles-linkage perspective is also proposed as a useful characteristic for further study as the concept of information integration from a business network aspect is still in a preliminary status. Few studies from IS disciplines have followed this angle except Gulati (1999) who did so based on the management disciplines. Likewise, Warkentin *et al.*, (2001) categorize contemporary IOS into four sets by strategic network paradigms as supply chain management network, adserver network (i.e. the companies which have internet advertising service supporting each other), content syndication network, and B2B exchange network. There is a simple idea advocated by the IS vendors which focuses on the integrations of an entire supply chain level to increase channel visibility. Some literature has claimed that the current era is one of supply chains competing with supply chains (Archibald *et al.*, 1999). This prospect has been welcomed, but has not yet won the support of those enterprise owners who are still struggling with the challenge of upgrading their heterogeneous systems. In addition to

the lack of systems readiness for B2Bi, Oslen (2000) further indicates that there are at least two other concerns, the degree of synchronization and the degree of autonomy and insulation. These two concerns actually originate in the structure, roles and intermediaries of the B2Bi communities.

Based on another viewpoint from participation roles, Iacovou *et al.* (1995) propose that the roles of EDI adoption are ready adopters, coerced adopters, unmotivated adopters, EDI initiators and non-adopters. They further recommend the strategy for the initiators in creating long-term plans, partner assessment and the enactment of objectives for mutual interests. Notwithstanding, Iacovou *et al.*'s (1995) adoption model omits the influences by the formation of inter-firm collaboration and the intervention of intermediaries such as government entities or industrial association. Lee *et al.* (1999) focus on the performance measures of inventory control and provide evidence that B2Bi can create values for the initiator and adopters across the entire supply chain. Wang *et al.* (2004) further proposed an evaluation model that suggests the interactions and linkages of a business network should be encompassed to assess partners' system readiness. This preliminary model evaluates firms as different tiers of the business networks and suggests that the firms in different segments will have different interests and capabilities in adopting higher levels of information technology, while the highest level refers to the implementation of B2Bi IS. Zaheer & Venkatraman (1994) define B2Bi as a specific form of vertical quasi-integration achieved through the deployment of proprietary IS between relevant actors in adjacent stages of the value chain.

Literature (as shown in Table 1) from both management and IS disciplines calls for a multi-perspective analysis on structure, roles and intermediaries of B2Bi adoption, such as the study of ownership structures of B2B marketplaces by Christiannse & Markus (2002), the theories of transaction cost economics (Williamson, 1975), stakeholder theory, organization learning and institutional theory. Recent studies use transaction cost theory and social cost theory to identify several variables hypothesized to be associated with the extent of EDI adoption (Son *et al.*, 1999; Gallivan & Depledge, 2003; Bunduchi, 2005), including reciprocal investments, trust and power. Other studies stress the importance of strategic network theory, relational exchange theory and political economy to provide a model of channel relationship structure. B2B transaction can be seen as private trading exchanges, industrial consortia and independent electronic marketplaces (Christiannse & Markus, 2002). Rosenkopf *et al.* (2001) investigates the alliance formation and chief technology officers' participation in a dyad context of inter-firm information integration based on such structural aspects.

The literature also includes intermediaries as a portion of B2Bi participation of the business network structure (e.g. Damsgaard & Lyytinen, 1996; 2001), revealing that both the strategies and policies of governments and industrial associations are influential factors in catalysing the adoption processes. Kumar *et al.* (1999) state that caution is needed when applying economic theories in developing IS theory, that previous IS models and critical factors of successful systems adoption might have relied on their own cultural context rather than looking into the general patterns of culture, and that notions of trust, relationships and cooperation should be taken into account.

Table 1. Example of extant literature on business-to-business integration from the business network and structural aspect

The aspects of business network linkage and participation roles	
Researcher(s)/method(s)	Research focus
Barrett & Konsynski (1982)/anecdotal	Introducing a classification scheme with the issues of cost commitment, responsibility and complexity in different levels of participants
Kambil & Short (1994)/literature reflection	Business network redesign through electronic integration from a role-linkage perspective
Nulden (1995)/in-depth interview	Exploring the questions of how inter-organizational interaction will affect IT projects
Webster (1995)/anecdotal	Reflections of the question of networks collaboration and conflict and identifies power in the supply chain context
Kim & Umanath (1999)/conceptual	Propose a theoretical framework to measure the factors of electronic integration in supply chains
Damsgaard & Truex (2000)/case study	Discussion on the EDI standards in binary set up, market, and hub model by the accessing issues of common vocabulary, transaction cost, economies of scale, network externalities, risk etc.
Premkumar (2000)/anecdotal	Conceiving data process as the core in B2B IOS implementation factors are reviewed such as market uncertainty, partner's willingness, and technical capability
Warkentin *et al.*, (2001)/anecdotal	Categorizing contemporary IOS into four sets by strategic network paradigm
Hong (2002)/case study	Case studies of the linkage and network participants' roles
Gallivan & Depledge (2003)/case studies	Investigating the issues of trust, control, and the role of inter-organizational systems in electronic partnerships by the content analysis with the classification of partnership type and nature of the tasks

In summary, the studies of business network and B2Bi have shared interests in inter-firm relationships and linkages when there is an increasingly large number of firms using IT for more than operational and management support. Thus, this aspect becomes the major focus in our current study.

3. THE RESEARCH MODEL AND HYPOTHESES

The literature has yielded eight constructs, including seven determinants, which influence the intention to increase B2Bi sophistication. Some of the interrelationships between these constructs have been empirically tested, such as perceived benefits, competitive pressure (Iacovou *et al.*, 1995) and governance capability identified as 'power' in Hart & Saunders (1997), while other constructs are discussed without testing their relations, such as governmental and institutional intervention (Damsgaard & Lyytinen, 1996; 2001; Christiaanse & Markus, 2002). The research model developed from the following themes.

System support readiness of B2Bi vs. governance capability

The first hypothesis represents the relation of a firm's system support readiness to its governance capability of network partners. A firm's governance capability within a business network

context arises from resource dependency (Gulati, 1999), firm size (Zaheer & Venkatraman, 1994; Iacovou *et al.*, 1995) and asset specificity (Zaheer & Venkatraman, 1994; Son *et al.*, 1999). The higher system support a firm has, the more resource has to be invested in systems infrastructure, training, IT professionals and adjusting business processes. Very few enterprises can join a value-added network to undertake B2Bi benefits if they do not have adequate system support and are in the network boundaries or far from the core firm (Wang & Heng, 2002) where the governance centre of the business network is. Based on this view, sufficient system support can make a firm relatively cost-effective in information gathering and in communication (Hoffman & Novak, 1996). In that respect, it helps to reduce the dependence of a firm on its suppliers and customers (Bakos, 1991) and increases bargaining power. Consequently, system support readiness can strengthen information availability and change the power balance in an exchanging relationship. Hence,

$H_{1.1}$: System support readiness of B2Bi is positively related to a firm's governance capability.

System support readiness of B2Bi vs. participating roles in the network paradigm

Considering the business network paradigm (Liu & Brookfield, 2000) of a supply chain, core firms (Banerji & Sambharya, 1998) normally deal with orders from outside the network boundaries (Wang & Heng, 2002); the closer to the core of the business network, the more collaborative activities are involved. It is necessary that core firms should be larger than those in the middle area, and this pattern can be found in the Taiwanese machine tool industry when those firms cooperate to compete with large overseas firms (Liu & Brookfield, 2000). The network paradigm reflects the types of cooperation as temporary or project-like in a strategic network, virtual enterprise, regional network and operative network (Pfohl & Buse, 2000). Evidence of the empirical relevance of relational capabilities and system support readiness can be found. For example, a study of three comparative production networks in Italy by Lorenzoni and Liparini (1999), who assert that the ability to integrate knowledge resides in both sides of the firms' boundaries, emerges as a distinctive organizational capability. Such organizational capability is positively associated with the support readiness of IS. Therefore,

$H_{1.2}$: System support readiness of B2Bi is positively related to participating roles in the network paradigm.

System support readiness of B2Bi vs. competitive pressure

The external economy is often an incentive in affecting the use of electronic media by a firm (Christiaanse & Markus, 2002). Competitive pressure has been identified to be positively associated with technology competence (Zhu *et al.*, 2002; Teo *et al.*, 2003). Such technology competence is strongly supported by IT infrastructure, IT expertise and eCommerce expertise (Zhu *et al.*, 2002) which belong to affiliated factors of system support readiness in both extant literature and this research. Information asymmetry among the participating units of the supply chain leads to inefficiency of the supply-demand processes. While all organizations in the

supply chain are eager to reduce uncertainty, it may be at the expense of others in the supply chain. If high competitive pressure surrounds a firm, it must catch up to the standards of system support readiness of its partners or take the risk of losing sales and collaboration opportunities. An extreme example is the supply network of the semiconductor industry. Wang *et al.* (2004) find that most firms in the Taiwanese semiconductor industry must have a mature level of system supports because of external pressure. Therefore, the second relation in this research model is,

$H_{1.3}$: System support readiness is positively related to a firm's competitive pressure.

System support readiness of B2Bi vs. social embeddedness

Social links in the inter-firm context have been discussed in literature in terms of social embeddedness. Kumar *et al.* (1999) indicate that the existing social embeddedness in the industrial district of Prato in Italy hinders participants' use of EDI technology for B2Bi since the pre-existing channel integration forged by social ties can function well without such systems. Some other literature seems to provide opposite views on this issue (Hart & Saunders, 1997; Patterson *et al.*, 1997). One acceptable explanation is that social embeddedness triggers off the similar standards of system support among participants in the business network. Business networks with stable social embeddedness may not require high system support readiness in business processes but through traditional channels. Once the core firm or most partners commence to link with each other via electronic media, social embeddedness becomes the trigger to B2Bi maturity by partners' governance capability. Damsgaard & Lyytinen (2001), claim that the network externalities make it attractive to postpone the IS adoption until most of the others have done so. Therefore, the proposed hypothesis of system support readiness and social embeddedness is:

$H_{1.4}$: System support readiness is associated with the social embeddedness among the network participants.

Existing system support readiness moderates the impacts of B2Bi adoption on network relationships

Firms often find B2Bi adoption a more complex process than traditional intra-organization systems because it involves integration with existing ways of trading and collaboration (Chan & Swatman, 2000). When networked firms commence adopting new B2Bi systems for business operations, they usually encounter distrust, ambivalence and resistance to change (Turner, 2000). Such effects can in turn cause disequilibrium of business relationships (Vlosky & Wilson, 1994) and imbalance of information exchange, until the networked firms have reached the maturity of system support readiness. Indeed, there is speculation in the literature that partners' readiness in system capability (e.g. Angeles *et al.*, 2001) has a significant impact on B2Bi adoption. Without the maturity of existing system support, network relationships might

be weakened or dismantled if other network participants have a higher level of system support for B2Bi adoption. This proposition has not been empirically tested. Therefore, it is hypothesized as:

$H_{1.5}$: The influence of B2Bi adoption on the above network determinants is moderated by the maturity of B2Bi systems support.

Participating roles in the context of network paradigm and competitive pressure

According to Iacovou *et al.* (1995), external pressure derives from channel levels and dyad inter-firm levels. While the latter relates to other firms' governance capability (Webster, 1995), external pressure from the channel level is linked with a firm's participating role in the network paradigm. Problems may arise as firms are usually not part of one linear chain but are integrated into various inter-firm links. Competitive pressure can be generated from horizontal, lateral, circular or general reciprocal sides (Pfohl & Buse Hans 2000). It is important to know the explicit role of the participants in a certain business network. Some firms may directly face the competitive pressure generated from the partner selection processes because they are in the first or second tiers adjacent to the core firm (Wang & Heng, 2002). Therefore, it is hypothesized as:

$H_{2.1}$: Participating roles in the context of the network paradigm is positively related to competitive pressure.

Governmental and institutional intervention related to perceived benefits

Perceived benefit refers to the expected value after adopting B2Bi or increasing its maturity. Government and industrial associations may directly intervene in the B2Bi diffusion processes of domestic business networks (Wang & Heng, 2004) or indirectly foster the environment by creating potential benefits such as opting for network strategy deployment, innovation directive, mobilization and standard setting (Damsgaard & Lyytinen, 2001) so that interconnected firms can become aware of an innovation potential. The intervention processes can also ensure the early involvement of trading partners to gain clarity in the exchanging of agreements and compatibility of infrastructures among participants (Angeles *et al.*, 2001). Consequently, the intermediators can engage in developing shared and interoperable B2Bi systems that can increase positive externalities (Damsgaard & Lyytinen, 2001). Therefore, to hypothesize,

$H_{2.2}$: Governmental and institutional intervention is positively related to perceived benefits.

Social embeddedness with a firm's trading partners influences its governance capability

Organizations would pursue network legitimacy as social embeddedness since it is a factor for the formation of inter-organizational relationships (Oliver, 1990). Network legitimacy which

creates a governance mechanism is also necessary for an organization to fit inter-firm expectations within social embeddedness. An organization generally accumulates resources and reputation in an attempt to gain social recognition and build a good reputation with partners. Usually, the larger a firm is, the easier it accumulates resources, demonstrates capabilities and gains social recognitions. When one of the firms in a business network is an organization of equivocal status in the network context, social embeddedness can act as endorsements. By strengthening its social embeddedness in the alliances, the firm builds public confidence in the value of products and services and thereby facilitates the governance capability to bargain with trading partners and gain control over the supply chain. Particularly, it affects the inter-firm interdependence as studied by Chatfield & Yetton (2000). Thus, this notion is hypothesized as,

$H_{2.3}$: Social embeddedness is positively related to governance capability.

Governmental and institutional intervention foster the firms' intentions to increase B2Bi sophistication

Besides the indirect influences through perceived benefits of B2Bi adoption, government entities and industrial associations can affect a firm's decision regarding B2Bi investments through policy legitimation and standard setting. No more than grounded studies and anecdotal accounts are found in the literature except Teo *et al.* (2003), who measures the normative pressure from governmental intervention on Singaporean enterprises. In order to test their relationship and to seek the congruence between actual practice and theory, it is hypothesized that

$H_{1.6}$: Intervention of government and institution is positively related to a firm's system support readiness.

$H_{3.1}$: Intervention of government and institution is positively related to the intent of increasing B2Bi sophistication.

Competitive pressure leads to a firm's intention of increasing its B2Bi sophistication

A core firm and its affiliate firms face different competitive pressures. Affiliate firms face powerful influences from larger players. This viewpoint is supported by Webster's (1995) multiple case studies, where Ford Motor showed little inclination to downgrade its system standards to fit those of established suppliers. The introduction of IT for effective business network operations and coordination will only function in a predicted way when the participants have an accurate design model of the systems for inter-firm exchange processes (Franken *et al.*, 2000). Hence, this research forms the hypothesis as:

$H_{3.2}$: Competitive pressure is positively related to the intent of increasing B2Bi sophistication.

Perceived benefits lead to a firm intention of increasing its B2Bi sophistication

The consideration of perceived benefits derives from both internal and external issues through planning activities (Ibbott & O'Keefe, 2004). IT applications can create competitive advantage

based on the generic strategies or cost leadership, product differentiation and market focus (Kearns & Lederer, 2000, p. 266). Empirical evidence suggests that the adoption of B2Bi systems can benefit not only the initiator but also the affiliate adopters, though the benefits may not be equal to all participants (Lee *et al.*, 1999). Increasing the levels of B2Bi sophistication can improve a firm's ability to fulfil customer demand and after-sales services (e.g. Lim & Palvia, 2001). The relationship between perceived benefits and the intent of increase B2Bi sophistication is hence proposed as:

$H_{1.7}$: Existing system support readiness is positively related to perceived benefit.

$H_{3.3}$: Perceived benefit is positively related to the intent of increasing B2Bi sophistication.

Governance capability leads to the intention of increasing its B2Bi sophistication

Governance capability generated by firm size and resources causes the unbalanced dependency of the channel relationship, and is an important variable in industrial organization economics. It is considered as an adoption factor facilitator (i.e. Damanpour, 1992) and used in B2Bi adoption, since researchers believe larger firms have abundant resources, are more capable of bearing risks and possess more power to recommend trading partners adopt such systems (Zhu *et al.*, 2002). A firm with strong governance capability tends to use its coercive power to lock in its suppliers and customers by B2Bi systems (Webster, 1995). The lock-in strategy restricts the ability of suppliers and dealers to trade with other manufacturers (Webster, 1995) or at least to reduce their business relationships outside the network boundaries. Hence,

$H_{3.4}$: Governance capability is positively related to the intent of increasing B2Bi sophistication.

In summary, there are eight constructs in the relational model, including one internal situation, six from the network aspects, and the behaviour outcome. Each of these constructs has been hypothesized in association with the identified interrelationships that illustrate the research model (Figure 1) deduced from the extant literature.

4. RESEARCH METHOD, DATA ANALYSIS AND FINDINGS

Sampling, questionnaire drafting and pilot testing

The survey method adopted in this research utilizes multiple steps of the sampling processes as suggested by the literature (Cooper & Emory, 1995). The IT firms selected from the major industry parks in Northern Taiwan have become the target population of initial frame through such a purposive arrangement, which avoids the population specification error (Cooper & Emory, 1995). This area has 12 industry parks including the government-founded Hsin Chu Science Park that has held a solid relationship with the Silicon Valley USA since the 1980s.

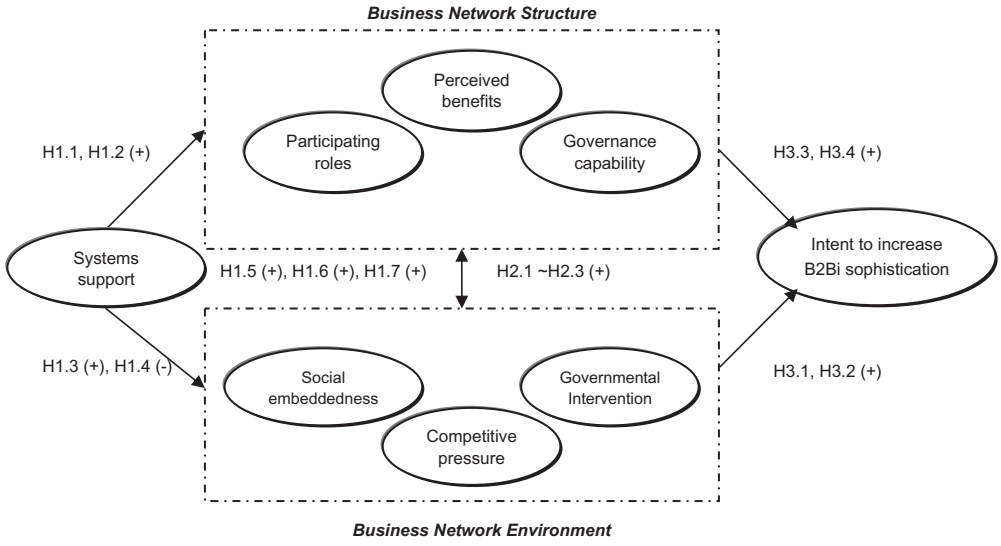

Figure 1. The proposed interrelations of constructs in the theoretical framework.

Subsequently, 976 firms were randomly chosen from the corporate lists of the industrial associations as the sample frame of total population. Managers of the IS department from a PC manufacturer, a chip designer and a system integrator were invited to participate in drafting the questionnaire. Each of the questions was discussed by face-to-face interview and some minor changes were made. Twenty IS students were then invited to be part of the respondent debriefing processes.

The pilot testing helped in preparing the final questionnaire that has two types of measurements – nominal and interval (Neuman, 2000). They are designed for gathering data of the objective and subjective characteristics of the target sample. Nominal scale is used to identify the sample profiles and thus can facilitate the work of comparing and contrasting the results of different groups with their corresponding variables. Accordingly, the Likert seven-point interval scale is used in generalized signification by the words from 'strongly disagree' to 'strongly agree' for measuring the 46 indicators which contribute to 7 variables in the structural model (e.g, the indicator, 'Efficien, X25', refers to the perceived benefits on increasing efficiency of business processes; the variable, 'CSSR, $\xi 1$' is the composite factor of systems support readiness).

In this research, 183 responses were returned, giving a response rate of 20.3%. The respondents were IS managers, supply chain professionals and general managers in the sample companies. Each of the items was then named and labelled on SPSS 11.0, which can import data to AMOS directly. Raw data were consequently screened and 18 questionnaires were not analysed due to incomplete answers or missing data. Additionally, four questionnaires were discarded during the outliers testing. In short, 161 usable responses from 953

delivered questionnaires resulted in a response rate of 16.9%, which is acceptable for statistical analysis by Structural Equation Modelling.

Response profile

The demographic information of the respondents is shown in Table 2, including the industry type, number of employees, capital amount and annual revenue. The largest group (32.9%) of respondents are involved in the sub-sector of computer peripheral manufacture/design. The middle groups range from 10% ~ 20% and represent manufacturers, software providers and components suppliers, etc. The minor groups below 10% are driver designers, semiconductor firms and channel distributors. It represents certain degrees of the business network formation in this particular industry. For example, integrated circuits (IC) and semiconductor firms (e.g. Taiwan Semiconductor Manufacturing Company (TSMC) and United Microelectronic Corporation (UMC)), which require billions of dollars as initial investments, are normally the core firms

Table 2. Respondent profiles

	Category	Frequency ($N = 161$)	Percent (%)
Industry types	Telecommunication	19	11.8
	IC & semiconductor	6	3.7
	Consuming electronic products	8	5.0
	Computer peripheral	53	32.9
	Channel distributor	6	3.7
	Material manufacturer	20	12.4
	Computer systems integrator	12	7.5
	Software developer	13	8.1
	Enterprise systems vendor	13	8.1
	Hardware driver designer	5	3.1
	Others	6	3.7
Number of employees	Under 100	23	14.3
	101 ~ 500	36	22.4
	501 ~ 1000	39	24.2
	1001 to 3000	23	14.3
	Over 3000	40	24.8
Capital*	Under NT80 million	31	19.3
	NT80 ~ 200 million	19	11.8
	NT200 million ~ 1 billion	33	20.5
	NT1 ~ 2 billion	11	6.8
	Over $2 billion	67	41.6
Revenue*	Under NT80 million	30	18.6
	NT80 ~ 200 million	27	16.8
	NT200 million ~ 1 billion	34	21.1
	NT1 ~ 2 billion	23	14.3
	Over $2 billion	47	29.2

NTD, New Taiwan dollar; USD, US dollar. *Exchange rate on 7/2/2004 NTD : USD = 33.3 : 1.

in their corresponding networks and the material manufacturers are typically the affiliate firms. This situation can also be applied to the relationships among computer systems integrator (e.g. Acer, Asus, or Inventec), hardware driver designers and computer peripheral manufacturers (e.g. keyboard, USB drive, and adapter makers). Additionally, the other sectors play the role of assisting other firms to complete their business processes, which can be channel distributors linking computer system integrators to the market. The sample cases thus represent most stakeholders of the business network format, and may strengthen the credibility of findings and conclusions through statistical analysis.

The numbers of employees in the respondents' enterprises vary from 51 to 30 000, with a flat distribution. The information from the capital amount showed most samples are large enterprises and less than 19.3% are small to medium-sized enterprises. The IT industry is a knowledge intensive industry, and there are many exceptions to the correlation result reported, with some small IT firms having a higher revenue/employee ratio than the large firms. Again, these three profile indicators can imply a well-distributed sample of network participants.

Reliability and validity

All the constructs present good estimated results except competitive pressure, which has only marginal variance extracted. This information indicates that the variance regarding measurement error is larger than the items explained by the latent variable of competitive pressure and confirms the result of moderate Cronbach's coefficient α and composite reliability $\rho_{\xi j}$. There are only 4 out of 45 indicators that have standardized regression weights less than 0.5 (which are close to 0.5) as an accepted condition suggested by the literature (Hair *et al.*, 1998; Tabachnick & Fedell, 2000).

Content validity has been achieved through careful attention in drafting the questionnaire, population sampling and item preparation. Criterion validity concerns the estimated score of item performance (Pedhazur & Schmelkin, 1991), with the regression weight and path analysis result for the constructs and proposed model being done in the analysis. The satisfactory convergent validity is achieved since each observed variable of the posited latent variable is significant and the estimated standardized regression weights are greater than twice their associated standard errors, as shown in Table 3 (suggested by Anderson & Gerbing, 1988). As for the discriminant validity, the report shows high Cronbach's coefficient α value of most constructs and the indicators support the related latent variable well enough. In addition to each of the measurement models, an intermediating model has also been tested with an adequate fit of Chi-squire $X^2 = 1126.088$ (DF = 646, $P = 0.21$), $X^2/DF = 1.743$, RMR = 0.141, RSMEA = 0.047, GFI = 0.909, AGFI = 0.892, NFI = 0.859, CFI = 0.881, IFI = 0.882, and TLI = 0.870. These tests provide the foundation to support using the proposed items and constructs in the path estimation of the complete structural model.

Results of full structural model

Due to the limitation of length, the evaluation results of the measurement models and intermediating model are omitted from this paper. The hypothesized model posits a second-order

Table 3. Assessment of internal consistency and convergent validity

Measurement models (latent variables)	Variance extracted	Cronbach's coefficient α	Composite reliability $\rho_{\xi i}$
System support readiness	0.501	0.926	0.925
Governance capability	0.538	0.830	0.822
Network paradigm	0.540	0.809	0.818
Perceived benefits	0.650	0.916	0.903
Social embeddedness	0.543	0.859	0.963
Competitive pressure	0.337	0.571	0.557
Government intervention	0.665	0.895	0.888
Intention to increase B2Bi	0.568	0.857	0.838

B2Bi, business-to-business integration.

model that indicates the intermediating constructs moderate the effects of B2Bi determinants on the intention of firms to make further investments. In other words, the theoretical interpretation of the main model is an overall trait of the intermediating model and associated constructs.

The observed Chi-square of the hypothesized model is 1372.094 with DF = 794 and probability at 0.19. The X^2/DF ratio is 1.728 with an acceptable RMSEA 0.044, which indicates that the model fits properly with the survey data (Table 4). The absolute goodness-of-fit measured by GFI and AGFI are marginal (0.889 and 0.793), which is not unusual in a complete model with a large degree of freedoms (Huang, 2000). The other incremental fit indices are also marginally presented, being TLI (0.861), NFI (871) and IFI (0.889). Overall, these results suggest that the main model can be considered adequate for the testing of hypotheses.

Estimating the main model reveals that there are 11 of 14 paths statistically significant, including six moderately given at the $P < 0.05$ level and five strongly at the $P < 0.01$ level. Three paths are not significant, that are perceived benefits – government intervention, B2BI intention – system readiness and B2BI intention – competitive pressure. As the result of three path analyses is seen against the previous literature, a bootstrap method that treats a random sample of data as a substitute for the target population based on these observed quantities has been adopted in order to test the robustness of the current model (Efron, 1982). The bootstrap approach is used since the original middle sample size is 161 and the observed cases are normally distributed (West *et al.*, 1995). The estimated information for the interrelations among latent constructs further supports the main model. Therefore, the measured path analyses are accepted for the purposes of testing the hypotheses (see Figure 2).

At the level of internal situation to the external environment, the findings of this research support all interrelationships between existing system support readiness and network determinants, either significantly or moderately. The rejection of H1.7 has provided a counter-example to Iacovou *et al.*'s (1995) adoption model since the moderate path coefficient is not significant. Nonetheless, it does not indicate that there is no relationship between system support readiness and the adoption of B2Bi. Rather, it shows that the network determinants play the roles as intermediate variables, interacting with current system support to affect the intention of further actions on B2Bi.

Table 4. Estimated values of the main structural model

Standardized regression weight λ_c				S.E.	C.R.	*P*
Social embeddedness	←	System readiness	0.448	0.124	3.607	***
Network paradigm	←	System readiness	0.615	0.104	5.928	***
Government intervention	←	System readiness	0.644	0.094	6.867	***
Governance capability	←	System readiness	0.532	0.107	4.981	***
Competitive pressure	←	System readiness	0.394	0.143	2.754	0.008
Perceived benefits	←	Government intervention	0.217	0.122	1.397	0.289
Governance capability	←	Social embeddedness	0.541	0.146	3.706	***
Competitive pressure	←	Network paradigm	0.396	0.174	2.272	0.024
Perceived benefits	←	System readiness	0.268	0.109	2.445	0.003
B2Bi intention	←	System readiness	0.135	0.129	1.042	0.297
B2Bi intention	←	Government intervention	0.204	0.085	1.893	0.045
B2Bi intention	←	Competitive pressure	0.122	0.097	1.256	0.209
B2Bi intention	←	Perceived benefits	0.180	0.073	2.462	0.012
B2Bi intention	←	Governance capability	0.197	0.085	2.154	0.021
Chi-square (X^2)					1372.094, P = 0.19	
Degree of freedom (DF)					794	
Normed chi-square (CMIN/DF)					1.728	
Root mean square residual (RMR)					0.138	
Root mean square of error of estimation (RMSEA)					0.044	
Goodness-of-fit index (GFI)					0.889	
Adjusted goodness-of-fit index (AGFI)					0.793	
Tucker-Lewis index (TLI)					0.861	
Normed fit index (NFI)					0.871	
Incremental fit index (IFI)					0.889	

B2Bi, business-to-business integration. *$P < 0.10$; **$P < 0.05$; ***$P < 0.01$ (2-tailed).

At the level of testing the interrelationships of mediating factors, there are two proposed paths accepted and one rejected that investigate the interrelationships of network determinants in the generic literature. For instance, they confirm previous research that the participating role of network paradigm is associated with the competitive pressure that a firm is under and social ties affect its governance capability towards trading partners. Although current studies report that the Taiwanese government and industrial institutions intervene in the development processes of IT infrastructure and supply chain integration (Wang & Heng, 2004), the estimation of such actions calculated for the perceived benefits of enterprises is not significant. It implies that the Taiwanese IT companies may not acknowledge the existence of potential benefits proposed by the government plans. To confirm this, an interview was conducted with the CIO from a sample company that had participated in a government project. It shows that there are sometimes conflicting interests between firms and governmental plans which can lead to the barriers of the government intervention in B2Bi projects. For example, a participating enterprise may not include its subordinates in China within the project scope due to the political tension of the cross-strait relationship. Moreover, participants need to report to the government regularly and under supervision by the assigned third party while the funds

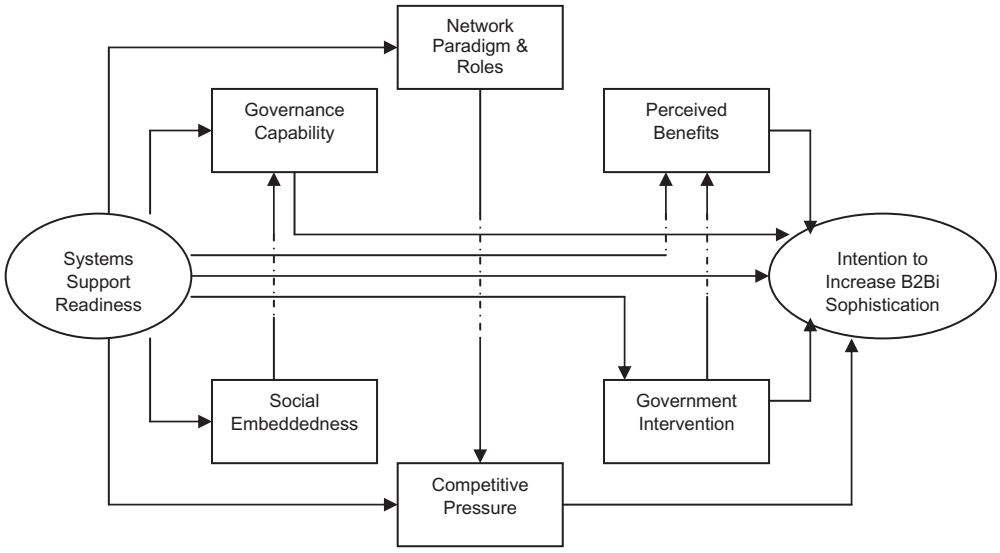

Figure 2. The result of path analysis (path coefficients are reported in Table 4).

provided by the government are sometimes small comparing to the operation scales of the enterprises.

In conclusion, the three path analyses confirm the interrelationships of network determinants as the intermediating variables in the current research model.

At the last level of mediating factors to the adoption behaviour, three of the proposed paths are accepted in the relational model that is designed for investigating the driving forces of B2Bi investments. Most of the estimated results show moderate effects on the intentions of the respondents in regard to their future planning. Some of the estimated results indicate moderate effects on the paths because the path coefficients often decline in the second level based on the nature of casual model measurement. Although there is disconfirmation of previous literature related to competitive pressure, the discussion still contributes reflectively to the knowledge with proper suggestions based on observation in the Taiwanese IT industry. In addition, the findings of this research highlight some important issues in B2Bi adoption literature, for example, adapting governance capability from network studies into the relational model rather than firm size or asset specificity. It is because the establishment of the standards for inter-firm transactions involve enacted power that is derived from persuasive and acting ability.

5. CONCLUSIONS AND IMPLICATIONS

The main contribution of this research is to test the behaviour model, which can be divided into three parts and affects the final decision of firms on increasing B2Bi sophistication. First, the

empirical data have indicated that existing system support readiness corresponds to the business network environment by its atmosphere and structure. Second, the network determinants may affect each other, which indirectly contribute to the understanding of the channel structures. For example, the interrelationship between social embeddedness and governance capability of trading partnership has been discussed at length in management literature. This research has confirmed that social ties enhance a firm's governance capability towards its trading partners. Interestingly, the tested model also disconfirms the proposed relationship between perceived benefits and governmental and institutional intervention in the adoption literature. The last sets of path analysis link with the organizational behaviour to increase the sophistication of IS for channel integration.

Separating the adoption of IT into existing system readiness and B2Bi sophistication can provide a possible answer to the controversy about the role that governmental and institutional intervention plays in the intentions of firms to adopt and utilize IS for supply chain integration (Damsgaard & Lyytinen, 1996; Kumar & *et al.*, 1999; Damsgaard & Lyytinen, 2001; Wang & Heng, 2004). As for the B2Bi, level intention to invest further may not derive from the perceived benefits, but rather derive from/lead to coercive pressure from the peer groups or from governmental interventions.

Previous research has identified many factors that have operated for IT adoption in the past, but few strategic and evaluative position models have been developed in order to anchor those factors strategically in regard to supply chain theories. With the literature review and empirical data of our surveys, there is the basis to further explore concerns such as the B2Bi scope and changing effects of technology on network partnership. In particular, it may involve the co-ownership structure, resource interdependency (Gulati, 1999), and the success of adjusting firms' strategies by utilizing the structural model. Future research can also investigate the failure of governmental intervention in the supply chain and B2Bi projects.

This paper reflects on the extant literature and combines the theories of business network, B2Bi and the relational paths in a structural model as it applies to the strategic evaluations of supply chain integration. The results of this study can provide insights for managers who intend to participate or who have already participated in the B2Bi IS in the supply chain into prioritizing the important factors in establishing strategies. It is possible that additional factors for the model can be uncovered in future research since the B2Bi sophistication would vary as networks grow and the environment changes.

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