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CAN INTRA-FIRM IT SKILLS BENEFIT SUPPLY CHAIN INTEGRATION AND PERFORMANCE?

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Abstract

While inter-firm collaboration and integration remain critical for supply chain performance and information technology (IT) has been playing an increasingly important role in inter-firm cooperation, whether intra-firm IT skills can impact the inter-firm integration of IT has not been explored in the IS area. IT human capital involving soft skills and hard skills is a relatively unexplored topic, especially in the supply chain context. This study develops a model to examine whether intra-firm IT skills can have cross-boundary effects on supply chain collaboration and integration, which then can lead to greater supply chain performance. Accordingly, eight hypotheses were proposed and the model was tested with Partial Least Square technique based on the data collected from a survey of 250 manufacturing firms in Taiwan. The results largely support our model with seven hypotheses confirmed. By focusing on the supply chain context, this study thus extends and integrates the literatures on IT skills and supply chain management by showing the boundary-spanning effect of intra-firm capabilities on inter-firm collaboration, integration and performance. Implications of the results are provided and limitations and future research directions are discussed.

Keywords: IT skills, collaboration, integration, supply chain, performance.

1 INTRODUCTION

Inter-organizational information system (IOS) integration has been recognized as an important avenue for improving supply chain performance. IOS integration can provide information visibility to mitigate the bullwhip effect (Putzger 1998; Lee et al. 1997), reduce the complexity of supply chain activities (Power 2005), and promote flexibility to meet varying business demands (Bhatt 2000). Although prior researches have recognized that IOS integration requires technical and managerial skills from supply chain partners (Zhu et al. 2006; Crook & Kumar 1998), it remains unclear whether a firm's internal IT skills would have an effect across organizational boundaries when the firm attempts to collaborate with its supply chain partners for implementing an IOS. In the supply chain context, fulfilling collaborative objectives requires not only the participation of relevant stakeholders but also the application of separate skills (Roy & Whelan 1992). Prior studies have also identified that partners' collaboration is a critical factor for improving supply chain performance both directly and indirectly. For example, feedback and mutual participation in collaboration can facilitate supply chain integration (van der Vaart & van Donk 2008); collaboration can improve goal alignment (Wood 1997); and robust collaborative arrangements can enable effective information flows and streamline logistics (Power 2005). However, as indicated by van der Vaart and van Donk (2008), while many prior studies examined the performance effect of inter-firm collaboration but few studies paid attention to the factors influencing the collaboration.

Further, to allow supply chain partners to work as a single organization to achieve greater competitiveness, supply chain integration, often enabled by IT, is critical (Forslund & Jonsson, 2009; Power 2005). IT-based supply chain integration can eliminate redundant processes, transform sequential processes into parallel ones, and provide consistent information support to respond to dynamic markets (Bhatt 2000). Although many scholars have argued that IT has no direct performance impacts (Grant 1996; Barua et al. 2004; Sambamurthy et al. 2003; Mithas et al. 2004), it should nevertheless be able to enable inter-firm process integration so as to impact supply chain performance at least indirectly. Besides, our understanding of the effect of collaboration on inter-firm integration such as IOS integration and process integration remains limited.

By taking an inside-out perspective (Day 1994; Wade & Hulland 2004; Roberts et al. 2012) and focusing on a dyadic relationship in the supply chain context, this study examines whether a buyer's internal IT (hard and soft) skills would affect supply chain performance through the mediation effects of inter-firm collaboration and integration. Overall, this research attempts to answer the following questions: (1) why and how a firm's internal IT skills facilitate inter-firm collaboration and IOS integration; (2) why and how inter-firm collaboration facilitates supply chain integration, including IOS integration and process integration; (3) why and how supply chain integration contributes to supply chain performance.

The remainder of this paper is arranged as follows. We first discuss the theoretical foundations of our research and then develop the research model and the associated hypotheses. Next, we introduce our methods for collecting and analyzing the data. After discussing our results and the implications, we assess the limitations of our research and suggest future research directions.

2 THEORETICAL FOUNDATION AND HYPOTHESIS DEVELOPMENT

Human capital theory suggests that people who possess knowledge, skills, and abilities (KSAs) would provide economic value to firms via increased productivity (Youndt et al. 1996). However, in the supply chain context, firms tend to utilize a number of mechanisms such as collaboration and integration that cut across organizational boundaries to deal with environmental uncertainty. Therefore, firms must develop and maintain a highly skilled competent workforce that can resolve problems when developing and operating these mechanisms. Under such circumstances, both technical and problem-solving skills are needed (Youndt et al. 1996). For IT personnel, when they engage in activities related to IOS integration and human-based collaboration, they would be expected to possess not only technical hard skills but also such soft skills as problem-solving and interpersonal communication. As supply chain operations increasingly rely on information technology, the ability of IT personnel to work effectively with the staffs of other companies for resolving trading problems has become more important. That is, they must have the skills spanning the organizational boundaries in order to make efficient IT-based, inter-firm integration possible.

On the other hand, supply chain management traditionally takes a systems view as its theoretical foundation, which can be traced back to Forrester's (1961) work on system dynamics. This view recognizes that the value creation process extends beyond organizational boundaries and involves integrated business processes among entities of a supply chain (Sanders 2007). The essential idea in this view is that a supply chain must be managed as a single entity or one complete system and exploitation of linkages among supply chain members is critical for superior performance (Tan et al. 1998; Frohlich & Westbrook 2001). Hence, a number of mechanisms such as integration and collaboration are required to maintain the system (Sanders 2007). As suggested by the literature, we identify and focus on three mechanisms that could have important performance implications for supply chain performance: collaboration, IOS integration, and process integration.

Supply chain relationships have evolved from arms-length transaction processes to collaborative processes over the past two decades and the latter are better in responding to dynamic and unpredictable changes (Hoyt & Huq 2000). The evolution from adversarial relationships to "win-win" partnerships is frequently documented in the academic and trade press (Corsten & Felde 2005). The primary motives behind supply chain collaborations are the reduction of uncertainties, thereby gaining cost, cycle time, and quality advantages (Kumar & van Dissel 1996). To gain such benefits, partners voluntarily agree to integrate human and technical resources without the burden of financial ownership (Bowersox et al. 2003). However, traditional supply chains are a sequence of weakly connected activities and decisions both within and outside of organizations, in which lack of cohesion undermines the value creation of the supply chain (Fu & Piplani 2004). Therefore, collaboration is viewed as a process that holds the value creation opportunity with more effective supply chain management (Bauknight 2000; Anderson & Lee 1999). Min et al. (2005) suggest that collaborative processes include joint decision-making and joint problem-solving. Then collaborative supply chain involves independent companies working jointly to plan and execute supply chain operations with greater success than acting in isolation (Simatupang & Sridharan 2002).

However, supply chain collaboration has been referred to as a process that requires “a high level of purposeful cooperation” (Spekman 1988, p.77). In other word, supply chain collaboration means that the supply chain partners must see the big picture in the product planning and delivery system to attain a larger gain (Simatupang & Sridharan 2008). Hence, collaboration between supply chain members can facilitate both strategic and operational foci, allowing them to exploit individual core competencies and in turn to strengthen the entire supply chain (Daugherty et al. 2006). Giving the supply chain members being viewed as stakeholders (Angerhofer & Angelides 2006), Min et al. (2005) claims the nature of collaboration includes information sharing, joint planning, joint problem solving, joint performance measurement, and leveraging resources and skills. On the other hand, Simatupang and Sridharan (2005; 2008) emphasize that supply chain collaboration has three important dimensions: information sharing, decision synchronization, and incentive alignment. In addition, Tracey and Smith-Doerflein (2001) highlight the communication and cooperation across all parties in the supply chain as the important human dimension. In particular, Daugherty et al. (2006) recognize collaboration is characterized by formal meeting held on a regular basis in which the supply chain members can monitor progress, reassess goals and objectives, discuss collaboration results and action plans, and identify future business opportunities. Similarly, Mihajlovic (2010) captures the strategic nature of collaboration and distinguishes strategic collaboration from process collaboration and technical collaboration. Therefore, we define inter-firm collaboration as that supply chain members share information and jointly involve in human-based activities for shared strategic goals. Stank et al. (2001) also view such human-based collaboration as relationship integration, which requires sharing common vision and proprietary planning and operational information.

Another theoretical view for analyzing inter-firm collaboration may be the relational view (Dyer & Singh 1998), which highlights knowledge-sharing routines as one important dimension for inter-firm relationship management and these routines can instill additional capabilities in organizations (Vachon & Klassen 2008) to contribute to firm performance. Dyer and Singh (1998) argue that a firm's partners are the most important source of new ideas and information that result in performance-enhancing technology and innovations. Accordingly, they suggest that superior inter-firm knowledge-sharing routines for partners' human-based interactions can generate economic rents. The inter-firm knowledge-sharing routines may involve strategic thinking, relevant information exchange, human-based activity, and joint problem-solving that collectively imply inter-firm collaboration. However, these routines substantially aim to forge an environment for knowledge-sharing and in turn nurture solutions as well as shape performance rather than focus on technology and innovations that are ready to become products. Hence, such routines may facilitate addressing the difficulties resident in integration works and thereby forming solutions for greater supply chain performance. Therefore, the relational view may provide the foundation for analyzing the effect of collaboration on the integration mechanisms for improving supply chain performance.

Overall, human capital theory, systems view, and relational view may provide an integrated perspective to explore the antecedents of supply chain governance by recognizing the importance of integration as well as collaboration resident in such governance. That is, tightly integration is a rather traditional way to pursue superior supply chain performance when supply chain members take the systems view. However, human-based collaboration, which represents relational view, could take care of the blind side of incentive alignment while supply chain members emphasize "win-win" partnership for co-creating value in demanding business environment. Even so, the rarely-explored human capability antecedents to drive the governance mechanisms derived from systems view or relational view are still worthy of investigation. Namely, IT professionals' skills, drawn from human capital theory, may deserve to more attentions when we consider that effective governance hardly emerges without adequate human capability. In sum, human capability could improve the effects of governance mechanisms at least in terms of problem-solving and communication productivity that informs the relationships among human capital theory, the systems view, and the relational view. Figure 1 shows our research model. In what follows, we develop our research hypotheses.

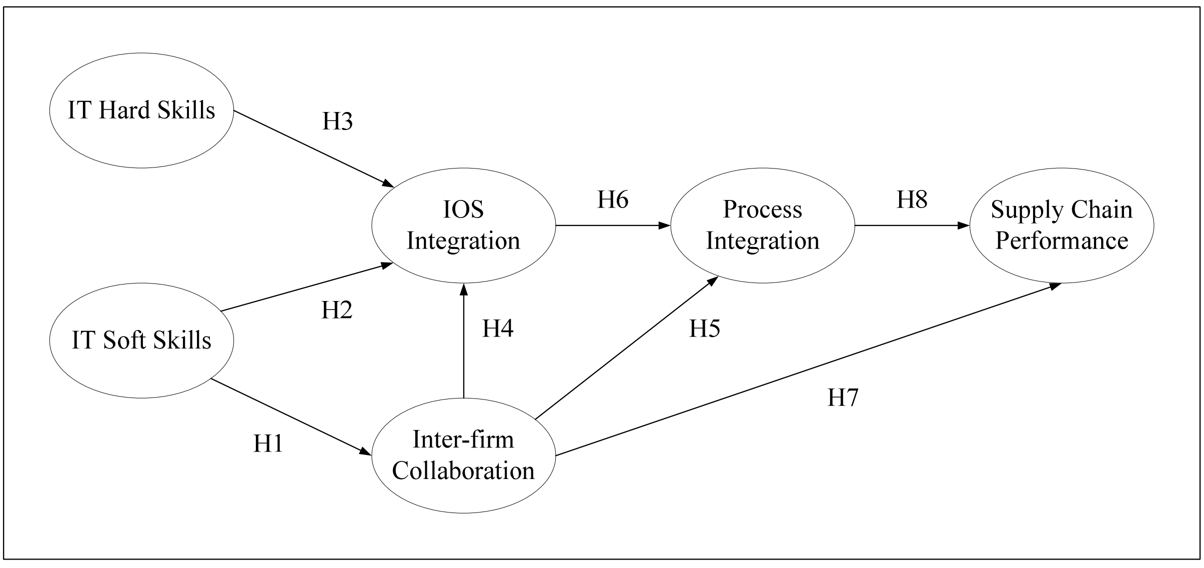

Figure 1. Research Model

2.1 Soft Skills and Collaboration

Although lack of trust between business partners is one of the main hindrances to collaboration in the supply chain context (Ireland & Bruce 2000; Barratt 2004), the insufficiency of skills/competences of partners may be another critical reason for collaboration failure. Fulfilling collaborative objectives not only require the participation of the relevant stakeholders, but also the application of separate skills in the supply chain environment (Roy & Whelan 1992). Gold et al. (2010) suggest that competences and resources for building and maintaining effective relationships with suppliers and customers turn out to be the preconditions of successful collaboration in supply chains. Vlachopoulou et al. (2002) also point out that the antecedents of collaboration are competencies leveraged by the skills and expertise of each partner. In other words, successful supply chain collaboration is leveraged by joint capabilities and resources across the supply chain (Daugherty 2006). In fact, supply chain collaboration involves explicit and tacit knowledge transfer that resides in "social interactions" (Lang 2004). Boundary-spanning personnel and activities are thus critical for achieving effective collaboration, implying the importance of human aspect of collaboration. Fawcett et al. (2008) observe that sustained investment in people's skills and emotional safety is needed to overcome the resisting forces of inertia and risk aversion and establish a collaboration culture. Similarly, Gray (1991) and Tjosvold (1988) also emphasize the success of collaborative behaviour depends on the ability of individuals to build meaningful relationships. In the same vein, Braithwaite (2005) thinks that the skills underlying supply chain best practice and a strong focus on developing people skills are also critical success factors for supply chain collaboration. He then highlights that the development of skills and talent in relation to the supply chain requires soft interpersonal skills because the concept of supply chain collaboration has relationships and working together as a basic principle. Moreover, Hoegl and Wagner (2005) emphasize, given the performance relevance of the quality of collaborative exchanges between buyer and supplier members on projects, the buyer organization needs to recognize that not only technical expertise and experience but also social and project management skills are important in ensuring supplier involvement and the desired benefits.

Specifically for IT personnel, they are expected to have both business and interpersonal skills (Lee et al. 1995; Rockart et al. 1996). A good mix of technical, business, and interpersonal skills are needed to meet the challenges from their working environment (Chung et al. 2005). Since soft skills may implicitly include a few relevant dimensions depending on the specific context, we define IT soft skills as a set of technology management skills and interpersonal skills (Lee et al. 1995). While technology management skills emphasize how to deploy IT effectively for meeting strategic business objectives, interpersonal skills focus on how to access success through interactions between individuals. Technology management skills may reflect such abilities as IS functions management, project management, and an understanding of technological trends as well as business knowledge. In the supply chain context, IT personnel are equivalently expected to possess such soft skills to facilitate inter-firm collaboration for addressing IT-related problems under the shared strategic goals. For example, technology management skills are needed for understanding the key success factors and closely following the trends in current technologies to ensure the desired quality of supply chain collaboration. Also, the interpersonal skills, such as involving in cross-functional teams to address business problems and working cooperatively in a project team, can also benefit supply chain collaboration. Consequently, we propose the following hypothesis:

Hypothesis 1: IT soft skills are positively associated with inter-firm collaboration.

2.2 Soft Skills and IOS Integration

IOS integration is a specific configuration of IOS that reflects tighter linkages between trading partners enabled by IT (Grover & Saeed 2007). Hong (2002) defines IOS as the information and communications technology that transcends organizational boundaries, such as electronic data interchange (EDI), electronic funds transfer (EFT) and supply chain management systems (White et al. 2005). Rai et al. (2006) suggest that IOS integration includes two elements: data consistency and cross-functional application systems integration. While data consistency pursues the consistency of information, physical, and financial flows, cross-functional application systems integration aims to generate cross-functional information visibility for facilitating the coordination of supply chain processes (Kalakota & Robinson 2001; Rai et al. 2006).

When using previous generations of IOS such as EDI, firms have fostered technical and managerial skills for IOS implementation as well as have developed a deeper understanding about the economic and organizational impacts of IOS (Lyytinen & Robey 1999). Such skills and knowledge are acquired primarily through learning-by-doing (Fichman & Kemerer 1997) and they are critical for successful adoption of new technology standards (Cohen & Levinthal 1990). However, prior IOS studies largely presume that firms possess the necessary skills and focus on non-human factors to account for the effectiveness of IOS integration. Implementing IOS has its inherent complexity that implies the lack of managerial capability will increase the risk of needed changes, incur greater costs, or obtain fewer benefits than expected (Zhu et al. 2006). Hence, Zhu et al. (2006) indicate that firms need to shift their attention from technical skills to managerial capabilities to effectively migrate inter-firm coordination to IOS. Managerial capabilities/skills are soft abilities in contrast with the traditionally focused hard skills of various professionals. The appeal for soft skills has pervasively existed in practice for a long time. For IT personnel to address the problems of IOS integration, we hold that they need not only IT management skills but also interpersonal skills to entrench the effectiveness of IOS integration, as trading partners' involvement always account for the success/failure of IOS integration. When IT personnel possess such skills as IS functions management, project management, and understanding of technological trends, they are able to facilitate the integration of the data and application architecture, the allocation of resources, and the avoidance of technological risks, which all contribute to IOS integration. Further, if IT personnel possess the interpersonal skills such as teaching, co-working and interacting with others, they will be more effectively to address the inter-firm issues that require cross-boundary interaction and cooperation. Therefore, this study holds that IT soft skills should facilitate IOS integration, as the following proposition suggests.

Hypothesis 2:IT soft skills are positively associated with IOS Integration.

2.3 Hard Skills and IOS Integration

Many studies of innovation adoption claim large organizations are more likely to adopt EDI than small organizations because they possess the resources and the skills necessary to assimilate the innovation effectively (O'Hanlon 1993). Kauffman (2000) also emphasizes the noneconomic reasons, such as site-specific implementation requirements and availability of skilled personnel, for innovation adoptions. In addition to soft skills addressed above, hard, technical skills, such as programming, database design, and network configuration, are undoubtedly needed for implementing IOS integration. For example, with sufficient programming skills, IT personnel are able to shoot and fix the troubles encountered with application integration. Similarly, database design skills are useful for dealing with the issues of data inconsistency between firms. Consequently, we propose the following hypothesis:

Hypothesis 3: IT hard skills are positively associated with IOS Integration.

2.4 Inter-firm Collaboration and IOS Integration

The core of supply chain management is integration (Zeng & Pathak 2003). Rahim and Kurnia (2006) define IOS integration as seamless electronic exchange of data between IOS and back-end applications such as inventory systems and purchasing management systems. However, systems integration is all about interoperability (Shen et al. 2010). Implementing IOS integration inevitably has to deal with a variety of technology problems caused by conflicts of networks, data, and applications (Mouzakitis et al. 2009; Ramamurthy et al. 1999). Consequently, supply chain partners have to collaborate in order to resolve the incompatibility problems when implementing IOS integration. Further, collaboration, which generates goal alignment among partners, is a precondition for improving supply chain management practices such as IOS integration (Wood 1997). Power (2005) also stresses that effective information flows and streamlined logistics in integrated supply chains are based on robust and durable collaborative arrangements between trading partners. The feedback and mutual participation in collaboration are critical factors for achieving supply chain integration (Anderson & Narus 1990; Forslund 2007; Forslund & Jonsson 2009). Such collaboration, which promotes the willingness to share information and risk between partners, should therefore help overcome the difficulties of IOS integration. Thus, we propose the following hypothesis:

Hypothesis 4: Inter-firm collaboration is positively associated with IOS Integration.

2.5 Inter-firm Collaboration and Process Integration

Business processes denotes a structured and measured set of activities with specified business outcomes for customers (Davenport & Beers 1995). Chen et al. (2009) state that the process paradigm implies looking at organizations based on the processes they perform rather than on the functional units, divisions, or departments they are divided into (Cooper 1997; Cooper et al. 1997; Trkman et al. 2007). Process integration is ascribed to the logistics perspective (Otto & Kotzab 2003). Process integration refers to the management of various sets of activities by seamlessly linking relevant business processes within and across firms and eliminating duplicate or unnecessary parts of the processes for building a better-functioning supply chain (Chen et al. 2009). By integrating interrelating steps and stages of processes across organizational borders, process integration enables new services with effective monitoring and control of process flow (Klischewski 2004), and reduces cost, improve operation, increase responsiveness, and enhance long-term competitiveness and growth (Rai et al. 2006). Sokol (1996) similarly emphasizes that buyer and seller processes must be integrated for rapid purchase and responsive order fulfilment. The current focus for partners is on how they can better manage their supply chain activities to reduce cost, shorten cycle times, and increase innovations, and reduce time-to-market for new products and services (Handfield et al. 1999). Therefore, integrating inter-firm process toward a seamless supply chain has become a high priority for firms (Frohlich & Westbrook 2001).

In the prior literature, supply chain integration and process integration as well as coordination are interchangeable concepts due to the logistics tradition of supply chain. However, scholars are increasingly capable to distinguish human-based collaboration from process-based integration. In contrast to process integration, inter-firm collaboration means that the supply chain members share sticky information and jointly involve human-based activities for shared strategic goals. Skjoett-Larsen et al. (2003) emphasize that the previous arm's-length relationship can be replaced by a collaborative relationship characterized by a high degree of information exchange for creating more streamline business processes through open exchange of information. On the other hand, process integration has its inherent complexity to be simplified. Park and Kusiak (2012) point out that the work of process integration needs continuous splitting and combining of the process, and therefore it requires significant collaboration from partners and endures some level of inconvenience to reduce the complexity to a manageable level. As suggested by Chen et al. (2009), collaborative relationship can facilitate the connection and simplification of business processes across firm boundaries. Besides, collaborative arrangement may generate extensive communication and nurture shared values (Zineldin & Jonsson 2000) for addressing the difficulties in process integration. Common wisdom also suggests the use of collaboration among channel partners to share business information so as to achieve effective supply chain integration by simplifying core processes, streamlining cross company operations, and reducing consequent channel-wide costs (Lee 2000; Hammer 2001). Close collaborative relationships allow firms to focus on what their trading partners want and hence facilitate process integration to create more tailored service (Daugherty 2006). In sum, collaboration has the potential to improve process integration in many ways. For example, the collaborative action that partners meet frequently to discuss important issues both formally and informally facilitates relevant information exchange and problem-solving and thereby process integration. Thus, we propose:

Hypothesis 5: Inter-firm collaboration is positively associated with process integration.

2.6 IOS Integration and Process Integration

Grant (1996) advances the resource-based view (RBV) by arguing that resources have to transform into higher-order capabilities to ensure competitive advantage as well as organizational performance because capabilities in comparison to resources are difficult to imitate. Therefore, recent IS researches (Barua et al. 2004; Sambamurthy et al. 2003; Mithas et al. 2004) aim to reframe the notion from the direct performance impacts of IT resources to how IT shapes higher-order process capabilities that create firm performance. In the supply chain context, when IOS integration is viewed as a configured IT resource/capability, process integration can then be a higher-order organizational capability enabled by IOS integration. Information sharing is the core of inter-firm business process integration because data exchange is underlying material process (Becker 2003). For example, Parfett (1993) illustrates that EDI as the IOS in Ford were developed and implemented to streamline business processes and thus suggests that technological integration will prompt organizational integration. The rationale is that the enabling technology, which provides accurate, timely, and relevant information to all players in the supply chain, can support the management and control of material flows across organizational boundaries (Angerhofer & Angelides 2006). Past studies suggest that IOS integration not only improves information sharing in the supply chain and minimizes the bullwhip effect (Yao et al. 2007), but also enables process changes (Saraf et al. 2007). Bhatt (2000) further indicates that an integrated set of IT can eliminate redundant processes and provide opportunities for coordinating disparate processes, and the data integrated through IOS integration allows many sequential processes to be handled in parallel. In other words, IOS integration provides the flexible foundation for process adjustment or redesign, thus facilitating inter-firm process integration. Thus, the following hypothesis is proposed:

Hypothesis6: IOS Integration is positively associated with process integration.

2.7 Inter-firm Collaboration and Supply Chain Performance

Chow et al. (1994) conclude that performance is a complex concept in supply chains because of the multiple goals, and selecting the appropriate performance measures is challenging due to the inherent complexity and interdependence within supply chains. Neely et al. (1995) suggest that cost, time, quality, delivery, and flexibility are the important measures of operational performance. However, while removing unnecessary steps as well as speeding up information and material flows are critical operational dimensions of supply chain performance, creating long-term collaborative partnerships sets the foundation for achieving continuously improved supply chain performance (Zailani & Premkumar 2005). Many studies indicate that collaboration offers the promise for improving supply chain performance in such areas as increased sales, reduced costs, improved forecasts, reduced inventory, more accurate and timely information, and improved customer service (Daugherty et al. 1999; Waller et al. 1999; Industry Directions, Inc. & Syncra Systems, Inc. 2000; Barratt & Oliveira 2001; Angulo et al. 2004). By collaborating, firms are encouraged to exchange tacit knowledge and thus generate new knowledge for mutual benefits (Lang 2004). For example, the collaborative effort for better logistics design has the potential to reduce cost and improve responsiveness, and supply-side collaborative information sharing benefits available-to-promise (Swaminathan 1996) and shorten stock-out waiting time (Zipkin 2000). Numerical experiments also show that partners' collaboration has the ability to improve the supply chain performance in terms of better stabilizing effect and service level (Fu & Piplani 2004). In general, supply chain collaboration facilitates partners to reduce costs and increase revenues (Lee et al. 1997). In particular, supply chain collaboration reduces the costs of opportunism and monitoring and therefore increases the probability that supply chain partners behave in the best interest of the partnership (Croom 2001). All these can help supply chain partners increase competitiveness and thereby enhance firm performance (Duffy & Fearne 2004). A recent study by AMA (American Marketing Association) Research shows that supply chain collaboration can add as much as three percentage points to profit margins for all types of supply chain players (Attaran & Attaran 2007). Consequently, we propose:

Hypothesis7: Inter-firm collaboration is positively associated with supply chain performance.

2.8 Process Integration and Supply Chain Performance

Process integration may consist of process connectivity and process simplification. While process connectivity refers to smooth linkages between different business processes within and across firms, process simplification is about eliminating unnecessary parts or steps of connected processes (Chen et al. 2009). Thus, process integration inherently encompasses some kinds of problem-solving works. Klischewski (2004) suggests a number of differences in comparing process integration with information integration. While information integration focuses on information flow, information modelling, and interoperability of system function components, process integration emphasizes workflow, modelling of performance entities, and interoperability of organizational function components. Hence, process integration should have a more direct effect on supply chain performance than IOS integration. In addition, Rai et al. (2006) report that physical process integration can bring tangible benefits such as improving productivity, increasing order frequency, cutting buffer inventory, reducing purchasing costs, as well as generate intangible benefits such as increasing responsiveness, improving customer relationships and service, improving long-term competitiveness. Moreover, Lambert and Cooper (2000) emphasize that performing the order fulfilment process effectively requires integration of manufacturing, distribution, and transportation processes for developing a seamless process between supply chain members. Besides, while Zailani and Rajagopal (2005) point out the goal of process integration lies on seamlessly creating and coordinating manufacturing processes that most competitors cannot easily match, Birou et al. (1998) consider the opportunity to use process integration as a key to competitive success. In fact, process integration is a necessary condition for agile supply chain (Christopher 2000), and the performance effect of process integration is well documented in the literature (Stevens 1989; Lee et al. 1997; Metters 1997; Narasimhan & Jayaram 1998; Lummus et al. 1998; Anderson & Katz 1998; Hines et al. 1998; Johnson 1999; Frohlich & Westbrook 2001). Thus we propose:

Hypothesis 8: Process Integration is positively associated with supply chain performance.

3 RESEARCH METHODOLOGY

3.1 Measurement Development

All measures of the study are adapted from existing measures in the literature to fit the context of supply chain. A seven-point Likert scale is adopted, with anchors ranging from strongly disagree (1) to strongly agree (7), and all measurement items are reflective indicators of the research constructs. After compiling an English-language version of the questionnaire, the original questionnaire was translated into Chinese. The survey items then were verified and refined for translation accuracy by an MIS professor and a senior doctoral student.

3.2 Survey Administration

This study focused on large and medium-sized manufacturing companies in Taiwan and the sampling frame was “The Top 5,000 Corporations in Taiwan 2010” published by China Credit Information Service. The top 2,000 manufacturing firms were selected to distribute our survey. IT managers were chosen as the informants because we believe that senior IT managers should be the most knowledgeable and reliable informants within a company to answer the questionnaire.

A total of 2,000 survey packets were mailed on April 18, 2012 and subsequently 300 surveys were returned with 250 completed surveys for subsequent analysis, yielding an effective response rate of 12.5%. The mailing to each respondent included a cover letter explaining the purpose of the study, the questionnaire, and a self-addressed stamped return envelope. To encourage response, the mailing also noted that NT$30 would be donated to United Way of Taiwan, the largest non-profit organization of the kind in Taiwan, for each effective questionnaire.

3.3 Data Analysis

Data analysis utilized a two-step approach as recommended by Anderson and Gerbing (1988). The first step involves the analysis of the measurement model, while the second step tests the structural relationships among the latent constructs. The aim of the two-step approach is to establish the reliability and validity of the measures before assessing the structural relationship of the model. SmartPLS 2.0 M3 was used to assess both the measurement model and the structural model because PLS places minimal restrictions on measurement scales, sample size, and residual distribution (Chin and Newsted 1999).

3.3.1 Measurement Model

The adequacy of the measurement model was evaluated on the principles of reliability, convergent validity, and discriminant validity. Reliability was examined by the composite reliability values. Table 1 shows that all the values are above 0.7, satisfying the commonly accepted threshold. The convergent validity of the scales was assessed by two criteria (Fornell & Larcker 1981): (1) all indicator loadings are significant and exceeds 0.7 and (2) average variance extracted (AVE) of each construct exceeds the variance due to measurement error for that construct (i.e., AVE should exceed 0.50). As shown in Table 2, most items exhibited a loading higher than 0.7 on their respective construct, and as shown in Table 1, all the AVEs range from 0.51 to 0.86, thus satisfying both the criteria for convergent validity.

Constructs	Items	Composite Reliability	Mean (STD)	AVE
IT Soft Skills (SS)	13	0.93	5.65 (0.99)	0.51
IT Hard Skills (HS)	5	0.85	5.00 (1.18)	0.53
Inter-firm Collaboration (CO)	6	0.94	4.53 (1.41)	0.73
IOS Integration (IOSI)	6	0.96	2.93 (1.65)	0.79
Process Integration (PI)	5	0.97	3.57 (1.66)	0.86
Supply Chain Performance (SCP)	11	0.97	4.92 (1.27)	0.72

Table 1. Reliabilities and Average Variance Extracted

Discriminant validity was assessed by two criteria. First, that the loading of each measurement item on its assigned construct is larger than its loadings on all other constructs will be consider as having good discriminant validity (Chin 1998). Second, the square root of the AVE of a construct should be greater than the correlations between the construct and other constructs in the model (Fornell & Larcker 1981). As shown in Tables 2 and 3, both criteria are clearly met, demonstrating sufficient construct validity of the scales.

	SS	HS	CO	IOSI	PI	SCP
SS1	**0.64**	0.35	0.26	0.06	0.11	0.19
SS2	**0.79**	0.42	0.28	0.07	0.10	0.27
SS3	**0.79**	0.42	0.28	0.05	0.11	0.24

SS4	**0.70**	0.44	0.26	0.09	0.11	0.18
SS5	**0.72**	0.38	0.26	0.10	0.15	0.24
SS6	**0.75**	0.31	0.22	0.01	0.08	0.19
SS7	**0.75**	0.33	0.30	0.04	0.15	0.23
SS8	**0.78**	0.47	0.42	0.22	0.26	0.32
SS9	**0.74**	0.43	0.43	0.28	0.19	0.33
SS10	**0.63**	0.39	0.40	0.14	0.18	0.24
SS11	**0.67**	0.46	0.31	0.12	0.14	0.29
SS12	**0.64**	0.27	0.24	-0.01	0.08	0.23
SS13	**0.68**	0.38	0.31	0.11	0.08	0.31
HS1	0.28	**0.67**	0.18	0.21	0.19	0.19
HS2	0.47	**0.81**	0.45	0.29	0.21	0.23
HS3	0.46	**0.61**	0.24	0.10	0.15	0.25
HS4	0.40	**0.75**	0.32	0.21	0.20	0.29
HS5	0.46	**0.79**	0.45	0.27	0.27	0.17
CO1	0.39	0.40	**0.84**	0.45	0.38	0.27
CO2	0.38	0.45	**0.88**	0.51	0.45	0.33
CO3	0.36	0.43	**0.89**	0.56	0.53	0.34
CO4	0.43	0.41	**0.89**	0.45	0.48	0.33
CO5	0.34	0.41	**0.85**	0.52	0.49	0.32
CO6	0.43	0.31	**0.80**	0.38	0.35	0.26
IOSI1	0.11	0.23	0.47	**0.85**	0.55	0.28
IOSI2	0.18	0.28	0.55	**0.81**	0.51	0.29
IOSI3	0.12	0.29	0.49	**0.94**	0.57	0.32
IOSI4	0.19	0.31	0.51	**0.90**	0.56	0.33
IOSI5	0.15	0.29	0.49	**0.90**	0.58	0.34
IOSI6	0.12	0.28	0.48	**0.93**	0.59	0.33
PI1	0.16	0.25	0.48	0.63	**0.91**	0.35
PI2	0.19	0.27	0.52	0.56	**0.94**	0.39
PI3	0.17	0.25	0.49	0.63	**0.96**	0.40
PI4	0.21	0.28	0.49	0.54	**0.94**	0.42
PI5	0.21	0.25	0.45	0.57	**0.88**	0.42
SCP1	0.28	0.21	0.24	0.26	0.39	**0.77**
SCP2	0.23	0.21	0.29	0.33	0.40	**0.85**
SCP3	0.26	0.26	0.32	0.29	0.39	**0.87**
SCP4	0.28	0.20	0.32	0.30	0.36	**0.86**
SCP5	0.30	0.18	0.25	0.23	0.33	**0.87**
SCP6	0.35	0.23	0.34	0.28	0.36	**0.86**
SCP7	0.35	0.29	0.33	0.38	0.37	**0.85**
SCP8	0.32	0.23	0.32	0.33	0.39	**0.89**
SCP9	0.28	0.26	0.29	0.30	0.34	**0.83**
SCP10	0.35	0.29	0.33	0.31	0.32	**0.84**
SCP11	0.40	0.35	0.35	0.30	0.34	**0.83**

Table 2. Cross Loadings of Measurement Items

	SS	HS	CO	IOSI	PI	SCP
SS	**0.72**					
HS	0.56	**0.73**				
CO	0.45	0.47	**0.86**			
IOSI	0.16	0.32	0.56	**0.89**		
PI	0.20	0.28	0.53	0.63	**0.92**	
SCP	0.36	0.29	0.36	0.36	0.43	**0.85**

Table 3. Correlation among Constructs and the Square Root of the AVE

3.3.2 Structural Model

For the structural model, we examined the structural paths and the R-square scores of endogenous constructs to assess the explanatory power of the model. Figure 2 shows the results of structural path analysis. All paths exhibited as significant with a P-value less than 0.01. The significance of all paths was assessed with 500 bootstrapping runs. Overall, the R-square scores of endogenous variables range from 20.5% to 44.4%, presenting good explanatory power in this model.

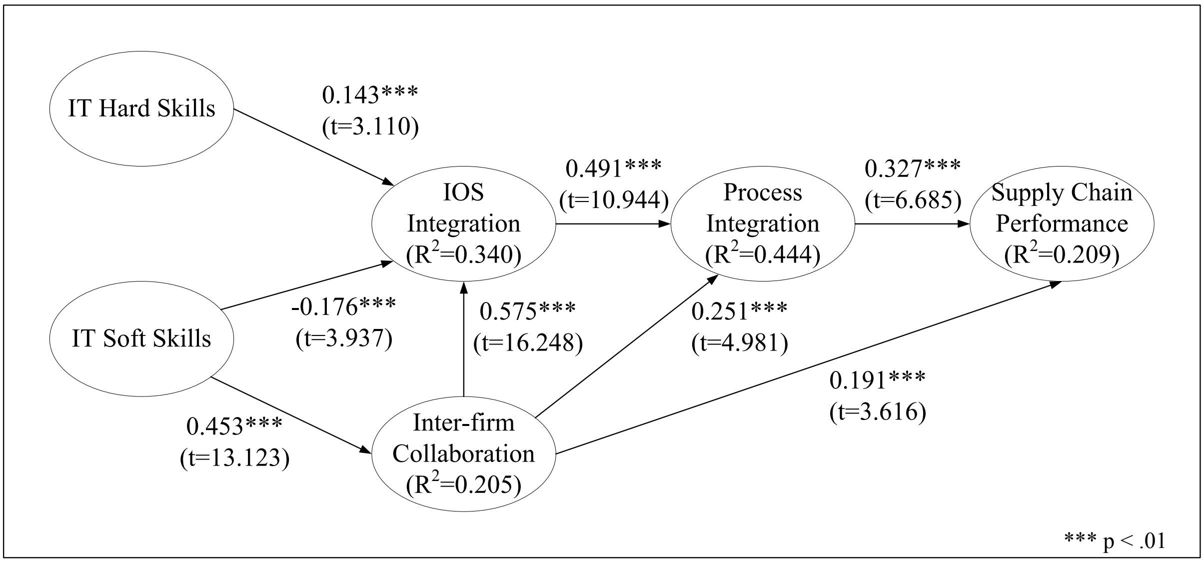

Figure 2. PLS Analysis of Results

4 DISCUSSION AND IMPLICATIONS

4.1 Summary of Results

According to the result, seven out of eight hypotheses are positively significant as expected, except for the effect of soft skills on IOS integration, which is surprisingly negatively significant. Trust and bargaining power may play a latent role in confounding the proposed effect but their potential effects require further investigation. IT cultural values (Leidner & Kayworth 2006) may also provide an explanation to this surprising result. That is, the higher extent of soft skills, such as technology management skills and interpersonal skills, the higher possibility of the IT personnel's intention to employ these non-technical skills to solve the technical problems that often are perceived as hard work in IT personnel's values. Such intention may become the handicap of dealing with the "dirty job" in IOS integration and accumulate pains of other colleagues or partners. As such, the willingness to faithfully conduct the required work of IOS integration may decrease, thus hindering IOS integration. Nevertheless, despite the unexpected effect, the model overall suggests that soft skills can influence IOS integration through inter-firm collaboration, which in turn facilitate supply chain integration, eventually leading to greater supply chain performance.

4.2 Implications for Theory

Although human capital theory suggests that people who possess knowledge, skills, and abilities would provide economic value to firms via increased productivity, the academics have little understanding of what kinds of skills are required and what contexts are relevant for exerting these skills. Our study provides an avenue to distinguish soft skills from hard skills for understanding their idiosyncratic impacts on IT personnel's practical work in the supply chain context and thus embodies the theoretical perspective as well as improves our knowledge of the impact of IT skills. More important, we show that intra-firm IT skills indeed can have cross-boundary effects that benefit supply chain management and performance. On the other hand, the systems view of supply chain recognizes that a supply chain should be treated as a single entity or one complete system while linkages among supply chain members are premised to lead to superior performance. According to this theoretical view, we not only identify IOS integration and process integration as critical for linking supply chain members together but also recognize that IOS integration serves as the enabler of process integration for optimizing supply chain systems. We also emphasize collaboration based on the relational view to highlight knowledge-sharing routines as the soft side of supply chain relationship governance in comparison to the hard side through integration. Our model demonstrates the softer collaboration not only facilitates hard integration works but also contributes to supply chain performance and hence recognizes the importance and value of the relational view in the supply chain context.

4.3 Implications for Practice

Practitioners have recognized and called for the importance of soft skills for decades. For IT personnel, our model demonstrates how to decompose IT skills into hard skill, i.e. technical skills, and soft skills including technology management skills and interpersonal skills. Such a distinction of IT skills should be helpful for IT personnel development in today's increasingly dynamic task environment. Further, according to our results, conducting IOS integration before process integration can realize greater integration benefits and thus provides guidelines for considering the priority of various supply chain integrations. Further, inter-firm collaboration, which contributes to "win-win" strategies, proves its worth for co-creating value between supply chain partners and allow the opportunity to reconfigure supply chain partners' mindsets for entering the winner zone in the increasingly competitive business environment.

4.4 Limitations

Our research has a number of limitations. First, for the constructs of hard skills and soft skills, collecting the data from the both sides of a dyad demands much more effort and resource. We thus chose the buying firms as the respondents to represent the dyadic relationship because buying side is closer to customers who fire the demand to bring supply chain performance. Second, because power asymmetry is traditionally notorious in dyadic relationships in the supply chain environment, we cannot eliminate the confounding effect of power on some of our research constructs. Third, our variance model tested by data from a cross-sectional survey cannot offer clear-cut causality among those constructs such as IOS integration, process integration, and inter-firm collaboration. Longitudinal process model may be more pertinent to clarifying the causality. Fourth, our definition and operationalization of soft skills are hardly complete. For current research, we just extract the essences from the literatures to frame technology management skills and interpersonal skills as IT personnel's soft skills. A more comprehensive study of IT soft skills is still needed.

4.5 Future Research

Based on the importance of soft skills and the context of supply chain, we suggest the following directions for future research. First, academics could investigate soft skills in other contexts rather than the supply chain. Second, understanding the relationships between the mechanisms in this research and additional governance mechanisms such as trust may deserve more research attention. Third, exploring dimensions of the relational view other than collaboration that affect those integration mechanisms may also be a fruitful direction for future research.

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