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THE IMPACT AND IMPLICATIONS OF INFORMATION TECHNOLOGY FOR SUPPLY CHAIN MANAGEMENT SYSTEMS ON CHANNEL RELATIONSHIPS AND FIRM MARKET PERFORMANCE

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THE IMPACT AND IMPLICATIONS OF INFORMATION TECHNOLOGY FOR SUPPLY CHAIN MANAGEMENT SYSTEMS ON CHANNEL RELATIONSHIPS AND FIRM MARKET PERFORMANCE

By

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ABSTRACT

THE IMPACT AND IMPLICATIONS OF INFORMATION TECHNOLOGY FOR SUPPLY CHAIN MANAGEMENT SYSTEMS ON CHANNEL RELATIONSHIPS AND FIRM MARKET PERFORMANCE

By

Daekwan Kim

Although the impact of information technology (IT) on firm activities is known to be radical, practitioners and researchers have claimed that IT has a weak or no impact on firm performance. This study explores how IT for supply chain communication systems (SCCS), a critical component of supply chain management systems (SCMS), affects channel relationships and firm market performance. Adopting the resource-based view of the firm as the theoretical framework, the current study hypothesizes that firm IT resources (e.g., IT advancement, IT appropriability, and SCCS integration) facilitate internal channel capabilities such as interfirm information exchange, interfirm coordination, and supply chain responsiveness, which in turn affect firm market performance.

The empirical research is based on 184 responses from a survey with corporate supply chain managers and logistics managers. The results suggest that the impact of IT advancement on channel capabilities (i.e. interfirm information exchange and interfirm coordination) is mediated by SCCS integration as no direct relationship was found between IT advancement and channel capabilities. In contrast, IT appropriability for SCCS enhances interfirm information exchange and coordination activities directly, without such mediation by SCCS integration. The influence of IT advancement on channel capabilities through SCCS integration is weaker than the direct impact of IT

appropriability. Furthermore, although significantly mediated by SCCS integration, the impact of IT advancement is not strong enough to affect either supply chain responsiveness, which is an immediate outcome variable of IT resources and other channel capabilities, or firm performance. On the other hand, IT appropriability influences both supply chain responsiveness and firm performance.

The implication is that firms which depend upon IT advancement for channel capabilities are more likely to experience incremental improvements in those capabilities as well as firm market performance. Therefore, IT investment directed toward appropriability is more likely to have a significant impact on performance than that directed toward IT advancement. However, managers should not overlook the role of IT advancement as a facilitator of SCCS integration, which also has a significant impact on supply chain responsiveness and firm performance. These findings explain when and how firm's investments in IT resources enhance firm capabilities and performance. Moreover, the results reveal that a strategic IT investment in SCMS is key to the improvement of firm channel capabilities and performance.

This dissertation is dedicated to

my wife, Soojin, precious son, Urim (Joseph), and lovely daughter, Erin,

in appreciation of their patience, sacrifice, support, and encouragement;

and to my mother, Yonghee Won, father, Kiman Kim,

mother-in-law, Choonja Park, and father-in-law, Dukno Yoon,

in appreciation of the encouragement they offered to me.

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CHAPTER 1

INTRODUCTION

Recently the role of information technology (IT) has received a great deal of attention from researchers as a potential enabler of competitive advantage for firms (Humphreys, Lai, and Sculli 2001; Sanders and Premus 2002). IT provides various interfaces that enhance not only firms' relationships with consumers or partners but also their competitive advantages, through the improved internal capability that results when IT is adopted and used effectively (Humphreys, Lai, and Sculli 2001; Porter 2001). The rapid adoption of the Internet for communication with customers and/or partners seems to reflect the perceived potential of this communication medium. Practitioners and scholars alike have high expectation for the benefits of the Internet, and the growing popularity of dot-coms in stock markets seems to echo that optimism. Certainly, there are apparent benefits of IT: the significant expansion of geographic market boundaries, efficient communication, and improved management tools, such as enterprise resource planning (ERP), customer relationship management (CRM), and supply chain management (SCM). If deployed adequately, IT is expected to give firms a clear competitive advantage (Porter 2001; White 1999).

Despite the wide availability of and investments in IT, some are pessimistic about the potential benefits of IT. For example, the *Financial Times* (e.g., "Forget IT, it is Wal-Mart behind US Miracle," October 17, 2001), and other popular business media cast doubt on the contributions of IT to firm performance. A growing number of scholars claim that the real value of IT (Chircu and Kauffman 2000) is questionable (Baker and Abrahams 2001; Baker and Sinkula 1999; Kettinger et al. 1994; Powell and Dent-

Michallef 1997). Thatcher and Oliver (2001) note that the "IT productivity paradox" has been debated in the literature since the 1970s. Since then, concerns about IT productivity have spread from the economy level to the industry, firm, and activity level (Thatcher and Oliver 2001) as researchers report either no impact or even a negative influence of IT on productivity (Baker and Abrahams 2001; Brynjolfsson 1993; Kettinger et al. 1994; Loveman 1991; Mukherjee 2001; Panko 1991; Powell and Dent-Michallef 1997; Rai 1997; Rai, Patnayakuni, and Patnayakuni 1996; Roach 1987; Roach 1991; Strassmann 1990). Specifically, Kettinger et al. (1994) report that 21 firms out of 30 experienced negative consequences of IT investment on market share or profits within five years of IT deployment. Powell and Dent-Micallef (1997) also found a significant negative relationship between IT and overall store performance in their survey with retailers. Moreover, the sharp decline of the stock market in 1999 and the erosion of interest in IT among practitioners and researchers have raised questions about the vital role of IT within a firm (Porter 2001).

A gap seems to exist between the expectations of researchers and practitioners and the real role of IT despite its substantial potential. This gap stems from several different factors: the slow diffusion of IT across industries and markets, the relatively slow development of IT, and the lack of physical interaction between parties. Nevertheless, these do not fully explain the rapid decline of interest in dot-coms or broadly IT because the development of IT is still better than initially expected, and the diffusion of IT has been relatively rapid in North American markets. Furthermore, the deficiency in physical interaction is not an unexpected characteristic for IT. What is, then,

the real value of IT in the modern business enterprise? Do firms derive positive returns from IT investment?

According to the resource-based view (RBV) of the firm, internal resources give the firm competitive advantage only when they are unique and inimitable by competitors (Barney 1991; Collis 1994; Porter 1991). These resources include firm's various assets, capabilities, organizational processes, knowledge, technologies, and information (Barney 1991; Collis 1994). RBV argues that when IT facilitates information exchange and sharing, it can lead to such internal capability of firms as information collection and knowledge creation. RBV further maintains that resources will provide competitive advantage to the owning firm only if they are inimitable by competitors, durable enough to promise future advantages, unique to the owner, and immobile across firms (Barney 1991; Collis 1994). The theory is powerful in explaining how a firm's resource advantages relate to performance, especially in terms of efficiency and effectiveness. In the similar vein, DiMaggio and Powell (1983) argue that firm performance or other benefits from a technology will decrease over time as it diffuses across firms. In other words, a resource becomes less valuable for the owner as more firms deploy it. DiMaggio and Powell (1983) and RBV share the viewpoint that the uniqueness of a resource is critical to maximize its return.

RBV seems to explain the recent dramatic devaluation of dot-coms (Porter 2001). Although IT (i.e. the Internet) was viewed as a tool to improve firm performance in the introductory stage, the busting of the bubble should not have been unexpected given the rapid diffusion of it across firms with its wide compatibility and availability. According to RBV, uniqueness, immobility, and inimitability are key features of resources for

sustainable competitive advantages of firms (Barney 1991; Barney, Wright, and Ketchen 2001; Collis 1994). As a major breakthrough in IT, the Internet has significantly improved communication between parties, and the efficiency and effectiveness of communication in general. Yet, its massive adoption has made the deployment of the Internet, for instance, only a necessary but not a sufficient condition for the creation of competitive advantage (Andersen and Segars 2001; Porter 2001). That is, unless the IT is unique to an organization so that it cannot be imitated by competitors or is immobile across firms, its value for competitive advantage will decrease significantly as more firms adopt the same technology (DiMaggio and Powell 1983; Porter 2001). In such case, RBV argues that firms need to find unique ways to utilize the advanced IT that will lead to competitive advantages considering the extensive availability of IT (Andersen and Segars 2001). Despite the demand on IT research, studies on how IT enhances firm's internal capabilities and thus influences firm performance remain sparse.

Interorganizational Interaction and Corporate Information Systems

With recent advances in IT, more firms are interested in achieving efficient and effective communication with their partners (Bowersox et al. 1995; Cunningham and Tynan 1993). Manufacturers need to work closely with their suppliers and distributors to reduce unnecessary inventory, which usually leads to cost reduction and, then, ultimately to competitive price of their products (Porter and Millar 1985). In addition, without active information exchange with partners, manufacturers are likely to lag behind competitors due to slow reaction to market and/or environmental changes, and less competitive new product development due to lack of market information shared among

channel members (Bowersox, Closs, and Stank 1999; Cunningham and Tynan 1993; Humphreys, Lai, and Sculli 2001). Distributors have to work closely with their inbound suppliers and outbound retailers to postpone the point of sale to end-consumers as far as possible in order to reduce inventory cost (Heskett 1977; Waller, Dbaholkar, and Gentry 2000). Retailers also need to share information about customer preference to serve them better by incorporating those preferences into products (Chandra, Kumar, and Smirnov 2001). Briefly, interorganizational interaction among channel members is more critical than ever before (Bowersox et al. 1995; Bowersox, Closs, and Stank 1999; Chandra, Kumar, and Smirnov 2001; Cunningham and Tynan 1993; Humphreys, Lai, and Sculli 2001; Steinfield, Kraut, and Plummer 1995).

Contemplating this need for interorganizational interaction, interorganizational systems (IOS) are designed to facilitate information sharing between partners in order to serve customers better and to reduce costs (Cunningham and Tynan 1993; Humphreys, Lai, and Sculli 2001; Johnston and Vitale 1988; Lewis 2001). By working closely with their partners, supplying them with internal information, and transmitting information to and retrieving it from partner's systems directly, firms can shorten delivery time and incorporate critical market information into their production by increasing communication efficiency and effectiveness through IOS (Humphreys, Lai, and Sculli 2001; Truman 2000).

IOS is a type of corporate information systems (CIS). A CIS consists of media (the firm's computer hardware and software), actors (users), and content (information) stored in hardware and software. There are many popular types of CIS that directly and indirectly support interorganizational interaction: enterprises resource planning (ERP)

systems, customer relationship management (CRM) systems, supply chain management (SCM) systems, and selling (chain) management systems (SMS) (Rayport and Jaworski 2001). Similarities and differences among various CIS are compared and contrasted in Table 1.

ERP systems focus on sharing firm's internal information in a unified manner (Rayport and Jaworski 2001; Robinson and Winson 2001). Through standardized processes and codified information, from top management to managers across functional areas, internal decision makers have full access to necessary information, usually through their corporate intranet. ERP systems with this definition are not necessarily an IOS. However, some researchers consider ERP systems as an IOS by including interorganizational resource planning concept in its definition (Bowersox, Closs, and Cooper 2002). That is, although ERP systems are focusing on internal information sharing, the systems should be able to interface with other channel partners' systems to facilitate decisions making adequately, accessing the inventory information of partner's systems, the current stock level of retailers for production planning, or changes in customer preference.

TABLE 1: CORPORATE INFORMATION SYSTEMS

	System Components			Primary Objective
	Media	**Actors**	**Content**	
ERP Systems	Internal hardware (HW) and software (SW)	Internal users	Internal information	Internal information sharing
CRM Systems	Internal HW and SW	Internal users	Information about customers	Customer relationships
Procurement Systems	Internal HW and SW + network + supplier's HW and SW	Internal users and suppliers	Information about suppliers and suppliers' products	Limited collaboration with suppliers
Selling Chain Management Systems	Internal HW and SW + network + distributor's HW and SW	Internal users and distributors	Information about products	Coordination with internal users and distributors
SCM Systems	Internal HW and SW + network + partner's HW and SW	Internal users, Suppliers, and distributors	Information about both firm's own and partner's products, production, inventory, customers, planning, forecasting, replenishment	Collaboration and relationships with suppliers and distributors

CRM systems are another type of CIS and emphasize efficiency and effectiveness in dealing with customers. The ultimate goal of CRM systems is to improve customer profitability through effective customer service by understanding their customers better based on customer account information and by increasing coordinated actions across functional areas (Rayport and Jaworski 2001). In the competitive business environment, a firm cannot serve customers effectively without talking to its business partners. Therefore, ideal CRM systems should be connected to key partners in order to share critical information. For example, if amazon.com were not connected to their suppliers' systems, its CRM systems would take orders from their online shoppers without knowing the current inventory level of suppliers. Under this situation, effective promotion activities would not be feasible for amazon.com, let alone efficient customer service. Therefore, although the main purpose of CRM systems is to enhance customer service by collecting and maintaining relevant customer information, they do not rule out interorganizational interaction for adequate system performance.

Another increasingly popular type of CIS is SCMS, which is the focus of the present study. These systems are designed to help firms gain a competitive position in the market by increasing the efficiency of information and product flow across channel members, from the inception to distribution of a new product (Humphreys, Lai, and Sculli 2001; Rayport and Jaworski 2001). Traditional electronic data interchange (EDI), a typical SCCS, plays a key role in the success of SCMS and information sharing across channel members (Humphreys, Lai, and Sculli 2001; Roberts and Mackay 1998). Recently, EDI technology has advanced significantly. Especially the emergence of Internet-based EDI has lowered the initial entry barriers that most proprietary EDI

systems have (Humphreys, Lai, and Sculli 2001; Lewis and Talalayevsky 1997). The barriers include initial investment in hardware and software, and employee training. As they are usually transaction-specific, the EDI requirement for transactions has been seen as a barrier for many firms. However, the improved compatibility of Internet-based EDI no longer requires high transaction-specific investment (Gudmundsson and Walczuck 1999B). But, the disadvantage is that each partner can be opportunistic in transactions, and therefore long-term commitment or relationship is unpredictable (Clemons and Row 1992) because of the low initial transaction-specific investment. EDI is now moving toward extensible markup language (XML) technology, which seeks complete elimination of the software compatibility issue. As firms reassess the importance of interfirm collaboration in the supply chain along with new technology such as XML, SCMS will play an increasingly critical role (Humphreys, Lai, and Sculli 2001).

Other types of CIS are selling chain management systems and procurement systems. Selling chain management systems is aimed at increasing efficiency in a firm's selling activities including pricing, quoting, and service. It allows more efficient team selling or sales force coordination (Rayport and Jaworski 2001). Procurement systems are specialized for a firm's procurement or purchasing activities. By reducing paperwork and processing time through streamlined approval process, procurement systems increase efficiency and effectiveness in procurement. However, both selling chain management systems and procurement systems are likely to be a part of above major CIS. Especially, sophisticated SCMS are embracing the major functions of both selling chain management systems and procurement systems as dynamism in a supply chain that seeks an improved competitive position requires the integration of selling activities and procurement

activities with supply chain activities. Furthermore, the close integration of ERP and CRM systems with SCMS should improve the efficiency of all three systems simultaneously (Roberts and Mackay 1998) although SCMS is key for active electronic interorganizational interactions with various internal information collected and maintained by ERP systems or CRM systems (Bowersox, Closs, and Cooper 2002). Overall, it is worth noting that an SCMS connects ERP and CRM systems across channel partners using supply chain communication systems (SCCS) and integrates procurement systems and selling chain management systems within a firm (Bowersox, Closs, and Cooper 2002). Table 1 highlights each type of CIS in terms of media, actors, and content.

Bowersox et al. (2002) share the view that SCMS is internally and externally integrated systems. But, they identify four different subsystems of SCMS: ERP or legacy systems, communication systems, execution systems, and planning systems, depending on the functions of those subsystems of SCMS. According to Bowersox et al. (2002), legacy systems include the mainframe systems adopted before the 1990s for order management (e.g., order entry and processing, warehousing, inventory management, transportation, and other order-related activities). Communication systems are those that facilitate efficient interfirm communications for transactions, forecasting, and planning. Subsequently, typical communication systems include EDI, the Internet, and/or satellite technology (Bowersox, Closs, and Cooper 2002). Execution systems include warehouse management systems, transportation management systems, and yard management systems that facilitate efficient logistics functions in conjunction with other CIS, such as ERP or communication systems (Bowersox, Closs, and Cooper 2002). Finally, planning

systems refer to the systems that support production scheduling, inventory resource planning, and transportation planning (Bowersox, Closs, and Cooper 2002).

Although different classifications and terminologies are used in the literature, it seems that SCMS comprises various content from different internal systems, media like EDI systems or communication systems, and actors who operate the systems. However, the current study explores the media aspect of SCMS rather than actors or content aspects. The media aspect of SCMS (i.e. communication systems) is the key component for the interorganizational interaction among channel partners, allowing an effective investigation on the impact of IT on channel relationships.

From Electronic Market to Electronic Hierarchy

According to the IT literature, electronic interorganizational interaction can be carried out in two forms: electronic hierarchy and electronic markets (Malone, Yates, and Benjamin 1987). Under an electronic hierarchy, the interaction is governed by management decisions of participating firms (Malone, Yates, and Benjamin 1987; Steinfield, Kraut, and Plummer 1995), while those decisions are based on such strategic reasons as reliable supply, quality control, and inventory cost reduction. Therefore, the relationship under an electronic hierarchy is long-term (Steinfield, Kraut, and Plummer 1995). A good example of the electronic hierarchy is the partnership between amazon.com and toysrus.com. The two independent firms formed a partnership in which amazon.com represents transactions made on its website from order acceptance to customer service for the products offered by toysrus.com, and toysrus.com provides online product information and connections between its suppliers and amazon.com to

make the online transactions possible (Bonisteel 2001). Under this partnership, price, supply and demand, and competition are less important for the transactions made at amazon.com website for the toysrus.com products. Only predetermined arrangements between the two firms control the electronic interaction between them.

On the other hand, under an electronic market, the electronic interorganizational interaction is primarily determined by such market mechanisms as price and/or supply and demand. Consequently, the interaction under electronic markets is not necessarily long-term, because a better price or other favorable transaction conditions may lead to transactions with other sellers or buyers (Malone, Yates, and Benjamin 1987; Steinfield, Kraut, and Plummer 1995). A typical example of electronic market would be NASDAQ, the electronic stock trading systems in the U.S., which has buyers or sellers who do not even know the identity of the other party to the transaction. Most of the interactions are extremely short-lived for most buyers and sellers. And, price is the only determinant of transactions within the systems (Steinfield, Kraut, and Plummer 1995).

The literature further argues that high coordination costs for transactions favor electronic markets, because interconnected systems make such coordination activities as searching for products in the systems cost-effective, which is referred to as the electronic brokerage effect (Steinfield, Kraut, and Plummer 1995). Alternatively, when there is a high need for integration between firms, an electronic hierarchy offers a synergy effect, the primary benefit, from systems interconnection, which is referred to as the electronic integration effect (Steinfield, Kraut, and Plummer 1995).

In general, electronic markets provide more business opportunities at lower transaction-specific investment as corporate systems continue to adopt highly compatible

technology. Competition can be severe, however, because market entry and exit are made more freely than in traditional markets with significantly lower switching costs. In other words, due to a significant expansion of geographic market boundaries in electronic markets, firms are able to buy from more potential suppliers and sell their products to more potential customers (Humphreys, Lai, and Sculli 2001). At the same time, the low market entry barriers can result in more competition and greater uncertainty.

For instance, in the internet service provider (ISP) industry, low-cost market entry and exit meant that even small firms could resell the Internet access service to end-users easily, with small margins on the wholesale price from national service providers. Due to the low entry barrier, the price of the Internet access service declined rapidly to well below $10 a month. Even free Internet service providers, with and without banner ads, expanded their shares very quickly (Kong 1999). Yet, competition in the industry did not allow most ISPs to stay in business more than a few years because most of them had to compete on price, while any difference in quality of service among ISP carriers did not seem to be very discernible to end-users. Although it was easy to enter the market, it was extremely hard for most of them to survive in such extremely competitive market. Major ISP firms in the industry are now forming alliances to compete effectively in the broadband market (Angwin 2002).

On one hand, firms that can handle severe competition gain the benefit of low entry cost and expanded opportunities in electronic markets. On the other hand, firms that cannot bear the loss from the increased competition in the markets would prefer an electronic hierarchy, with close ties to a limited number of channel members and high switching costs (Humphreys, Lai, and Sculli 2001). Electronic markets offer relatively

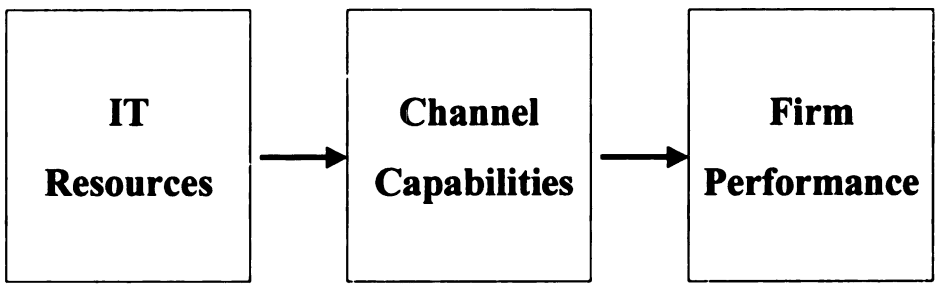
free market entry and exit and have a high level of uncertainty, whereas an electronic hierarchy requires a new type of transaction-specific investment in terms of goal alignment, a high level of information sharing, acceptance of dependence, and strategic integration (Chandra, Kumar, and Smirnov 2001; Humphreys, Lai, and Sculli 2001).

Although some researchers strongly predict the popularity of electronic markets (Bakos 1991; Malone, Yates, and Benjamin 1987; Steinfield, Kraut, and Plummer 1995), there seem to be some forces that drive electronic transactions toward electronic hierarchy. As firms perceive the gain from an electronic hierarchy greater than the benefits from an electronic market, more firms are likely to prefer the stability of an electronic hierarchy. While strategically critical components for their products require trustworthy and reliable suppliers, transactions for these components in electronic markets may result in the loss of strategic information to suppliers (Humphreys, Lai, and Sculli 2001). Historical data support this argument that more firms prefer an electronic hierarchy to an electronic market (Steinfield, Kraut, and Plummer 1995). This preference may indicate that the uncertainty inherent in electronic markets is more costly than the transaction-specific investment required in electronic hierarchies (Humphreys, Lai, and Sculli 2001). In short, there are forces in electronic buyer-seller relationships that drive firms to electronic hierarchies such as the uncertainty embedded in the electronic market and a strategic need for reliable relationship (Humphreys, Lai, and Sculli 2001). This justifies the focus of the current study on electronic channel relationships.

Key Research Questions

A CIS helps firms cultivate electronic interactions among channel members. The increased electronic interaction between firms through IOS is likely to affect both the nature of channel relationships and their performance in the market (Chandra, Kumar, and Smirnov 2001; Cunningham and Tynan 1993; Humphreys, Lai, and Sculli 2001; Malone, Yates, and Benjamin 1987; Roberts and Mackay 1998). Thus, the current study explores the impact of IT on firm channel relationships and performance in the RBV framework, as shown in Figure 1.

Figure 1: Conceptual Framework of the Study within the Resource-Based View



Note: Drawn from Amit and Schoemaker 1993; Barney 1991; Barney et al. 2001; Collis 1994; Grant 1991; Porter 1991

Specifically, the current study investigates how firm IT resources such as IT advancement and IT appropriability affect its strategic integration with channel partners and its internal channel capabilities including interfirm information exchange,

coordination activities, and supply chain responsiveness. This study also addresses whether or not IT resources affect firm performance through interfirm integration and channel capabilities within the RBV framework by asking the following key research questions. The first research question of this study is whether or not firm internal capabilities are enhanced by IT and related resources. If so, how does IT improve those capabilities? More specifically, what is the effect of IT for supply chain communication systems, an essential element of SCMS, on channel relationships? This set of questions explores the empirical relationship between IT as a resource and capability as a mediator that will link IT to firm performance. Furthermore, as channel relationships become increasingly vital for strategic movements and as more firms recognize the importance of interfirm collaboration in dynamic and uncertain market conditions (Humphreys, Lai, and Sculli 2001; Sarkar 1999; White 1999), these research questions will investigate the significance of IT resources for adequate channel relationships.

The second research question explores how a firm's deployment and appropriability of advanced IT influences firm performance through enhanced channel relationships. As a stream of literature and the recent decline in dot-com stocks suggest weak or no link between IT investment and firm performance (Andersen and Segars 2001; Baker and Abrahams 2001; Fisher 2001; Loveman 1991; Panko 1991; Weill 1991), this study attempts to refute the argument by exploring the empirical relationship between IT and firm capabilities. That is, this study will argue that a firm's deployment and appropriability of IT resources leads to firm performance if they are adequately integrated into the existing capabilities of the firm.

Finally, the extent to which IT is a resource for firm competitive advantage will be evaluated from the RBV perspective. Actually, RBV argues that IT is not likely a source of firm competitive advantage (Barney 1991). However, when IT is well embedded into a firm's core competency or decision-making process, it is likely to provide a distinctive benefit to the owner as a possible resource (Barney 1991). Therefore, an investigation of the conditions under which IT gives the owner competitive advantage will provide valuable implications for both researchers and managers. Table 2 summarizes the main research questions asked in this study.

TABLE 2: KEY RESEARCH QUESTIONS

Research Question 1:	Are firm internal capabilities enhanced by IT and related resources?
Research Question 2:	How does the deployment and appropriability of IT influence firm performance through enhanced channel relationships?
Research Question 3:	Under what conditions does IT become a source of firm competitive advantage?

Domain of the Study

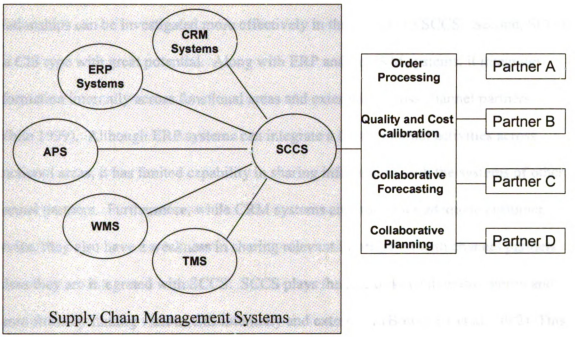
Information Technology

Despite the importance of electronic hierarchical relationships and the critical role of IT for them, the impact of IT on channel relationships is not well understood. That may be due to the fact that IOS has a relatively short history, and the electronic market alone has been the focus of attention. As a result, how IOS changes channel relationships remains to be explored.

Contemplating the need for research on interorganizational interaction especially under electronic hierarchies, this study investigates the impact and implications of IT

resources on channel relationships and firm performance in the context of supply chain communication systems (SCCS), a key element of SCMS for electronic interfirm interactions. This study views SCMS as an internally and externally integrated system that helps firms gain a competitive position in the market by increasing efficiency in information and product flow across channel members, from the inception to distribution of a product (Bowersox, Closs, and Cooper 2002; Humphreys, Lai, and Sculli 2001). The operational definition of an SCCS for this study is an information system that is involved in a firm's interactions with channel partners in order to carry out electronic transactions, quality and cost calibration, and collaborative forecasting and planning (Bowersox, Closs, and Stank 1999; Roberts and Mackay 1998; Stank, Daugherty, and Autry 1999; Tang, Shee, and Tang 2001). It incorporates elements of and interfaces with various CIS such as enterprises resource planning (ERP) systems, customer relationship management (CRM) systems, advanced planning systems (APS), transportation management systems (TMS), and warehouse management systems (WMS) for the purpose of sharing information with channel partners. The most typical SCCS is EDI, which plays a key role in the success of SCMS and information sharing within the channel (Humphreys, Lai, and Sculli 2001; Roberts and Mackay 1998). As firms reassess the importance of interfirm collaboration within their supply chain and of new technology such as XML, SCCS will play an increasingly critical role (Humphreys, Lai, and Sculli 2001). Figure 2 illustrates the role of SCCS for SCMS.

Figure 2: SCCS as a Key Element of SCMS



SCCS in this study refers to both the hardware and software of the focal firm and partners (suppliers and distributors), plus the network infrastructure that links the firms. It includes elements of and interfaces with various CIS components that provide information, the imperative content of SCMS. That is, an SCCS is a critical element of the SCMS that is internally and externally integrated CIS for electronic transactions and collaborative business activities, such as forecasting and planning. An SCCS includes any computer-mediated transaction systems but not such traditional communication systems as fax or telephone. Furthermore, the way in which the content is collected and maintained within a firm by such systems is beyond the scope of this study.

The focus of the current study on SCCS is justified for several reasons. First, SCCS is the most typical IOS that involves two or more independent channel partners (Humphreys, Lai, and Sculli 2001). This means that the impact of IT on channel relationships can be investigated more effectively in the context of SCCS. Second, SCCS is a CIS type with great potential. Along with ERP and/or CRM systems, it integrates information internally across functional areas and externally across channel partners (White 1999). Although ERP systems can integrate a firm's internal activities across functional areas, it has limited capability in sharing information with the systems of other channel partners. Furthermore, while CRM systems are crucial for adequate customer service, they also have a weakness in sharing relevant information with channel partners unless they are integrated with SCCS. SCCS plays the role of key integrator within and across firms by linking various CIS internally and externally (Bowersox et al. 2002). This makes it very likely that IT advancement for SCCS will lead to firm competitive advantage. Finally, because SCCS is one of the most widely deployed CIS types, it offers benefits in terms of data collection and validity of study. Although the SCCS industry is still growing, many firms have adopted these systems for a stronger competitive position in today's competitive markets (Moran 2001; White 1999). This will provide the current study a sufficient size of sampling frame. Furthermore, key informants are likely to have adequate experience with SCCS. In sum, a study of SCCS will contribute to the literature by providing a number of implications for both practitioners and researchers.

Methods

This study will use survey methodology for data collection. Particularly, web survey will be deployed as its primary means of data collection. Data will be collected in the United States. The unit of analysis is the firm's supply chain partnerships. As a collaborative supply chain involves more than one party (e.g. buying firm and selling firm) in most cases, this study explores both selling and buying firms perspective, focusing on down-stream channel members (i.e., distributors) as well as up-stream members (i.e., suppliers).

The primary respondents of the study are supply chain managers. However, although increasing, not many firms have supply chain manager. In many firms, supply chain management is still a broadly accepted concept that oversees procurement and logistics activities as a whole for efficient collaboration across channel members. Thus, some firms are still conducting supply chain management activities as a part of either procurement or logistic functions. A number of large firms use the title, supply chain manager, for those managers who supervise all channel relationships from the firm's strategic point of view. In the absence of that position, respondents will be logistics managers. Therefore, the sampling frame of this study will consist of major firms with a supply chain manager, or a logistics manager from different industries in the United States.

Expected Managerial Contributions

This research is expected to provide important implications for managers in SCM and IT. First, it will reveal empirical evidence that IT investment leads to firm

performance, refuting the weak or no link between IT investment and firm performance claimed in the literature. The study further seeks when and how IT investments facilitate performance. These will help more managers make informed decisions on IT investments that will lead to an adequate level of firm performance.

By identifying the optimal level of IT advancement and/or appropriability, this study will inform firms about both efficient and inefficient investment in IT resources. Furthermore, by pinpointing the ideal level of information exchange between partners for the best firm performance coupled with the optimal level of IT investment, it will enable firms to benchmark their IT investment. Collaboration emphasized under market uncertainty requires a certain amount of information exchange with channel partners. But, too much exchange may result in leaking its competency while less-than-required information exchange is likely to cause ineffective collaboration. Therefore, locating the optimal levels of IT advancement and IT appropriability that lead to an adequate level of information exchange will explicate how firms become competitive in the markets with minimum level of risk of exposure.

Finally, this study will highlight the role of mediators (i.e. channel capabilities) in gaining adequate benefits from IT investment. Only when IT investment is directed to appropriate channel activities such as information exchange and coordination, the impact of IT resources will be realized in the form of firm performance. The research will, therefore, reveal the importance of each mediating construct that links IT resources to the firm level performance.

Expected Theoretical Contributions

The first theoretical contribution of this study is the evaluation of IT advancement and IT appropriability as firm resources for competitive advantage. RBV claims that internal information and production-related technology can be resources for competitive advantage of firms. However, the RBV literature has not considered the technology associated with interfirm information exchange and other channel activities as another type of resources for competitive advantages. If IT resources are linked to firm performance through improved channel capabilities, then there is a theoretical justification for IT investments directed to firm capabilities.

This study first attempts to test the impact of IT resources on performance through channel capabilities. Previous work has investigated the direct link between IT adoption and firm performance (Davis 1989; Davis, Bagozzi, and Warshaw 1989; Lucas and Spitler 1999), focusing on the technology adoption process of firms or individual consumers. Therefore, by examining whether or not IT has an impact on firm performance in the context of IT and supply chain management, the study will contribute to the RBV literature.

Although they are assumed in the literature (Dennis, Hilmer, and Taylor 1997/1998; Mohr and Nevin 1990; Shin 1999), empirical studies on the impact of interfirm information exchange and coordination on firm level performance are also sparse. Filling this gap in the literature, this study explores how interfirm information exchange and coordination activities affect firm performance both directly and indirectly through supply chain responsiveness, an immediate supply chain level outcome. Even if this study expects both direct and indirect impacts of them on performance, it will be also

interesting if the impacts of interfirm information exchange and coordination are totally mediated by supply chain responsiveness, invalidating the assumption in the literature.

Finally, there is no comprehensive work on IT in the context of SCMS, let alone SCCS. Academic research so far has only contemplated the conceptualization of SCMS. Therefore, the current study will contribute to the literature by investigating the impact and implications of SCCS on channel relationships and firm performance empirically in the context of supply chain management for the first time.

CHAPTER 2

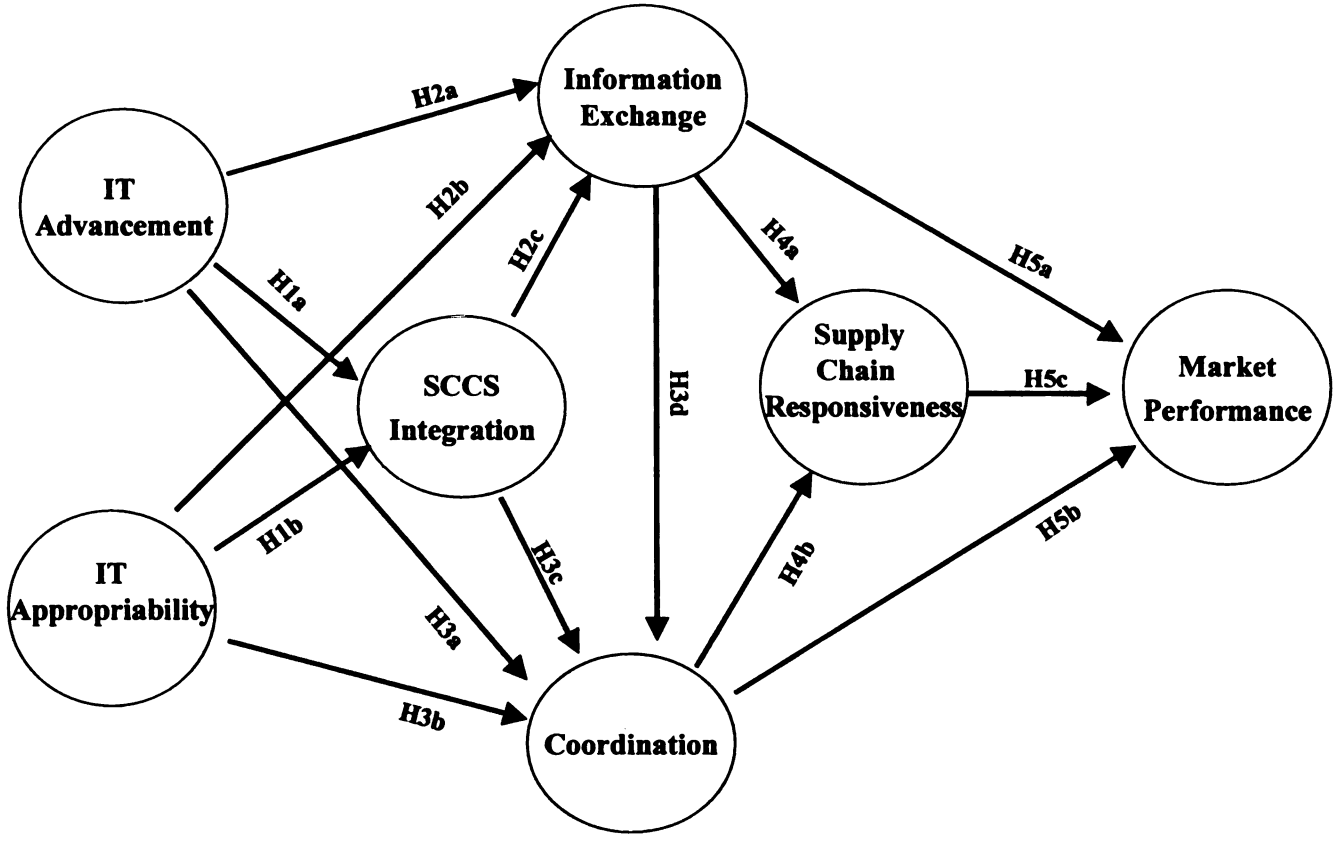
MODEL AND HYPOTHESES

Conceptual Framework

Drawing on the resource-based view (RBV) of the firm, the proposed conceptual framework of this study consists of firm IT resources, channel capabilities, and firm performance, as was depicted in Figure 1. In accord with RBV, this study postulates that firm internal IT resources enhance internal channel capabilities and the enhanced capabilities in turn influence firm performance (Amit and Schoemaker 1993; Barney 1991; Barney, Wright, and Ketchen 2001; Collis 1994; Grant 1991). Supporting this framework, Barney (1991) argues that a firm's resources lead to competitive advantage while Collis (1994) claims that various firm capabilities are a source of competitive advantage. In the similar vein, Amit and Schoemaker (1993) maintain that "capabilities are often developed in functional areas (e.g., brand management in marketing) or by combining physical, human, and technological resources at the corporate level (p. 35)." They further assert that "resources, information and people are combined and sequenced over time in order to evolve specific capabilities (p. 39)." Grant (1991) also supports the framework by identifying resources and capabilities as the foundation for firm strategies and postulating that capabilities depend on resources.

The operational model of the study is presented in Figure 3. It claims that firm IT resources such as IT advancement, IT appropriability, and SCCS integration are expected to facilitate firm channel capabilities such as interfirm information exchange, coordination, and supply chain responsiveness. As illustrated in the framework, the enhanced capabilities, then, lead to favorable firm performance.

Figure 3: Operational Model and Hypotheses



IT Resources of Firms

According to Barney (1991), firm resources include "all assets, capabilities, organizational processes, firm attributes, information, knowledge, etc. controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness (p. 101)." This definition has a broad view on resources that embraces all assets and capabilities among others. On the other hand, Amit and Schoemaker (1993) contend that the *strategic* assets of firms include resources and capabilities providing a possibly inconsistent view on the relationship between firm assets and resources with Barney (1991).

However, note that Amit and Schoemaker (1993) adopt and use "strategic assets" whose characteristics are different from "assets" that are part of resources according to Barney (1991). Barney (1991)'s definition of assets focuses on tangible and intangible firm assets as an input to gain competitive advantages while Armit and Schoemaker (1993)'s definition of strategic assets deals with strategic competencies acquired from resources and capabilities. The difference between them becomes clearer as Amit and Schoemaker (1993) argue, in discussing the definition of resources, that "these *resources* consist, *inter alia,* of knowhow that can be traded (e.g., patents and licenses), financial or physical assets (e.g., property, plant and equipment), human capital, etc. (p. 35)" Therefore, although they adopt similar terms, "strategic assets" of Amit and Schoemaker (1993) rather mirror "resources" of Barney (1991). Consequently, the definition of resources for Amit and Schoemaker (1993) is narrower than that of Barney (1991) as it does not include firm capabilities. Adapting Barney (1991)'s definition of resources into the current study context, this study defines IT resources as various firm specific and

scarce IT knowhow, tangible and intangible IT assets, and IT capitals including IT department, that provide the owning firm a unique competitive position (Barney 1991). For example, IT skills, a type of intangible IT assets, are resources as they are uniquely embedded in the owning firm.

According to RBV, resources can be classified into three types; physical capital resources, human capital resources, and organizational capital resources (Barney 1991; Becker 1964; Tomer 1987; Williamson 1975). Barney (1991, p. 101) explains that,

> physical capital resources include the physical technology used in a firm, a firm's plant and equipment, its geographic location, and its access to raw materials. Human capital resources include the training, experience, judgement, intelligence, relationships, and insight of individual managers and workers in a firm. Organizational capital resources include a firm's formal reporting structure, its formal and informal planning, controlling, and coordinating systems, as well as informal relations among groups within a firm and between a firm and those in its environment.

RBV further emphasizes that resources are distributed heterogeneously and are not perfectly mobile across firms (Barney 1991; Barney, Wright, and Ketchen 2001; Collis 1994). This resource heterogeneity and immobility can be a source of sustained competitive advantages of the firm (Amit and Schoemaker 1993; Barney 1991; Barney, Wright, and Ketchen 2001; Collis 1994; Grant 1991). Nonetheless, not all physical capital, human capital, and organizational capital contributes to competitive advantages of the firm (Barney 1991). Therefore, it is critical to understand the conditions under which IT resources can serve as a source of competitive advantage in order to receive the full benefits the IT resources can create.

IT Advancement

IT advancement for SCCS is defined as the extent to which a firm adopts the most sophisticated available technology. It concerns the degree of proactive adoption or use of the most advanced IT to build new technical solutions to answer partners' needs ahead of

competitors. IT advancement is likely to be an important firm resource as the literature argues that firms with advanced technology outperform their competitors (Rogers, Daugherty, and Stank 1993).

Recognizing the critical role of IT, more firms are investing in IT for their SCCS and are building expensive IT departments than ever before in an effort to accrue the internal skills to utilize the advanced technology fully. Barney (1991) argues, however, that information processing systems alone can not be a resource for competitive advantage because of their availability in the market to any firm and, thus, their homogeneity (Powell and Dent-Michallef 1997). He further stresses that only information processing systems that are closely embedded into a firm's managerial process can provide a competitive advantage. Therefore, according to RBV, IT by itself is not likely to be a resource that leads to competitive advantage of the firm.

Then, under what conditions does IT provide competitive advantage? One way to make IT unique and imperfectly mobile across firms is to adopt new technology ahead of competitors, receiving the exclusive benefits from the advanced IT. The advanced technology can be a resource for competitive advantage as long as it makes firm activities more efficient than those of competitors (Amit and Schoemaker 1993; Barney 1991; Barney, Wright, and Ketchen 2001; Collis 1994). However, early adoption of IT requires tremendous financial investment. Furthermore, it may result in frequent technology updates, which can also cause inefficient user training as the full migration to new technology always takes time and expensive training.

Until recently, the transition of SCCS from proprietary EDI to Internet-based EDI was widely observed across industries (Lancioni, Smith, and Oliva 2000) seeking a better

system compatibility. However, the more sophisticated XML technology has now been introduced. The XML technology is known to be very flexible, with various operating system platforms, and provides powerful interaction capability to channel members (Xml.org 2002). It is likely that in several years Internet-based EDI systems may give way to XML technology. There are some other emerging technologies such as satellite technology and radio frequency data communication technology that will replace current IT in the near future (Bowersox, Closs, and Cooper 2002).

Although it may not be a cost-effective strategy, early adoption of new IT for SCCS can lead to competitive advantage of the firm. That is, by deploying the newest technology especially before it is diffused widely across competitors, firms are expected to be more efficient than their competitors in interfirm information exchange and coordination activities, both within the firm and with channel partners (Boone and Ganeshan 2001; DiMaggio and Powell 1983; Porter 2001).

IT Appropriability

Another way to have unique IT within a firm is to maximize IT appropriability. Firms vary in the degree of resource utilization. Some receive the full benefits a resource can create while others gain only a fraction of the benefits. Therefore, the ultimate goal for many firms that deploy a new resource is to receive the full benefits improving resource appropriability. Grant (1996A) defines resource appropriability as "the ability of the owner of a resource to receive the benefit equals to value created by the resource." In this study, IT appropriability of firm refers to the ability of the firm that deploys IT to exploit the potential of the IT resource fully.

Firms can enhance IT appropriability in various ways. For example, hardware and/or software based on the advanced technology can be developed internally, or IT deployment can be tailored to the firm's core competencies or capabilities. These processes involve long-term investment and knowledge accumulation. Moreover, developing hardware or software internally may not be very cost-effective as advanced but standard hardware or software is readily available in the market at reasonable costs. However, IT deployment without customizing it into firm's core competencies would lead to lack of heterogeneity and immobility as the same IT is available to all competitors. Therefore, only when a firm customizes and utilizes software or even hardware based on an advanced technology to integrate its core strengths with its central assets or capabilities, such as strong channel relationships and customer reputations will give the firm an enduring competitive advantage (Barney 1991; Barney, Wright, and Ketchen 2001; Porter 2001; Powell and Dent-Michallef 1997). Therefore, whether sourcing the technology externally or internally, firms can still gain competitive advantage from IT if the technology enhances firm capabilities through heterogeneity and immobility that the firm created through the enhanced IT appropriability.

Barney (1991) emphasizes the integration of information processing systems with other resources or capabilities of the firm in order to gain competitive advantage. This synergy from the integration of IT with other core firm and channel capabilities is critical for achieving the full benefits of the IT (Bharadwaj 2000). It is particularly important, in the SCCS context, whether IT links supply chain members with respect to collaborative planning, demand forecasting, and order replenishment for the success of SCCS (Bowersox, Closs, and Stank 1999; White 1999). In other words, IT appropriability

stems from certain internal and external factors, such as the existence and skills of an IT department for applications and support, internal functional integration, management objectives for SCCS, industry and product characteristics, and partner characteristics is likely to be a source of competitive advantage for supply chain management. Although the main focus of this study is not on the antecedents of IT appropriability, an understanding of them provides insights for the model development of this study. Therefore, the conditions for high IT appropriability will be discussed briefly in the context of SCCS.

Just like IT advancement, high resource appropriability leads to competitive advantage only when it is uniquely embedded in the firm's relevant activities (Barney 1991; Barney, Wright, and Ketchen 2001; Grant 1996A; Porter 2001). Especially in the context of SCCS, certain internal and external conditions contribute to IT resource appropriability of the firm. The first internal factor is IT skills. Firms can achieve an adequate level of IT appropriability by accumulating internal IT skills and knowledge. Because IT is readily available in the marketplace to any firm (Powell and Dent-Michallef 1997), what makes it a unique resource is the internal IT experience and skills that support firm activities (Byrd and Turner 2001; Powell and Dent-Michallef 1997). When firms outsource IT and its related skills, it is highly likely that neither the outsourced technology nor the outsourced skills will be a source of sustainable competitive advantage. Therefore, accumulated internal IT skills coupled with IT advancement can be a condition for high IT appropriability.

Another internal condition for IT appropriability in the context of SCCS is functional integration within a firm (Byrd and Turner 2001; Evans, Naim, and Towill

1993; Henderson and Venkatraman 1993; Truman 2000). Even the most advanced technology and skills will not ensure adequate SCCS performance unless internal activities across different functional areas are well integrated and coordinated. A typical SCCS requires contents in addition to media and actors (Bowersox, Closs, and Cooper 2002), and the contents are created mostly by data from various functions, such as order taking, production, inventory management, distribution, and promotions. Without internal integration and coordination, IT appropriability for SCCS is not viable.

One external factor that influences IT appropriability is IT resource alignment across channel partners (Evans, Naim, and Towill 1993; Henderson and Venkatraman 1993). That is, a firm can gain an adequate level of IT appropriability when its channel partners have compatible technology in the context of SCCS. This advocates the alignment of IT advancement and IT skills across channel members. Without such alignment of IT resources, the SCCS cannot function well. When EDI was mostly proprietary, IT alignment was a challenge for many small and medium-sized partners wishing to do business with large firms (Evans, Naim, and Towill 1993) because of the transaction-specific nature of the investment and skills needed for EDI use. Although this challenge has diminished due to advances in the related technology and infrastructure, the alignment of IT advancement and appropriability across channel partners is still difficult to achieve (Clemons and Row 1993). Thus, an adequate level of IT resource alignment with other partners is critical for the appropriability of SCCS technology of a particular channel member.

Finally, especially in the context of SCCS, the competitiveness of the supply chain itself is a crucial factor in IT appropriability. That is, even with an adequate level

of IT advancement, and with the alignment of IT resources across channel partners, an adequate level of appropriability is not feasible unless the existing supply chain is competitive (Powell and Dent-Michallef 1997).

Given the favorable conditions outlined above, IT appropriability is reflected in two dimensions: absorptive capacity and agility. Absorptive capacity refers to the internal knowledge pool that enables the firm to convert IT resources (i.e., technology advance) into other firm capabilities, including channel capabilities. Low absorptive capacity stems from unfavorable conditions and leads to inefficient transformation of those resources. High absorptive capacity resulted from a favorable appropriability condition is associated with efficient resource utilization in creating internal firm capabilities. On the other hand, agility refers to how quickly a firm transforms IT resources into its capabilities. The speed of appropriability reflected in agility is imperative, especially for IT advancement as a source of sustained competitive advantage along with the speed of IT adoption because of IT availability in the marketplace (Powell and Dent-Michallef 1997). Even though a firm has an adequate level of absorptive capacity, the transformation of a resource into a firm capability can be slower than its competitors if agility is low. Thus, firms with low agility are unlikely to outperform their competitors in the markets. In sum, there are certain favorable conditions for IT appropriability, which is reflected in a firm's absorptive capacity and agility.

SCCS integration

Firms are integrating their activities both internally and across channel partners (Clark and Stoddard 1996; Henderson and Venkatraman 1993; Kambil and Short 1994). However, the current study focuses on firm's integration with its channel partners as the

integration within firm is beyond the scope. Clark and Stoddard (1996) view the channel partner integration process as two separate steps: technological innovation and process innovation. Technological innovation refers to technology advance (e.g. from no technology to EDI for channel activities), whereas process innovation involves a shift from discrete transactions to continuous and consistent transactions (Clark and Stoddard 1996). Alternatively, this study views the interfirm channel integration as a two dimensional process: SCCS integration and interfirm activity integration. This study focuses on SCCS integration as another type of IT resource that indirectly reflects the technology alignment among channel partners. The literature does not explicitly consider SCCS integration as a separate dimension from interfirm activity integration. Thus, investigating SCCS integration as a separate process in exploring the impact of IT advancement and appropriability on firm capabilities will reveal the distinctive impact of SCCS integration on supply chain activities as well as the firm level performance.

SCCS integration in this study refers to the extent to which a firm's SCCS is integrated with that of channel partners, and ready for collaborative channel activities with other channel members in order to increase the efficiency and effectiveness in interfirm communication (Malone, Yates, and Benjamin 1987). High integration allows two proprietary systems to reduce technical barriers and incompatibility so as to communicate more effectively (Byrd and Turner 2000). The lowest level of SCCS integration would allow partners to conduct electronic order-fulfillment only, a fundamental function of SCCS (Johnson 1999; White 1999). Intermediate systems integration, however, should permit partners to share more proprietary information including sales and demand forecasts (Bowersox, Closs, and Cooper 2002; Bowersox,

Closs, and Stank 1999; Roberts and Mackay 1998; White 1999). The most sophisticated SCCS integration should afford joint planning for business development in addition to the above SCCS activities (Bowersox, Closs, and Cooper 2002; Bowersox, Closs, and Stank 1999; Lamming 1986; White 1999).

The literature discusses how the improvement in IT advancement and appropriability have driven channel partners toward closer SCCS integration (Clemons and Row 1992; Evans, Naim, and Towill 1993; Malone, Yates, and Benjamin 1987; Rasheed and Geiger 2001; Roberts and Mackay 1998; Tang, Shee, and Tang 2001). As technology and appropriability improve, these lead to more active sharing of planning, strategies, resources, and competencies among partners (Armistead and Mapes 1993; Roberts and Mackay 1998). This sharing at the same time implies systems integration among partners (Malone, Yates, and Benjamin 1987). Furthermore, Clemons and Row (1992, p. 2) assert that "IT can facilitate the development of stable, tightly coupled relationships among firms." Roberts and Mackay (1998, p. 176) also stress "the role of IT systems such as EDI, as a key enabler for competitive advantage through cementing relationships with customers, enabling integration forwards or backwards in the industry value chain or in establishing a technical lead." Evans et al. (1993) share the view that IT is imperative for supply chain integration. Moreover, in an empirical study, Rasheed and Geiger (2001) found that a firm's IT resources have a positive impact on the degree of integration for technical support functions within the value chain. Accordingly,

H1a: IT advancement facilitates SCCS integration.
H1b: IT appropriability facilitates SCCS integration.

Channel Capabilities of Firms

Grant (1996) views organizational capability as an outcome of knowledge integration within and across firms. In other words, firm capability is pre-determined by its ability to integrate knowledge and resources within the firm or across channel partners (Amit and Schoemaker 1993; Collis 1994; Grant 1991). In this study, channel capability of the firm refers to the ability to exploit resources and other capabilities to derive efficiency in channel activities and, thus, ultimately sustainable competitive advantage (Amit and Schoemaker 1993; Bharadwaj 2000; Collis 1994; Grant 1991). Subsequently, the channel capabilities investigated here include such channel related activities as interfirm information exchange, transaction-related coordination activities, and supply chain responsiveness.

Collis (1994) discusses three types of organizational capabilities, synthesizing the literature. The first type of organizational capability reflects the ability to perform the basic functional activities of the firm, such as plant layout, distribution logistics, and marketing campaigns, more efficiently than competitors" (Collis 1994, p. 145). Among the channel capabilities this study investigates, information exchange and coordination may be classified into this category of organizational capabilities. The second type of organizational capability is related to a firm's ability to "learn, adapt, change and renew over time" in order to improve its efficiency in activities (Collis 1994, p. 145). In this study, supply chain responsiveness would be of this category. The third type of organizational capabilities Collis (1994, p. 145) discusses consists of "more metaphysical strategic insights that enable firms to recognize the intrinsic value of other resources or to

develop novel strategies before competitors." Although Collis (1994) identifies three types of capabilities, it is worth noting that making distinctions among the three types of organizational capabilities is difficult in many cases as some firm capabilities result from complex situations that involve more than one type (Collis 1994).

Information Exchange

Information exchange is conceptualized as the extent to which channel partners share internal information effectively with their channel partners regarding any changes in market and customer preferences. This information exchange is the most obvious and direct benefit that firms gain from an SCCS (Clemons and Row 1993; Lancioni, Smith, and Oliva 2000; Lewis 2001; Malone, Yates, and Benjamin 1987; Moberg et al. 2002; Roberts and Mackay 1998). An accurate and fast information exchange electronically helps channel partners share more information, both quantitatively and qualitatively (Clemons and Row 1993; Evans, Naim, and Towill 1993; Lewis 2001; Malone, Yates, and Benjamin 1987; Moberg et al. 2002; Tang, Shee, and Tang 2001). Highlighting the dramatic impact of IT on information exchange across channel members, Clemons and Row (1993, p. 9) explicate that,

> IT has led to a dramatic increase in the availability of information on product movement in the distribution channel. Prior to the introduction of UPC and scanner systems, the only sources of information on product movement were manufacturer shipments or warehouse withdrawals. This information was only available at a high level of aggregation and with considerable delay. Retailers had to rely on manufacturers for data on what products were moving. UPC and checkout scanners at the store made it possible for retailers to track product movement themselves, first at the distribution center level, and then, as scanners became widely used, at the individual store level.

In other words, the more advanced the IT for SCCS and the higher the level of SCCS integration, the higher should be the quality of information exchange (Clemons and Row 1993; Moberg et al. 2002).

Lewis and Talalayevsky (1997, p. 145) assert that supply chain partners are integrating systems in order to seek "better information." With SCCS, channel partners do not need to rekey all transaction-related correspondence, which reduces errors and delays. As a result, SCCS helps firms improve their efficiency in obtaining accurate, necessary, and timely information (Rogers, Daugherty, and Stank 1993). Furthermore, the scope of information domain expands because channel members have access to information not only from channel partners but also from the partners of those channel partners. For example, SCCS allows a manufacturer to exchange information with distributors, who in turn exchange with their own distributors or retailers using SCCS (Anderson, Havila, and Salmi 2001; Clemons and Row 1993). As a result, the scope of information the manufacturer has access to is expanded exponentially with the deployment of SCCS. Partners within a supply chain act as a source of market information for other partners, which results in better information exchange (Lewis 2001).

SCCS allows real-time information exchange in most cases (Clemons and Row 1993), making information exchange easy and fast (Moberg et al. 2002). In addition, the expanded scope of information domain also makes more information exchange between partners possible. Stank, Crum, and Arango (1999, p. 24) stress the importance of "timely, accurate information" using EDI or the Internet to link channel partners. That is, the more advanced the IT for SCCS and the higher level the SCCS integration, the higher should be the quality of information exchange (Moberg et al. 2002; Stank, Crum, and Arango 1999). Thus,

H2a: IT advancement for SCCS facilitates information exchange.
H2b: IT appropriability for SCCS facilitates information exchange.

Coordination

Interfirm coordination in this study refers to activities involved in transactions between channel partners (Clemons and Row 1993; Kambil and Short 1994; Malone, Yates, and Benjamin 1987; Shin 1999). These range from product-related information collection to order follow-up. As firms deploy more advanced IT for SCCS, they can perform the coordination activities more efficiently at less costs or provide a higher quality of coordination activities for the same costs (Clemons and Row 1992; Clemons and Row 1993; Evans, Naim, and Towill 1993; Roberts and Mackay 1998; Steinfield, Kraut, and Plummer 1995). Thus, sophisticated SCCS enhances coordination activities of the firm (Lewis 2001; Roberts and Mackay 1998). Malone et al. (1987, p. 484) assert that firms with advanced technology and high appropriability will benefit from "the possibilities for closer coordination provided by electronic hierarchy." Likewise, Shin (1999) reports from his empirical analysis that IT improves interfirm coordination.

Clemons and Row (1993) also discuss two possible sources of improvement in coordination: change of strategy and change of structure along with IT investment. Change of strategy refers to new ways of coordination with partners (e.g., automatic replenishment through SCMS), and change of structure occurs when radical changes in the mechanism of coordination between partners lead to the improvement of overall channel efficiency (e.g., the adoption of scanners by retailers to enhance the coordination activities with channel partners).

In addition, Clemons and Row (1993, p. 3, 10) argue that "a proposition that underlies of the work in the area of strategic information systems is that IT reduces the cost of coordination, leading firms to coordinate more." and "for some segments of retail

market this increased coordination (from new coordination structure initiated by IT improvement) was observed." Lewis and Talalayevsky (1997, p. 144) also claim that "improvement in IT have reduced logistics transactions costs and promoted better communications between organizations." In the same vein, Lewis (2001, p. 7) stresses that "improvements in IT should lead to a reduction in coordination costs." Therefore,

H3a: IT advancement leads to coordination.
H3b: IT appropriability leads to coordination.

In terms of the causal relationship between information exchange and coordination, no significant empirical investigation has been made according to the literature. Yet, because information exchange alone does not help channel partners create competitive advantage unless it leads to other capabilities, such as coordination or supply chain responsiveness, it seems plausible to argue that information exchange enhances coordination (Lewis 2001; Tarn, Yen, and Beaumont 2002). In other words, the purpose of an SCCS is to collect, interpret, filter, store, and share information within and across partners to improve efficiency in coordination activities (Truman 2000). Thus, channel partners exchange more information in an effort to enhance coordination activities (Tarn, Yen, and Beaumont 2002; Truman 2000).

H3d: Information exchange facilitates coordination.

SCCS Integration as a Mediator

This study claims that SCCS integration, a type of firm IT resource, mediates the influence of IT advancement and appropriability on a firm's channel capabilities, including interfirm information exchange and coordination. Supporting this argument, Clemons and Row (1992, p. 5) contend that

> often environmental and technological factors will make it possible to increase the overall efficiency of production or exchange through closer integration of decisions and operations. ... A supplier with access to the customer's production schedule can rationalize production and distribution, reducing inventories and increasing utilization of resources. However, the supplier must invest in information systems to accumulate the information and in decision processes to utilize that information for production scheduling and delivery.

In the same vein, Stank, Crum, and Arango (1999, p. 25) claim that

> many firms have discovered that heightened coordination and information flow can be achieved by strengthening their relationships with product and service suppliers and customers rather than relying on short-term, single-transaction arrangements or producing the activity in-house.

In other words, as channel partners are integrated more closely through SCCS integration and/or activity integration, coordination activities and information exchange are expected to be more efficient (Kambil and Short 1994). Thus,

> **H2c: SCCS integration facilitates information exchange.**
> **H3c: SCCS integration facilitates coordination.**

Supply Chain Responsiveness

Supply chain responsiveness is defined as the extent to which channel members react *cooperatively* to new inquiries that stems from environmental changes or market developments. Through enhanced information exchange and coordination due to advanced SCCS technology and SCCS integration, each partner is expected to improve its responsiveness (Clemons and Row 1991; Clemons and Row 1993; Roberts and Mackay 1998; Thatcher and Oliver 2001). In a discussion of how technology affects firm capability, Clemons and Row (1993, p. 73) argue that

> Just-in-time inventory techniques with key suppliers or customers are reducing channel inventories and improving system responsiveness. Strategic partnerships are reducing design cycle times, facilitating total quality management, and helping companies compete in time.

Today's complicated marketplace requires reliable, efficient and collaborated response (Rogers, Daugherty, and Stank 1993) delivered from the whole supply chain. Accordingly, the responsiveness of a particular supply chain as a whole should be addressed in the context of SCCS.

The responsiveness of a supply chain should be differentiated from that of individual members within the channel, although the responsiveness of a major player in the channel can influence that of the channel. Specifically, supply chain responsiveness reflects the reaction to market changes in a coordinated and cooperated manner among channel members through SCCS. For example, even though the responsiveness of a retailer is favorable and, thus, market changes are well transferred to upper level channel members (e.g. manufacturer), the overall supply chain responsiveness will remain poor if the manufacturer in the chain is slow to react.

Channel partners with a higher level of information exchange and more efficient coordination are likely to have a better understanding of other chain members as well as the nature of changes especially when their systems and/or activities are well integrated. In other words, an SCCS supported by advanced IT and adequate appropriability should facilitate information exchange and coordination that affect supply chain responsiveness positively (Singh 1996). Channel members with an efficient SCCS tend to have a greater ability to accommodate market changes or customer requests in a timely manner (Clemons and Row 1992; Clemons and Row 1993; Roberts and Mackay 1998; Rogers, Daugherty, and Stank 1993). Thus,

H4a: Information exchange facilitates supply chain responsiveness.
H4b: Coordination facilitates supply chain responsiveness.

Market Performance as the Ultimate Outcome

The impact of IT on firm performance can be measured in many ways. However, this study focuses on the efficiency improvements made by enhanced channel capabilities. It is argued that these channel capabilities mediate the impact of IT resources on competitive advantage, and that the enhanced capabilities should lead to efficiency improvements as an outcome. As a firm's supply chain activities are carried out in the markets, market performance is adopted as the ultimate outcome variable of the study, in order to assess the impact of IT resources on firm performance through channel capabilities. These market performance measures are expected to capture efficiency improvements observed in the market as a result of enhanced channel capabilities. Some supply chain activities are likely to affect firm market performance more than others. In particular, various customer service quality metrics-such as ordering procedure, timeliness, order accuracy, order fill rate, and customer alertness-are likely to be closely related to firm market performance (Stank, Crum, and Arango 1999). Thus, customer service quality, one of the core metrics of firm's supply chain management, is briefly discussed below.

Customer service quality is a well-studied area especially as an outcome of logistics activities (Mentzer, Flint, and Hult 2001; Mentzer, Gomes, and Krapfel 1989; Pisharodi and Langley 1990; Stank, Daugherty, and Ellinger 1999; Wetzels et al. 1995). It is actually one of the most important issues for supply channel managers because it is directly related to purchasing/logistics decision (Mentzer, Flint, and Hult 2001; Mentzer, Gomes, and Krapfel 1989; Wetzels et al. 1995). Five major dimensions of customer service quality are investigated in the logistics literature: ordering procedure, timeliness,

order accuracy, order fill rate, and customer alertness (Mentzer, Flint, and Hult 2001). Although not explicitly investigated by this study, customer service quality provides good evidence of enhanced information, coordination, and supply chain responsiveness, and, thus, of the effect of IT resources for SCCS on firm performance (Stank, Crum, and Arango 1999).

- Ordering procedure involves the effectiveness and ease of the order process (Mentzer, Flint, and Hult 2001; Mentzer, Flint, and Kent 1999). An advanced and well-integrated SCCS should provide all transaction-relevant information, and the ordering procedure should not be complicated or require extra work off the system, so that the positive effect of enhanced channel capabilities will affect firm performance as expected.
- Delivery timeliness addresses the extent to which deliveries arrive on time (Mentzer, Flint, and Hult 2001; Mentzer, Flint, and Kent 1999). It implicitly measures any unexpected redundant time, such as back-order waiting, processing delay, or delivery delay. Therefore, an SCCS with advanced technology and adequate appropriability should lead to improved delivery timeliness through enhanced channel capabilities (Thatcher and Oliver 2001).
- Order accuracy can improve firm performance by ensuring that the wrong items or incorrect quantities are not shipped (Bienstock, Mentzer, and Bird 1997; Mentzer, Flint, and Hult 2001; Mentzer, Flint, and Kent 1999). It is obvious that order accuracy can be improved by enhanced channel capabilities. That is, when a supply chain deploys SCCS properly, improved information exchange and

coordination are expected to reduce errors in processing orders enhancing order accuracy.

- An improved order fill-rate from enhanced information exchange and coordination also can contribute to firm performance (Emerson and Grimm 1996; Hult, Ketchen, and Nichols 2002; Mentzer, Flint, and Hult 2001). There may be many reasons for unfilled or cancelled orders, such as component shortage, unexpected orders for large-quantities, or orders for less quantity than required. Adequate IT resources for SCCS should increase the order fill-rate by communicating information to channel partners. For example, the order-fill date for a large quantity cannot be estimated unless the channel member communicates with other partners about incoming and/or outgoing shipments. SCCS should help channel members exchange the right and accurate information. Therefore, enhanced channel capabilities should be reflected in an improved order-fill rate.
- A high level of customer alertness should be associated with enhanced information exchange, coordination, and supply chain responsiveness. This refers to the extent to which a firm accommodates the needs, wants, and inquiries of its customers (Mentzer, Flint, and Hult 2001; Stank, Daugherty, and Ellinger 1999). It is a similar metric to supply chain responsiveness, which is an immediate channel outcome variable in this study. However, note that customer alertness is a firm-level outcome variable whereas supply chain responsiveness is a supply chain level variable.

These outcomes of supply chain activities should reflect enhanced channel capabilities and be closely associated with market performance. Supporting this view, Rogers et al.(1993) assert that IT such as EDI enables channel partners to be responsive to customer requests. Stank, Crum, and Arango (1999) find in their empirical study that coordination stemming from information exchange leads to on-time delivery, efficient ordering procedures, and customer alertness. Lewis (2001, p. 7) also argues that IT allows firms to engage in "large scale tracking of customer preferences" (p. 7) which is eventually associated with stronger channel capabilities, including information exchange, coordination activities, and supply chain responsiveness, and ultimately affects firm performance. In addition, Mohr and Nevin (1990) convincingly claim that coordination leads to firm performance. Thus,

H5a: Information exchange leads to market performance.
H5b: Coordination leads to market performance.
H5c: Supply chain responsiveness leads to market performance.

Partner Criticality as a Moderator

Although a firm may have numerous channel partners, not all partners are equally important and critical for the success of its business (Anderson, Havila, and Salmi 2001). Depending on the criticality of the partner, the level of information exchanged and/or the degree of strategic integration should vary, because the exchange of internal information more than necessary with partners could result in a leakage of its competencies (Singh 1996; Turnbull and Gibbs 1987).

Although partner criticality is likely to affect various aspects of channel relationships, it has received very little attention from researchers. Instead, dependence (Buchanan 1992) and power (Frazier 1983; Frazier and Summers 1986; Hickson et al.

1971; Johnson et al. 1993) among others have been widely studied in the channel relationship context reflecting partner criticality indirectly. Furthermore, Morgan and Hunt (1994) investigated the role of "shared values" and "relationship benefits" in forming a long-term relationship, reporting that the commitment and trust between partners depend on "shared values" and "relationship benefits." That is, the importance of a channel partner may affect the other partner's commitment in information exchange, coordination, and strategic integration.

Firms are willing to exchange more information and integrate their systems and activities with their critical partners in order to strengthen the relationship (Anderson, Havila, and Salmi 2001). Therefore, firms need to determine the optimal level of information exchange and interfirm integration based on their assessment of criticality for each partner. Different levels of integration and information exchange, then, should lead to different levels of performance. Thus, this study incorporates partner criticality as a moderator.

H6: The impact of IT advancement and IT appropriability on information exchange and coordination is greater when the partner is more critical to the firm.

All the hypotheses are summarized in Table 3.

TABLE 3: PROPOSED HYPOTHESES

Hypothesis	Expected Sign
H1a: IT advancement facilitates SCCS integration.	+
H1b: IT appropriability facilitates SCCS integration.	+
H2a: IT advancement for SCMS facilitates information exchange.	+
H2b: IT appropriability for SCMS facilitates information exchange.	+
H2c: SCCS integration facilitates information exchange.	+
H3a: IT advancement leads to coordination.	+
H3b: IT appropriability leads to coordination.	+
H3c: SCCS integration leads to coordination.	+
H3d: Information exchange facilitates coordination.	+
H4a: Information exchange facilitates supply chain responsiveness.	+
H4b: Coordination facilitates supply chain responsiveness.	+
H5a: Information exchange leads to market performance.	+
H5b: Coordination leads to market performance.	+
H5c: Supply chain responsiveness leads to market performance.	+
H6: The impact of IT advancement and IT appropriability on information exchange and coordination is greater when the partner is more critical to the firm.	+

CHAPTER 3

RESEARCH METHODS

Unit of Analysis

As discussed in chapter 1, the unit of analysis for this study is supply chain partnerships. Since a supply chain relationship involves more than one party (e.g. buying firm and selling firm), this study explores the perspectives of both selling and buying firms. Ideally, informants need to have some knowledge of IT resources, the degree of systems and activities integration with channel partners, any enhancement of channel capabilities the firm has experienced, and the firm's market performance.

Furthermore, because of the dyadic perspective of this study, key informants may hold different positions. The most appropriate informant in a firm would be the supply chain manager, considering the scope of knowledge required to fill out the questionnaire. However, although increasing, not many firms have a supply chain manager who oversees both inbound and outbound channel activities. Consequently, some firms are still conducting supply chain management activities as part of logistic activities. Therefore, the primary respondents for this study are firm's supply chain managers. But, upon the absence of that position, alternative informants will be logistics managers.

Sampling Frame and Sampling Method

This study uses survey methodology for data collection. The sampling frame for the survey consists of major firms with either a supply chain manager or a logistics manager from various U.S. industries. A list of qualified managers was obtained from the Council of Logistics Management with contact information, including email

addresses. Those managers are from such following functional areas as *Logistics Planning, Logistics Management, Management Information System Planning*, or *International Planning and/or Operations*. A web survey was deployed as its primary means of data collection although a mail survey was also administered to support the web-survey to ensure the quality of data collection considering the infancy stage of web survey (Sills and Song 2002; Slevin 1997).

Web Survey Advantages

There are numerous advantages of web surveys (Kaye and Johnson 1999; Sills and Song 2002; Weible and Wallace 1998). Low costs and fast response are major among them and others are noted below as well.

- Low cost: there are no mailing expenses, such as stamps, envelopes, and printing (Simsek and Veiga 2001).
- Fast response: turn-around time is relatively short compared to mail surveys (Simsek and Veiga 2001).
- Worldwide access: access to the web questionnaire is possible anywhere in the world with Internet access.
- Enhanced flexibility: unlike a mail survey where corrections on questionnaire are not possible once it is mailed out, a web survey is flexible in terms of making corrections or any other adaptations.
- New media: supplementary audio and video materials can be used to help respondents fill out the web questionnaire (Simsek and Veiga 2001).
- Increased interactivity: respondents can get some help interactively (Simsek and Veiga 2001).

- No data entry: data can be saved in a database format that requires no further coding. So, coding errors are minimized.
- Sophisticated analysis: manipulations can be made easily to the survey instrument to conduct more sophisticated analyses than with mail surveys.

Web Survey Disadvantages

There are some disadvantages of a web survey researchers should be aware of and cautious with. Major disadvantages of web survey have been discussed in the literature as follows:

- Low response rate: web surveys tend to generate a lower response rate than do a mail survey (Crawford, Couper, and Lamias 2001; Sills and Song 2002; Weible and Wallace 1998).
- Possible sampling error: a web survey cannot be conducted with respondents who do not have Internet access (Kaye and Johnson 1999; Sills and Song 2002) raising a possible issue of sampling error. However, this issue becomes less relevant as the Internet penetration rate increases consistently.

Implementation of web survey

The following procedure was used for the implementation of the web survey to minimize all those potential biases.

- The web questionnaire was prepared based on the suggestions (e.g., a negative impact of progress indicator) by Crawford et al. (2001), Kaye and Johnson (1999), and Simsek and Veiga (2001).

- A pre-test of web survey was conducted to determine server reliability (Crawford, Couper, and Lamias 2001; Simsek and Veiga 2001).
- An email list was acquired.
- A pre-test was carried out to assess the reliability of the web questionnaire.
- Email solicitations were sent out (Crawford, Couper, and Lamias 2001; Simsek and Veiga 2001) inviting potential respondents to participate in the web-survey.
- Reminder emails were sent out after ten days to avoid any negative effect of receiving multiple emails in a relatively short period of time although literature recommends two days (Crawford, Couper, and Lamias 2001; Simsek and Veiga 2001).
- The dataset was imported and purified for analysis.

Measures

Questionnaire Development

In developing measures, the current study adapted existing scales from the literature wherever possible. Given the exploratory nature of the study, some scale development was necessary. In adopting scales, the following procedure, suggested by Churchill (1979) and DeVellis (1991), was used. First, the domain of each construct was clearly defined, delineating what would be included in and excluded from the definition. Second, the literature was searched to locate any relevant scales available for the current study. Existing scales were adopted into the study wherever possible, or new scales were developed if adoption from the literature was not feasible or no scale was available.

Multiple items were used for each construct to increase reliability. Then, the developed instrument had been examined and purified by experienced academic researchers in SCM before it was pre-tested with several corporate managers to enhance the quality of the instrument and adequacy of the terms used in the scales. As a result of the pre-tests, some scales were modified to recuperate the point each scale conveys. A brief explanation and items for each construct are discussed below.

Measurement Items

IT Advancement

IT advancement assesses the extent to which a firm is proactive in adopting or using the most advanced IT to build new technical solutions to answer partner's needs ahead of its competitor. The scales for IT advancement were adapted from Gatignon and Xuereb (1997) and was implemented as follows:

Please circle the number that best reflects your agreement with the following statements regarding information technology at your BU for supply chain communication systems (SCCS).

	Strongly Disagree						Strongly Agree
1. My BU uses the most advanced IT for SCCS.	1	2	3	4	5	6	7
2. Our IT for SCCS is always state-of-art technology.	1	2	3	4	5	6	7
3. My BU is very proactive in adopting or developing advanced IT for SCCS.	1	2	3	4	5	6	7
4. Relative to our competitors, our SCCS are more advanced.	1	2	3	4	5	6	7
5. My BU is very proactive in building new technical solutions to answer our partner's needs.	1	2	3	4	5	6	7
6. My BU is always first to use new IT for SCCS in our industry.	1	2	3	4	5	6	7
7. My BU has the will and the capacity to build sophisticated SCCS.	1	2	3	4	5	6	7
8. My BU has built a strong network of relationships with suppliers of technological solutions.	1	2	3	4	5	6	7
9. My BU is regarded as an IT leader in our industry for SCCS.	1	2	3	4	5	6	7

IT Appropriability

IT appropriability is defined as the ability of a firm that adopted IT to receive the full benefits of its IT (Grant 1996A) and operationalized by assessing a firm's efforts to accumulate technical knowledge for SCCS and to receive benefits from IT for SCCS in a way that competitors cannot imitate easily (Barney 1991; Barney, Wright, and Ketchen 2001). No scale for IT appropriability was available in the literature. Subsequently, scales for IT appropriability were developed and implemented as follows:

Please circle the number that best reflects your agreement with the following statements regarding the ability to receive benefits from SCCS in your BU.

	Strongly Disagree						Strongly Agree
1. Relative to competitors, our technical knowledge for SCCS is clearly superior.	1	2	3	4	5	6	7
2. My BU is able to utilize IT for SCCS fully.	1	2	3	4	5	6	7
3. My BU utilizes IT for SCCS in a way that competitors cannot imitate easily.	1	2	3	4	5	6	7
4. My BU has abilities to capture the benefits that IT for SCCS can create.	1	2	3	4	5	6	7
5. My BU exploits IT for SCCS better than competitors.	1	2	3	4	5	6	7
6. My BU receives more benefits from IT for SCCS than competitors.	1	2	3	4	5	6	7
7. My BU has high regard for the technical expertise required to use SCCS.	1	2	3	4	5	6	7
8. My BU has extensive IT knowledge for SCCS.	1	2	3	4	5	6	7

SCCS integration

SCCS integration is operationalized by the extent to which firm's SCCS has built-in functions for various collaborative interfirm activities including collaborative forecasting and planning. No Scales for SCCS integration were available in the literature. Subsequently, the scales for interfirm integration by Bowersox, Closs, and Stank (1999) were adapted into the study context. The scales, therefore, are expected to capture the degree of SCCS integration, which should be distinguished from interfirm *activity* integration. The items used for SCCS integration are as follows:

Please circle the number that best reflects your agreement with the following statements regarding the functionality of your SCCS.

	Strongly Disagree						Strongly Agree
1. Our SCCS has built-in functions to collaborate forecasting and planning with our partner.	1	2	3	4	5	6	7
2. My BU can forecast and plan collaboratively with our partner through SCCS.	1	2	3	4	5	6	7
3. Our SCCS allows us to project and plan future demand collaboratively with our partner.	1	2	3	4	5	6	7
4. Collaboration in demand forecasting and planning with our partner is always possible through our SCCS.	1	2	3	4	5	6	7

5. Please check all items that apply.

		Online Orders and Fulfillment	Automatic Replenishment	Collaborative Forecasting	Collaborative Planning
My BU and our partner actually do	⇒	( )	( )	( )	( )
Our SCCS is capable of	⇒	( )	( )	( )	( )

Information Exchange

Information exchange assesses the extent to which channel partners exchange timely, accurate, adequate, complete, and credible information about customers, markets, and transactions more frequently (Mohr and Sohi 1995). Scales was developed to measure the amount of information exchange between channel partners as follows:

Please circle the number that best reflects your agreement with the following statements regarding your information exchange with your primary partner.

	Strongly Disagree						Strongly Agree
1. My BU exchanges more information with our partner than our competitors do with their partners.	1	2	3	4	5	6	7
2. Information flows more freely between my BU and our partner than between our competitors and their partners.	1	2	3	4	5	6	7
3. My BU benefits more from information exchange with our partner than do our competitors from their partners.	1	2	3	4	5	6	7
4. Our information exchange with our partner is superior to the information exchanged by our competitors with their partners.	1	2	3	4	5	6	7

In addition, scales are adopted from Mohr and Sohi (1995) to assess the *quality* of information exchange between channel partners as follows:

To what extent is your information exchange with your partner:

Untimely	1	2	3	4	5	6	7	Timely
Inaccurate	1	2	3	4	5	6	7	Accurate
Inadequate	1	2	3	4	5	6	7	Adequate
Incomplete	1	2	3	4	5	6	7	Complete
Not credible	1	2	3	4	5	6	7	Credible

Coordination

Coordination in this study refers to a firm's activities involved in transactions between firms. This study hypothesizes that IT resources lead to efficient coordination because less time and costs for the same transaction are minimized (Clemons and Row 1992; Clemons and Row 1993; Evans, Naim, and Towill 1993; Roberts and Mackay 1998; Steinfield, Kraut, and Plummer 1995). The scales for coordination were developed to assess the efficiency of firm coordination activities with its partner as follows:

Please circle the number that best reflects your agreement with the following statements regarding your efficiency of transaction coordination activities.

	Strongly Disagree						Strongly Agree
1. Our partner spends less time searching for information about our products than its major competitors do for the information of their own partner's products.	1	2	3	4	5	6	7
2. Our partner has reduced product searching costs more than its competitors.	1	2	3	4	5	6	7
3. My BU is more efficient in coordination activities with our partner than are our competitors with theirs.	1	2	3	4	5	6	7
4. My BU conducts transaction follow-up activities more efficiently with our partner than do our competitors with theirs.	1	2	3	4	5	6	7
5. My BU spends less time coordinating transactions with our partner than do our competitors with theirs.	1	2	3	4	5	6	7
6. My BU has reduced coordinating costs more than our competitors.	1	2	3	4	5	6	7
7. My BU can conduct the coordination activities at less cost than our competitors.	1	2	3	4	5	6	7

Supply Chain Responsiveness

Supply chain responsiveness is conceptualized as the extent to which the whole supply chain reacts quickly and effectively to new inquiries stemmed form environmental or market changes or developments. The scales for this construct were adapted from Bello and Gilliland (1997) and McGinnis and Kohn (1990). Adaptation was needed because the existing scales measured the firm-level responsiveness, whereas the focus of this study is the supply chain level responsiveness. The items for supply chain responsiveness are as follows:

Please circle the number that best reflects your agreement with the following statements regarding the responsiveness of your supply chain (i.e. your BU and your partner together).

	Strongly Disagree						Strongly Agree
1. The relationship with our partner has increased our supply chain responsiveness to market changes through collaboration.	1	2	3	4	5	6	7
2. Compared to our competitors, our supply chain responds more quickly and effectively to changing customer or supplier needs.	1	2	3	4	5	6	7
3. Compared to our competitors, our supply chain responds more quickly and effectively to changing competitor strategies.	1	2	3	4	5	6	7
4. Compared to our competitors, our supply chain develops and markets new products more quickly and effectively.	1	2	3	4	5	6	7
5. In most of our markets, our supply chain is competing effectively.	1	2	3	4	5	6	7

Performance

Firm level performance is operationalized by market performance. Scales were adopted from Sarkar (1999) and Sarkar, Echambadi, and Harrison (2001) to assess firm market performance in sales growth, market share, market development, and product development as follows:

The items below assess the degree to which IT investment in your BU has affected your BU's performance. Please circle the number that best reflects your agreement with the following statements.

	Strongly Disagree						Strongly Agree
1. My BU performs much better than competitors in sales growth.	1	2	3	4	5	6	7
2. My BU performs much better than competitors in market share.	1	2	3	4	5	6	7
3. My BU performs much better than competitors in market development.	1	2	3	4	5	6	7
4. My BU performs much better than competitors in product development.	1	2	3	4	5	6	7
5. My BU performs much better than competitors in alliances/partners.	1	2	3	4	5	6	7

Partner Criticality

Partner criticality refers to the importance of a channel partner for the success of the focal firm (Anderson, Havila, and Salmi 2001). Scales for the construct were developed to assess the importance of partner in terms of meeting customer requirement, long-term benefit, and focal firm's core competency and implemented as follows:

Please circle the number that best reflects your agreement with the following statements regarding your primary partner.

	Strongly Disagree						Strongly Agree
1. Our partner is important for meeting customer requirements	1	2	3	4	5	6	7
2. Our partner is critical for our SBU's long-term benefit	1	2	3	4	5	6	7
3. Our partner is important for our SBU's core competency.	1	2	3	4	5	6	7

CHAPTER 4

ANALYSIS AND FINDINGS

Data Collection and Nonresponse Bias

For the study, it was important to seek the opinions of executives who specialized in supply chain management or logistics. After considering various trade associations, this study sought cooperation from the Council of Logistics Management, which provided a list of their member companies. It was important for us to include qualified managers only to increase the response rate. So, consultants, freight forwarders, third-party logistics companies were eliminated from the database, which left a pool of 1,949 managers on the list. A preliminary request was sent out via email to these managers requesting their participations in our study. There were 223 emails returned as undeliverable for various reasons, such as recipient out of the office, user name not valid, or recipient no longer with the company. Another five managers indicated that they were not interested in participating the study. The remaining 1,726 managers were contacted with a URL link to the web-survey, and 264 responses were received within the self-established three-week deadline. Any responses thereafter were not included in the analysis. Therefore, the effective response rate was 15.3% (264/1,726). But, only 184 responses were analyzed, as the remaining 80 were incomplete.

Subsequently, nonresponse bias was assessed by grouping responses into two groups: early responses vs. late responses (Armstrong and Overton 1977). Table 4 presents the results of t-test for selected variables. According to the results, there is no significant nonresponse bias present in the dataset (Armstrong and Overton 1977).

TABLE 4: NON-RESPONSE BIAS ASSESSMENT

Variable	Early Respondents Mean	Late Respondents Mean	t-value
Annual sales	2529.66	1882.55	.703
Number of employees	7383.31	6606.11	.285
Upstream channel members	937.50	814.55	.286
Downstream channel members	7624.75	1712.00	1.257
Year for major IT investment	1994.22	1992.26	1.743
IT advancement	3.7773	3.5543	1.157
IT appropriability	4.0154	3.7598	1.317
SCCS integration	3.5947	3.3382	1.014

Table 5 presents the number and distribution of the responses by industry. Respondents are from various major industries, including computer and communication (13.0%), consumer products (17.9%), industrial machinery (15.8%), automotive (9.2%), electronic equipment (9.2%), chemical (4.9), and other industries (21.2%).

TABLE 5: INDUSTRY DISTRIBUTION OF RESPONDENTS

Industry	Number of Responses	%
Automotive	17	9.2
Computer and communication	24	13.0
Consumer products	33	17.9
Chemical	9	4.9
Electronic equipment	17	9.2
Industrial machinery	29	15.8
Medical equipment	12	6.5
Other	39	21.2
Not reported	4	2.2
Total	184	100.0

Measurement Model

Before proceeding to conduct data analyses to test the hypotheses embedded in the theoretical model, confirmatory factor analysis (CFA) is carried out as part of two-step approach (Anderson and Gerbing 1982; Anderson and Gerbing 1988; Bollen 1989) to investigate the validity of each construct using EQS for Windows 5.7b (Bentler 1989). Particular attention was given to those scales developed originally for this study including IT appropriability and IT advancement. Before the overall CFA model is investigated, a nested CFA was carried out with those three IT resource constructs (i.e., IT advancement, IT appropriability, and SCCS integration) to assess their construct validity among them. In the purification process of items, some items that were weakly loaded on their respective constructs were eliminated due to problems with convergent validity. Furthermore, items that are cross-linked to multiple constructs weakening discriminant validity were examined and deleted if necessarily for the item level discriminant validity based on the multivariate Lagrange Multiplier (LM) test. There were at least three purified items for each construct remained that will be included in the overall CFA model later.

The CFA results based on those purified items revealed an excellent fit between the CFA model and the dataset with Chi-square of 30.378 on 32 d.f., Comparative Fit Index (CFI) of 1.000, and Root Mean Square Error of Approximation (RMSEA) of 0.0 as Table 6 presents. Items loaded on each hypothesized construct significantly as expected and no construct suffers from a lack of convergent validity or the presence of discriminant validity at the construct level, as all correlations between constructs were significantly different from 1.00 (Bagozzi, Yi, and Phillips 1991; Burnkrant and Page

1982; Schmitt and Stults 1986). Most other fit indexes were close to 1.00, confirming the excellent fit.

TABLE 6: GOODNESS OF FIT INDEXES OF CFA FOR IT CONSTRUCTS

Chi-square =	30.978
Degrees of Freedom =	32
Comparative Fit Index (CFI) =	1.000
Bentler-Bonett Normed Fit Index =	0.978
Root Mean Sq. Error of App. (RMSEA) =	0.000
90% Confidence Interval of RMSEA	(.000, .052)
Constructs Included:	IT advancement IT appropriability SCCS integration

Another nested CFA model was carried out with channel capability constructs, including information exchange, coordination, and supply chain responsiveness, along with market performance. The same purification process deployed for the first nested CFA model was used to purify items again using EQS for Windows 5.7b (Bentler 1989). The CFA results based on those purified items indicated a very good fit of the CFA model with the dataset with a Chi-square of 61.891 on 48 degrees of freedom, CFI of .990, and RMSEA of .040, as shown in Table 7. Just like the first nested CFA model, all items are loaded significantly on the expected constructs while no construct pair suffered from lack of discriminant validity.

TABLE 7: GOODNESS OF FIT INDEXES OF CFA FOR CHANNEL CAPABILITIES AND PERFORMANCE

Chi-square =	61.891
Degrees of Freedom =	48
Comparative Fit Index (CFI) =	0.990
Bentler-Bonett Normed Fit Index =	0.958
Root Mean Sq. Error of App.(RMSEA) =	0.040
90% Confidence Interval of RMSEA	(.000, .066)
Constructs Included:	Information exchange Coordination Supply chain responsiveness Market performance

Based on the two nested CFA models, the overall CFA with all constructs was carried out using EQS for Windows 5.7b (Bentler 1989). The results of the overall CFA model yielded excellent fit indexes including Chi-square of 213.473 based on 188 degrees of freedom, CFI of .991, Normed Fit Index of .932, and RMSEA of .028, indicating that the measurement model has a very good fit with the covariances provided by the sample. As a part of a unidimensionality assessment of each construct, convergent validity and discriminant validity at both the item level and the construct level were assessed first. For convergent validity, the standardized loading of each item must be greater than .5 (Bagozzi and Yi 1988; Bagozzi, Yi, and Phillips 1991). And all correlations between two constructs should be significantly less than zero for discriminant validity (Bagozzi, Yi, and Phillips 1991). According to the results, items were loaded appropriately on their respective constructs and no standardized loading was less than .5, which means that there is an adequate level of convergent validity established for each construct. Moreover, no construct in the measurement model is

suffering from discriminant validity at the construct level, as all correlations between constructs were significantly different from 1.00 (Bagozzi, Yi, and Phillips 1991).

In addition, discriminant validity at the item level was assessed. Assessing the item level discriminant validity was important for the current study as it incorporated newly developed scales for IT constructs. Thus, the item level discriminant validity was assessed using primarily Lagrange Multiplier (LM) test (Bentler 1989). The LM test results indicated that one item of IT advancement might be correlated significantly with two items of SCCS integration. Subsequently, the covariances between those items were assessed by running another CFA model with their covariances freed. Unlike the LM test results, a further assessment on the covariances revealed no significant correlation between those items ($p > .10$). Furthermore, the Chi-square difference between the two CFA models also revealed the same as no significant correlation was found between those items. Therefore, the item level discriminant validity for the overall CFA model was established.

As a final step to assess the unidimensionality of each construct (Churchill 1979; Fornell and Larcker 1981; Gerbing and Anderson 1988), composite reliability for each construct was calculated using the formula suggested by Fornell and Larcker (1981). As shown in Table 8, all composite reliabilities are above .7, which indicates that measures adopted for each construct are reliable (Bagozzi and Yi 1988; Fornell and Larcker 1981). Table 8 also provides items deployed in the overall CFA model and their standardized loadings.

TABLE 8: MEASURES AND COMPOSITE RELIABILITIES

Constructs and Measures	Standardized Parameter	Composite Reliability
IT Advancement		**.8163**
My BU uses the most advanced IT for SCCS.	.755	
My BU is very proactive in building new technical solutions to answer our partner's needs.	.828	
My BU is always first to use new IT for SCCS in our industry.	.733	
IT Appropriability		**.8879**
Relative to competitors, our technical knowledge for SCCS is clearly superior.	.866	
My BU utilizes IT for SCCS in a way that competitors cannot imitate easily.	.775	
My BU receives more benefits from IT for SCCS than competitors.	.910	
SCCS Integration		**.9362**
Our SCCS has built-in functions to collaborate forecasting and planning with our partner.	.765	
My BU can forecast and plan collaboratively with our partner through SCCS.	.941	
Our SCCS allows us to project and plan future demand collaboratively with our partner.	.902	
Collaboration in demand forecasting and planning with our partner is always possible through our SCCS.	.929	
Information Exchange		**.8929**
To what extent is your information exchange with your primary partner:		
Inadequate ..... Adequate	.880	
Incomplete ..... Complete	.920	
Not credible ..... Credible	.738	
Coordination		**.8865**
My BU is more efficient in coordination activities with our partner than are our competitors with theirs.	.867	
My BU conducts transaction follow-up activities more efficiently with our partner than do our competitors with theirs.	.966	
My BU spends less time coordinating transactions with our partner than do our competitors with theirs.	.702	
Supply Chain Responsiveness		**.8683**
Compared to our competitors, our supply chain responds more quickly and effectively to changing customer or supplier needs.	.871	
Compared to our competitors, our supply chain responds more quickly and effectively to changing competitor strategies.	.881	
Compared to our competitors, our supply chain develops and markets new products more quickly and effectively.	.729	

TABLE 8 (Cont'd)

Constructs and Measures	Standardized Parameter	Composite Reliability
Market Performance		.8374
My BU performs much better than competitors in sales growth.	.770	
My BU performs much better than competitors in market development.	.881	
My BU performs much better than competitors in product development.	.729	
CFA Model Goodness of Fit Indexes: Chi-square: 207.618 on 188 d.f. CFI: .991 NFI: .932 RMSEA: .028 90% Confidence Interval of RMSEA (.000, .044)		

Structural Model

A full latent variable model with items adopted from the overall CFA model was estimated (Anderson and Gerbing 1988; Bentler 1989; Bollen 1989) using EQS for Windows 5.7b (Bentler 1989). The structural nature of the research framework strongly favors the use of structural equation modeling (SEM). The results revealed a very good fit between the theoretical model and the empirical covariances provided by the sample with a Chi-square of 226.451 on 194 degrees of freedom, CFI of .989, NFI of .928, and RMSEA of .031, as shown in Table 9. These goodness of fit indexes are well above acceptable levels, and so it can be concluded that hypothesis testing based on this model is reliable.

Also shown in Table 9 are standardized parameter estimates and t-value for each parameter. According to the results, Hypothesis 1a, which states that IT advancement facilitates SCCS integration, is supported with a standardized coefficient of .697 ($p<.01$).

Hypothesis 1b postulates that IT appropriability facilitates SCCS integration and is not supported ($p>.10$).

The next set of hypotheses relates to information exchange. The facilitating role of IT advancement proposed in Hypothesis 2a is not supported empirically ($p> .10$). Support is found, however, for Hypothesis 2b, which states that IT appropriability for SCCS facilitates information exchange; the standardized coefficient is .421 ($p<.05$). The claim that SCCS integration leads to information exchange as stated in Hypothesis 2c, is also supported: the standardized coefficient is .284 ($p<.01$).

Hypothesis 3a, which claims that IT advancement leads to coordination, is not supported ($p>.10$). In contrast, the results reveal that IT appropriability leads to coordination, as stated in Hypothesis 3b. Therefore, Hypothesis 3b is supported with a standardized coefficient of .433 ($p<.05$). Also supported is Hypothesis 3c, which postulates that SCCS integration leads to coordination; the coefficient is .303 ($p<.01$). The claim that information exchange facilitates coordination is supported with a standardized coefficient of .265 ($p< .01$). So Hypothesis 3d is supported.

Hypothesis 4a, which states that information exchange facilitates supply chain responsiveness, is supported; the standardized coefficient is .158 ($p< .05$). Coordination is also expected to facilitate supply chain responsiveness, according to Hypothesis 4b, which is strongly supported with a standardized coefficient of .608 ($p< .01$).

There are three constructs that are expected to lead to firm market performance. Hypothesis 5a deals with the effect of information exchange on market performance and is supported with a standardized coefficient of .202 ($p<.05$). However, Hypothesis 5b, which asserts that coordination leads to market performance, is not supported ($p> .10$).

Finally, the current study maintained that supply chain responsiveness leads to market performance, as stated in Hypothesis 5c. It is strongly supported with a standardized coefficient of .458 ($p < .01$).

Table 9 and Figure 4 summarize the results of hypothesis testing of the current study. In the figure, the arrows in boldface show supported paths.

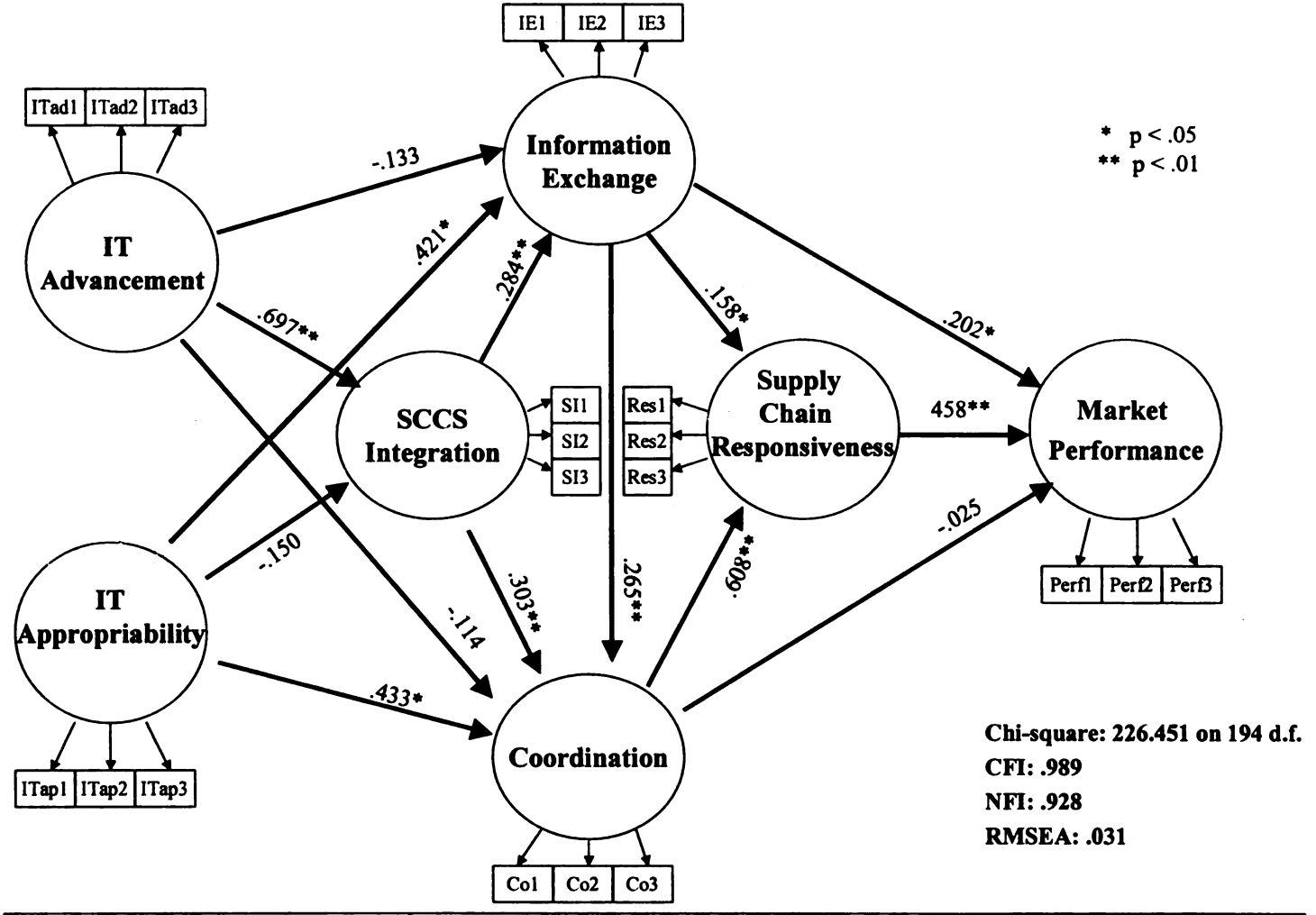
TABLE 9: PROPOSED HYPOTHESES AND TEST RESULTS

Hypothesis	Standardized Parameter Estimate	t-value	Conclusion
H1a: IT advancement facilitates SCCS integration.	.697	3.085**	Supported
H1b: IT appropriability facilitates SCCS integration.	-.150	-.708	Not Supported
H2a: IT advancement for SCCS facilitates information exchange.	-.133	-.560	Not Supported
H2b: IT appropriability for SCCS facilitates information exchange.	.421	1.980*	Supported
H2c: SCCS integration facilitates information exchange.	.284	2.966**	Supported
H3a: IT advancement leads to coordination.	-.114	-.576	Not Supported
H3b: IT appropriability leads to coordination.	.433	2.365*	Supported
H3c: SCCS integration leads to coordination.	.303	3.600**	Supported
H3d: Information exchange facilitates coordination.	.265	3.671**	Supported
H4a: Information exchange facilitates supply chain responsiveness.	.158	2.063*	Supported
H4b: Coordination facilitates supply chain responsiveness.	.608	7.412**	Supported
H5a: Information exchange leads to market performance.	.202	2.277*	Supported
H5b: Coordination leads to market performance.	-.025	-.226	Not Supported
H5c: Supply chain responsiveness leads to market performance.	.458	3.976**	Supported

Structural Model Goodness of Fit Indexes:
Chi-square: 226.451 on 194 d.f.
CFI: .989
NFI: .928
RMSEA: .031
90% Confidence Interval of RMSEA (.000, .046)

* $p < .05$
** $p < .01$

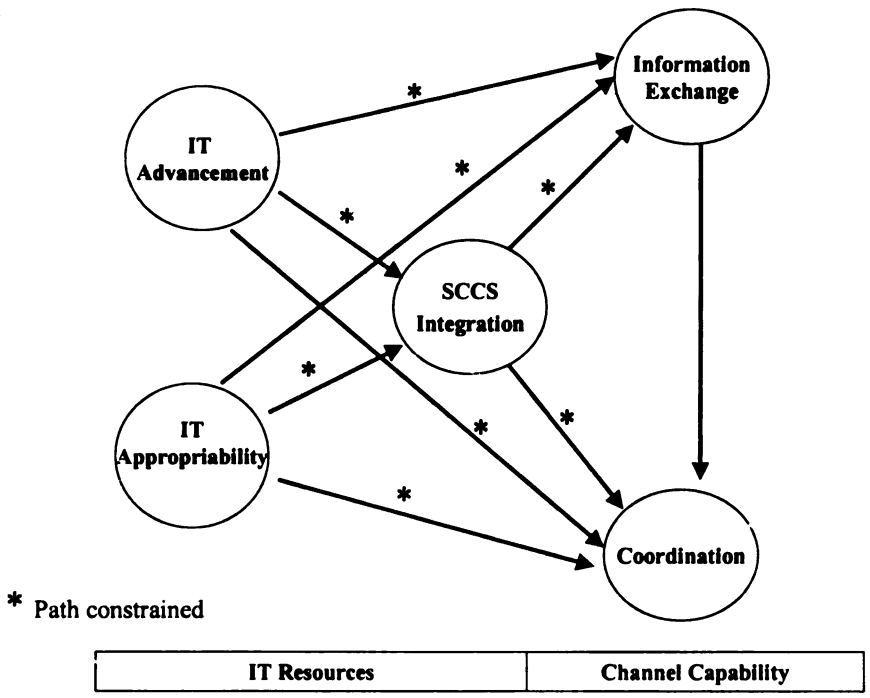
Figure 4: Hypothesis Test Results



The Moderating Effects of Partner Criticality

The moderating effects of partner criticality on the impact of IT advancement and IT appropriability on channel capabilities (i.e., information exchange and coordination) were assessed by a two-group analysis with EQS for Windows 5.7b (Bentler 1989). First, the data were split into two groups based on the parceled level of partner criticality. Then, a two-group analysis was carried out with constraints on paths between IT resource constructs and channel capability constructs. To avoid sample size issues of the model, a nested model of the empirical model was deployed. That is, supply chain responsiveness and market performance were dropped as the primary objectives of the two-group model is to investigate any moderating effects partner criticality may have on the relationships between IT resource constructs and channel capability constructs as depicted in Figure 5.

Figure 5: Two-Group Analysis



The low partner criticality group includes 73 cases whereas the high partner criticality group has 110 cases. The goodness of fit indexes indicate a very good fit of the two-group model with the covariances provided by the sample with a Chi-square of 239.078 on 196 d.f., CFI of .980, NFI of .901, NNFI of .976, and RMSEA of .036. As shown in Table 10, the results reveal that none of the constrained paths have a significant Chi-square difference across the two groups at 5% level. The univariate Chi-square difference ranges from .135 for the IT appropriability → SCCS integration path to 2.149 for the IT appropriability → Information exchange path. Therefore, according to the results of Chi-square difference tests, Hypothesis 6 is not supported.

However, it is worth noting the standardized coefficient of some paths (i.e., IT appropriability → SCCS integration, IT appropriability → Information exchange, IT appropriability → coordination, and SCCS integration → information exchange) is in line with our expectations. That is, the coefficients of those paths are greater in the high partner criticality group than in the low criticality group as hypothesized although the differences between the two groups are not statistically significant. Other paths including IT advancement → SCCS integration, IT advancement → information exchange, IT advancement → coordination, and SCCS integration → coordination, reveal a greater coefficient in the low partner criticality group than in the high criticality group. In sum, although the differences are not significant, IT advancement has a greater impact on channel capabilities in the low partner criticality group than in the high criticality group, whereas IT appropriability shows a greater impact on channel capabilities in the high partner criticality than in the low partner criticality.

The result of t-test for the IT appropriability → coordination path from the two-group analysis is contradictory to that of Chi-square difference test. Specifically, unlike the insignificant Chi-square difference reported by the two-group analysis, the path coefficient of the high partner criticality is .430 ($p < .05$) while that of the low partner criticality is -.155 ($p > .10$). Since their signs are opposite and the coefficient for the high partner criticality group is significantly different from zero ($p < .05$), the t-test results actually reveal that the two coefficients are significantly different from each other. That is, the result of Chi-square difference test is inconsistent with that of t-test on the IT appropriability → coordination path. Therefore, the inconsistent t-test and Chi-square difference test results could suggest that the moderating effects of partner criticality may be inconclusive.

TABL

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TABLE 10: TWO GROUP ANALYSIS ON THE MODERATING EFFECTS OF PARTNER CRITICALITY

H6: The impact of IT advancement and IT appropriability on information exchange and coordination is greater when the partner is more critical to the firm.
(Not Supported)

Individual Path	Standardized Parameter Estimate†		Univariate Chi-Square Difference	Conclusion
	Low Partner Criticality Group (73 Cases)	High Partner Criticality Group (110 Cases)		
IT Advancement ↓ SCCS Integration	1.386	.605*	.777	Not Supported
IT Advancement ↓ Information Exchange	-.044	-.216	1.654	Not Supported
IT Advancement ↓ Coordination	.366	.008	.270	Not Supported
IT appropriability ↓ SCCS Integration	-.920	-.031	.135	Not Supported
IT appropriability ↓ Information Exchange	.361	.471	2.149	Not Supported
IT appropriability ↓ Coordination	-.155	.430*	1.133	Not Supported**
SCCS Integration ↓ Information Exchange	.071	.376*	2.074	Not Supported
SCCS Integration ↓ Coordination	.276*	.213*	.211	Not Supported

Structural Model Goodness of Fit Indexes:
Chi-square: 239.078 on 196 d.f.
CFI: .980
NF[illegible].91

36

est for the difference from zero

difference test and t-test reveal conflicting results on this path.

Indirect Effects of IT Resources on Intermediate and Outcome Variables

The EQS output of the theoretical model also provided test results for the indirect effects of IT resources on intermediate and ultimate outcome variables. Even though these results were not hypothesized and tested explicitly, they offer important theoretical and managerial implications. Because this study investigates the extent to which IT resources influence firm performance through its various channel capabilities, it is worth discussing these results of indirect effects of IT resources.

First, whether or not IT resources (i.e., IT advancement and IT appropriability) have a significant impact on the immediate outcome variable, supply chain responsiveness, and the ultimate outcome variable of the model, market performance, was assessed. The paths included to assess the indirect effects of IT advancement on supply chain responsiveness are as follows:

- IT advancement → SCCS integration → Information Exchange → Supply Chain Responsiveness
- IT advancement → SCCS integration → Coordination → Supply Chain Responsiveness
- IT advancement → SCCS integration → Information Exchange → Coordination → Supply Chain Responsiveness

According to the results, IT advancement does not have a significant effect on supply chain responsiveness or market performance. That is, the total indirect effect of IT advancement on supply chain responsiveness through significant paths is not significant ($p > .10$) as shown in Table 10.

Furthermore, the indirect effect of IT appropriability on supply chain responsiveness also was investigated. The relevant paths included to assess the indirect effects are as follows:

- IT Appropriability → Information Exchange → Supply Chain Responsiveness
- IT Appropriability → Coordination → Supply Chain Responsiveness
- IT Appropriability → Information Exchange → Coordination → Supply Chain Responsiveness

According to the results, IT appropriability has a significant impact on supply chain responsiveness, with a standardized coefficient of .357 ($p < .05$).

Next, the indirect effect of IT advancement on market performance was examined. The paths included for this assessment are as follows:

- IT advancement → SCCS integration → Information Exchange → Supply Chain Responsiveness → Market Performance
- IT advancement → SCCS integration → Coordination → Supply Chain Responsiveness → Market performance
- IT advancement → SCCS integration → Information Exchange → Coordination → Supply Chain Responsiveness → Market Performance
- IT advancement → SCCS integration → Information Exchange → Market Performance

The results reveal that IT advancement has no significant effect on market performance ($p > .10$).

In contrast, IT appropriability shows a significant influence on market performance, with a standardized coefficient of .198 ($p < .05$). The paths included in the assessment of the indirect effect of IT appropriability on market performance are as follows:

- IT Appropriability → Information Exchange → Supply Chain Responsiveness → Market Performance

- IT Appropriability → Coordination → Supply Chain Responsiveness → Market Performance
- IT Appropriability → Information Exchange → Coordination → Supply Chain Responsiveness → Market Performance
- IT Appropriability → Information Exchange → Market Performance

Finally, the indirect effects of IT resources on channel capabilities such as information exchange and coordination were assessed. The paths used in the evaluation are:

- IT advancement → SCCS integration → Information Exchange
- IT advancement → SCCS integration → Coordination
- IT advancement → SCCS integration → Information Exchange → Coordination

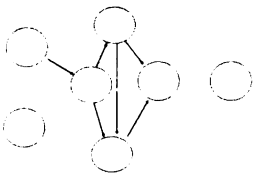
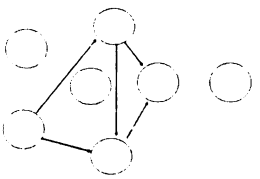
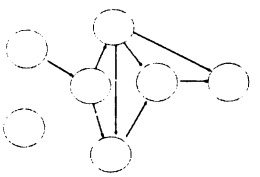
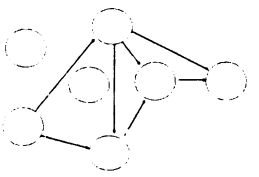
The results reveal that IT advancement contributes to firm channel capabilities through SCCS integration, as shown in Table 12. That is, the indirect impacts of IT advancement on information exchange and coordination are significant with standardized coefficients of .198 ($p < .05$) and .229 ($p < .05$), respectively.

Surprisingly, IT appropriability does not *indirectly* contribute to coordination through information exchange. Therefore, IT appropriability has direct effects on channel capabilities only as discussed previously. The path adopted to assess the indirect effect of IT appropriability is as follows:

- IT Appropriability → Information Exchange → Coordination

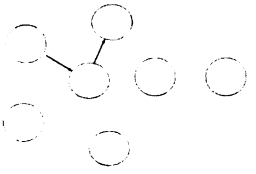
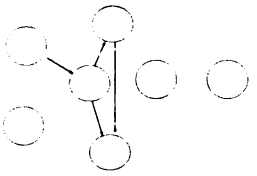
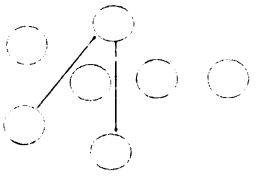
Table 11 and 12 summarize the paths and results of tests on the indirect effects of IT resources on channel capabilities and market performance.

TABLE 11: INDIRECT EFFECTS OF IT RESOURCES ON OUTCOME VARIABLES

Indirect Effect	Significant Mediated Paths	Path Magnitude	t-value
IT Advancement ↓ Supply Chain Responsiveness		.080	.587
IT appropriability ↓ Supply Chain Responsiveness		.357	2.604**
IT Advancement ↓ Market Performance		.047	.514
IT appropriability ↓ Market Performance		.228	2.348**

* $p < .05$
** $p < .01$

TABLE 12: INDIRECT EFFECTS OF IT RESOURCES ON CHANNEL CAPABILITIES

Indirect Effect	Significant Mediated Paths	Path Magnitude	t-value
IT Advancement ↓ Information Exchange		.198	2.066*
IT Advancement ↓ Coordination		.229	1.961*
IT Appropriability ↓ Coordination		.055	.558

* $p < .05$
** $p < .01$

CHAPTER 5

DISCUSSION AND IMPLICATIONS

The Impact of IT advancement on Channel Capabilities

As discussed in chapter 2, IT resources are expected to facilitate channel capabilities of firms including information exchange, coordination, and supply chain responsiveness. In particular, IT advancement and IT appropriability that meet the conditions for a resource as claimed by RBV should have a positive impact on the channel capabilities of firms (Barney 1991; Barney, Wright, and Ketchen 2001; Collis 1994). For instance, IT resources should be well embedded into a firm's core competency and decision making process in order to enhance channel capabilities (Barney 1991; Barney, Wright, and Ketchen 2001; Grant 1996A; Porter 2001). However, according to the study results, IT advancement does not facilitate information exchange or coordination directly. Proactive adoption or use of the latest IT in an effort to build new technical solutions to answer partner's needs ahead of its competitors, as reflected in IT advancement, does not directly help firms enhance interfirm information exchange and coordination as Hypothesis 2a and 3a were not supported.

Furthermore, the results further suggest that firm IT advancement is only helpful when its impact is mediated by SCCS integration, as suggested by support for hypotheses 1a, 2c, and 3c. When IT advancement enhances SCCS functions such as collaborative forecasting and planning, firms gain improved interfirm information exchange and coordination capabilities within the channel relationship. This implies that firms

interested in improving channel capabilities with IT[1] investment should focus on systems integration with partners. Therefore, firm's investments in IT advancement in an effort to enhance channel capabilities that, however, are not aimed at integrating interfirm systems for collaborative interfirm activities, would not necessarily lead to what it is seeking.

Then, why there is no direct impact of IT advancement on information exchange and coordination but an indirect impact through SCCS integration? The message from the results is that IT advancement for supply chain activities should focus on enhancing the interfirm nature of SCCS. That is, a firm's efforts to adopt the most advanced IT available without an IT strategy as to how IT will be utilized for supply chain activities are likely to result in no favorable impact.

There are two evidences that support this argument. First, IT advancement has an indirect impact only on channel capabilities through SCCS integration. SCCS integration here is likely to reflect the strategic IT adoption of firms. In other words, SCCS integration can be viewed as an outcome of IT investments aimed specifically at integrating communication systems across channel partners. Therefore, only the IT advancement that targets the functional enhancement of interfirm systems (i.e. SCCS) among channel partners is likely to improve interfirm information exchange and coordination activities through SCCS integration. On the other hand, IT advancement that does not focuses on the enhancement of online interactions with channel partners would deliver no additional value in terms of interfirm information exchange and coordination activities.

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[1] Although this chapter uses the term, IT, heavily, it is a generalized term from SCCS, which is the context the research model was tested.

For illustration, suppose a firm that is interested in deploying the latest technology (e.g. internet-based EDI) for its SCCS. If the firm is purporting to upgrade technology only without any functional enhancement with the latest technology, the IT investment is likely to result in an incremental improvement of channel capabilities. However, if the IT upgrade sought additional functions such as online collaborative planning or forecasting, then it is likely to improve overall interfirm information exchange as well as coordination activities.

Second, IT appropriability with a direct impact only on channel capabilities indicates the need for a clear IT strategy. IT appropriability is likely to be improved only with a good IT strategy. As it reflects how a firm accumulates IT knowledge and skills for SCCS, it implies the existence of IT strategy within the firm. Since IT appropriability also reflects the existence of firm IT strategy, it should influence channel capabilities without the mediation by SCCS integration as suggested by the results.

The results regarding SCCS integration and IT appropriability, therefore, reveal how crucial the adoption of IT investment strategy for supply chain management is. That is, only IT advancement with an IT strategy that focuses on functional improvement in SCCS and that is used to its full potential will enhance channel capabilities as well as firm performance. If there is no IT strategy as to what it is deployed for or what interfirm functions are added on the current SCCS, it is unlikely to result in channel capability enhancement. Therefore, an IT strategy for IT advancement is a critical necessary condition for the enhancement of channel capabilities and performance from the IT.

The Impact of IT Appropriability on Channel Capabilities

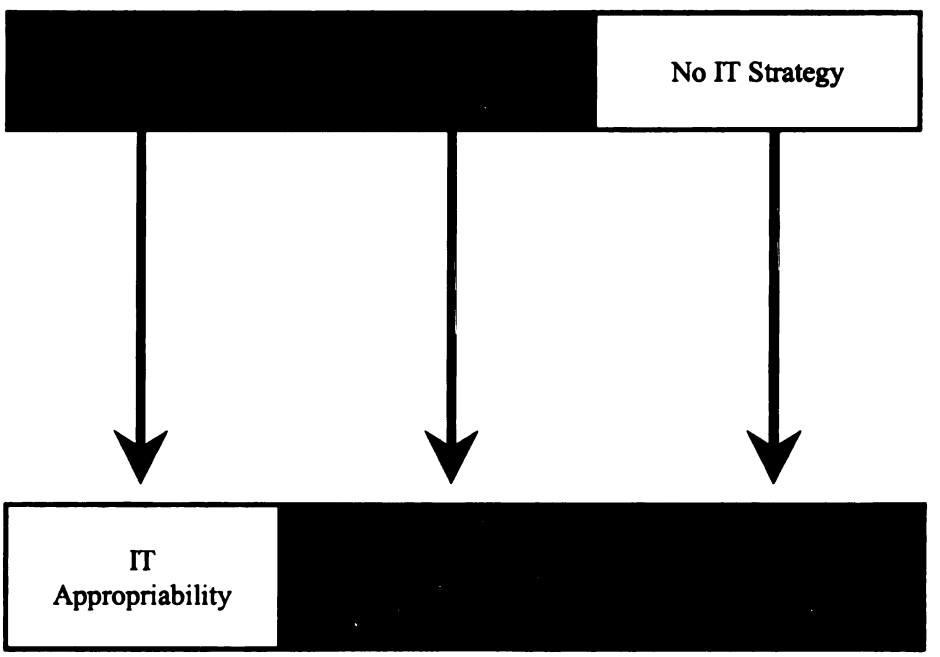
Unlike IT advancement, IT appropriability that mirrors a firm's ability to make full use of IT for SCCS adds value to the channel capabilities of firms as Hypothesis 2b and 3b were supported. In other words, firm's efforts to accumulate technical knowledge about SCCS and how to receive benefits from relevant IT in a way that competitors cannot easily imitate, will enhance the channel capabilities of firms. The impact of IT appropriability on channel capabilities is not mediated by SCCS integration, as Hypothesis 1b is not supported. In other words, IT appropriability directly affects interfirm information exchange and coordination activities but not indirectly through SCCS integration. This finding is opposite to that for IT advancement that affects channel capabilities of firms only indirectly.

Interestingly, IT appropriability as a firm's resource does not seem to have a parallel role with IT advancement, another IT resource, with regard to SCCS integration. IT advancement requires the mediation of such integration in order to affect channel capabilities and performance, whereas IT appropriability has a direct impact on interfirm information exchange and coordination activities. Then, does it necessarily suggest that IT appropriability does not need any IT strategy? Why does SCCS integration not mediate the impact of IT appropriability?

Actually, the finding is in line with what RBV claims (Barney 1991; Barney, Wright, and Ketchen 2001; Collis 1994) because IT appropriability reflects firm's IT strategy implicitly embedded in it. Figure 6 illustrates how a firm's IT strategy is related with IT advancement and IT appropriability. A high IT appropriability is likely to result

from an IT strategy whereas IT advancement does not necessarily reflect the existence of an IT strategy as IT advancement may be improved without it as illustrated in Figure 6.

Figure 6:
IT Strategy for IT Advancement and Appropriability



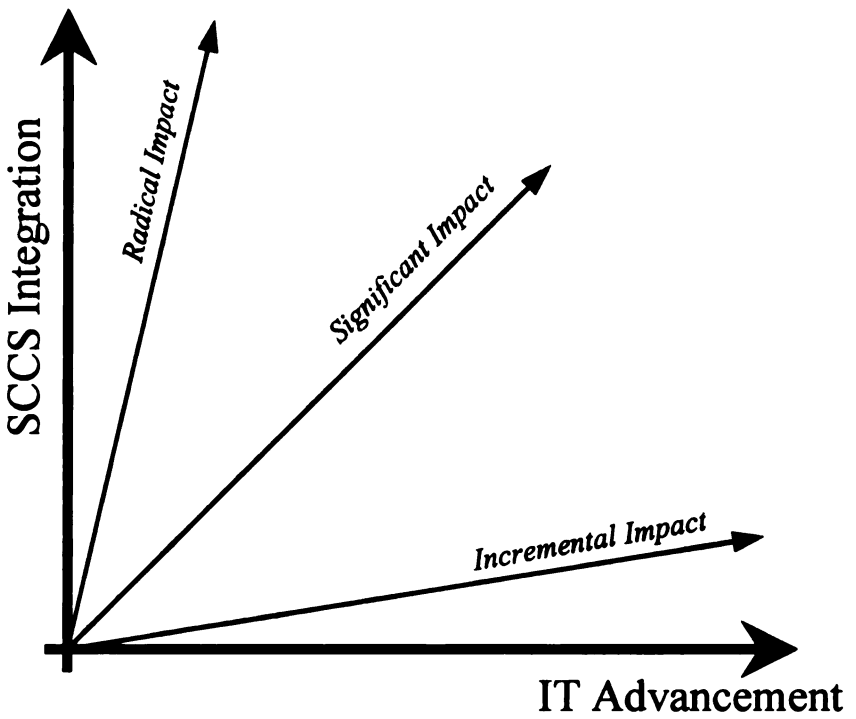
SCCS Integration as a Mediator

The study results provide a few interesting implications with regards to SCCS integration in terms of the use of IT. As discussed in chapter 2, the current study adopted SCCS integration as a mediator of the impact of IT resources on channel capabilities. In particular, IT advancement alone without SCCS integration would result in an incremental impact. As the study results do not provide support for its direct impacts on channel capabilities, the role of SCCS integration is becoming much more important to

derive an adequate return on IT advancement. Subsequently, the impact of IT advancement on supply chain responsiveness, another channel capability and immediate outcome, is also questionable without the mediation of SCCS integration. That is, without the mediation of SCCS integration, firm's investment in IT advancement is most likely to result in an incremental impact on market performance. Therefore, the significant role of SCCS integration as a mediator in deriving the impact of IT advancement on both channel capabilities and firm performance should be recognized especially in the context of supply chain management.

Furthermore, SCCS integration explains why some practitioners and researchers have warned that IT investments deliver weak or no improvement in firms' productivity (Baker and Abrahams 2001; Barchillon 2001; Fisher 2001; Kettinger et al. 1994; Powell and Dent-Michallef 1997). As a key mediator, SCCS integration needs to be present in order to derive favorable returns from IT advancement. It should be noted that IT advancement for SCCS can fall somewhere between two extremes: the simple transition to better technology without functional additions or improvements, on the one hand, and functional additions to the current SCCS, on the other. The former is likely to result in an incremental impact on channel capabilities or firm market performance, as shown in the lower right area of Figure 7. At the other extreme, IT advancement that substantially contributes to SCCS integration is likely to have a radical impact on the channel activities as well as market performance of firms as shown in the upper left area of Figure 7. Of course, there can be cases between these two extremes that yield some degree of significant impact.

Figure 7:
Impact of IT Advancement and SCCS Integration



The Impact of IT Resources on Supply Chain Responsiveness and Performance

Supply chain responsiveness is conceptualized as one of the channel capabilities of firms while serving as an immediate outcome construct of IT resources as well as the other two channel capability constructs: interfirm information exchange and coordination. The results of t-tests reveal that both IT advancement and IT appropriability facilitate supply chain responsiveness and firm market performance, the ultimate outcome variable, through SCCS integration, information exchange, and coordination. That is, the impact of both these IT resources is significantly mediated by SCCS integration and other

channel capabilities such as interfirm information exchange and coordination. For example, significant paths were found from IT advancement to supply chain responsiveness through SCCS integration and information exchange. There were multiple routes that link the impact of IT resources on supply chain responsiveness and market performance. Interestingly, however, the results of statistical tests suggest that the indirect effects of IT advancement on supply chain responsiveness and market performance are not significant, whereas those of IT appropriability are statistically significant, as discussed in chapter 4.

Specifically, the indirect impact of IT advancement on supply chain responsiveness turned out to be relatively trivial, which is consistent with its impacts on the other channel capabilities. The finding is also consistent with the literature that claims weak or no impact of IT on firm performance (Baker and Abrahams 2001; Barchillon 2001; Fisher 2001; Kettinger et al. 1994; Powell and Dent-Michallef 1997). The ultimate influence of IT advancement on market performance is not significant, either. In contrast, the indirect impact of IT appropriability on outcomes (i.e., supply chain responsiveness and market performance) is statistically significant, which means that it influences firm market performance significantly. As an IT resource, IT appropriability plays a dramatically distinctive role for firm market performance in comparison to that of IT advancement.

The Effects of Coordination, Information Exchange, and Partner Criticality

It was hypothesized that coordination facilitates both supply chain responsiveness and market performance. However, the results indicate that coordination only leads to

supply chain responsiveness but not to market performance directly. This is interesting, because the literature discusses coordination as a possible antecedent of firm performance (Mohr and Nevin 1990). Instead, the results reveal that the impact of coordination on market performance is totally mediated by supply chain responsiveness, as the impact of coordination on supply chain responsiveness and that of supply chain responsiveness on market performance are significant ($p < .01$). Obviously, coordination explains supply chain responsiveness better than market performance.

In contrast, information exchange directly affects both supply chain responsiveness and market performance simultaneously. That is, enhanced information exchange with channel partners has not only an indirect effect on firm performance mediated by supply chain responsiveness but also a direct influence on firm market performance.

Regarding the role of partner criticality, this study hypothesized that partner criticality moderates the effect of IT resources on channel capabilities. However, the results of Chi-square difference test provide no support for the moderating effect. That is, the degree of criticality of a channel partner does not influence the effect of IT resources on channel capabilities. However, further research on the moderating effect of partner criticality is necessary to validate the findings as the results of t-test for the IT appropriability → Coordination path are not consistent with that of Chi-square difference test.

Managerial Implications

These findings provide numerous managerial and theoretical implications. For managers, the importance of an IT strategy, which is connoted by the direct impact of IT appropriability and the mediation of the impact of IT advancement by SCCS integration, cannot be overemphasized. Investment in IT advancement for SCCS should not be contented with just technology upgrades. Instead, the investment should seek functional improvements or additions for supply chain activities. The deployment of advanced IT ahead of competitors for new technical solutions without seeking strategic benefits or advantages will not yield favorable returns.

The strategic deployment of IT refers to a firm's efforts to derive benefits from the investment by adopting a clear strategy with regards to how it will enhance the current SCCS so that competitors cannot easily replicate the IT strategy. IT investments in supply chain management activities must seek benefits from the IT in a unique way. Merely upgrading technology chasing the advancement of IT will not improve channel capabilities or performance of the firm according to the study results.

Furthermore, managers need to differentiate between new technology, as captured by IT advancement, and its use, as captured by IT appropriability. IT advancement will not necessarily lead to improvement in channel capabilities not to mention firm performance unless it results in a higher level of SCCS integration, manifested by functional additions to the current SCCS. Therefore, it is more important for firms to analyze partner's needs to determine mutual benefits that could be derived from further systems integration rather than to seek new technology aimed at enhancing firm performance.

In the similar vein, chasing IT is not a good way to improve supply chain responsiveness and market performance. Although IT advancement may facilitate information exchange and coordination, its total indirect effects are not strong enough to influence either supply chain responsiveness or market performance. However, IT investment that seeks the enhancement of appropriability by improving utilization and by accumulating technical knowledge internally, will eventually lead to enhanced supply chain responsiveness as well as market performance.

The results also provide additional implication that firms should internalize key IT resources to gain distinctive competencies (Beaumont and Costa 2002). As the advanced technology is widely available, firms should focus on IT appropriability, the key IT resource that will provide a distinctive benefit. Firms that concentrate on IT advancement are likely to outsource it, whereas those relying on IT appropriability are more likely to internalize its IT resources. Even if firms internalize IT resources, this does not mean that all IT resources are internalized. It rather means that a firm's core SCM competence must stem from IT appropriability not IT advancement. There are advantages and disadvantages of internalizing key IT resources discussed in the literature (Beaumont and Costa 2002; Benko 1992; Lacity and Willcocks 1998; Loh and Venkatraman 1992).

Most firms do not develop IT internally but outsource it because of time and resource constraints. Internal development of technology is rarely cost effective for most firms (Beaumont and Costa 2002; Benko 1992; Lacity and Willcocks 1998; Loh and Venkatraman 1992). Therefore, while IT advancement of a firm in most cases relies on available advanced technology in the market, IT appropriability can be improved only

when the firm is willing to customize the technology so that it is embedded in the firm's core competence or managerial strengths (Beaumont and Costa 2002). The technical knowledge accumulated internally in the process enables full use of the IT, receiving more benefits.

Although it is beyond the scope of the current study, the extent to which firms receive benefit from internalizing IT resources is likely to vary across industries. For example, firms in consumer product industry (e.g. cereals) may not receive benefit as much from the deployment of a new IT as those in construction industry. As the heterogeneous IT penetration rates between the two industries makes the deployment of new technology a sufficient condition for deriving competitive advantage in the construction industry, while it is only a necessary condition for consumer products firms. Managers need to consider this aspect when determining the level of internalization of its IT resources between IT advancement and IT appropriability to receive the optimum benefits of advanced technology.

Managers also need to pay more attention to human factors rather than to technology factors. The study results suggest that IT advancement for SCCS in a supply chain, which is mostly determined by technology advancement, does not add much value to firm performance, whereas IT appropriability, which hinges on internal IT employees, contributes a great deal. The level of IT knowledge accumulation, IT utilization, and benefits from IT can vary significantly across firms, depending on the skills and expertise of IT employees. This emphasizes the role of human more than that of technology in deriving benefits from IT. Consequently, IT investment should focus on human factors rather than technology alone.

In the similar vein, the results imply that it is not IT itself but the firm that makes IT a resource for competitive advantage. Whether this is achieved depends less on the IT and its built-in benefits than on how the firm utilizes it. Therefore, it is more important for firm competitive advantage to accumulate knowledge and skills with the deployed IT than to upgrade technology consistently. These human-centric results seem to explain why the same IT is employed successfully by some firms and not by others.

The findings on the roles of information exchange and coordination also provide multiple implications. First of all, it can be inferred from the results that firm market performance can be improved by supply chain responsiveness, not by coordination, which only improves supply chain responsiveness. Therefore, managers should be aware of the importance of supply chain responsiveness for the impact of coordination. Firms expecting a positive impact on its performance from IT investment in SCCS need to improve supply chain responsiveness through coordination activities.

Second, IT resources have an impact on firm market performance only through channel capability mediators: information exchange and coordination. This suggests that IT investment in SCCS should focus on improvements in these areas. Particularly, in the context of supply chain management, IT resources that are not directed toward these channel capabilities are less likely to have an influence on supply chain responsiveness not to mention firm performance.

Managers also need to pay attention to the mediating effects on firm performance of information exchange, coordination, and supply chain responsiveness. Especially, these indirect effects of information exchange and coordination on firm market performance through supply chain responsiveness are not homogeneous: the standardized

indirect effect of information exchange on market performance was .140, while that of coordination was .279. Yet, the total effects of those two channel capability constructs are not consistent with the indirect effects because of the significant direct effect of information exchange on market performance. The standardized total effect of information exchange on firm market performance was .342, including the indirect effect whereas that of coordination was .254, due to the insignificant direct negative influence of coordination on market performance. Only when managers understand the heterogeneous effects of these mediators of IT resources on firm performance, an IT investment strategy will be adequately directed to appropriate channel activities.

Although the results are inconsistent between Chi-square difference test and t-test for a path, the insignificant moderating effect of partner criticality on the impacts of IT resources on channel capabilities suggests that the importance of a channel partner should not dictate how IT resources will be deployed for the relationship. At least, it indicates that firms do not differentiate important partners from less important partners in deploying IT for channel activities with them. In other words, better information exchange and coordination are desirable throughout the supply chain, regardless of the importance of channel partners.

However, it is worth noting that this finding is counter-intuitive, in that the deployment of IT without regards to the importance of partner is not in the best interest of a rational firm. Obviously, the indifferent impact of IT resources on information exchange and coordination regardless of partner importance reveals the unbiased practice of firms with IT deployment for their supply chain activities. At the same time, it means their information exchange and coordination activities would not be carried out in a

manner that will protect firm's core competence. More information exchange than necessary could leak confidential information associated with core competence. By exchanging only necessary amounts of information and by coordinating transactions in keeping with their best interest, firms can maintain not only its core competence in the market but also a superior place in the relationship with channel partners. Therefore, firms need to adopt a strategy with regards to information exchange and coordination activities that will protect core competence and their superior position in the chain.

Theoretical implications

The study results provide valuable theoretical implications as well. RBV assumes that firm resources for competitive advantage are distributed across firms heterogeneously while not perfectly mobile (Barney 1991; Barney, Wright, and Ketchen 2001; Collis 1994). This immobility of a resource implies that the resource should not be easily imitable by competitors so that the owner of the resource can appropriate the resource adequately (Grant 1996A). The findings of this study are consistent with the RBV argument. Of the two IT resources examined by this study, IT advancement is more imitable by competitors than is IT appropriability. IT appropriability is based on a firm's internally accumulated IT knowledge, level of IT utilization, and IT benefits received, whereas IT advancement involves firm efforts to adopt the latest IT ahead of competitors. It is obvious that IT appropriability is more inimitable and, therefore, should have a greater impact on firm performance than IT advancement, as implied by RBV.

The findings of the current study reveal no direct impact of IT advancement on channel capabilities of firms and insignificant indirect effects on the two outcome variables: supply chain responsiveness and market performance. In contrast, IT appropriability directly affects on channel capabilities such as interfirm information exchange and coordination and has significant indirect effects on supply chain responsiveness and market performance. The results clearly distinguish IT appropriability, a firm's IT resource, from IT advancement, an illusive IT resource. As Barney (1991) claims, information processing systems by themselves can hardly be a resource for competitive advantage because of their wide availability in the market to any firms, which results in the lack of heterogeneity. The study results support his claim by revealing that there is no competitive advantage from the chase of new technology, which also explains why there is no or weak relationship between IT investment and firm productivity. On the other hand, IT appropriability is an obvious source of competitive advantage because it facilitates not only channel capabilities but also firm performance. Barney (1991) further argues that IT well embedded in the managerial process or other core capabilities, is a resource for competitive advantage of firms, and the findings on IT appropriability unlike IT advancement support this claim.

Another theoretical implication of this study is that IT resources (i.e., IT appropriability) may offer possibly sustainable competitive advantage of firms. A firm with a high level of IT appropriability is likely to hold competitive advantage from IT for a long time, assuming that the IT skills, knowledge, and experience it accumulates are not easily transferable across firms (Barney 1991; Barney, Wright, and Ketchen 2001; Collis 1994). Therefore, depending on how firms allocate their investments in IT resources

between IT appropriability and IT advancement, the IT resources may be a resource for their sustainable competitive advantage.

The results support the RBV framework fairly well, which claims that firm internal resources facilitate the firm's capabilities, while the enhanced capabilities lead to better firm performance (Barney 1991; Barney, Wright, and Ketchen 2001; Collis 1994). This study proposed hypotheses in accord with that view, and the results generally support them. Although the current study did not find the direct effect of IT advancement on information exchange and coordination, the indirect effect through SCCS integration revealed a significant links between IT advancement and channel capabilities. Likewise, the significant indirect effect of coordination on firm performance through supply chain responsiveness, despite the insignificant direct effect, supports the theoretical framework adopted by this study well.

The study also found that the influence of IT investment is well explained by the proposed mediation model. Some of the literature that reports weak or no link between IT investment and the firm performance or productivity (Andersen and Segars 2001; Baker and Abrahams 2001; Fisher 2001; Loveman 1991; Panko 1991; Weill 1991) lacks proper mediators to connect IT investment and firm performance. The study results suggest that it is necessary to incorporate realistic mediators into the research in order to find the true influence of IT investment.

Another theoretical implication of this study, in contrast with the IT literature, is that IT appropriability is a distinctive construct from IT advancement. Previous research on IT adoption focuses mainly on how organizations or individuals adopt IT (Davis 1989; Davis, Bagozzi, and Warshaw 1989; Lucas and Spitler 1999) and the effect on

performance (Lucas and Spitler 1999). Subsequently, the literature does not distinguish between adoption and utilization of technology. This study argues that a simply adoption of IT needs to be differentiated from the utilization of IT. The study results clearly reveal that the adoption of technology is a necessary but not a sufficient condition for the significant influence of IT on firm performance whereas the utilization of technology has a significant direct impact on both supply chain level and firm level performance.

Yet, some of the findings of this study are consistent with the IT adoption literature, which claims that ease of use of technology is a critical factor in adoption as well as in the benefits firms or individuals receive (Davis 1989; Davis, Bagozzi, and Warshaw 1989; Lucas and Spitler 1999). The current study reveals that IT appropriability is more crucial than IT advancement, which implies that utilization of IT is more important than adoption of IT, and the level of IT utilization should be strongly associated with ease of IT use. Thus, this study indirectly confirms the importance of the *ease* of IT use.

In addition, the current study makes another important contribution to the SCM and IT management literature by developing and validating scales for multiple constructs including IT advancement, IT appropriability, SCCS integration, and coordination. All scales consist of at least three items with high construct reliabilities. Thus, these scales are expected to provide an important foundation for the future studies on the impact of IT on business activities.

The results regarding partner criticality suggest that the moderating effect of partner criticality may not be as clear in the context of supply chain relationships as in the context of partnerships and alliances. The latter two generally do not necessarily imply a

long-term association, whereas a supply chain relationship usually assumes a more on-going association. In doing business with a partner over the long-term, adequate information exchange and coordination activities are always desirable. Therefore, in the context of a supply chain, the moderating effect of partner criticality would be less important than in any other interfirm cooperation contexts.

SCM Specific Implications

The analysis results also suggest the following SCM specific implications. First, the results reveal that IT advancement for SCCS plays an important role for SCCS integration across partners. As IT advancement for SCCS leads to SCCS integration in terms of collaborative planning, forecasting, and replenishment (CPFR), IT advancement for SCCS is a crucial part of IT investment to enhance the possible CPFR activities between channel partners. The finding is interesting in that IT appropriability, which concerns a firm's efforts devoted to the utilization of deployed SCCS, does not affect SCCS integration directly whereas IT advancement helps firms enhance SCCS integration. That is, technology investment is a critical part in carrying out CPFR activities with SCCS with channel partners. Therefore, as more logistics and supply chain managers view CPFR as a competitive tool, firms should view the deployment of new technology as a way to get their SCCS ready for CPFR activities.

Second, SCCS integration facilitates interfirm information exchange and coordination activities. As IT advancement itself does not affect information exchange and coordination directly, managers need to be aware of the role of SCCS integration that intervenes between IT advancement and information exchange and coordination. A

firm's investment in technology without enhancing SCCS integration is likely to result in no significant returns or benefits. Therefore, technology investment directed toward supply chain activities will provide significant returns when it contributes to more strategic activities such as CPFR through SCCS. It also accentuates that the return from technology investment is determined not by the technology itself but by firm's effort to direct the new technology into the improvement of its current supply chain competency.

Third, unlike IT advancement, SCCS integration affects a firm's market performance and supply chain responsiveness significantly. A further analysis reveals that the total indirect effect of SCCS integration through information exchange and coordination on supply chain responsiveness is very significant ($p < .01$) with its standardized coefficient of .275. Its indirect impact on a firm's market performance is also significant ($p < .01$) with the standardized coefficient of .174. These findings advocate that a firm's SCCS integration efforts will be paid off. Actually, it is unlikely that a firm would gain any significant benefits directly from its investment in advanced technology according to the results. However, the investment directed to the strategic needs of SCCS is likely to yield some substantial benefits evidenced in supply chain responsiveness and market performance.

Therefore, it is management's responsibility to identify the strategic needs of the current SCCS before investing in new technology to receive returns. For instance, management's new emphasis on collaborative business planning through SCCS sharing business goals with channel partners should result in the deployment of new functions and elements in SCCS. Any investment in advanced technology that supplements this

functional addition in SCCS is likely to enhance both supply chain and firm performances.

Furthermore, even though IT advancement does not improve a firm's supply chain outcome (i.e., supply chain responsiveness) and firm level outcome (i.e., market performance) significantly, managers should recognize its role as a facilitator for SCCS integration, one determinant of supply chain responsiveness and market performance. This is a critical finding regarding the role of IT advancement as firms need to invest in technology not to improve supply chain responsiveness and market performance directly but to facilitate SCCS integration, which will, then, eventually lead to supply chain responsiveness and market performance according to the results. In other words, IT advancement should not be viewed as a strategic tool to improve supply chain and firm performance but as a facilitator of SCCS integration in addressing the returns from IT advancement. As IT advancement improves communication and coordination environments, managers are highly likely to appreciate its value as a facilitator for SCCS. Thus, only when managers understand that the return from the technology investment is materialized through SCCS, they will be able to see the indirect benefit from the investments in technology.

Fourth, IT advancement for SCCS is less important than IT appropriability for SCCS in improving supply chain responsiveness and firm market performance from a firm's investment perspective. However, from the SCCS perspective, IT advancement is pertinent to SCCS integration across partners, which in turn affects supply chain responsiveness and market performance. Thus, it could be controversial whether IT investment in supply chain activities provides adequate returns. A firm's financial

manager may claim that technology investment in supply chain management does not yield significant returns and, thus, not deserve investments as the investment does not lead to supply chain and firm performances. However, from the supply chain manager's point of view, it is a critical necessary investment for the adequate returns from SCCS integration. Unless the role of IT Advancement for SCCS integration is fully recognized, the contribution of technology investment to supply chain and firm performances may appear to be negligible. Thus, a firm's management should be able to see the returns from technology investment from the supply chain management's perspective that recognizes IT advancement as an important necessary condition for SCCS integration. Only when the subtle but important role of IT advancement for the returns from SCCS integration is acknowledged, a firm's expectation on returns from technology investment is likely to be more fine-tuned. This also affirms that managers should focus more on the use of the technology than the level of technology investment for adequate returns from investments in both IT advancement and IT appropriability.

CHAPTER 6

FUTURE RESEARCH AND CONCLUSION

Study Limitations

As the first comprehensive empirical research into the impact of IT on channel capabilities and firm performance in the context of supply chain management, this study found the conditions necessary for favorable returns on IT investment and pointed out the implications for managers and researchers. Some limitations should be noted, however. First, although the sample provides excellent measurement reliabilities and concrete results, it seems to have multivariate nonnormality for the research model (Bollen 1989; Hoyle 1995). In order to further explore this issue, the model was rerun using robust standard errors (Hoyle 1995). The results revealed that both measurement and theory models would have had slightly better goodness of fit indexes if variable distributions were multivariate normal. Furthermore, all t-tests based on the robust statistics were compared with the initial t-test results to identify any significant changes in t-values. They suggest that multivariate nonnormality has affected all t-tests negligibly and, therefore, has not influenced hypothesis-testing results.

Second, the data collection of this study was limited by resource constraints. Although the effective response rate exceeds 15%, it could have been improved by follow-up phone calls or personal contact. A better response rate could have provided a more solid ground for the findings and implications of the study (Cook, Heath, and Thompson 2000). While a sampling frame of well-qualified potential respondents would have been helpful, it was not feasible for the current study to refine the list used thoroughly, due to time and financial constraints. It is certain that future researchers will

be able to confirm all the findings of this study even with a better response rate from a refined list.

Third, some researchers are skeptical about the validity and reliability of web-surveys. However, there is no solid ground for their concerns. According to the literature, it is unlikely that the web-surveys lead to method bias (Best et al. 2001; Weible and Wallace 1998). Furthermore, a survey with corporate managers is not likely to suffer from sampling or nonresponse bias, because the lists are randomly generated from a sampling pool with similar qualifications (Sills and Song 2002). That is, those on the list are unlikely to be systematically different from those not on the list whether for a mail survey or email survey. For example, Best et al. (2001) conclude that Internet users and nonusers seem to use similar psychological mechanisms in responding to world problems. In addition, exploratory factor analysis and reliability tests with the data of this study revealed an adequate quality of responses for the web-survey, and both construct reliabilities and goodness of fit indexes for CFA were very good. Therefore, it is highly unlikely that the sample of the current study was influenced significantly by any sampling and non-sampling biases.

Future Research

There are numerous interesting constructs that could be incorporated in the future research on IT in the context of supply chains. The seminal trust and commitment theory of Morgan and Hunt (1994) needs to be tested for any discrepancies between the personal interaction setting and the online interaction setting. This study conjectures that trust does not play as significant role in the online setting simply because the lesser degree of

human contact in the online setting is likely to lead to a greater level of partner dependency. In other words, repeated online interaction without human contacts would likely result in reinforcing previous relationship rather than improving the partnership to trust based relationship (Croom 2000; Gudmundsson and Walczuck 1999B; Kambil and Short 1994; Lewis 2001; Malone, Yates, and Benjamin 1987; Roberts and Mackay 1998; Steinfield, Kraut, and Plummer 1995).

In the similar vein, partner role dependency would be another construct that needs to be investigated empirically in the future as well. The literature reports that electronic relationships and interactions increase the role dependency of channel partners (Croom 2000; Gudmundsson and Walczuck 1999B; Kambil and Short 1994; Lewis 2001; Malone, Yates, and Benjamin 1987; Roberts and Mackay 1998; Steinfield, Kraut, and Plummer 1995). That is, as partners maintain electronic relationships and interactions, they will rely more and more on the role specified within the channel relationship for their success. This increased role dependency of channel partners is associated with high switching costs (Gudmundsson and Walczuck 1999B; Steinfield, Kraut, and Plummer 1995; Tang, Shee, and Tang 2001) and functions as a channel capability of the leading partners. As another channel capability, partner role dependency may mediate the effect of IT resources on firm performance, and therefore deserves research attention.

In the context of supply chain relationships, the alignment of technology across partners may be an important antecedent of channel capabilities. That is, this study views IT advancement and IT appropriability as antecedents of channel capabilities, the technology alignment that concerns the compatibility of technologies deployed by channel partners may be another antecedent. Although some researchers link the

alignment of organizational characteristics and priorities to firm performance (Sanders and Premus 2002), the alignment of IT as an influence on performance remains unexplored. For example, one manager interviewed during the pretest stage of this study noted that, in order to avoid any technical incompatibility, firms use multiple technologies because each major channel partner uses different technology. Obviously, these firms could enhance its channel capabilities by aligning the technology across channel partners.

Another issue is whether IT resources lead to interfirm activity integration. This study found that IT advancement facilitates SCCS integration. That is, as better IT resources are deployed, channel partners integrate their SCCS to enhance electronic collaboration. However, it remains to be investigated whether either IT resources or enhanced SCCS integration actually leads to real activity integration, manifested in the form of partner collaboration. Moreover, future research should inquire into the causal relationship between SCCS integration and activity integration.

Although the current study finds no significant *direct* influence of IT advancement on channel capabilities (i.e. information exchange and coordination), it is possible that the relationship between IT advancement and channel capabilities is quadratic, not linear. That is, IT advancement may have a significant effect on channel capabilities up to a certain point and then diminish in importance or even have a negative influence. For instance, if a firm simply deploys the latest IT, channel capabilities may deteriorate as technology adoption always involves employee training and education. Therefore, until users are adequately trained, the information exchange and coordination

activities would be carried out inefficiently. Future research should examine any quadratic relationship between IT advancement and channel capabilities.

The inconsistent results between Chi-square difference test and t-test on the moderating effect of partner criticality warrant further research to clarify the findings of the current study. One of the plausible reasons for the insignificant Chi-square difference would be the relatively large degrees of freedom compared to the sample size. Therefore, future studies with a large sample size may provide a more comprehensible explanation on the mix results the current study found for the moderating effect of partner criticality.

Conclusion

This study explored how IT affects firm performance through three mediators: information exchange, coordination, and supply chain responsiveness. Using the RBV framework suggested by Barney (1991), Barney et al. (2001), and Collis (1994), and strategic management perspective from DiMaggio and Powell (1983), Porter (2001), and Porter and Millar (1985), this research tested a number of hypotheses and found support for most. The results indicate how a firm utilizes IT as opposed to simply deploying newest technology is crucial in terms of market performance as well as supply chain responsiveness.

Among the numerous implications and contributions of this study, the central findings are that certain channel capabilities strongly mediate the influence of IT resources on firm performance and that IT appropriability and IT advancement play a distinctive roles in enhancing supply chain capabilities and firm market performance. From the IT investment perspective, firms may prefer to invest in IT appropriability for

an adequate level of returns or benefits in supply chain responsiveness and market performance. However, the supply chain perspective recognizes the crucial role of IT advancement for SCCS integration while emphasizing the significant impact of SCCS integration on firm performance. Therefore, firms invest in technology for supply chain activities should focus on the use of technology (e.g., IT appropriability and the role of IT advancement for SCCS integration) rather than the technology itself to understand the benefits of IT resources. Firms should also have a clear objective stemmed from their strategy with technology investment, as different technology investment objectives require different types of IT resources they have to focus on. If improving SCCS integration is the objective, a firm should invest in IT advancement. Yet, for other firms that seek to enhance supply chain level and/or firm level outcomes, the investment priority should be given to IT appropriability.

This study, thus, highlights the importance of mediators and the human-centric nature of the influence of IT resources on channel relationships. Technology by itself will not provide returns. Only management that navigates will gain the benefits from IT investments.

APPENDICES

Appendix 1: First Email Request for the Web-Survey

Dear CLM Member:

We, at Michigan State University, are continuing our efforts to identify logistics best practices. As a part of our on-going research agenda, we are requesting that you participate in the following study. The primary focus of this investigation concerns logistics information technology (LIT). The specific research questions concern:

- To what extent does LIT help firms gain better supply chain capabilities including information exchange and transaction coordination activities?

- To what extent is firm's LIT investment in supply chain activities justifiable?

We are contacting CLM members who have expertise in the area of LIT and your contribution to this study is very important. If you participate in this study, you may elect to receive a summary of the final result by providing us with your e-mail in the optional segment of survey. It should take about 20 minutes to complete this questionnaire, although your completion time may vary. Your responses will remain confidential and your privacy will be protected as each survey will be assigned a random code which we have not tracked. More information about this research and the survey can be found at the following link:

http://globaledge.msu.edu/surveys/sm/

If you have any questions or need additional information, please feel free to contact us at (517) 353-6381 ext. 259 or msu-clm@ciber.bus.msu.edu (email). Your opinion is highly valued and we appreciate your willingness to participate in this study!

Best regards,

Dr. David Closs
Dr. S. Tamer Cavusgil
Dr. Roger Calantone
Mr. Daekwan Kim
Department of Marketing and Supply Chain Management
Eli Broad Graduate School of Management
Michigan State University

Appendix 2: Reminder Email for the Web-Survey

Dear CLM Member:

This is the second and final e-mail from us to remind you about the opportunity to participate in the logistics research being conducted by a Michigan State University research team. The online survey and more information can be found at http://globaledge.msu.edu/surveys/sm/.

We, at MSU, are continuing our efforts to identify logistics best practices. As a part of our on-going research agenda, we are requesting your participation in this study. The primary focus of this investigation concerns logistics information technology (LIT). The specific research questions concern:

- To what extent does LIT help firms gain better supply chain capabilities including information exchange and transaction coordination activities?
- To what extent is firm's LIT investment in supply chain activities justifiable?

We are contacting CLM members who have expertise in the area of LIT and your contribution to this study is very important. If you participate in this study, you may elect to receive a summary of the final result by providing us with your e-mail in the optional segment of survey. It should take about 20 minutes to complete this questionnaire, although your completion time may vary. Your responses will remain confidential and your privacy will be protected as each survey will be assigned a random code which we have not tracked. For more information about this research and the survey, please visit the following link:

http://globaledge.msu.edu/surveys/sm/

If you have any questions or need additional information, please feel free to contact us at (517) 353-6381 ext. 259 or msu-clm@ciber.bus.msu.edu (email). Your opinion is highly valued and we appreciate your willingness to participate in this study!

Best regards,

Dr. David Closs
Dr. S. Tamer Cavusgil
Dr. Roger Calantone
Mr. Daekwan Kim
Department of Marketing and Supply Chain Management
Eli Broad Graduate School of Management
Michigan State University

Appendix 3: Introduction Pages for the Web-Survey

About Survey

Study Objectives

Why Participate?

Privacy Protection

Contact Information

The Benchmark Survey on the Impact of IT on Logistics Relationships

BROAD COLLEGE OF BUSINESS MICHIGAN STATE UNIVERSITY

The following survey on the Impact of IT on Logistics Relationships is conducted by a team of supply chain researchers at Michigan State University for academic research purpose only, using an email list provided by the Council of Logistics Management.

This survey is expected to take about 20 minutes, although your completion time may vary. Your responses to the survey will remain confidential and your privacy will be protected to the maximum extent allowable by law. In addition, all reports of research findings will be aggregated.

To start, please click on the button below. Also, let us know at the end of the survey if you want to receive the summary report with benchmark data obtained from other CLM members. Thanks for your contribution!

START SURVEY

The Benchmark Survey on the Impact of IT on Logistics Relationships

BROAD COLLEGE OF BUSINESS MICHIGAN STATE UNIVERSITY

About Survey

Study Objectives

Why Participate?

Privacy Protection

Contact Information

Study Objectives

This research examines when and how IT contributes to firm competitiveness, a critical link to justify IT investments in supply chain (logistics) activities.

This research should provide more definitive answers to such critical managerial issues as:

- Does IT have any impact on supply chain relationships?
- Do advanced IT and its utilization lead to interfirm integration?
- Do IT advances and firm's IT utilization ability lead to better interfirm information exchange and coordination activities?
- Do they lead to improved global supply chain management, firm performance, and customer equity?
- Is firm's IT investment in supply chain management justifiable? Are there any conditions under which it becomes worthwhile?

START SURVEY

The Benchmark Survey on the Impact of IT on Logistics Relationships

BROAD COLLEGE OF BUSINESS MICHIGAN STATE UNIVERSITY

About Survey

Study Objectives

Why Participate?

Privacy Protection

Contact Information

Why Participate?

Reason 1:
You are making contributions to academic research in supply chain and logistics management, which will guide future supply chain and logistics management.

Reason 2:
Participating executives will receive a summary of key findings, with the opportunity to receive a full report. The report will highlight current industry IT practices and experience with which managers can evaluate their current practices in IT investment and their performance.

Reason 3:
In appreciation of your participation and remembrance of our heroes, we will make a $2.00 donation to New York City Fire Department when we receive your completed survey. Show them that they are in your memories and hearts.

START SURVEY

The Benchmark Survey on the Impact of IT on Logistics Relationships

BROAD COLLEGE OF BUSINESS

About Survey

Study Objectives

Why Participate?

Privacy Protection

Contact Information

Your Privacy Protection

Your responses will remain confidential and your privacy will be protected to the maximum extent allowable by law. In addition, all findings will be reported in aggregate fashion and names and addresses will be removed from the analyses to ensure confidentiality. Your participation is voluntary. You may refuse to answer any question and may terminate your participation at any time. You indicate your voluntary agreement to participate by completing and returning this questionnaire.

For further questions regarding your rights as a participant of the research, please contact

Ashir Kumar, M.D.
Chair of the University Committee on Research Involving Human Subjects
202 Olds Hall, East Lansing, MI 48824
Tel: (517) 355-2180
Fax: (517) 432-4503

START SURVEY

The Benchmark Survey on the Impact of IT on Logistics Relationships

BROAD COLLEGE OF BUSINESS MICHIGAN STATE UNIVERSITY

About Survey

Study Objectives

Why Participate?

Privacy Protection

Contact Information

Contact Information

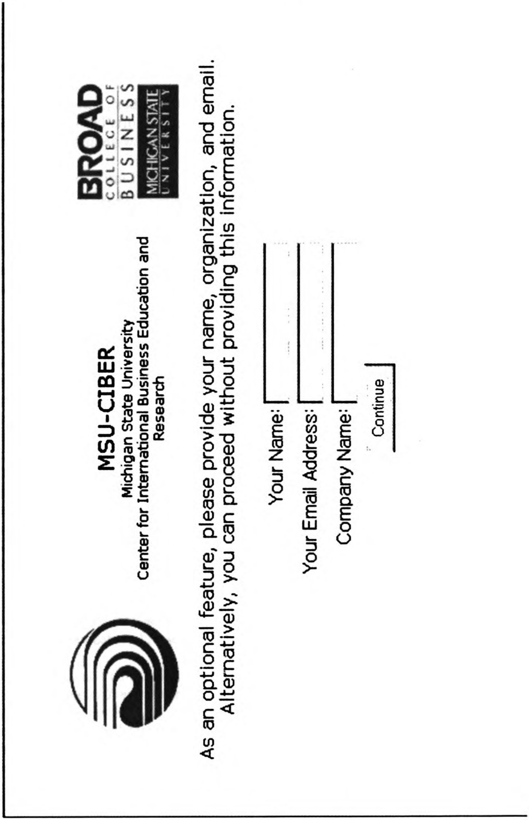
If you have any questions or concerns regarding this research, please feel free to contact us at (517) 353-6381 ext. 259 or **msu-clm@ciber.bus.msu.edu** (email).

Supply Chain Research Team

Dr. S. Tamer Cavusgil
Dr. Roger Calantone
Dr. David Closs
Mr. Daekwan Kim
Department of Marketing and Supply Chain Management
Eli Broad Graduate School of Management
Michigan State University

START SURVEY

Appendix 4: Start-up Page for the Web-Survey



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