A Dissertation

entitled

Alignment of Information Systems with Supply Chains: Impacts on Supply Chain Performance and Organizational Performance

by

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Submitted to the Graduate Faculty as partial fulfillment of the requirements for the Doctor of Philosophy Degree in Manufacturing Management

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May 2010

An Abstract of

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Over the past decade, an important focus of researchers has been on supply chain management (SCM), as many organizations believe that effective SCM is the key to building and sustaining competitive advantage for their products/services. To manage the supply chain, companies need to adopt an SCM strategy (SCMS) and implement appropriate SCM practices. However, different SCM strategies and practices require support from appropriate information technology (IT) applications and their usage. To effectively manage the supply chain, there is therefore a need for aligning these applications and their usage with the supply chain strategy and practices of the firm. While the literature on IT-business alignment has mainly focused on various aspects of the alignment between information systems (IS) strategy (ISS) and business strategy, it is largely deficient in offering an understanding of how specific supply chain strategies should be aligned with relevant IS strategies. Similarly, prior studies on SCM have developed considerable detail on supply chain strategies, without enunciating the implications of these strategies for the use of IT. Additionally, many studies have examined the importance of implementing SCM practices and their impact on supply chain and firm performance without identifying the corresponding IS usage that might be

required for executing those practices in a more effective manner. Thus, there are no studies that explore the alignment between SCMS and ISS and between SCM practices and the usage of IT. This study contributes to the literature of SCM and IT by examining the alignment between the supply chain and information systems (SC-IS) at two levels. First, it looks at different SCM strategies and assesses appropriately- aligned information strategies that would enhance their effectiveness vis-à-vis their effect on the supply chain and firm performance; this is what this study refers to as alignment at the planning/strategic level. Second, the study looks at SCM practices and identifies corresponding IS usage practices that enhance the success of those practices vis-à-vis their effect on the firm and its supply chain performance; this is what this study refers to as alignment at the practice/operational level. Alignment was assessed using the moderating and mediating methods.

Research methods included item development, Q-sort, a large scale survey of 205 respondents, who were mainly purchasing managers/directors of large organizations, and data analysis using Structural Equation Modeling (SEM). The research developed and validated reliable instruments for supply chain management strategy, information systems strategy, IT utilization, the alignment between SCMS and ISS, and the alignment between SCM practices and the usage of IT constructs through an extensive literature review, and then revised the instruments by using pre-test, structured interviews, and Q-sort methodologies. Valid and reliable measures from SCM practices were adapted and validated from previous research to fit the context of the present study.

The research findings suggest that at the strategy level, aligning a particular IS S with the corresponding SCMS enhances supply chain performance and firm performance specific to the type of SCMS. At the operational level, the results suggest that implementation of particular SCM practices requires the use of corresponding IT applications, in order to have an enhanced positive effect on firm performance and supply chain performance. The theoretical contribution of this research is in two domains. The contribution in the IS domain is in introducing alignment concepts in the supply chain context and analyzing ISS/SCMS and IT usage type/SCM practice pairs, the co-presence of which can enhance supply chain performance. The study thus forwards current contingency-based thinking in the IS literature that is beginning to suggest that study of IS deployment or use at the aggregate level might be less informing than looking at specific contexts and requirements against which applications are adopted. In the SCM domain, this research shows the importance of the adoption and use of specific types of IS in achieving enhanced benefits from particular SCM practices and strategies. The study thus extends recent literature that is beginning to recognize the importance of understanding the benefits of different types of IS applications to supply chains. This study also has several important implications for practitioners, by demonstrating to managers the importance of adapting an ISS that matches their SCMS, and the importance of using the appropriate IT applications that match their SCM practices. As a result, the findings help managers to better position, structure, and utilize their IS applications in line with their SCM strategies and practices. So, for instance, if a focal firm acquires a new supply chain related application, it should make sure that the application supports and enhances the supply chain's ability to achieve its particular goals; this will result in better supply integration and quicker response to customers' demands, which will allow the firm to achieve its market and financial goals. Therefore, these results should be useful for strategic decision making, especially with regards to investment decisions concerning IT integration in supply chains.

Acknowledgements

First, and foremost, I would like to thank Dr. T.S Ragu-Nathan and Dr. Monideepa Tarafdar (the co-chairs of my dissertation) for their time, support, inspirations, and advices throughout the entire process of completing my dissertation. Equal thanks also go to Dr. Thuong T. Le and Dr. Hokey Min for their participation in my dissertation committee and for their feedback and comments on my dissertation.

Thanks are also given to the wonderful professors at the University of Toledo. I want to thank specially Dr. S. Subba Rao, Dr. James Pope, and Dr. Ken Kim for their support in my entire Ph.D. journey. I want also to thank Drs. Mark Vonderembse, Jerzy Kamburowski, Paul Hong, Udayan Nadkeolyar, William Doll, Ellen Pullins, Thomas Sharkey, Anand Kunnathur, and other professors at the College of Business for their encouragement during my doctoral studies.

I want to specially thank my good friend Susita Asree for her support throughout the program. I also want to thank my other friends Melvin Williams, Erika Marsillac, Abdullah Aldakhil, Oanh Tran, and David Dobrzykowski, and other doctoral students for their professional and personal support. Finally, I am also grateful to the 205 individuals who respondent to my survey. It would not be possible to complete this dissertation without their participation.

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Chapter 1

Introduction

Supply chain management (SCM) has been defined in many different ways (Tan, 2001). A common definition of SCM includes the flow of materials and information along the supply chain in order to meet customer requirements in an efficient manner. Two important elements in the definition of SCM are: (1) flow of products, and (2) flow of information. Supply chain practices focus on products' movement (Chopra and Meindl, 2001), while information systems (IS) focus on sharing information.

As more firms realize that effective SCM is the key to building and sustaining competitive edge in their products and services, they are finding ways to improve the performance of their supply chains by managing and integrating key information elements into their supply chains (Gunasekaran and Ngai, 2004). It is impossible to achieve effective supply chain integration without information technology (IT), since IT plays a critical role in the success or failure of the supply chain. Handfield and Nichols (1999) noted the significance of IT in determining the ultimate success in managing the supply chain and cited evidence that IT was a necessary factor in the survival of SCM projects. Brandyberry et al. (1999) suggest that IT has the potential to manage the flow and to impact many dimensions of the supply chain, such as cost, quality, delivery, flexibility, and, ultimately, the profit of firms. Byrd and Davidson (2003) provided empirical evidence that IT impacts the supply chain, showing that the development and utilization of long-term IT plans lead to a better firm performance measured by return on investment (ROI), return on equity (ROE), and market share. Vickery et al. (2003) provided empirical evidence that supply chain coordination and integration is facilitated by the use of integrated information technologies, which directly impacts a firm's financial performance (cost performance).

Despite the importance of IS in managing the supply chain and with many firms investing in costly new systems and applications, a number of firms continue to struggle in their efforts towards effectively integrating the physical goods and information flow in their supply chains. One study suggests that over 50 percent of the respondents (U.S. industries on their supply chains) agree that SCM is not meeting their needs (Staff, 1999). At the same time, however, Procter and Gamble has reported generating more than U.S. $325 million in supply chain savings. Shah et al. (2002) believe that Procter and Gamble excel in managing its supply chain by having IT capabilities aligned with appropriate supply chain activities. Shah et al. (2002) suggest that SCM practices and strategic initiatives taken by supply chain members require using information intensively; and thus, they require the support of inter-organizational information systems. They argue that supply chains at different levels of integration and coordination require different levels of IS integration. Therefore, they propose a conceptual framework to study the alignment of IS with the needs of the supply chain members, arguing that a high level of supplier integration must be aligned with a high level of IT integration. Similarly, a low level of supplier integration requires a lower level of IT integration among suppliers in order to achieve better performances.

Further, to achieve a competitive advantage and better performances, SCM strategy (SCMS) should directly support and drive forward the business strategy. In other words, SCMS should be aligned with the business strategy; at the same time, supply chain managers need to use the best IT solution to support their SCMS in order to stay competitive. A good example of this is Wal-Mart's use of IT to support its supply chain. Wal-Mart has made significant investments in inventory control, materials management, point of sale integration, and inventory tracking RFID systems. These systems provide up-to-the-minute information on inventory and logistics, leading to rapid response to customer requirements, higher inventory turnover, and reduction of its labor and inventory costs; thus supporting the company's low cost supply chain. This example clearly shows the importance of aligning SCMS with IS to achieve better performance (Cohen and Roussel, 2005; Nickles et al., 1998; Jones et al., 2005).

While most of the literature regarding IT alignment focuses on strategic alignment between business strategy and IS strategy (ISS) and its relationship to performance (King, 1978; Henderson and Venkatraman, 1993; Chan et al., 1997; Gupta et al., 1997; Sabherwal and Chan, 2001; Kearns and Lederer, 2003; Kearns and Sabherwal, 2006/2007), other literature has focused on social alignment or the alignment of IS-business partnerships at various levels in the organization (Bassellier and Benbasat, 2004). However, there are no studies that explore the alignment between supply chain and information systems (SC-IS), specifically the alignment between SCMS and ISS, and the alignment between SCM practices and the usage of IT. In the absence of such understanding, there is a lack of framework that managers can use for effectively positioning and utilizing their IS in line with their SCM strategy and practices.

This study intends to fill the gap by examining the alignment between SCM and IT; it examines SC-IS alignment at two levels. First, it looks at different SCM strategies and assesses appropriately-aligned information system strategies that would enhance their effectiveness vis-à-vis their effect on SCM and firm performance. Second, it looks at SCM practices and identifies corresponding IS usage practices that enhance the success of those practices vis-à-vis their effect on supply chain and firm performance.

It is important to align SCMS with business strategy. Evans and Danks (1998) suggest that business strategy should address three questions: (1) What products/services should the firm sell? (2) What customer segments should the firm service? (3) In what geographic markets should the firm operate? The answers to these questions will determine the context within which the firm's SCMS is developed. A good example of this is Wal-Mart's strategic vision to build customer loyalty through everyday low prices being accomplished by adopting a cross-docking strategy in its supply chain.

This study argues that not only should the business strategy and SCMS be aligned, but the alignment should also include ISS. It is important to plan for an IT application that supports and enhances a SCMS. This is what this study refers to as "*the alignment between SCMS and ISS*"; or the alignment at the planning/strategic level. In other words, this study argues that once a company plans to invest in an application, the goal and the objective of this application should support the objective of the supply chain. For instance, if the strategic positioning of a company is to have the lowest price in the market relative to its competitors, then this company should emphasize having an efficient supply chain, and then invest in applications that assist and enhance the goal of the supply chain in order to have better supply chain and organizational performance.

Furthermore, this research also argues that it is important to utilize IT effectively in the supply chain to achieve superior supply chain performance. In other words, IT should be used to support and enhance the SCM practices; this is what this study refers to as "*the alignment between SCM practices and the usage of IT*", or the alignment at the practice/operational level. For instance, if one of the practices of SCM is postponement (delaying activities in the supply chain until the customer's requirement is known), then the firm should use a "push-pull" supply chain strategy to implement this practice. An example of a "push-pull" supply chain strategy is one in which the manufacturer builds to order. This implies that component inventory is managed based on the forecasting but final assembly is managed by responding to specific customers' requests (Simchi-Levi, 2005). In other words, the manufacturing process starts by producing a generic or family product based on forecasting, and then differentiates its specific end-product when demand is revealed. Implementing postponement practices requires using IT to share and coordinate timely information across suppliers so the firm can react quickly to the specific customers' orders. This will result in improved supply chain performance by (1) reducing the lead times by better anticipating incoming orders from the customers, (2) increasing service levels, (3) and improving the responsiveness to changes in customers' demand.

As IS continues to increase in use and importance in supply chain processes, the IS alignment with supply chain practices and strategies becomes very critical. Literature in this area is still emerging. This research thus attempts to make a significant contribution to the literature on supply chain and IS research by addressing the following two important questions:

Research Question 1: Can the alignment at the planning/strategic level (SCMS with ISS) have a positive impact on SCM performance and firm performance?

Research Question 2: Can the alignment at the practice/operational level (SCM practices with the usage of IT) have a positive impact on SCM performance and firm performance?

This research identifies three SCM strategies (lean, agile, and hybrid). A lean supply chain is a supply chain that utilizes a strategy aimed at creating the most cost efficiency. An agile supply chain is a supply chain that utilizes a strategy aimed at being responsive and flexible to changing customer needs. A hybrid supply chain is a supply chain that utilizes an “assemble-to-order strategy. Furthermore, this research identifies three IS strategies (IS for efficiency, flexibility, and comprehensiveness). IS for efficiency is a strategy oriented toward operational support of internal and inter-organizational efficiency. IS for flexibility is a strategy oriented toward market flexibility and quick strategic decisions. IS for comprehensiveness is a strategy that enables comprehensive decisions.

At the strategic level, this study argues that the moderating alignment between SCMS –lean, agile, and hybrid- and ISS -IS for efficiency, flexibility, and comprehensiveness- will enhance SCM and firm performance. Furthermore, at the operational level, this research identifies six SCM practices: strategic supplier partnership; customer relationship; information sharing; information quality; internal lean practices; and postponement. This research also identifies three ways to utilize IT -- externally internally and through a focus on infrastructure. This study argues that the moderating alignment between SCM practices and IT utilization will enhance SCM and firm performance.

Chapter 2 describes the literature review on SCMS, ISS, SCM practices, and the usage of IT. The theoretical development and the hypothesis development are presented in Chapter 3. The research methodology is described in Chapter 4. The validity and reliability results are reported in Chapter 5. In Chapter 6, the results of hypotheses testing are shown. Finally, Chapter 7 concludes the summary of the research--its theoretical and practical contributions, managerial implications, and limitations. Recommendations for future research are provided.

Chapter 2

Literature Review

This chapter presents the literature review and the definition for the constructs (SCMS, ISS, SCM practices, IT utilization) and their sub-constructs.

2.1 SCM Strategy (SCMS)

Supply chain management (SCM) is becoming increasingly important in today's global competition. As competition shifts from company vs. company to supply chain vs. supply chain, SCM becomes a significant strategic tool for firms to survive and create competitive advantages (Stalk and Hout, 1990; Quinn, 1997; Rich and Hines, 1997; Tan et al., 2002). Market leaders in the retail industry such as Wal-Mart and Dell constantly search for new ways to add value and push the boundaries of performance by realizing the importance of managing their supply chains (Cohen and Roussel, 2005). To compete at the supply chain level, companies must adopt an appropriate SCMS. Such strategy needs integration and coordination throughout the supply chain to enhance the performance of supply chain members (Green Jr. et al., 2008; Cohen and Roussel, 2005; Wisner, 2003).

Mason-Jones et al. (2000) argue that supply chains need to adopt a strategy that suits both their particular product and marketplace. Fisher (1997) suggests that the first step in developing the supply chain strategy is to consider the nature of the demand for an organization's product, proposing that these are either functional or innovative.

Functional products are like commodities; they are typically stable, fast moving consumer goods that are widely available and satisfy basic needs that do not change over time. As a result, functional products should have a very efficient low-cost supply chain. On the other hand, innovative products have short life cycles with volatile demand that is difficult to predict. They need a flexible and fast supply chain to deal with uncertainty in the demand. Since by definition SCM requires collaboration of all supply chain participants to satisfy final customers, an SCM strategy must be adopted. Implementation of such a strategy requires creating a greater level of trust throughout the supply chain, establishing more frequent contact with supply chain members, and increasing information sharing and communication among suppliers (Wisner, 2003). Porter (1990, p.41) argues that a "*strategy guides the way a firm performs individual activities and organizes its entire value chain*". For instance, if a firm has a low-cost strategy, then the firm should optimize and coordinate the supply chain by having frequent and timely deliveries from suppliers to reduce the required level of inventory and achieve low cost. Porter (1990) argues that there are two types of generic strategies to achieve a competitive advantage: low-cost and differentiation strategies. A low-cost strategy enables a firm to design and produce a product more efficiently than its competitors. A differentiation strategy allows a firm to offer a variety of products to the customer with reliability and responsive services.

Fisher (1997) explains the need to match the appropriate supply chain management strategy to product characteristics as shown in figure 2. 1., which illustrates only two extreme types of product characteristics: functional and innovative products. Fisher argues that functional products which are considered to have stable and predictable demand require an efficient process (efficient chains) to supply that product. On the other hand, innovative products which are considered to have unpredictable demand require a responsive supply chain. This match between product type and supply chain strategy will result in a better profit margin for the organization as Fisher was able to calculate the profit based on the contribution margin and the stockout rate of functional and innovative products.

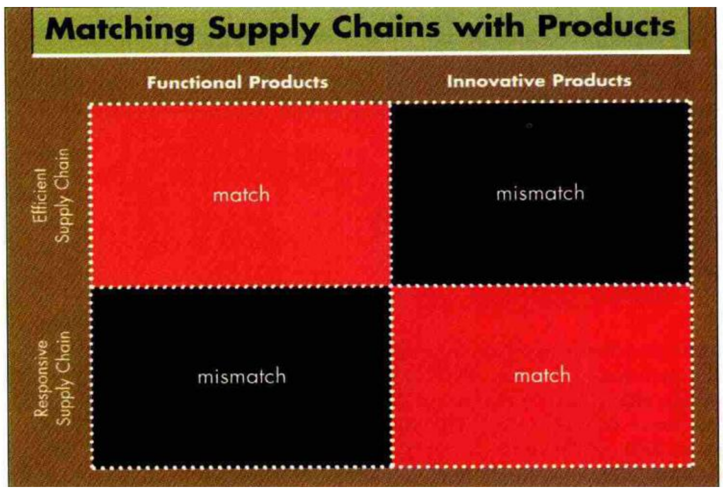

Figure 2.1 Matching supply chains with product characteristics (source: Fisher, 1997)

Vonderembse et al. (2006) discuss three types of supply chains that are necessary to match three types of products: standard, innovative, and hybrid. They demonstrate that standard products, which tend to be simple products with limited amounts of differentiation, should be produced by a lean supply chain (LSC). LSCs employ continuous improvement efforts and focus on eliminating wastes across the supply chain. On the other hand, innovative products which may employ new and complex technology require an agile supply chain (ASC). ASCs respond to rapidly changing global markets by being dynamic and flexible across organizations. Hybrid products, which are complex products, have many components and participating companies in the supply chain; therefore, a variety of supplier relationships may be needed, which they refer to hybrid supply chains (HSC). HSCs combine the capabilities of lean and agile supply chains to meet the needs of complex products.

Lee (2002) expands on Fisher's ideas but focusing on the "supply" side of the supply chain in determining the supply chain strategy. He suggests that there are uncertainties revolving around the supply side that determine the supply chain strategy. The supply side may be characterized by: (1) stable supply processes and (2) evolving supply processes. A stable supply process is one where the manufacturing process and the underlying technology are mature and the supply base is well established. An evolving supply process is one where the manufacturing process and the underlying technology are still under early development and are rapidly changing. Although functional products tend to have more mature and stable supply chains; and innovative products tend to have more evolving supply chains, this is not always the case. Some functional products could be supplied by a rapidly changing process i.e. supply of hydroelectric power, which relies on rainfall in a region. Similarly, there are also innovative products with a stable supply process. Based on this, Lee (2002) was able to classify supply chain strategy into four types: efficient supply chains, risk-hedging supply chains, responsive supply chains, and agile supply chains. An efficient supply chain strategy aims at cutting cost and eliminating non-value activities. A risk-hedging supply chain strategy aims at pooling and sharing resources in a supply chain and it is quite common in retailing. A responsive supply chain strategy tends to focus on being flexible and responsive to changes in customers' demand. An agile supply chain strategy combines both risk-hedging and responsive supply chain strategies. In other words, it aims at being flexible and responsive to customers while pooling and sharing resources among suppliers.

Furthermore, Towill and Christopher (2002) suggest that there are three types of supply chain strategies: agile supply chains; lean supply chains; and hybrid supply chains. In their study, a case study was provided to show how a lean and agile supply chain can be successfully combined to have a lean/agile supply chain strategy which they refer to as “hybrid” or “leagile” supply chain. Naylor et al. (1999) uses the term “leagility” as an integration of lean and agile paradigms with the aid of a decoupling point in the supply chain. Thus, they provide a personal computer company as a case study to demonstrate how agility and leanness can be combined successfully within the supply chain to meet customers’ requirements.

Regardless of the type of supply chain strategy the organization decided to adopt (lean, agile, risk hedging, responsive, hybrid), the decision to adopt a supply strategy should be made at a corporate level (Towill and Christopher 2002). In this study, three types of supply chain strategies are considered, and they are as follows: (1) lean supply chain; (1) agile supply chain; (3) hybrid supply chain (Huang et al., 2002; Wang et al., 2004; Vonderembse et al., 2006). Table 2.1 shows the SCMS construct and its sub constructs’ definitions.

Table 2.1 The SCMS construct, its sub-constructs definitions, and literature support

Constructs	Definitions	Literature
Supply Chain Management Strategy (SCMS)	A strategy that requires an end-to-end supply chain focus that supports integration of business processes throughout the chain for the purpose of providing optimum value to the ultimate customer/consumer.	Cohen and Roussel, 2005; Wisner, 2003; Green Jr. et al., 2008
Lean Supply Chain (LSC)	A supply chain that utilizes a strategy aimed at creating the most cost efficiency in the supply chain by reducing the inventory and focusing on improving the quality in the supply chain, thus eliminating waste.	Huang et al., 2002; Wang et al., 2004; Vonderembse et al., 2006; Towill and Christopher, 2002; Christopher and Towill, 2000; Lee, 2002.
Agile Supply Chain (ASC)	A supply chain that utilizes a strategy aimed at being responsive and flexible to changing customer needs by responding quickly and effectively (to rapidly changing dynamic and continually fragmenting markets).	Huang et al., 2002; Christopher and Towill, 2000; Wang et al., 2004; Vonderembse et al., 2006; Christopher, 2000; van Hoek et al., 2001; Lin et al., 2006; Agarwal et al., 2007; Towill and Christopher, 2002; Power et al., 2001; Lee, 2002.
Hybrid Supply Chain (HSC)	A supply chain that utilizes "assemble to order" strategy. This is a combination of a lean and agile supply chain aimed at achieving mass customization by postponing product differentiation until final assembly.	Huang et al., 2002; Naylor et al., 1999; Wang et al., 2004; Vonderembse et al., 2006; Towill and Christopher, 2002; Christopher and Towill, 2000.

2.1.1 Lean Supply Chain (LSC)

A lean supply chain (LSC) refers to a supply chain that utilizes a strategy aimed at creating the most cost efficiency in the supply chain by reducing the inventory and focusing on improving the quality in the supply chain, thus eliminating waste (Huang et al., 2002; Wang et al., 2004; Vonderembse et al., 2006). Christopher (2000) argues that lean supply chains work well where demand is relatively stable and predictable, and variety is low.

Christopher and Towill (2000) suggest that an important lean supply chain attribute is the minimization of total lead-times in the supply chain since by definition excess time is waste and leanness calls for elimination of all wastes. Vitasek et al. (2005) define six attributes for lean supply chains: (1) demand management capability, which means doing a better job of managing demand signals by getting demand data from customers to suppliers, (2) waste and cost reduction, which means working together to modify policies, procedures, and practices that produce or encourages waste, (3) process and product standardization, which means determining the best way to manage a process then standardizing that process across the chain, (4) industry standards adoption which extends standards beyond a company's particular supply chain to the industry overall to reduce development costs for the original equipment manufacturers and allow for standardized processes in assembly, (5) cultural change competency, which is considered as one of the obstacles to successfully applying lean supply chains and getting lean strategies accepted in the organization. Companies with cultural change competency view their employees as valued assets and emphasize lean and total quality management programs, (6) cross-enterprise collaboration, which means that supply chain partners must work together to maximize the value stream to the customer. In lean supply chains, teams must work toward solutions that benefit all members of the supply chain.

In summary, a lean supply chain can be recognized as a strategy for managing the supply chain in an efficient way by eliminating waste and employing continuous improvement techniques across the chain.

2.1.2 Agile Supply Chain (ASC)

An agile supply chain (ASC) refers to a supply chain that utilizes a strategy aimed at being responsive and flexible to changing customer needs by responding quickly and effectively to rapidly changing dynamic and continually fragmenting markets (Christopher, 2000; Huang et al., 2002; Wang et al., 2004; Vonderembse et al., 2006).

Lin et al. (2006) suggest that ASC focuses on promoting adaptability, flexibility and has the ability to respond appropriately and react quickly and effectively to changes in the market. They developed a conceptual model of agile supply chain that consists of agility drivers and agility enablers which impact and determine the capability of an agile supply chain. They identified four main capabilities of an agile supply chain: (1) responsiveness, which is the ability to identify changes and respond quickly to them, (2) competency, which is the ability to efficiently and effectively realize enterprise objectives, (3) flexibility/adaptability, which is the ability to implement different processes and apply different facilities/equipments to achieve the same goal, and (4) quickness/speed, which is the ability to complete an activity as quickly as possible. They also identified main attributes for measuring agility in the supply chain: (1) collaborative relationships (strategy), (2) process integration (foundation), (3) information integration (infrastructure), and (4) customer/marketing sensitivity (mechanism). Christopher (2000) distinguishes four characteristics of an agile supply chain: (1) market sensitivity, which means that the supply chain is capable of responding faster to customers, (2) virtual supply chain, which means using IT to share data between manufacturers and suppliers, (3) process integration, which means collaborative work between manufacturers and suppliers, joint product development, common system, and shared information, and finally (4) network, which means linking all the suppliers together as one entity rather than stand-alone entities. van Hoek et al. (2001) argue that there is a lack of insight into supply chain agility since the focus of researchers has been on manufacturing agility and not supply chain agility. Therefore, they developed a framework for supply chain agility and suggested specific dimensions/capabilities of supply chain agility based upon an empirical study conducted in Europe. They came up with the same four dimensions identified by Christopher (2000). Agarwal et al. (2007) developed a model of variables for improving supply chain agility. Those variables are important for managers to formulate and build supply chain agility strategies. The variables are: delivery speed, data accuracy, new product introduction, centralized and collaborative planning, process integration, use of IT tools, lead-time reduction, service level improvement, cost minimization, customer satisfaction, quality improvement, uncertainty minimization, trust development, and minimization of resistance to change. Power et al., (2001) identified critical factors for managing an agile supply chain based on the result of an empirical study of Australian manufacturing firms. Some of those factors are related to the involvement of suppliers, focus on customers, and technology utilization that differentiates the “more agile” organizations from “less agile”.

In summary, the notion of agility in supply chains can be recognized as a strategy for managing the supply chain when organizations need to respond quickly and effectively to rapid changes in customers' demand. Some of the attributes, characteristics, and capabilities of ASC have been identified in this literature.

2.1.3 Hybrid Supply Chain (HSC)

A hybrid supply chain (HSC) refers to a supply chain that utilizes an "assemble to order" strategy. It's a combination of a lean and agile supply chain in which the supply chain achieves mass customization by postponing product differentiation until final assembly (Huang et al., 2002; Wang et al., 2004; Vonderembse et al., 2006). Naylor et al. (1999) define a hybrid supply chain as "*The combination of lean and agile paradigms with the supply chain strategy by positioning the decoupling point so that they best suit the need for responding to a volatile demand downstream yet providing level scheduling upstream from the marketplace"*. The point that separates part of the supply chain that responds directly to customers (being agile) from the part of the supply chain that uses strategic stocks to buffer against the variability in the demand (being lean) is referred to as "decoupling point". The aim of postponement is to increase the efficiency of the supply chain by moving product differentiation (at the decoupling point) closer to the end customer (Naylor et al., 1999). Towill and Christopher (2002) argue that processes are designed to be lean at the upstream of the decoupling point, and agile at the downstream of the decoupling point in a hybrid supply chain.

The difference between lean, agile, and hybrid supply chains has been presented in some studies (Huang et al., 2002; Wang et al., 2004; Vonderembse et al., 2006). Table

2.2 summarizes the differences between lean, hybrid, and agile supply chains (Huang et al., 2002).

Table 2.2 A comparison of lean, hybrid, and agile supply chains (source: Huang et al., 2002; Wang et al., 2004)

Category	Lean supply chain	Hybrid supply chain	Agile supply chain
Purpose	Focuses on cost reduction, flexibility and incremental improvements for already available products Employs a continuous improvement process to focus on the elimination of waste or non-value added activities across the chain	Interfaces with the market to understand customer requirements, maintaining future adaptability Tries to achieve mass customization by postponing product differentiation until final assembly and adding innovative components to the existing products	Understands customer requirements by interfacing with the market and being adaptable to future changes Aims to produce in any volume and deliver into a wide variety of market niches simultaneously Provides customized products at short lead times (responsiveness)
Approach to choosing suppliers	Supplier attributes involve low cost and high quality	Supplier attributes involve low cost and high quality, along with the capability for speed and flexibility, as and when required	Supplier attributes involve speed, flexibility, and quality
Inventory strategy	Generates high inventory turnover and minimizes inventory throughout the chain	Postpones product differentiation until as late as possible. Minimizes functional components inventory	Deploys significant stocks of parts to tide over unpredictable market requirements

Lead time focus	Shortens lead-time as long as it does not increase cost	Is similar to the lean supply chain at component level (shorten lead-time but not at the expense of cost). At product level, accommodates customer requirements, it follows that of an agile supply chain	Invests aggressively in ways to reduce lead times
Manufacturing focus	Maintains high average utilization rate	It is a combination of lean and agile, where the beginning part is similar to lean and the later part is similar to agile	Deploys excess buffer capacity to ensure that raw material/components are available to manufacture the product according to market requirements
Product design strategy	Maximizes performance and minimizes cost	Components follow the lean concept (cost minimization) at the beginning. Modular design helps in product differentiation towards the latter stages	Uses modular design in order to postpone product differentiation for as long as possible

2.2 Information Systems Strategy (ISS)

The traditional domain of the information systems strategy (ISS) is to improve the efficiency and effectiveness of organizations (Bakos and Treacy, 1986). Earl (1989, p. 67) defines ISS as "*The long-term, directional plan which decided what to do with IT*". In his definition, the issue ISS deals with is the applications. In other words, it asks the question, what should we do with the technology (applications)? Barnes et al. (2003)

suggest that ISS is concerned with what applications should be acquired and how they should be managed?

Earl (1989) argues that the ISS should originate from the business strategy. This means that IT should facilitate implementing the business strategy (whatever that business strategy is) and help achieve its goals. In another study, King (1978) argues that ISS should be derived from the business strategy. He argues that ISS cannot exist in a vacuum. Thus, organizations need to ensure that the development of an effective ISS does not occur in isolation from the business strategy; it must support and occur within the business strategy (Puckridge and Woosley, 2003). This implies that in order for organizations to develop an ISS, it should first consider its business strategy. Furthermore, Weill (1990) developed a framework to investigate the impact of originating an ISS from a business strategy on firm performance. The result of his empirical study suggests that investing in applications that support business strategy will provide the firm with a competitive advantage.

A strategy at the business level (also referred to as strategic business unit “SBU”) is concerned with the following question: *How do we compete effectively in each of our chosen product- market segments?* (Venkatraman, 1989a). This suggest that if a company decided to compete in the market by offering the lowest price to achieve a competitive advantage, then its ISS should support its business strategy and focus more on being efficient to cut cost and therefore achieve the lowest price possible. Camillus and Lederer (1985) suggest that there should be a match between the design of the IS and the strategic management choices of the organization. Hence, if business strategy demands creativity, quick response and innovation, an ISS should adopt a flexible approach to help foster different managerial responses and attitudes; this is what Earl (1989) refers to as the *"Opportunity-led"* strategy. This opportunity-led strategy focuses on investing in specific applications that provide and create new opportunities for organizations which are necessary for developing the business. The ISS for those applications creates and adopts new strategic opportunities. As a result, there is a need for particular applications that focus on being flexible. On the other hand, where efficiency is the heart of the business strategy, the ISS strategy should emphasize efficient execution of some practices (e.g. enable the organization to share quality information between entities) to support its business strategy. This is what Earl (1989) refers to as the "*Infrastructure-led*" strategy. This ISS helps the business deliver its goods and services in the sector e.g., banks and retail industries. The infrastructure for those industries, which is an IT-based infrastructure, becomes the platform for product development. At this point the business strategy and the ISS is the same thing. Here, the ISS is concerned with laying down telecommunications networks, rationalizing data standards, creating an appropriate hardware environment and developing a basic business systems foundation. The ISS focuses on developing efficient and updated basic systems. In other words, companies which depends on IS to deliver their products will not care that much if they do not have specific cutting edge systems. However, the focus of those companies is to obtain highly standardized and efficient systems to help them deliver their products/services and keep them in business. The ISS goal here is to invest in applications that helps improve the efficiency of day-to-day activities. So the question becomes, what are the types of business strategy that the ISS should support or be derived from?

Miles and Snow (1978) identified three different business organizational types which employ different strategies: (1) defenders; (2) prospectors; (3) analyzers. Defenders are organizations which have narrow product-market domains. They always try to focus on improving the efficiency of their existing operations by developing a single core technology that is highly cost-efficient. Prospectors are organizations which continually search for market opportunities. They always focus on being innovative which creates uncertainty in the market. Analyzers are organizations which focus on improving their existing operations and also seek new market opportunities (innovative). In other words, they use a combination of defenders' and prospectors' business strategy. Venkatraman (1989a) developed an important construct termed Strategic Orientation of Business Enterprise (STROBE). He assumes that this construct is a multidimensional construct. Six important dimensions/attributes of (STROBE) are identified in his study: (1) aggressiveness, (2) analysis, (3) defensiveness, (4) futurity (5) proactiveness, and (6) riskiness. Sabherwal and Chan (2001) mapped the six STROBE attributes to the business strategy types (defenders, prospectors, and analyzers). They also mapped four ISS attributes (operational support systems, market information systems, strategic support systems, and inter-organizational information systems) to the ISS types (IS for efficiency, IS for flexibility, and IS for comprehensiveness). They argue that there are three types of ISS (IS for efficiency, IS for flexibility, and IS for comprehensiveness) corresponding to the defenders', prospectors', and analyzers' business strategies, respectively. They found that, for defenders, an IS for efficiency strategy is oriented towards intra and inter-organizational efficiencies and long term decision making. An IS for flexibility strategy is focused on market flexibility and quick strategic decisions (suitable for the prospectors). Finally, an IS for comprehensiveness strategy enables comprehensive decisions and quick responses through knowledge of other organizations (suitable for the analyzers).

In summary, the ISS outlines the applications/technology needed to support an organization's goals. The ISS provides a clear understanding of the role of IS in organizations. Based on the above analysis, this study considers three types of ISS: (1) IS for efficiency, (2) IS for flexibility, and (3) IS for comprehensiveness. These strategies are believed to be comprehensive types of ISS based on the types of the business strategy discussed earlier. Table 2.3 shows the ISS construct and its sub constructs' definitions.

Table 2.3 The ISS construct, its sub-constructs' definitions, and literature support

Constructs		Definitions	Literature
Information Systems Strategy (ISS)		The long-term, directional plan which decides what to do with IT.	Earl, 1989.
	IS for Efficiency	A strategy that is oriented toward operational support of internal and inter-organizational efficiencies.	Sabherwal and Chan, 2001.
	IS for Flexibility	A strategy that is focused on market flexibility and quick strategic decisions support.	Sabherwal and Chan, 2001.
	IS for Comprehensiveness	A strategy that enables comprehensive decisions and quick responses (both efficiency and flexibility).	Sabherwal and Chan, 2001.

2.2.1 IS for Efficiency

IS for efficiency is defined in this study as a strategy that is oriented toward operational support of intra and inter-organizational efficiencies. A good example of ISS for efficiency is investing in operational support systems (i.e. enterprise resource planning). This application helps in monitoring and controlling the day-to-day operations that are expected to facilitate operational efficiency (Sabherwal and Chan, 2001).

Moreover, Bakos and Treacy (1986) discuss how ISS helps organizations to be more efficient by improving the internal operational efficiency of a single firm, and the inter-organizational efficiencies through better coordination with customers and suppliers. For example, one might connect the production planning systems of a firm with the order entry system of suppliers to lower the amount of inventory in process and the turnaround time for new orders. Therefore, improving coordination and collaboration of information across suppliers will increase the information availability and process capability, which will result in reducing the coordination cost and therefore result in being more efficient (Clemons et al., 1993).

In summary, internal and inter-organizational operations can be made more efficient if organizations have an ISS that support being more efficient and cost effective.

2.2.2 IS for Flexibility

IS for flexibility is defined in this study as a strategy that is focused on market flexibility and quick strategic decision support (Sabherwal and Chan, 2001). For example, strategic decision support systems (SDSS) help organizations make strategic decisions quickly and effectively by enabling executives to analyze (threats, opportunities, strengths, and weaknesses), describe strategic situations, select alternative strategies, and monitor performances (Belardo et al., 1994).

Rockart and Morton (1984) provided a good example of how ISS can be used to achieve flexibility. When a distributor company decided to use IS to allow customers to enter their orders directly, customers started to order directly from the distributor company. Additionally, customers began to request new items that are not previously carried by the company. The company decided to use the order data proactively, by becoming closely involved with their customers and tracking and forecasting their preferences. As a result, IS was able to help the company to speed up the response time, introduce new products, and introduce potential new customers.

Porter and Millar (1985) argue that IS leads to flexibility and new product development. They provided an example of how planning for IS at the strategic level could lead to achieving flexibility. When General Electric (GE) decided to rebuild its Erie locomotive facility, they decided to use IS to help them in the design of motors. As a result, GE was able to design different types of motor frames without the need to use manual adjustments. This really helped GE to respond faster to the market. Another example of how IS leads to new product development is Western's Union link service. "*Western Union's easy link service (a sophisticated high-speed data-communications network) allows personal computers, word processors, and other electronic devices to send messages to each other and to telex machines throughout the world. This service was not needed before; the spread of information technology caused a demand for it*." (Porter and Millar, 1985 p. 158).

Furthermore, planning to use IS to select fewer suppliers, monitor their performance, or store information regarding complaints about the suppliers will help in coordinating decision making with suppliers through information sharing (Clemons et al., 1993). Hence, sharing information with suppliers will lead to increased flexibility and improve timeliness of production (Bakos and Brynjolfsson, 1993).

2.2.3 IS for Comprehensiveness

Allen and Boynton (1991) suggest that organizations need to face the challenges of both "low cost and efficient" and of "speed and flexibility". They argue that in order for organizations to meet the challenges of the market, organizations need to combine elements of both (low cost and flexibility) through a revamped IS architecture.

IS for comprehensiveness is defined in this study as a strategy that enables comprehensive decisions and quick responses (both efficiency and flexibility) (Sabherwal and Chan, 2001). Allen and Boynton (1991) argue that there are two extreme ways to achieve IS for both efficiency and flexibility: First, organizations must decentralize the IS applications so that IS becomes the responsibility of every level of operating management, and inter-link communications of those applications with suppliers. This is what they refer to in their study as "the low-road" solution, which will result in companies achieving a low-cost production and being more efficient. Second, organizations must centralize IS applications by having common/standardized application systems that help achieve flexibility. This is what they refer to in their study as "the high-road" solution. The result of their study shows that companies must combine both solutions (the high and low-road solutions) to achieve IS for efficiency and flexibility in order for firms to meet the challenges of the market. A good example of an organization that takes elements of both solutions is Hewlett-Packard (HP). A manager of HP focuses on the ISS in order to achieve low cost and flexibility. *"The company is an innovator and is organized with considerable decentralized responsibility throughout its 54 manufacturing sites and 375 sales and service offices. Following a low-road philosophy, IS is decentralized and IS management is considered a critical part of every manager's* *responsibility. Yet the corporation has concluded that high-road needs exist for company-wide data and common systems in five key areas: Sales and service, procurement, quality, personnel, and accounting." (*Allen and Boynton, 1991 p. 443).

Moreover, Zhang and Lado (2001) argue that ISS plays an important role in supporting organizational capabilities which convert inputs into outputs, by improving the operational efficiency and flexibility. Weerakkody and Hinton (1999) provide case studies to illustrate how organizations should rethink their ISS and redesign their systems in line with business processes to improve the efficiency, effectiveness, and speed of product/service.

Sabherwal and Chan (2001) suggest that market information systems help organizations observe the market in order to respond very quickly to market changes. They argue that IS for comprehensiveness should help organizations understand and monitor the market (external analysis) to seek any opportunity (by making quick decisions), to introduce new products, and to help organizations maintain their position in the market. In other words, IS should assist in, first understanding the market, then making quick decisions to introduce new products and to maximize any opportunities for growth. McLaren et al. (2004) expand on this by arguing that ISS should support SCM to enable operational efficiency, flexibility, internal planning and analysis, and external planning and analysis. They refer to such IS in the supply chain as "*enterprise or inter-organizational systems used to coordinate information between the manufacturers, suppliers, distributors, and other partners in the supply chain*" to reduce costs and increase the responsiveness of their supply chain.

2.3 Supply Chain Management (SCM) Practices

SCM includes a set of approaches and practices that effectively integrate suppliers, manufacturers, distributors, and customers to improve the long-term performance of firms and their supply chains (Chopra and Meindl, 2001). These practices represent opportunities for organizations to differentiate themselves on the basis of superior performance in the context of demand forecasting, product availability, inventory management, and distribution (Zielke and Pohl, 1996). Thus, organizations that successfully implement SCM practices achieve superior supply chain performance. This, however, requires internal cross-functional integration within a firm and external integration with suppliers or customers (Narasimhan, 1997).

In this study, SCM practices are defined as a set of activities aimed at improving the performance of the supply chain (Li et al., 2005; Li et al., 2006; Wong et al., 2005; Zhou and Benton, 2007; Koh et al., 2007). Table 2.4 shows the SCM practices construct and its sub constructs' definitions and literature support.

Table 2.4 The SCM practices construct, its sub-constructs' definitions, and literature support

Construct	Definition	Literature
SCM practices	A set of activities aimed at improving the performance of the whole supply chain.	Li et al., 2005; Li et al., 2006; Wong et al., 2005; Zhou and Benton, 2007; Koh et al., 2007.
Strategic supplier partnership	The long term relationship between the organization and its suppliers to influence the strategic and operational capabilities of individual participating companies to	Li et al., 2005; Li et al., 2006; Monczka et al., 1998.

		help them achieve significant ongoing benefits.	
	Customer relationship	The entire array of practices that are employed for the purpose of managing customer complaints, building long-term relationships with customers, and improving customer satisfaction.	Li et al., 2005; Li et al., 2006; Claycomb et al., 1999; Tan et al., 1998.
	Internal lean practices	The practices of eliminating waste (cost, time, etc.) in manufacturing systems, characterized by reduced set-up times, small lot sizes, and pull-production.	Li et al., 2006; Li et al., 2005; Handfield and Nichols 1999; Mason-Jones and Towill 1997; McIvor 2001; Taylor 1999; Womack and Jones 1996.
	Postponement	The practice of moving forward one or more operations or activities (making, sourcing and delivering) to a much later point in the supply chain.	Li et al., 2006; Li et al., 2005; Naylor et al., 1999; van Hoek et al., 1999; Beamon, 1998.
	Information sharing	The extent to which critical and proprietary information is communicated to one's supply chain partner.	Li et al., 2005; Li and Lin, 2006; Monczka et al., 1998; Li et al., 2006; Mohr and Spekman, 1994.
	Information quality	The extent to which information exchange is accurate, timely, complete, adequate, and credible.	Li and Lin, 2006; Li et al., 2005; Monczka et al., 1998; Li et al., 2006; Mohr and Spekman, 1994.

Tan et al. (2002) recognized six aspects of SCM practices through factor analysis addressing various aspects of supply and material management issues, ranging from a broad- based supply chain integration to more specific just-in-time (JIT) capabilities. Zhou and Benton (2007) consider only three categories of supply chain practices: supply chain planning, JIT production, and delivery practices. Table 2.5 provides a list of SCM practices used in previous literature.

In the absence of consensus on a common set of SCM practices and, since the literature describes SCM practices from a variety of different perspectives with a common goal of improving supply chain performance and therefore improving organizational performance, this study intends to focus on the commonalities among these practices. They are as follows: (1) strategic supplier partnerships, (2) customer relationships, (3) internal lean practices, (4) postponement, (5) information sharing, and (6) information quality. This study considers the impact of aligning these SCM practices with the usage of IT in order to achieve a better supply chain management performance and ultimately better firm performance.

Table 2.5 A list of SCM practices and literature support

SCM practices	**References**
• Building alliances with suppliers • Outsourcing • Reducing cycle times • Continuous process flow • Sharing information technology	Donlon, 1996.
• Purchasing • Quality • Customer relations	Tan et al., 1998.
• Concentration on core competencies • Use of inter-organizational systems (e.g. EDI) • Elimination of excess inventory levels	Alvarado and Kotzab, 2001.
• Supply chain integration • Information sharing • Supply chain characteristics • Customer service management • Geographical proximity	Tan et al., 2002.

• JIT capabilities	
• Logistics • Supplier relations • Customer relations • Production	Ulusoy, 2003.
• Vision and goals that are agreed upon • Information sharing • Cooperation • Process integration • Long term relationships • Supply chain leadership that is agreed upon	Min and Mentzer, 2004.
• Supplier-based reduction • Long-term relationships • Communication • Cross-functional teams • Supplier involvement	Chen and Paulraj, 2004.
• Strategic supplier partnerships • Customer relationships • Information sharing • Information quality • Internal lean practices • Postponement • Delivery dependability • Time to market	Li et al., 2005.
• Leadership • Intra-organizational relationships • Inter-organizational relationships • Logistics • Process improvement orientation • Information systems • Business results and outcomes	Burgess et al., 2006.
• Supply chain planning • JIT • Delivery practice	Zhou and Benton, 2007.
• Close partnership with suppliers • Close partnership with customers • JIT supply	Koh et al., 2007.

• Strategic planning • Supply chain benchmarking • Few suppliers • Holding safety stock and sub-contracting • E-procurement • Outsourcing • 3PL • Subcontracting • Many suppliers	

2.3.1 Strategic Supplier Partnership

Dyer et al. (1998) suggest that not all suppliers should be considered as strategic suppliers. They argue that, first, suppliers should be analyzed strategically to determine which suppliers contribute to the core competence and competitive advantage of the buying firm. Only then should companies conduct a strategic supplier partnership with them. Sarkis and Talluri, (2002) propose an analytical network process (ANP) model to address the selection of strategic suppliers. The ANP model shows a graphical representation of analytical network hierarchy for strategic supplier selection. The model consists of a number of factors that determine how to select strategic suppliers. One of those factors is the strategic performance metric. Strategic performance metrics focus on considering the quality, cost, delivery speed, and flexibility of the suppliers in determining whether they are strategic suppliers.

Strategic supplier partnerships require a high degree of coordination between the organization and its suppliers; companies tend to have a long-term relationship with suppliers that create value to each party. In this study, a strategic supplier partnership is defined as the long term relationship between the organization and its suppliers which influences the strategic and operational capabilities of individual participating companies to help them achieve significant ongoing benefits (Li et al., 2005; Li et al., 2006; Monczka et al., 1998).

It is important to differentiate a strategic supplier partnership from a simple long-term partnership. A strategic supplier partnership is not only about buying goods and services from suppliers, but it is also about impacting the suppliers' systems and operational capabilities, adding value to the goods and services, and improving the performance of the whole supply chain (Monczka et al., 1998). This kind of partnership emphasizes a direct, long-term association with suppliers, encouraging mutual planning and problem solving efforts, and selecting fewer suppliers (Maloni and Benton, 1997; Gunasekaran et al., 2001). Furthermore, Graham et al. (1994) found that a strategic supplier partnership improves the quality of supplier operations and improves the quality of parts that are supplied, which results in better product quality. Thus, strategic partnerships will encourage suppliers to be involved and participate in quality certification programs. In another empirical study on strategic supplier partnership, Stuart (1993) suggests that sharing of information, continuous improvement, and the joint problem-solving effort are the keys to a successful strategic partnership with suppliers.

2.3.2 Customer Relationship

Tan et al. (1998) suggest that customer relationship is an important element of SCM practices; it involves the downstream element of SCM. In their study, customer-relations practices include the following: evaluating customer complaints, following-up with customers for feedback, enhancing customer support, predicting key factors affecting customer relationships, predicting customers' future expectations, interacting with customers to set standards, and measuring customer satisfaction. Furthermore, the result of their survey suggests that firms that have strong customer relationships are confident in their ability to evaluate customer complaints and provide support to their customers.

Customer relationship is defined as the entire array of practices that are employed for the purpose of managing customer complaints, building long-term relationships with customers, and improving customer satisfaction (Li et al., 2005; Li et al., 2006). According to Ulusoy (2003) customer satisfaction, customer services, and delivery performance are the elements of customer relationship. He suggests that meeting customers' requirements and expectations are broad indicators of customer satisfaction. Additionally, feedback from customers helps improve product design to meet customer expectations.

Vickery et al. (2003) emphasize the importance of establishing a close customer relationship as a major practice of supply chain integration to enable organizations to respond faster to customers. As the demand for customized products and personalized services increases, so does the need to have close relationships with customers (Wines, 1996). Furthermore, Tu et al. (2004) hypothesize that close customer contact will lead to higher levels of mass customization capabilities. This suggests that close and continuous interaction with customers is essential for organizations to develop highly customized products.

2.3.3 Internal Lean Practices

Global challenges during the past two decades have forced manufacturing firms to adopt new approaches/concepts to sustain a competitive advantage. Among those approaches is the concept of internal lean practices (Shah and Ward, 2003). They reviewed the literature and identified a list of lean manufacturing practices: bottleneck removal (production smoothing), cellular manufacturing, competitive benchmarking, continuous-improvement programs, cross-functional work forces, cycle time reduction, focused factory production, lot sizing reduction, maintenance optimization, new process equipment/technologies, planning and scheduling strategies, preventive maintenance, process capability measurements, pull production/Kanban, quality management programs, quick changeover techniques, reengineered production processes, safety improvement programs, self-directed work teams, and total quality management.

Just as manufacturing firms are required to change and adopt lean practices, so are the firm's suppliers. Li et al. (2005) suggest that if organizations do not attempt to eliminate waste from their internal supply chain, then the organization will run the risk of losing customers. Hence, organizations must extend lean practices down through the supply chain in order for the company to gain the full effectiveness of the lean system (McIvor, 2001).

Internal lean practices are defined as the practices of eliminating waste (cost, time, etc.) in manufacturing systems, characterized by reduced set-up times, small lot sizes, and pull-production (Li et al., 2005, Li et al., 2006). Lean practices focus on eliminating waste. The former president of Toyota, Fujio Cho, defines waste as "*anything other than the minimum amount of equipment, materials, parts, and workers (working time) which are essential to production*". Furthermore, Fujio Cho identified seven types of waste to be eliminated from the supply chain: (1) waste from overproduction, (2) waste of waiting time, (3) transportation waste, (4) inventory waste, (5) processing waste, (6) waste of motion, and (7) waste from production (Jacobs and Chase 2008).

2.3.4 Postponement

Postponement is defined as the practice of moving forward one or more operations or activities (making, sourcing, and delivering) to a much later point in the supply chain (Li et al., 2006; Li et al., 2005; Naylor et al., 1999; van Hoek et al., 1999; Beamon, 1998). Firms adopt postponement strategies to sustain competitive advantage. Hence, by keeping materials undifferentiated for as long as possible, companies such as Dell are able to (1) increase their flexibility in responding to changes in customer demand and (2) achieve cost-effectiveness in the supply chain by keeping undifferentiated inventories (van Hoek et al.,1999).

The literature has identified different types of postponement strategy. For instance, Pagh and Cooper (1998) distinguish between manufacturing, logistics, and full postponement. A manufacturing postponement strategy is one in which the final assembly of the product is often carried out by a third-party (3PL) logistics service provider. A logistics postponement strategy is relevant when a distribution center supplies dealers with spare parts. A full postponement strategy is a combination of both (manufacturing and logistics postponement strategies). In another study, van Hoek (1999) identifies three types of postponement strategy: form, time, and place. A form postponement (manufacturing postponement) means that a company will delay manufacturing, assembly or even design activities, until customers’ orders are received; this is what Mikkola and Skjøtt-Larsen (2004) refer to as modularization. Time and place postponement strategies which are referred to as (logistics strategy) suggest that goods are stored at central distribution points in the supply chain. Table 2.6 provides a list of postponement strategies and literature support.

Table 2.6 A list of postponement strategies and literature support

Postponement Strategies	Literature support
Generic supply chain postponement and speculation strategies • The full speculation strategy • The logistics postponement strategy • The manufacturing postponement strategy • The full postponement strategy	Pagh and cooper, 1998.
Generic types of postponement • Form • Time • Place	van Hoek, 1999.
Supply chain postponement strategies for global brands • Bundle manufacturing strategy • Unicentric strategy • Deferred assemble strategy • Deferred packing strategy	Cooper, 1993.
Strategies for form postponement • Labeling • Packaging • Assembly • Manufacturing • Time	Zinn and Bowersox, 1988.
Speculation-postponement strategy and a continuum of standardization/customization • Purchasing postponement • Manufacturing postponement • Assembly postponement • Packaging/labeling postponement • Logistics postponement	Yang and Burns, 2003.

Yang and Burns (2003) argue that the implementation of postponement strategies will often results in reconfiguration of the supply chain and often place the warehouse where the final assembly is processed. Waller et al. (2000) suggest that postponement can be extended further upstream in the supply chain to suppliers of raw materials or downstream in the supply chain to distributors and retailers. They argue that postponement decisions should be made with respect to SCM in market-oriented organizations. In other words, companies should consider their SCM capabilities, and coordinate appropriate changes in postponement among suppliers to achieve faster production and cost reduction.

2.3.5 Information Sharing

Li et al. (2005) emphasize the importance of information sharing to SCM practice. The main principle of SCM is sharing of information within supply chains (Moberg et al., 2002). By sharing information with members of the supply chain, an organization can respond more quickly to the customer's changing needs (Li and Lin, 2006).

Information sharing is defined as the extent to which critical and proprietary information is communicated to one's supply chain partner (Li et al., 2005; Li and Lin, 2006; Monczka et al., 1998; Li et al., 2006; Mohr and Spekman, 1994).

Mohr and Spekman (1994) suggest that information sharing and being knowledgeable about each other's business help partners maintain their relationship for a longer time. Thus, it will reduce uncertainties in the market if supply chain members have more information and knowledge about other members (Yu et al., 2001). Furthermore, Frazier et al. (1988) suggest that organizations should share and exchange information with their suppliers regarding production plans, core product, process design, schedules, and product development to create synergies between the organization and its suppliers. This synergy will increase the ability of supply chains to react effectively to sudden changes and uncertainties in the market (Lee, 2000).

2.3.6 Information Quality

As we noted earlier, sharing information is important for the functioning of the supply chain. However, sharing quality information between members of the supply chain is important as well. For instance, sharing information within the entire supply chain can create flexibility, but this requires accurate and timely information (Jarrel, 1998). Moberg et al. (2002) argue that accuracy, timeliness, and proper formatting of the information determine the quality of the information. They suggest that supply chain members emphasize the importance of having accurate, timely, and properly formatted information to fully realize the value of information exchange among them. Hence, managers may not even use information coming from their partners if the information has poor quality.

Information quality is defined as the extent to which information exchange is accurate, timely, complete, relevant, and credible (Li and Lin, 2006; Li et al. 2005; Monczka et al., 1998; Li et al., 2006; Mohr and Spekman, 1994). Inaccurate and missing data will add costs to the supply chain and can drive poor performance. Chopra and Meindl (2001) argue that information must be accurate, accessible in a timely manner, and valuable when making supply chain decisions. Inaccurate and missing data will make it very difficult for managers to make good decisions as it will not provide the manager with a true picture of the situation of the supply chain. For example, *Wal-Mart collects data in real time on what products are being purchased at each store of its stores and send these data back to the manufacturers to determine how much inventory to hold at each store and to decide when to ship new loads of products from the manufacturer.* Chopra and Meindl (2001) provide many examples of how inaccurate and missing data results in an increase in materials inventory and adds costs to the supply chain. Furthermore, Vijayasarathy and Robey (1997) argue that the more accurate, timely and complete information is, the fewer misunderstandings and misinterpretations between trading partners occur and the better the coordination between them is.

2.4 Information Technology Utilization

Porter and Millar (1985) argue that every value activity in the value chain requires usage of information in some way that differs from other activities. For example, a logistic activity utilizes IT for scheduling promises, transportation rates, and production plans to ensure timely and cost effective delivery. On the other hand, a company could use IT to enhance its ability to exploit internal activities as well as external activities i.e. coordinate their activities closely with suppliers and customers. Ward (1987) suggests that IS should be utilized to influence company growth, offset competitive threats, and enable business strategies to be implemented and sustained. Earl (1989) classifies IT usage in the supply chain as follows: (1) technology that can improve the physical task of any activity e.g., computer controlled machine tools in assembly operations, (2) technology that can physically connect or control activity linkages e.g., communications linkages between production and distribution centers, (3) information systems that can support or manage the value activities e.g., inventory control systems, and (4) information systems that can coordinate activities across linkages e.g., CAD-CAM systems for computer integrated manufacturing. This implies that IT can be utilized in different ways and for different purposes. Benjamin et al. (1984) developed a strategic opportunities framework to utilize IT. The framework suggests that companies can effectively utilize IT to gain competitive advantage by either focusing on an internal set of manufacturing processes to improve operations, or by creating strategic external links with suppliers and customers. In another study, Kyobe (2004) argues that IT resources such as hardware and software can be strategically utilized to achieve competitive advantage. Companies might focus on utilizing IT for internal operations or for external relationships i.e., improving customer services and links with suppliers by sharing useful information and obtaining reductions in cost. Narasimhan and Kim (2001) propose measuring IT utilization using the following three sub-constructs: (1) IS for value creation management (e.g., customer management systems, sales management systems, and inventory management systems), (2) IS for logistic operations (e.g., automatic ordering systems, resource management systems, transportation management systems, and forecasting systems), and (3) IS for infrastructural support (e.g., network plan/design systems, office information systems, and accounting information systems). McFarlan and McKenney (1983) developed a framework of information management with a „strategic grid' and suggested some forms of planning, organizing, and controlling information resources in each quadrant of the strategic grid. Hence, the strategic grid helps management to position a firm appropriately based on the strategic impact of IT. The IT strategic grid consists of four quadrants. In the first quadrant, IT can be seen as a support to activity planning in which IS can represent islands of specialist technology that are introduced to help innovate the manufacturing processes. In the second quadrant, IT can be seen as a factory in which IT can help in planning and controlling daily production. Quality and other operational controls are important in running the business. In the third quadrant, IT is considered as a turnaround mechanism. Here senior executives consider IT to be critical to the organization's growth i.e., a top IT executive is appointed to oversee this. Finally in the forth quadrant, IT can be seen as truly strategic. In this case, the company will not function without IT i.e., new product development is computer based. From the previous discussion above, it is clear that the literature describes IT utilization from a variety of different perspectives. A firm may utilize information technology to assist in externally-focused strategic planning, to support its internal operations, and/or to build its information processing infrastructure (Narasimhan and Kim, 2001; Kim and Narasimhan, 2002; Benjamin et al., 1984; Kyobe, 2004; Boynton et al., 1994). This study identifies different aspects of IT utilization relevant to organizations: (1) strategic IT utilization which will be referred to in this study as *the external focus of IT* i.e., suppliers and customers, (2) operational IT utilization which will be referred to as *the internal focus of IT* i.e., daily production, and (3) infrastructural IT utilization i.e., the use of networks, servers, databases, platforms and other elements of IT that comprise organizational IT infrastructure. Table 2.7 shows the information technology utilization construct and its sub constructs' definitions and literature support.

Table 2.7 Information technology utilization construct definition and its sub-constructs' definitions and literature support

Construct	Definition	Literature
Information Technology Utilization	The method a firm uses to utilize information technology to assist in external strategic decision planning and to support internal operational and infrastructural decisions.	Narasimhan and Kim, 2001; Kim and Narasimhan, 2002; Benjamin et al., 1984; Kyobe, 2004; Boynton et al., 1994.
External Focus on IT	The extent to which firms uses IT for formulating and improving inter-organizational planning	Wiseman, 1988; Benjamin et al., 1984; Cash Jr.

		processes with respect to suppliers and customers.	and Konsynski, 1985.
	Internal Focus on IT	The extent to which firms uses IT for monitoring and improving internal processes.	Benjamin et al., 1984; Boynton et al., 1994.
	Infrastructural Focus on IT	The extent to which firms use IT to facilitate information sharing and data communication.	Narasimhan and Kim, 2001; Kim and Narasimhan, 2002; Weill, 1993; McKay and Brockway, 1989.

2.4.1 External Focus on IT

The external focus on IT in this study is defined as the extent to which firms deploy IT applications for formulating and improving inter-organizational planning processes with respect to suppliers and customers (Wiseman, 1988; Benjamin et al., 1984; Cash Jr. and Konsynski, 1985). Earl (1989) suggests that one of the purposes of using IT strategically is to share responsibilities with suppliers; this may be achieved by setting up automatic orders with suppliers. Moreover, this could result in having long-term relationships with suppliers and selecting suppliers with the lowest cost or best services. An example of a strategic IT utilization is given in Earl (1989, p. 56) when "*Ford had set up CAD links with their suppliers and reduced design costs, reduced the time taken in, and error rate of design and specification changes and improve parts stock and acquisition procedures. No doubt like the Japanese automakers, such links eventually will be developed with only one or two key suppliers of each product to integrate suppliers into their computer integrated manufacturing so that both the automakers and the supplier share growth and performance improvements together*."

This example clearly shows that IT is creating strategic links between organizations and their key suppliers. As a result, companies can coordinate their actions closely with their suppliers.

In another study, Parsons (1983) argues that utilizing IT strategically may change the relationship between an industry and its suppliers. For example, the use of sophisticated quality control systems is forcing suppliers to become more quality conscious. Thus, utilizing IT strategically will also help in selecting and considering certain suppliers for a partnership. Additionally, Parsons argues that IT can also contribute to superior customer service by providing historical customer profiles, increasing the availability of spare parts, and by improving the responsiveness to customer needs.

Benjamin et al. (1984) provide five case studies as examples of how companies can strategically utilize IT to gain competitive advantage. Their examples focus externally on IT utilization in regards to the company's suppliers and customers. For instance, IT is utilized strategically "*to have close interconnection between production facilities and key suppliers; to simplify ordering processes for customers; to improve customer's satisfaction through faster, high quality response time and improved productivity; and to facilitate the way they support their customers*" (Benjamin et al., 1984 p. 4, 5, and 6). This clearly shows that companies are strategically utilizing IS to improve customer satisfaction through faster, high quality response time, reduced customer complaints, and increased customer loyalty by improving customer service.

2.4.2 Internal Focus on IT

The internal focus on IT refers to the extent to which firms deploy IT applications for monitoring and improving their internal processes (Benjamin et al., 1984; Boynton et al., 1994). Digital Equipment Corporation provided a good example of how to utilize IS to improve an internal set of manufacturing processes when it used an "*expert system*" to help improve key internal operations (Benjamin et al., 1984). Weerakkody and Hinton (1999) provide a case study to demonstrate the role of IT in enabling business process reengineering (BPR) programs. Hence, BPR plays an important part in providing quality product.

One way to improve internal processes is through postponement, which involves fundamental changes to a company's manufacturing processes and internal operations. Using IT is essential to support the implementation of postponement (Prats, 2003). The rational of postponement strategy is to delay some of the activities of production after the information about customers' demand is known (Yang and Burns, 2003). In this sense, companies may have to wait until exact information of customers' demand is available. Here IT plays an important role in postponement by enabling the sharing of customers' demand information in a timely manner without distortion. For example, electronic data interchange (EDI) and a point-of-sale system may improve the information flow between manufacturer and suppliers by reducing the data collection errors and moving data quickly. This will transmit customers' demands and, therefore, enhance the value of postponement (Yang et al., 2004).

Another way to improve internal processes is through sharing information among all parts of the organization. For instance, successfully implementing an Enterprise

Resource Planning (ERP) system may help companies gain competitive advantage by integrating business processes and optimizing the resources available. As organizations share and integrate information through ERP systems, they will have more control over their operations by connecting and integrating all business processes so that workers (1) use less time to perform tasks and (2) have faster access to the information which improves the time and information for decision making (Zeng et al., 2003). In addition, ERP has also been credited with reducing manufacturing lead times (Goodpasture, 1995).

Suzaki (1987) identifies several approaches to internal process improvement i.e. developing quick setup, eliminating waste, and using lots sizes of one. According to Suzaki, the key that helps in implementing approaches to improve internal processes is having information and control systems that provide information on time, so firms can use it to facilitate further improvement in operations.

2.4.3 Infrastructural focus on IT

The infrastructural focus on IT refers to the extent to which firms use IT to facilitate organization-wide information sharing and data communication across data networks (Narasimhan and Kim., 2001; Kim and Narasimhan., 2002; Simchi-Levi et al 2003; Weill, 1993; McKay and Brockway, 1989). The IT infrastructure generally provides the foundation to enable present and future communication. This infrastructure usually includes: (1) platforms technology, (2) network and telecommunication technologies, (3) key data, and (4) core data-processing applications (Duncan, 1995). In another study, Simchi-Levi et al. (2003) suggest that IT infrastructure forms the basis for data collection, transactions, system access, and communication. They believe that IT infrastructure typically consists of four components: (1) interface/presentation devices, (2) communications, (3) databases, and (4) system architecture.

Narasimhan and Kim (2001) hypothesize that IT utilization for infrastructure support has a direct influence on using IT for value creation activities. In other words, they argue that the IT infrastructure provides the basis (foundation) for establishing strategic linkages with suppliers and customers. In the context of SCM, Rai et al. (2006) argue that data consistency (*which is defined as the degree to which common data definitions and consistency in stored data have been established across a focal firm's supply chain*), and cross-functional application integration *(which is defined as the degree of real-time communication of a focal firm's function-specific SCM applications with each other)* are critical elements of IT infrastructure integration for SCM. The result of their study suggests that data quality and standards are facilitators in the process of supply chain integration.

Simchi-Levi et al. (2003) suggest that without communication and database capabilities, which they refer to as "IT infrastructure", critical organizational goals may not be achieved. Hence, the IT infrastructure is a critical factor in the success or failure of any system implementation. Furthermore, Weill (1993) suggests that IT infrastructure provides flexibility so that firms can handle different customers' needs without increasing cost.

2.5 Supply Chain Management (SCM) Performance

Different researchers have attempted to measure SCM performance in different ways. To assist firms in measuring the effectiveness of their supply chains, the Supply-

Chain Council (SCC) developed the Supply-Chain Operations References (SCOR) model. The SCOR model provides a common process-oriented language for communicating among supply-chain partners in the following decision areas: planning, sourcing, making, and delivering (Lockamy and McCormack 2004)

In spite of the importance of measuring SCM performance, organizations often lack the insight for the development of effective performance measures and metrics for SCM performance (Gunasekaran et al., 2001). Furthermore, Holmberg (2000) noted a number of problems in measuring SCM performance. He argues that measuring the activities of SCM performance is fragmented within and across organizations. He briefly summarizes the measurement problems as follows: (1) lack of connection between strategy and measurement, (2) too much reliance on financial figures as the key performance indicators, (3) too many isolated and incompatible measures, and finally (4) use of a single-firm management style when measuring the supply chain.

In another study, Beamon (1999) presents a number of characteristics that are found to be valuable in measuring SCM performance: inclusiveness (measuring all related aspects), universality (allowing for comparison under various operating conditions), measurability (having data which are measurable), and finally consistency (performance measures consistent with the organizations' goals). Based on the above guideline, Beamon (1999) argues that measuring SCM performance should include three types of performance measurement: (1) resources measurement (generally efficient), (2) output measurement (generally customer satisfaction), and finally (3) flexibility (how well the system reacts to uncertainty). Each type is vital in measuring the SCM performance.

Although a growing body of literature has developed many different ways to measure performance for SCM (*integration, customer service, cost effectiveness, inventory level, service level, throughput efficiency, suppliers' performance, time, assets, flexibility, information and material flow integration, and delivery performance*), researchers point to the need for continued studies in this area (Holmberg, 2000; Beamon, 1999; Morgan, 2004; van Hoek, 1998).

In this study SCM performance is defined as the overall efficiency and effectiveness of SCM (Gunasekaran et al., 2001; Beamon, 1998; Beamon, 1999; Kiefer and Novack, 1999; Spekman et al., 1998). In this research, SCM performance will be measured through: supply chain flexibility, supply chain integration, and customer responsiveness. Those three dimensions of SCM performance are intended to cover the three types of performance measurement suggested by Beamon (1999): supply chain flexibility (flexibility measures), supply chain integration (resources measure), and customer responsiveness (output measure). Table 2.8 shows the SCM performance construct and its sub constructs' definitions and literature support.

Table 2.8 SCM performance construct and its sub-constructs' definitions and literature support

Construct	**Definition**	**Literature**
SCM Performance	The overall efficiency and effectiveness of SCM.	Gunasekaran et al., 2001; Beamon, 1998; Beamon, 1999; Kiefer and Novack, 1999; Spekman et al., 1998.

	Supply Chain Flexibility	The ability of supply chain partners to effectively adapt or respond to change that directly impacts an organization's customer.	Vickery et al., 1999; Kumar et al., 2006.
	Supply Chain Integration	The extent to which all the activities within an organization, suppliers, and customers are integrated together.	Stevens, 1990; Stock et al., 1998; Stock et al., 2000; Narasimhan and Jayaram, 1998.
	Customer Responsiveness	A firm's ability to respond in a timely manner to customers' needs and wants.	Tunc and Gupta, 1993; Chen et al., 2004.

2.5.1 Supply Chain flexibility

The need for flexibility originates from customers; since customers ask for variety, quality, competitive prices, and faster delivery. This has forced companies to make design changes quickly and respond faster to customer needs in order to sustain the company's competitive advantage. As a result, companies need to be flexible enough to react to changes in customers' demands (Aggarwal, 1997).

Most of the previous literature has focused on manufacturing flexibility (Kumar et al., 2006; Duclos et al., 2003). However, as the basis of competition expands to the supply chain, supply chain flexibility is becoming increasingly important (Duclos et al., 2003). Thus, there is a need for new supply chain flexibility framework and a comprehensive analysis of supply chain flexibility.

In this study, supply chain flexibility is defined as the ability of supply chain partners to effectively adapt or respond to changes that directly impact an organization's customer (Vickery et al., 1999; Kumar et al., 2006). Furthermore, Vickery et al. (1999, p.16) state that supply chain flexibility "*should be examined from an integrative, customer-oriented perspective.*" They propose five dimensions to measure supply chain flexibility. Since the definition of supply chain flexibility in this study has a customer-oriented perspective, this research will adopt the five dimensions that measure supply chain flexibility proposed by Vickery et al., (1999).

Vickery et al. (1999) propose that supply chain flexibility can be measured by the following five dimensions: (1) product flexibility or the ability to customize product to meet specific customer demand, (2) volume flexibility or the ability to adjust capacity to meet changes in customer quantities, (3) new product flexibility or the ability to launch new revised products; (4) distribution flexibility or the ability to provide widespread access to products, (5) responsiveness flexibility or the ability to respond to target markets' needs.

2.5.2 Supply Chain Integration

Stock et al. (1998) suggest that there are two kinds of logistics integration: (1) internal integration which reflects the extent to which logistics activities interact with other functions' areas, and (2) external integration, which is known as "supply chain integration," that reflects the integration of logistics activities across firm boundaries to include suppliers and customers. This integration deals with sharing resources, risk, and knowledge between supply chain partners (Kim et al., 2006). Furthermore, Frohlich and Westbrook (2001) classified supply chain integration into two types. The first type of integration involves coordinating and integrating the forward physical flow of deliveries between suppliers, manufacturers, and customers. The second type of integration involves the backward coordination of information technologies and the flow of data from customers, to manufacturers, to suppliers.

In this study, supply chain integration is defined as the extent to which all the activities within an organization, suppliers, and customers are integrated together (Stevens, 1990; Stock et al., 1998; Stock et al., 2000; Narasimhan and Jayaram, 1998). Supply chain integration requires effective communication among all members of the supply chain, which means that information systems must be integrated too (Turner, 1993). Moreover, Lee (2000) suggests that there are three key dimensions that constitute supply chain integration and they are: (1) information integration which refers to the sharing of information and knowledge among members of the supply chain i.e. demand information, inventory status, and capacity plans, (2) coordination which refers to the redeployment of decision-making authority, work, and resources to the best-position in the supply chain i.e. letting other suppliers replenish their inventory, and finally (3) organizational linkage which means tight organizational relationships with suppliers i.e. joint performance measures.

Supply chain integration can provide a firm with the opportunity to focus on its core competencies and particular areas of expertise (Simchi-Levi et al., 2003). It will also lead to the amplification of key resources be enabling the sharing of special resources and technological knowledge between the firm and its supply chain partners (Vickery et al., 2003). Such integration will not only help supply chains to reduce costs and be more efficient, but it will also create value for the company, its supply chain partners, and its shareholders (Lee, 2000).

2.5.3 Customer Responsiveness

Williamson (1991) examined the role of the supplier’s strategy in achieving customer responsiveness. Furthermore, Owens and Richmond (1995) suggest that achieving customer responsiveness not only involves a supplier strategy, but also includes the entire SCMS. They argue that the overall objectives of SCMS should be: (1) to become increasingly responsive to customer needs, and (2) to create value for the customer. As a result, the performance of SCM must be measured by its responsiveness to customers (Lee and Billington, 1992).

In this study, customer responsiveness is defined as a firm’s ability to respond in a timely manner to customers’ needs and wants (Tunc and Gupta, 1993; Chen et al., 2004). According to Beamon (1998) and Lee and Billington (1992), measuring customer responsiveness should include the following: lead time, stockout probability, order fill rate, total cycle time, average backorder levels, total respond time to an order, order lateness or earliness, and backlog profile.

Customer responsiveness is directly linked to information, in which appropriate use of information is essential to achieve customer responsiveness. To support this argument, Daugherty et al. (1995) conducted an empirical study to explore the relationship between information availability and customer responsiveness. The result of their study suggest that information availability and customer responsiveness are positively related which resulted in improving firm performance.

2.6 Firm Performance

The literature does not agree on a basic terminology and definition of firm performance (Venkatraman and Ramanujam, 1986). For instance, some researchers prefer to measure firm performance based on accounting data (financial indicators) such as ROI or return on assets (ROA) (Tan et al., 1999). Others argue that market or value measurement such as product quality and new product development are more appropriate than accounting-based measurements (Hax and Majluf, 1984). As a result, Yamin et al. (1999) developed a broader framework of firm performance that includes non-financial indicators in addition to financial performances.

In this study, firm performance refers to how well a firm achieves its market-oriented goals as well as its financial goals (Yamin et al., 1999). With regards to the financial goals, Yamin et al., (1999) posit 18 performance measurements (they are the accounting-based measurements such as ROI, percentage in market share, rapid turnover of inventories, ROA, etc…). As previously mentioned, this definition is believed to have a comprehensive framework of firm performance and has been adopted in previous studies (Li et al., 2006) to measure the impact of SCM practices on firm performance. Li et al., (2006) measured firm performance through its market share, ROI, the growth of market share, the growth of sales, growth in return on investment, profit margin on sales, and overall competitive position. Table 2.9 shows a firm performance construct definition and literature support.

Table 2.9 Firm performance construct and literature support

Construct	Definition	Literature
Firm Performance	How well a firm achieves its market-oriented goals as well its financial goals.	Yamin et al., 1999; Li et al., 2006.

Chapter 3

Theoretical Framework and Hypothesis Development

This chapter presents the theoretical foundation for this research, the research model, and the research hypothesis.

3.1Contingency Theory

The essence of the contingency theory implies that fitting the characteristics of the organization (i.e., technology, organization size, and strategy) to contingencies that reflect the situation of the organization leads to high organization performance (Donaldson, 2001). Lawrence and Lorsch (1967) proposed a contingency theory of organization in which they argued that an organization must establish a “fit’ between its internal structure and its external environment. Burns and Stalker (1961) argued that different kinds of management systems are appropriate to different kinds of technical environments. For instance, the flexible and decentralized structure (organic structure) is more suitable to a dynamic environment, while a centralized structure (mechanistic structure) is more appropriate under a stable environment.

Chandler (1962) argues that structures follow strategy in organizations. The strategy is the determination of long-term goals and objectives, courses of action and allocation of resources. The structure is the way the organization is put together to administer the strategy, with all the hierarchies and lines of authority that the strategy implies. As different strategies create different administration needs, organizational structure will eventually change to accommodate these needs. Mintzberg (1981) argues that the key to organizational success is matching or fitting the parts and characteristics of organizational structures to one another.

Galbraith (1973) discussed the contingency theory from the perspective of the information processing in organizations by developing an information processing model to explain the relationship between the information processing needs of a firm and the structural mechanisms that can address those needs. He argues that the ability of an organization to successfully coordinate its activities depends on how effectively and efficiently it can process the amount of information needed to be processed. This is done by either reducing the need for information processing, or by increasing the capacity to process the information. In other words, an information processing mechanism or capability should match the firm's information processing needs. Applying this concept to SCM, our theoretical basis for alignment between supply chain and IS strategies lies in effectively matching the contingencies of supply chain information requirements with appropriate IT applications that can address these requirements. To give an example, let us assume that a company wants to implement internal lean practices in the supply chain. Such a strategy would require certain applications to process information that would facilitate implementing those lean practices.

The contingency theory looks for a relationship between fit (alignment) and performance. At an abstract level, the contingency approach states that the effect of one variable (X) on another variable (Y) depends upon a third variable (W) (Donaldson, 2001). While applying this approach to this research, let us assume that variable (X) is

SCMS, variable (Y) is SCM performance, and variable (W) is ISS. In this case, this study intends to find the effect of SCMS (variable X) on SCM performance (variable Y) depending upon ISS (variable W). In other words, this research intends to find the impact of aligning SCMS with ISS on SCM performance. This is what this study refers to as "alignment at the strategic or planning level".

Applying the same approach to SCM practices and the usage of IT, this study intends to find the impact of aligning SCM practices with the usage of IT on SCM performance. This is what this study refers to as "alignment at the operational level". Finally, this study intends to find the effect of SCM performance on firm performance.

3.2 Alignment as Moderator

Venkatraman (1989b) identifies six types of fit, and they are as follows: (1) fit as moderation, (2) fit as mediation, (3) fit as matching, (4) fit as gestalts, (5) fit as profile deviation, (6) and fit as covariation. Each type of fit has its own theoretical meaning and requires a use of specific analytical methods. In this research, the fit as moderation will be used to study the alignment at the strategic level and at the operational level.

The fit as moderation suggests that an interaction exist between two variables to determine a third variable which is usually the performance. Looking at the diagram below (Figure 3.2), let's assume that variable X is the strategy and variable Z is the contextual variable that fits with strategy to achieve a better performance (variable Y). The moderating effect of variable Z (contextual) on the variables X (strategy) and Y (performance) as shown in Figure 3.1 is equivalent to the interaction effect (X.Z) as shown in Figure 3.2.

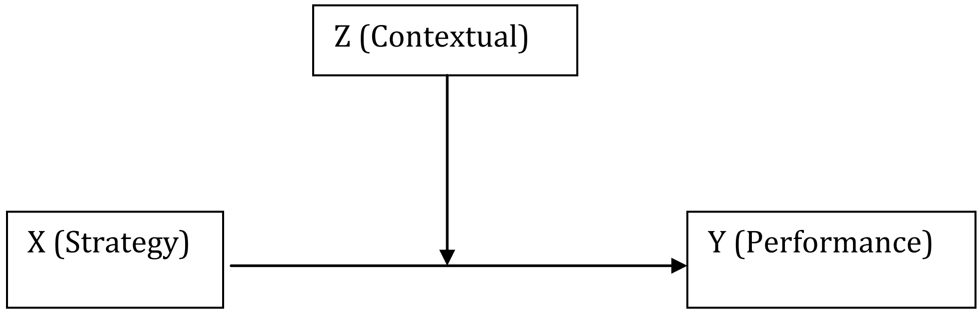

Figure 3.1 Schematic representation of the moderating effect

In this research, at the strategic level, SCM performance is jointly determined by the interaction of the predictor variable which is in this case is SCMS and the moderator variable which is ISS. At the operational level, SCM performance is jointly determined by the interaction of the predictor variable (SCM practices) and the moderator variable (IT utilization).

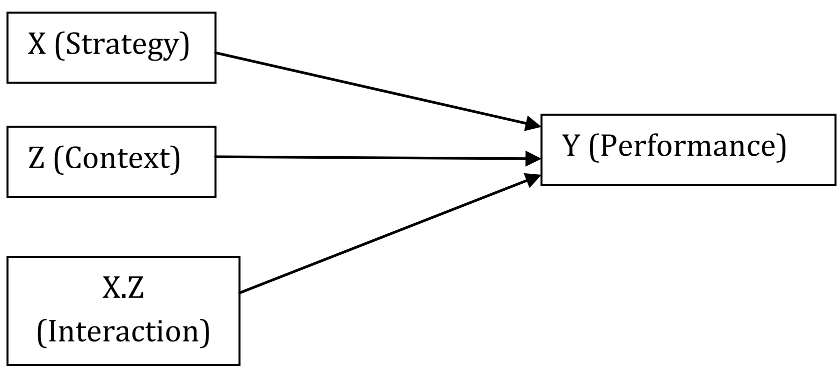

Figure 3.2 Schematic representation of fit as moderation (source: Venkatraman, 1989b)

The reason for using the moderator alignment approach is as follows: Many organizations focus on their supply chain strategy to gain a competitive advantage through their products/services. At the same time, they believe that acquiring and using appropriate information technologies are critical in managing the supply chain. Coronado et al. (2007) suggest that IS facilitates better management of supply chain activities by offering information about what kind of product the customers are demanding, what is available in the warehouse, and how much should be manufactured. These technologies enable organizations to effectively and efficiently coordinate and collaborate among partners in the supply chain. As a result, while supply chain strategies are expected to lead to improved supply chain performance, using the appropriate IT strategy in addition will positively impact or increase this improvement. Zara (a Spanish clothier) is a good example of a company that demonstrates the moderating alignment between IS Strategy and SCM Strategy. Zara is well known for its responsive supply chain, it can design, produce, and deliver a new garment and make it available in stores worldwide in just 15 days. However, Zara was only able to achieve the success in its supply chain by developing highly responsive systems and deploying the latest IT tools to facilitate the exchange of information between members of its supply chain (Ferdows et al. 2004). In a similar manner, with regard to SCM practices, Chopra and Meindl (2001) argue that utilizing IT systems in support of appropriate practices is critical to execute the plans and strategies of the supply chain. That is, the positive effect of supply chain practices such as supplier partnership, customer relationship, postponement, and information sharing on supply chain performance is expected to be enhanced by the simultaneous use of IT applications to support these practices. For example, one of Cisco's supply chain practices involves sharing orders electronically with its suppliers and customers. The expected positive effect of this practice on Cisco's supply chain is enhanced by the use of IT applications such as internet access, extranets, and B2B systems that link Cisco to its customers and suppliers, and integrate suppliers into its production systems, (Zhou and Benton, 2007). Cisco's interaction with its customers and suppliers is network-based and begins at Cisco's home page (Cisco.com). By using its home page, Cisco's customers can directly place an order online at lower costs and get technical support around-the-clock. Furthermore, Cisco automates its supply chain by using *an integrated enterprise platform* to electronically link with all its suppliers. This allows Cisco to exchange information freely with its partners which enables Cisco and it suppliers to respond quickly to customers demand (Nolan, 2005).

3.3 Proposed Research Model

Supply chain-information systems' alignment is important and leads to better SCM performance. To better understand this relationship, a proposed research model was developed based on a comprehensive literature review. The theoretical model presented in Figure 3.3 depicts the relationship among SCMS, ISS, SCM practices, IT utilization, SCM performance, and firm performance. In this framework, SCMS consists of lean supply chains, agile supply chains, and hybrid supply chains. ISS includes IS for efficiency, IS for flexibility, and IS for comprehensiveness. SCM practices consist of strategic supplier partnerships, customer relationships, internal lean practices, postponement, information sharing, and information quality. IT utilization consists of an external focus of IT, an internal focus of IT, and infrastructural IT. SCM performance includes supply chain flexibility, supply chain integration, and customer responsiveness. Finally, firm performance consists of market performance and financial performance. The definitions are given in Tables 2.1, 2.3, 2.4, 2.7, 2.8, and 2.9.

The rationale underlying this research framework proposes that there are two levels of moderating alignment. It is explained as follows: First, at the strategic level, aligning SCMS with ISS as a moderator will lead to better SCM performance. In particular, a lean supply chain is a better fit with IS for efficiency, whereas an agile supply chain is a better fit with IS for flexibility, and finally a hybrid supply chain is a better fit with IS for comprehensiveness. Second, at the operational level, aligning SCM practices with IT utilization as a moderator will lead to better SCM performance. In particular, strategic supplier partnerships and customer relationships are better aligned with an external focus of IT, whereas internal lean practices and postponement are better aligned with an internal focus of IT, and finally information sharing and information quality are better aligned with infrastructural IT. As a result of those moderating alignments, having better SCM performance will enhance firm performance.

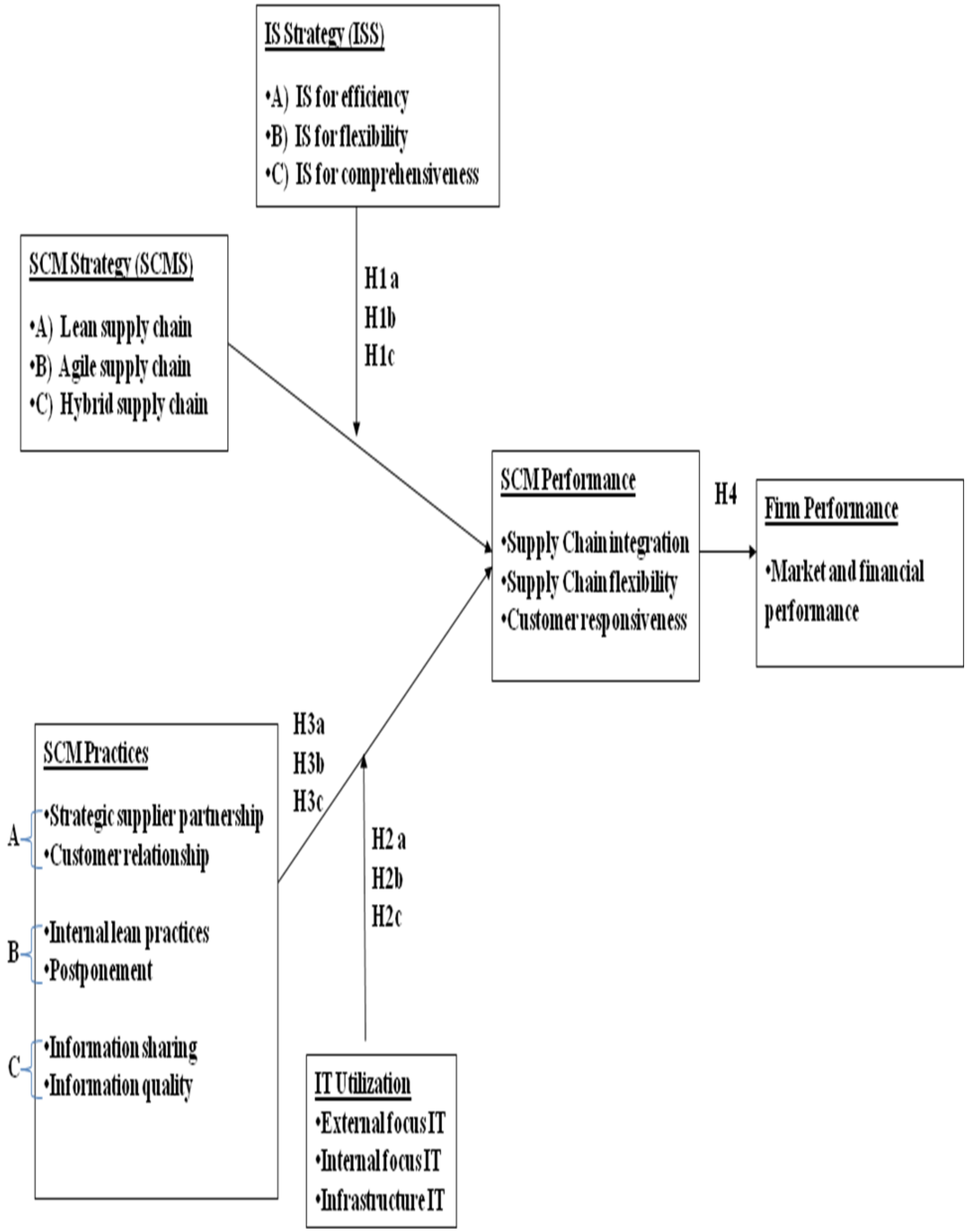

Figure 3.3 SCM and IS research framework

3.4 Research Hypothesis 1a, 1b, and 1c (Moderating Alignment between SCMS and ISS)

The literature has discussed many aspects of IS-business alignment. One type of alignment is known as strategic alignment. The alignment at the planning or strategic level ensures that IT plans and business plans are synchronized and that the organization plans to adopt applications which support its strategic goals (Chan et al., 1997; Sabherwal and Chan, 2001). Another type of alignment is structural alignment. The structural alignment is between business structures and IS structures (Brown and Magill, 1994). Alignment at the operational or tactical level is required for ensuring that planned applications are successfully implemented, maintained, and used (Tarafdar and Qrunfleh, 2009).

These studies show that different kinds of IS business alignment positively affect many aspects of firm performance, such as IS performance and competitive advantage (Chan et al., 1997; Sabherwal and Kris, 1994; Kearns and Lederer, 2003; Sabherwal and Chan, 2001). However, there are no studies that consider SC-IS alignment and its impact on SCM performance.

Nickles et al. (1998) argue that supply chain managers need to redesign their supply chain strategies based on IT investments. They argue that investing in applications should fully support the strategic goals of a supply chain. The result of their study suggests that SCMS and ISS should be developed together so companies can create a competitive advantage. This is what (Gunasekaran and Ngai, 2004) refer to in their study as "*the strategic planning of IS in SCM*" which plays an important role in achieving the goals of the organization. They argue that companies are now focusing on the strategic planning of IS in SCM with the objective of developing long term plans to improve their performances. How can this be done? To give an example, the strategic planning of IS should support the long-term objectives and goals of SCM in terms of flexibility and responsiveness by sharing the right information with suppliers. In other words, organizations should select and implement applications that support developing an effective supply chain. Nevertheless, selecting the right application for specific supply chain requirements is challenging. Richmond et al. (1998) addressed this issue by identifying a number of factors for selecting supply chain applications. One of those factors is aligning the technology with supply chains. They argue that a firm should choose an application that supports the way it interacts and communicates with its suppliers and customers.

Further, Puckridge and Woolsey (2003) emphasize the need to integrate ISS with the supply chain by aligning the ISS with the organization's strategy to achieve synchronization across the extended supply chain. For instance, if a firm's objective is aimed at being responsive and flexible to customer needs, then ISS should support this goal by investing in applications that enhance flexibility; this ISS must be extended across the supply chain. *"Requiring supply chains to become agile (the ability to respond rapidly to unpredictable changes in the market) also requires the same agility in the organization's IT capability. Success will be defined by those organizations that are able to meet the future requirements across their supply chain."* (Puckridge and Woolsey, 2003, p. 412). Additionally, Christopher (2000) suggests that in order to improve the responsiveness of the supply chain, agility in the supply chain is needed which requires agile IS so that firms can share information among supply chain partners. For instance, when AT&T (*electronic consumer products*) decided to improve the agility of its supply chain by employing an ISS to implement electronic transactions to share information among suppliers, the implementation resulted in a better SCM performance measured by its responsiveness to customers (Gunasekaran at el., 2008). AT&T's action was based on the argument that "selecting the right technology/application for the right supply chain strategy will enhance the performance of its supply chain".

The above arguments show the need to have an ISS that supports and enhances SCMS to have better SCM performance. In other words, the moderation (interaction) between SCMS and the ISS will result in better SCM performance. So for instance, if the firm's goal is to cut cost, then a lean supply chain (which emphasize being efficient) is preferred. The lean supply chain should be aligned with an ISS that emphasizes and supports being efficient (IS for efficiency). On the other hand, an agile supply chain is best aligned with IS for flexibility; and finally, a hybrid supply chain is best aligned with IS for comprehensiveness. Aligning SCMS with ISS will result in better SCM performance. Therefore, it is hypothesized that:

H1a: The impact of a lean supply chain on supply chain management performance (as measured by supply chain integration) is positively moderated by IS for efficiency.

H1b: The impact of an agile supply chain on supply chain management performance (as measured by supply chain flexibility) is positively moderated by IS for flexibility.

H1c: The impact of a hybrid supply chain on supply chain management performance (as measured by customer responsiveness) is positively moderated by IS for comprehensiveness.

3.5 Research Hypothesis 2a, 2b, and 2c (Moderating Alignment between SCM Practices and IT Utilization)

Using IT systems to capture and analyze information has a significant impact on SCM performance (Chopra and Meindl, 2001). Similarly, using IT has an impressive impact on supply chain practices. Both effective information sharing (which is facilitated by IT) and effective supply chain practices are critical elements in achieving good SCM performance (Zhou and Benton, 2007). Although the study of Zhou and Benton (2007) discusses the role of IT on SCM practices and its impact on SCM performance, it fails to discuss the role of alignment between SCM practices and the usage of IT in achieving better SCM performance. This research argues that external IT usage moderates the relationship between a strategic supplier partnership and customer-relationship aspects of SCM practices and SCM performance. On the other hand, internal IT usage moderates the relationship between internal lean practices and the postponement aspects of SCM practices and SCM performance. Finally, infrastructural IT moderates the relationship between information sharing and information quality of SCM practices and SCM performance; these three types of IT usage, when matched with the corresponding SCM practices, lead to better SCM performance.

3.5.1 Research Hypothesis 2a (Moderating Alignment of External Focus of IT with a Strategic Supplier Partnership and Customer Relationship on Supply Chain Management Performance)

The external focus of IT uses inter-organizational systems to maintain and acquire new relationships (partnership) with suppliers and to get closer to customers for better anticipating their needs (Philip and Booth, 2001). Mason-Jones and Towill (1997) argue that the key to building these partnerships lies in the way firms utilize their IT. They note that it is not enough to implement IT to build a relationship with suppliers, but the way firms manage and utilize IT is what counts. They give the example of how Wal-Mart utilizes its point-of-sale and inter-organizational IT to build a long term relationship with one of its main suppliers (Proctor & Gamble) by sharing information about its customers with Proctor & Gamble; this information helps Proctor & Gamble decide how much stock is needed to be delivered to Wal-Mart stores, and how frequently, to meet customer demand. As a result, the supply chain improves its overall speed of response to customers.

To put this in another perspective, Fawcett et al. (2007) developed a strategic management initiative framework or what they refer to as "*a contingency perspective of information sharing capability as a strategic enabler*" to understand how IT is used to enhance supply chain performance. They suggest that having a strategic relationship with partners requires IT to support achieving relationship goals which enable faster decision making in the supply chain. Specifically, they mentioned the importance of "*matching the technology to specific value-added capability need"* in which IT enhances strategic, managerial decision making to gain flexible customer responses. Therefore, it is hypothesized that:

H2a: The impact of strategic supplier partnerships and customer relationships on SCM performance is positively moderated by an external focus of IT.

3.5.2 Research Hypothesis 2b (Moderating Alignment of Internal Focus of IT with Internal Lean Practices and Postponement on Supply Chain Management Performance)

According to Philip and Booth (2001), an internal focus of IT deals with day-to-day operations. The internal focus of IT leads to better operational efficiencies and cost reductions in processes internal to the firm by improving everyday tasks through IT. Additionally, they suggest that in manufacturing environments, the internal focus of IT involves standard applications that are used in automation of repetitive tasks. Those standard applications reduce the time and effort in a particular business process. Some of the business processes are related to inter-organizational relationships, which include quality control processes, operating processes, just-in-time deliveries, and customized make-to-order processes (Subramani and Venkatraman, 2003). To perform these kinds of inter-organizational business processes, firms must use IT to facilitate changes to those processes. The usage of IT should match with the inter-organizational business processes, so suppliers can achieve operational benefits i.e., lower transaction and production cost (Sanders, 2008; Clark and Stoddard, 1996). Therefore, it is hypothesized that:

H2b: The impact of internal lean practices and postponement on SCM performance is positively moderated by an internal focus of IT.

3.5.3 Research Hypothesis 2c (Moderating Alignment of Infrastructural Focus of IT with Information Sharing and Information Quality on Supply Chain Management Performance)

IT infrastructure is generally described as a set of platforms, networks, and data processing and storage applications. The presence of an IT infrastructure enables sharing information within and across organizations and is required for timely and seamless information links throughout an organization. IT infrastructure thus plays a critical role in the firm's ability to use IT competitively, as a fragile IT infrastructure could hinder basic information sharing. McKay and Brockway (1989) suggest that an IT infrastructure enables sharing IT capabilities among business organizations. It could also facilitate the firm's requirements for mass customization by providing seamless information links throughout an organization.

The ability of an organization to respond rapidly and effectively to changes in customer demand relies on the IT infrastructure of that organization. This is what some studies have referred to as "*infrastructure flexibility*" (Duncan, 1995; McKay and Brockway, 1989; Weill, 1993; Chung et al., 2005). The key enabler of infrastructure flexibility is the adoption of a standard open system which uses compatible IT components to communicate across organizations (Chung et al., 2005) and which allows firms to be flexible and respond to changes in customer demand by sharing information across those organizations (Duncan, 1995). Further, improved IT infrastructure makes information more accessible and more valuable by allowing suppliers immediate access to information (Shapiro and Varian, 1999). Therefore, in order to have timely and accurate data, firms must make significant investments in their information infrastructure. Based on the arguments above it is hypothesized that:

H2c: The impact of information sharing and information quality on SCM performance is positively moderated by an infrastructural focus of IT.

3.6 Research Hypothesis 3a, 3b, and 3c (SCM Practices and SCM Performance)

Numerous studies have shown that well managed and well executed SCM practices will directly improve firm performance (Shin et al., 2000; Prasad and Tata, 2000; Tan et al., 1998; Tan, 2002). Although most studies have linked SCM practices directly to firm performance without explicitly considering any intermediate measures such as SCM performance; this study is considering a direct link between SCM practices and its impact on SCM performance.

Two of the SCM practices considered in this study are information sharing and information quality. Regarding those two practices, Zhou and Benton (2007) provided empirical evidence that sharing information and quality information are critical to SCM performance, specifically the delivery performance of the supply chain which includes on-time delivery, perfect order fulfillment rate, and delivery reliability/dependability.

Regarding postponement, van Hoek et al. (1999) suggest that keeping materials undifferentiated for as long as possible increases the flexibility in the supply chain in responding to changes in customer demand, as well as improving the cost effectiveness of supply chains.

Finally, Yu et al. (2001) provided a case study to illustrate the benefits of supply chain partnerships on SCM performance; those benefits are captured through reductions in inventory levels and cost savings from forming partnerships with one another. Based on the arguments above it is hypothesized that:

H3a: Strategic supplier partnerships and customer responsiveness are positively associated with SCM performance.

H3b: Internal lean practices and postponement are positively associated with SCM performance.

H3c: Information sharing and information quality are positively associated with SCM performance.

3.7 Research Hypothesis 4 (SCM Performance and Firm Performance)

Cohen and Roussel (2005) believe that an effective business strategy should be supported by a good supply chain strategy. Using the supply chain as a strategic weapon could improve firm performance, as many firms believe that SCM is the most popular operations strategy for improving organizational competitiveness (Gunasekaran et al., 2008). Companies such as Dell, Amazon, and Wal-Mart are constantly refining their supply chains so they can stay one step ahead of their competitors. In an interview with the CEO of Dell, Michael Dell explained that Dell was able to transform the struggling PC Company to a market leader by managing its supply chain and introducing supply chain innovations such as direct-to-consumer sales and build-to-order manufacturing that help reduce inefficiencies and costs by managing inventories and working closely with customers. This example clearly shows how SCM could impact firm performance (Magretta, 1998; Cohen and Roussel, 2005).

Further, Vonderembse and Tracey (1999) empirically tested the relationship between supplier performance and manufacturing performance. They argue that involving suppliers in product design efforts enhances firm performances with regards to production cost, work-in-process inventory levels, product quality, and on-time delivery to the final customer. Narasimhan and Kim (2002) emphasize the roles of supply chain integration on firm performance suggesting that supply chain integration enhances a firm's performance through moderating the relationship between product diversification (developing different products) and international market diversification. They evaluated firm performance by using sales growth, market share growth, and profitability.

Further, Shin et al. (2000) provided a good example of how an excellent SCM impacts a firm's performance "*when Chrysler launched a supplier- involvement program, which is called Supplier Cost Reduction Effort (SCORE), and benchmarked the supply chain management practices of Japanese companies, Chrysler announced that it achieved more than US$1.2 billion in cost savings through 1997 due to the SCORE program*". Based on the arguments above it is hypothesized that:

H4. *SCM performance is positively associated with firm performance.*

Chapter 4

Instruments Development--Item Generation and Pilot Test

This chapter discusses the instrument development and pilot testing of the measures of the research model. The instruments to measure -- (1) supply chain management practices, (2) supply chain management performance, and (3) firm performance-- were adopted from previous studies (Li et al., 2006; Li et al., 2005). Since these instruments have been tested in previous studies and were found to be valid and reliable, they will not be tested again in the pilot study of this research. However, they will be revalidated in the large-scale analysis in chapter 5.

The instruments to measure-- (1) supply chain management strategy (SCMS), (2) Information Systems strategy (ISS), (3) Information Technology (IT) utilization, (4) the alignment between SCMS and ISS, and (5) the alignment between SCM practices and the usage of IT-- will be developed or modified if they have been developed in earlier studies to make them relevant for this study (Sabherwal and Chan, 2001; Venkatraman, 1989a; Swafford et al., 2006).

The development of the instruments for the three constructs (SCMS, ISS, and IT utilization) and the alignment between SCM and ISS, and the alignment between SCM practices and the usage of IT was completed in three phases: (1) item generation, (2) a pilot study using Q-sort method, and (3) a large scale-data analysis and instrument validation. The item generation was done through an extensive and comprehensive literature review to identify the content domain of the major constructs in this study. The initial items and the definition of the constructs were generated from this literature review. The second stage of the study was scale development and testing through a pilot study using the Q-sort method. The objective of the Q-sort method is to pre-assess the convergent and discriminant validity of the scale by asking different practitioners to sort (place) the items into various construct categories. The goal of the Q-sort is to assess the reliability of the sorting conducted by the practitioners. This is what the literature refers to as *inter-rater reliability.* The study's final stage includes all the validity and reliability tests using the data from the large-scale sample which is described later in chapter 5.

4.1. Item Generation

In order to have valid and reliable empirical research, appropriate steps (techniques) to generate measurement items of any construct must be considered. First, the content validity, which means the measurement items contained in an instrument, should cover the major content domain of a construct (Churchill, 1979). Content validity is usually achieved through extensive and comprehensive literature review as a list of initial items for each construct is generated from the literature review. Thus, interviews and feedback from practitioners and academicians should help in achieving the content validity. The general literature bases for the items generation for each construct are briefly discussed below.

The items for SCMS (lean supply chain, agile supply chain, and hybrid supply chain) were generated based on previous SCM literature. In particular, the lean supply chain was generated based on previous studies of (Huang et al., 2002; Wang et al., 2004; Vonderembse et al., 2006; Towill and Christopher, 2002; Christopher and Towill, 2000; Lee, 2002). Agile supply chain was modified and generated from (Swafford et al., 2006; Huang et al., 2002; Christopher and Towill, 2000; Wang et al., 2004; Vonderembse et al., 2006; Christopher, 2000; van Hoek et al., 2001; Lin et al., 2006; Agarwal et al., 2007; Towill and Christopher, 2002; Power et al., 2001; Lee, 2002). Finally, hybrid supply chain was generated based on previous studies of (Huang et al., 2002; Naylor et al., 1999; Wang et al., 2004; Vonderembse et al., 2006; Towill and Christopher, 2002; Christopher and Towill, 2000). In regards to ISS (IS for efficiency, IS for flexibility, and IS for comprehensiveness), the items for those constructs were modified from the previous study of (Sabherwal and Chan, 2001; Venkatraman, 1989a) and the consideration of other studies (Bakos and Treacy, 1986; Clemons et al., 1993; Rockart and Morton, 1984; Porter and Millar, 1985; Allen and Boynton, 1991). Finally, IT utilization (external Focus of IT, internal focus of IT, and Infrastructural focus of IT) were generated based on previous literature. In particular, the external Focus on IT was generated for the studies of (Wiseman, 1988; Benjamin et al., 1984; Cash Jr. and Konsynski, 1985). An internal focus of IT was generated from the studies of (Benjamin et al., 1984; Boynton et al., 1994). Finally, the infrastructural focus of IT was generated from (Narasimhan and Kim, 2001; Kim and Narasimhan, 2002; Weill, 1993; McKay and Brockway, 1989).

Once item pools were created, they were reviewed by two academicians and six practitioners. The objective of this step is to check the relevance of each construct's definition and the clarity of the wording of the sample questionnaire items that has been developed or modified from previous literature. Based on the comments and feedbacks from the academicians and the practitioners, redundant and ambiguous items were either modified or eliminated, and some new items were added. As a result, a total of 11 constructs and 124 items were created. Below is the precise number of each construct and the items that belong to that construct. Appendix A presents the items entering the first Q-sort analysis.

Supply chain management strategy (SCMS)

Lean supply chain……………………………………..7
Agile supply chain……………………………………..12
Hybrid supply chain……………………………………5

Information systems strategy (ISS)

IS for efficiency…………………………………………7
IS for flexibility…………………………………………7
IS for comprehensiveness……………………………….6

Information technology (IT) utilization

External focus of IT…………………………………....13
Internal focus of IT……………………………………...8
Infrastructural focus of IT………………………………9

Alignment between SCMS and ISS……………………………………..24

Alignment between SCM practices and the Usage of IT……………….26

4.2 Scale Development: the Q-Sort Method

4.2.1 Sorting Procedures

First, the judges were presented with the model and all the definitions of the constructs for this study, followed by a brief explanation of the objective of the study. The items were printed on a 3" by 5" card, shuffled, and then given to the judges. After explaining the Q-sort procedure and answering any additional question the judges might have, the judges were asked to place each item (card) under the appropriate construct where they believed it belonged based on their knowledge, experience, and practice. In this study, a total of three rounds were conducted. In each round two judges were asked to sort the items according to the different dimensions. Based on this, an inter-judge agreement between two judges was calculated. There were 11 total constructs with a total of 124 items. A "not-applicable" category (construct) was also included as the 12th construct to ensure that the judges did not force any item into a particular category. Furthermore, judges were allowed to ask as many questions as they wanted throughout the process to ensure their understanding of the whole procedure of the Q-sort.

The criteria for evaluating the Q-sort results are based on the inter-judge agreement level. Two evaluation indices were used to measure inter-judge agreement level: (1) Moore and Benbasat's hit ratio (Moore and Benbasat, 1991), and (2) Cohen's Kappa coefficient agreement (Cohen, 1960). The inter-judge agreement level is determined by counting the number of items that both judges agree to place into a certain category, even though the category into which items are sorted by both judges may not be the intended one. The measurement based on Moore and Benbasat's deals with the "hit ratio". The hit ratio is a good indicator of how many items each pair of judges placed in the appropriate and intended category, by counting all the items that are correctly grouped together according to their intended theoretical construct by each judge and then dividing them by the total number of items for each pair of judges. Finally, the measurement of Cohen's Kappa coefficient agreement can be interpreted as the proportion of joint judgment in which there is agreement after chance agreement. With regards to Kappa coefficient agreement, there is no general agreement in the literature with respect to the required score. However, several studies considered scores greater than 0.65 to be acceptable such as the studies of (Jarvenpaa, 1989; Vessey, 1984).

4.2.2 Results of the First Sorting Round

In the first round, two senior managers of a major automobile firm participated in the Q-sort. The hit ratio score averaged 79% (Table 4.2.1). The hit ratio was calculated by counting all the items that were correctly sorted into the target category by each of the judges and dividing them by twice the total number of items. In this research, the total number of items that were correctly sorted by the two judges is 196, and the total number of items placed for both judges is 248.

Table 4.2.1 Items placement ratios: first sorting round

Theoretical Categories	Actual Categories													
		1	2	3	4	5	6	7	8	9	10	11	NA	Total	%
	1	13	1											14	93%
	2	4	20											24	83%
	3	1	4	5										10	50%
	4				14									14	100%
	5				2	11	1							14	79%
	6				4	1	7							12	58%
	7							19	1	6				26	73%
	8							1	13	2				16	81%
	9							11	1	6				18	33%
	10										41	7		48	85%
	11										5	47		52	90%
	NA													248	

Total item placement: 248	Number of Hits: 196	Overall Hit Ratio: 79%

1. Lean supply chain
2. Agile supply chain
3. Hybrid supply chain
4. IS for efficiency
5. IS for flexibility
6. IS for comprehensiveness
7. External focus of IT
8. Internal focus of IT
9. Infrastructural focus of IT
10. Alignment between supply chain management strategy and IS strategy
11. Alignment between supply chain management practices and usage of IT

Table 4.2.2 Inter-judge raw agreement scores: first sorting round

		Judge 1											
	Constructs	1	2	3	4	5	6	7	8	9	10	11	NA
Judge 2	1	6											
	2		8										
	3			0									
	4				7								
	5					4							
	6						3						
	7							9		1			
	8								5				
	9							3		1			
	10										17		
	11											21	
	NA												

Total Item Placement : 124	Number of Correct Agreements:81	Correct Agreement Ratio .65

1. Lean supply chain……………………………………………………………7
2. Agile supply chain…………………………………………………………12
3. Hybrid supply chain…………………………………………………………5
4. IS for efficiency……………………………………………………………..7
5. IS for flexibility……………………………………………………………...7
6. IS for comprehensiveness……………………………………………………6
7. External focus of IT………………………………………………………...13
8. Internal focus of IT…………………………………………………………..8
9. Infrastructural focus of IT……………………………………………………9
10. Alignment between supply chain management strategy and IS strategy…….24
11. Alignment between supply chain management practices and usage of IT…..26

The inter-judge raw correct agreement score averaged 65% (Table 4.2.2). The level of agreement between the two judges in categorizing the items is important in measuring Cohen's Kappa (Cohen, 1960). This index is a method of eliminating chances agreements, thus evaluating the true agreement score between the two judges by using the following equation:

$$k = \frac{N_i X_{ii} - \sum_i (X_{i+} X_{+i})}{N_i^2 - \sum_i (X_{i+} X_{+i})}:$$

Where:

Ni: is the total item.

Xii: is the total number of items on the diagonal (the number of items agreed correctly in the intended category by the two judges).

Xi+: the total number of items on the i th row of the table

X+i: the total number of items on the i th column of the table

(See Appendix B for the description of this methodology). The description of this method is taken from a paper published by (Nahm et al., 2002) in *The Journal of Modern Applied Statistical Methods*. The published paper provides a clear explanation of Q-Sort methodology supported with examples.

Based on this equation, the calculation for Cohen's Kappa coefficient is shown below:

$$K = \frac{(124)\,(81) - 1039}{(124)\,(124) - 1039} = 0.63$$

Cohen's Kappa score averaged 63% which is considered low, and the hit ratio averaged 79%. Furthermore, looking carefully into the items placement ratio for each category (construct), the results are not satisfying. For instance, the item # 3 (hybrid supply chain) has a placement ratio of only 50%. The same is true for the item # 5 (IS for flexibility) which has ratio of only 79%. Item # 6 (IS for comprehensiveness) has a placement ratio of only 58%. Item # 7 (external focus of IT) has a placement ratio of only 73%. Finally, item # 9 (infrastructure focus of IT) has a placement ratio of only 33%. As a result of the low scores for those constructs, a second round of Q-sort analysis is needed to improve Cohen's Kappa score and the placement ratios.

4.2.3 Results of the Second Sorting Round

After making the changes to the items based on the results/feedback from the first Q-sort round, some items were eliminated (8 items) and others were modified. A second Q-sort round involved two senior purchasing managers with a total of 116 items (entering the second Q-sort round). The hit ratio score averaged 93% (Table 4.2.3). The inter-judge raw correct agreement scored average 89% (Table 4.2.4). The calculation for Cohen's Kappa coefficient is shown below:

$$K = \frac{(116)\,(102) - 1382}{(116)\,(116) - 1382} = 0.87$$

Cohen's Kappa score averaged 87% which is considered an excellent score. However, looking carefully into the items placement ratio for each category (construct), the results are not satisfying. Construct # 4 (IS for efficiency) has a placement ratio of only 71.4%, and construct # 6 (IS for comprehensiveness) has a placement ratio of only 50%. In order to improve item placement ratio scores, a third Q-sort round was needed.

Table 4.2.3 Items placement ratios: second sorting round

Theoretical Categories	Actual Categories													
		1	2	3	4	5	6	7	8	9	10	11	NA	Total	%
	1	14												14	100
	2		20											20	100
	3			10										10	100
	4				10	2		1			1			14	71.4
	5				2	12								14	85.7
	6					1	4				3			8	50
	7							24						24	100
	8								16					16	100
	9									14				14	100
	10										42	6		48	87.5
	11										1	49		50	98
	NA													232	
Total item placement: 232				Number of Hits: 215							Overall Hit Ratio: 93%				

1. Lean supply chain
2. Agile supply chain
3. Hybrid supply chain
4. IS for efficiency
5. IS for flexibility
6. IS for comprehensiveness
7. External focus of IT
8. Internal focus of IT
9. Infrastructural focus of IT
10. Alignment between supply chain management strategy and IS strategy
11. Alignment between supply chain management practices and usage of IT

Table 4.2.4 Inter-judge raw agreement scores: second sorting round

	Judge 1											
	Constructs	1	2	3	4	5	6	7	8	9	10	11	NA
Judge 2	1	7											
	2		10										
	3			5									
	4				5								
	5					5							
	6						1						
	7							12					
	8								8				
	9									7			
	10										18		
	11											24	
	NA												
Total Item Placement: 116				Number of Correct Agreements:102						Correct Agreement Ratio 0.89			

1. Lean supply chain……………………………………………………………..7
2. Agile supply chain…………………………………………………………10
3. Hybrid supply chain………………………………………………………..5
4. IS for efficiency…………………………………………………..................7
5. IS for flexibility……………………………………………………………..7
6. IS for comprehensiveness…………………………………………………….4
7. External focus of IT………………………………………………………...12
8. Internal focus of IT…………………………………………………………..8
9. Infrastructural focus of IT……………………………………………………7
10. Alignment between supply chain management strategy and IS strategy.........24
11. Alignment between supply chain management practices and usage of IT…..25

4.2.4 Results of the Third Sorting Round

Taking into consideration the feedback/suggestions from the managers in the second round, many items have been reworded and a total of 11 items were eliminated from the pool. Two judges were involved in the third sorting round with a total of 105 items. Appendix C presents the items entering the third Q-sort analysis. In the third round, the hit ratio score averaged 98% (Table 4.2.5). The inter-judge raw correct agreement score averaged 95% (Table 4.2.6). The calculation for Cohen's Kappa coefficient is shown below:

$$K = \frac{(105)(100) - 1286}{(105)(105) - 1286} = 0.95$$

Kappa coefficient of 0.95 represents an excellent level of agreement for the judges in the third round and also indicates consistency in the results between the second and third sorting round. Moreover, eight constructs (lean supply chain, agile supply chain, hybrid supply chain, IS for efficiency, external focus of IT, internal focus of IT, and infrastructural focus of IT, and the alignment between supply chain management practices and the usage of IT) obtained a 100% item placement ration, indicating a high degree of construct validity.

Table 4.2.5 Items placement ratios: third sorting round

Theoretical Categories	Actual Categories												Total	%
	1	2	3	4	5	6	7	8	9	10	11	NA	Total	%
1	14												14	100
2		16											16	100
3			10										10	100
4				12									12	100
5					11						1		12	91.7
6					1	7							8	87.5
7							24						24	100
8								16					16	100
9									14				14	100
10				1				1		31	1		34	91.2
11											50		50	100
NA													210	

Total Item Placement: 210	Number of Hits: 205	Overall Hit Ratio: 98%

1. Lean supply chain
2. Agile supply chain
3. Hybrid supply chain
4. IS for efficiency
5. IS for flexibility
6. IS for comprehensiveness
7. External focus of IT
8. Internal focus of IT
9. Infrastructural focus of IT
10. Alignment between supply chain management strategy and IS strategy
11. Alignment between supply chain management practices and usage of IT

Table 4.2.6 Inter-judge raw agreement scores: third sorting round

	Judge 1												
	Constructs	1	2	3	4	5	6	7	8	9	10	11	NA
Judge 2	1	7											
	2		8										
	3			5									
	4				6								
	5					5							
	6						3						
	7							12					
	8								8				
	9									7			
	10										14		
	11											25	
	NA												
Total Item Placement: 105				Number of Correct Agreements:100						Correct Agreement Ratio .95			

1. Lean supply chain……………………………………………………………7
2. Agile supply chain…………………………………………………………8
3. Hybrid supply chain………………………………………………………..5
4. IS for efficiency……………………………………………….................6
5. IS for flexibility……………………………………………………………..6
6. IS for comprehensiveness…………………………………………………..4
7. External focus of IT………………………………………………………...12
8. Internal focus of IT…………………………………………………………8
9. Infrastructural focus of IT………………………………………………….7
10. Alignment between supply chain management strategy and IS strategy…......17
11. Alignment between supply chain management practices and usage of IT…..25

The total number of items after the third Q-sort has been reduced from 105 to 86. The number of items remaining for each construct after the third round of Q-sort was as follows:

1. Lean supply chain……………………………………………………….….6
2. Agile supply chain……………………………………………………..……6
3. Hybrid supply chain………………………………………………….…..5
4. IS for efficiency………………………………………….........................5
5. IS for flexibility……………………………………………………………...5
6. IS for comprehensiveness………………………………………………...4
7. External focus of IT……………………………………………………....5
8. Internal focus of IT…………………………………………………………5
9. Infrastructural focus of IT…………………………………………………..5
10. Alignment between supply chain management strategy and IS strategy…......17
11. Alignment between supply chain management practices and usage of IT…..24

At this point we stopped the Q-sort method at round three as the raw agreement score of 0.95, Cohen's Kappa of 0.95, and the average placement ratio of 0.95 were considered as an excellent level of inter-judge agreement, indicating a high level of reliability and construct validity. In the next chapter the test for the quantitative assessment of construct validity and reliability using the large-scale sample is presented.

Chapter 5

Instruments Development – Large-Scale Administration and Instrument Validation

5.1 Large-Scale Data Collection Methodology

The goal of the previous chapter (Chapter 4) was to partially validate the construct measurement items of the research model through an extensive literature review and Q-sort analysis. The main objective of this chapter is to further validate the measurement instruments using a larger sample size.

Choosing the right respondent is very important when designing a large-scale survey. The respondents are expected to have the best knowledge on the areas of the survey. In the case of this study, the respondents chosen needed to have experience and knowledge in managing the supply chain, and in information systems applications in their organizations. Therefore, it was decided to choose purchasing directors, supply chain directors, purchasing managers, and supply chain managers as the respondents for this study.

A mailing list was obtained from RSA LIST SERVICES. RSA LIST SERVICES provides an executive contact database for the manufacturing sector in the United States.

The initial mailing list used in this study contains 5000 records (names) which were randomly selected by the RSA database. The list was limited mostly to organizations with more than 200 employees and with sales revenue of more than $10 million, since small organizations are unlikely to acquire or use sophisticated information systems in their supply chains. Twenty SIC codes are covered in this study; they are summarized in Table 5.1.1. It is desirable for the respondents to represent different geographic areas. The mailing list purchased covered the following States: AL, AR, AZ, CA, CO, CT, DE, FL, GA, HI, IA, ID, IL, IN, OH, KS, KY, LA, MA, MD, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NV, NY, OK, PA, SC, TN, TX, UT, VA, VT, WA, WI, WV, and WY.

Table 5.1.1 SIC codes and their descriptions

SIC code	Description
20	Food and Kindred Products
21	Tobacco Products
22	Textile Mill Products
23	Apparel, Finished Products from Fabrics & Similar Materials
24	Lumber and Wood Products, Except Furniture
25	Furniture and Fixtures
26	Paper and Allied Products
27	Printing, Publishing and Allied Industries
28	Chemicals and Allied Products
29	Petroleum Refining and Related Industries
30	Rubber and Miscellaneous Plastic Products
31	Leather and Leather Products
32	Stone, Clay, Glass, and Concrete Products
33	Primary Metal Industries
34	Fabricated Metal Products, Except Machinery & Transport Equipment
35	Industrial and Commercial Machinery and Computer Equipment
36	Electronic, Electrical Equipment, Except Computer Equipment
37	Transportation Equipment
38	Instruments and Related Products
39	Miscellaneous Manufacturing Industries

In this study, a web survey is used to collect data. The designing of the web survey was done with the assistance of the Urban Affairs Center (UAC) at The University of Toledo. UAC helps in designing a professional, high-quality survey that facilitates the answering of the questionnaire. Furthermore, UAC helps by sending messages to the respondents to remind them to complete the survey. UAC also stores the data (responses) and provides them in a clear electronic file in SPSS or Excel format.

In designing the web survey, several aspects were taken into consideration: 1) it was decided to present the survey as a multi-page form, rather than a single page form. Even though previous research had not found significant differences between these two presentation methods (Batagelj and Vehovar, 1998), we choose a multi-page format because we did not want the respondent to see the whole questionnaire and get discouraged by the total number of questions presented at once; 2) some sections of the survey were designed by placing the scale at the right and left hand side of each alignment, SCM strategy, and SCM practices questions, to help in reducing the number of pages in the survey; 3) the online survey was designed to be as simple as possible in terms of format and navigation as there was no password required to answer the survey.

The UAC sent the first waves of e-mail as an invitation to participate in the survey. The e-mail briefly described the objective of the research and had a link to the survey. In the first wave, initially from the 5000 contacts, 1888 bounced back due to e-mails that do not exist. The results of the first waive shows that only 9 people responded to the survey (from the 3112 names that received an e-mail). A second reminder was sent exactly a week after the first attempt. In the second wave, to encourage participation in the survey, I arranged for a lottery price worth $100. In the e-mails and cover letters, the following sentence was added "*Those who complete the survey and provide their contact information will be automatically entered in a drawing for $100. Your contact information will not be used for any other purpose*".

Phone calls were also made (with the assistance of the UAC) to remind people to participate in the survey. A total of 730 people agreed to fill out the survey. However, only 68 people actually took the survey. Up to this point, the total number of the people who had completed the survey was 77 (9+68).

To encourage more people to participate in the survey, I provided a $20 check as an incentive for each person who completed the survey. As a result, 113 people responded to my survey from the initial list of the 3112 names. Seventeen people from outside the initial list participated in my survey, with a total responses of 207 (77+113+17). Two responses had to be removed from the data since they were not completed by the respondents. Therefore, the final number of complete and usable responses was 205, representing a response rate of **6.6%** (calculated as **205/ 5000-1888+17**).

The non-response bias was checked later in section 5.3 between the respondents who did participate before the $20 incentive was provided and those who participated after the $20 incentive was provided.

5.2 Sample Demographics

This section will discuss sample characteristics in terms of (1) the respondent (job function, job title, and number of years stayed at the organization), and (2) the organization (employment size, industry category, number of years in business, annual sale, annual information system budget, annual system budgets as a percentage of sale, percentage of electronic business transactions with customers and suppliers, horizontal position of an organization in the supply chain, the implementation of a SCM program, and technology application utilization).

5.2.1 Sample Characteristics of the Respondent

Job Title

More than half of the respondents (55%) are managers, while 29% of the respondents belong to the “other” category such as senior purchasing agent, procurement director, VP of supply chain, vice president, supply chain planner, purchasing manager, logistician, buyer/planner, project manager, supplier quality engineer, IT director, CIO, systems analyst, supervisor, and EVP-Supply Chain. 14% of the respondents are directors, and only 2% of the respondents are CEO/ Presidents of their organizations. Figure 5.2.1.1 displays the respondents by job title.

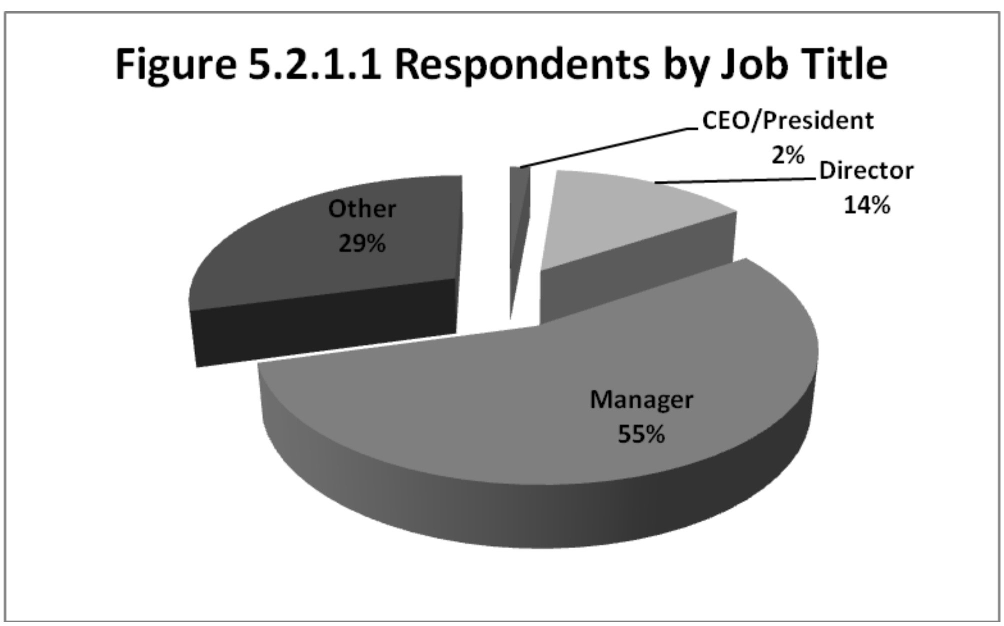

Figure 5.2.1.1 Respondents by job title

Job Function

Seventy-seven percent (77%) of the respondents are experts in the area of purchasing, while 21% of the respondents are experts in the area of manufacturing production. Fifteen percent (15%) are experts in the transportation and distribution areas, and 13% are corporate executives. Finally, only 3% are experts in the sales function. Figure 5.2.1.2 displays the respondents by job function. This shows that most of the respondents are knowledgeable and expert in the area of purchasing. (Note: one company may represent multiple data items; the calculation of the percentage is based on the total sample size of 205).

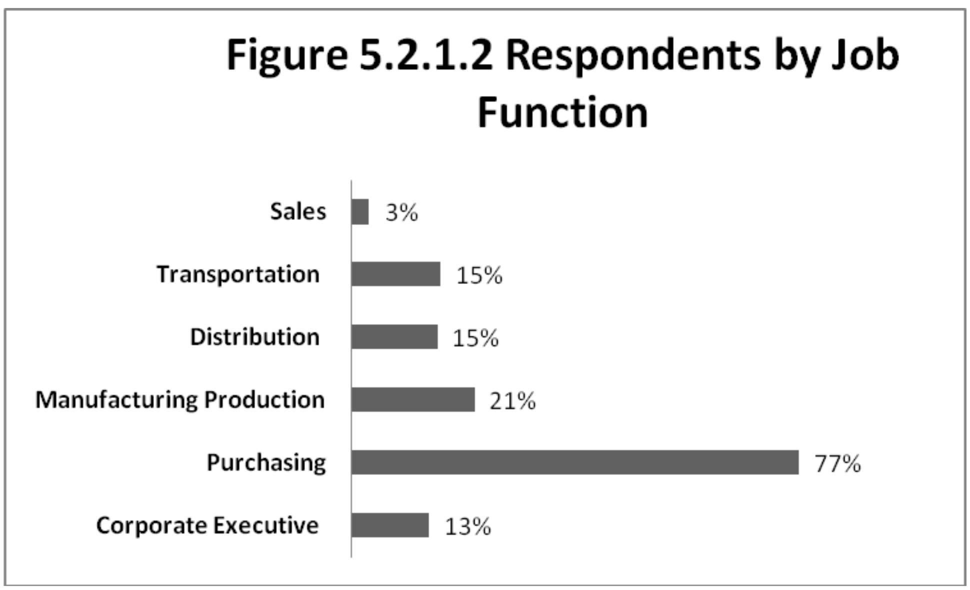

Figure 5.2.1.2 Respondents by job function

Years Stayed at the Organization

Forty-seven percent (47%) of the respondents indicate they have been working with the organization for over 10 years; 21% of the respondents have been working with the organization between 6-10 years; 25% of the respondents have been working between

2-5 years; and only 7% of the respondents had been at the organization for less than 2 years. Figure 5.2.1.3 displays the respondents by years worked at the organization. This clearly shows that most of the respondents are experienced and have been working in their organizations for many years.

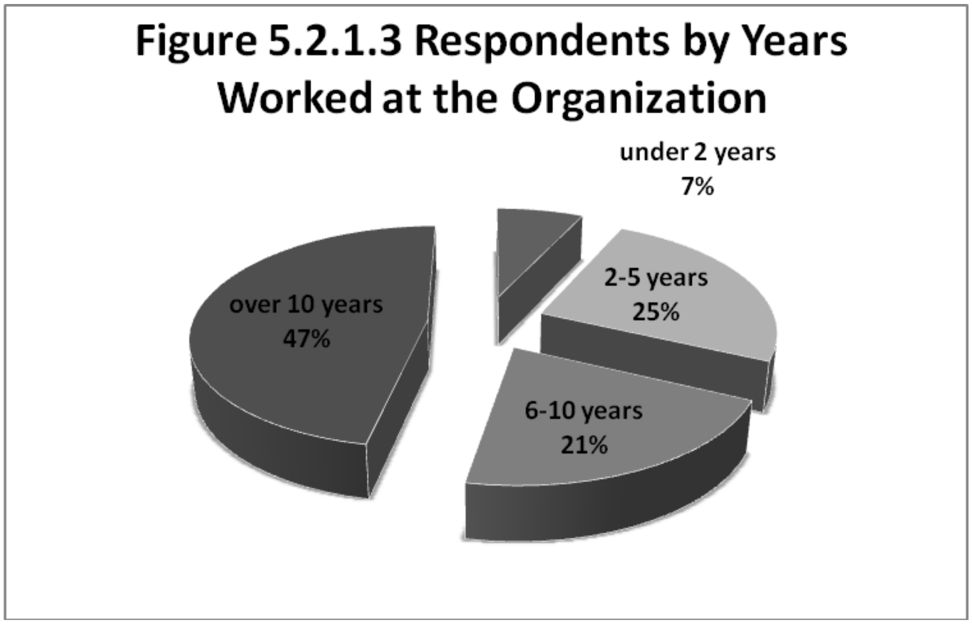

Figure 5.2.1.3 Respondents by years worked at the organization

5.2.2 Sample Characteristics of Surveyed Organizations

<u>Number of Employees</u>

Thirty-one percent (31%) of the organizations have over 1000 employees, 6% of the organizations have between 501-1000 employees and 6% of organizations have 1-50 employees. Organizations that have between 251 and 500 employees account for 17% of the sample while organizations with between 101 and 250 employees account for 27% of the sample. Finally, 13% of the organizations have between 51 and 101 employees. Figure 5.2.2.1 displays the organizations by number of employees.

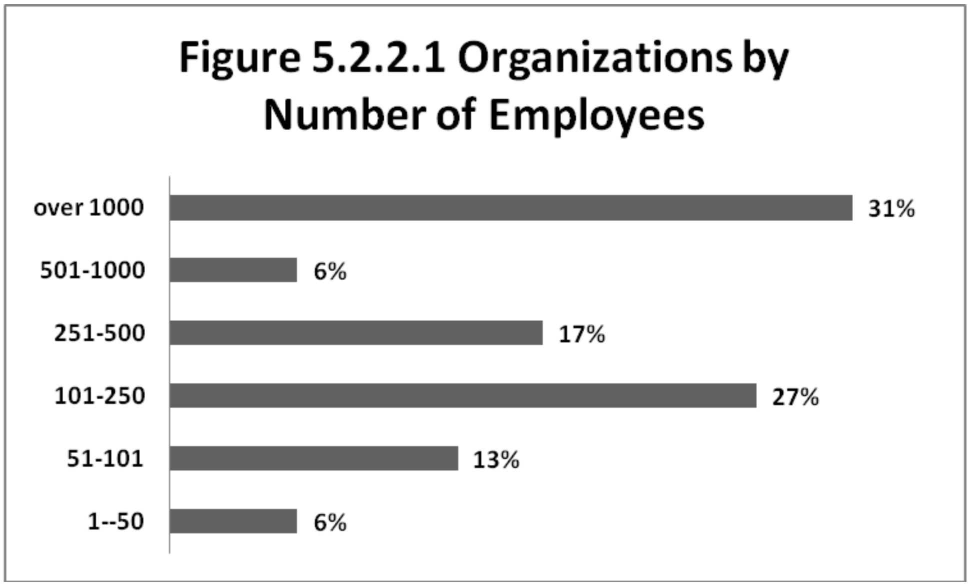

Figure 5.2.2.1 Organizations by number of employees

<u>Industry Category</u>

The majority of the organizations in the study are manufacturing organizations. Eighty-four percent (84%) of the organizations are considered manufacturing organizations, while 12% of the respondents belong to the "other" category such as retail, distribution, logistics, design, manufacturing, and overhaul/repair. Three percent (3%) of the respondents fall under the service category, and finally 1% of the organizations are considered as process industries. Figure 5.2.2.2 displays the organizations by industry category.

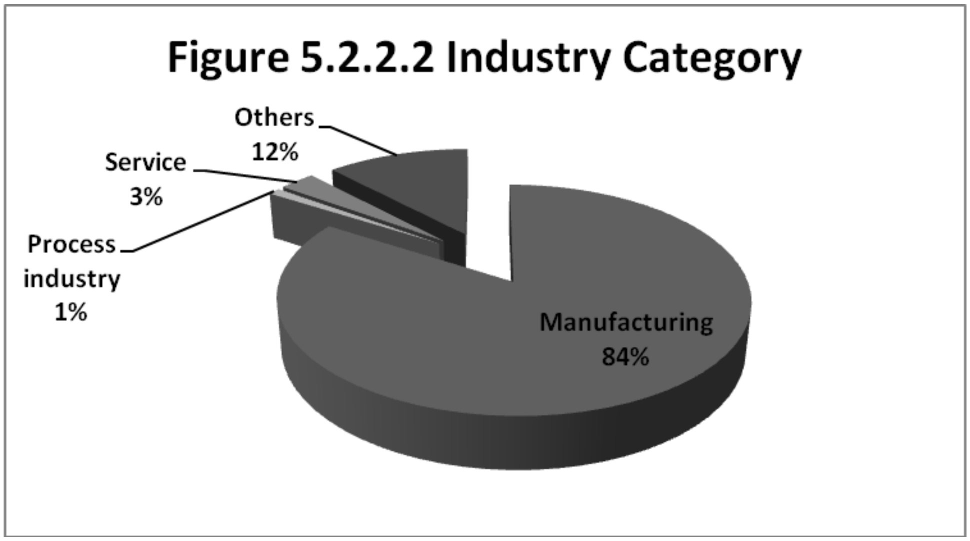

Figure 5.2.2.2 Industry category

<u>Number of Years in Business</u>

Ninety percent (90%) of the organizations have been in business for more than 10 years; 6% have been in business between 6 and 10 years; 4% have been in business between 2 and 5 years, and none of the organizations have been in business for less than 2 years. Figure 5.2.2.3 displays the organizations by years in business. This clearly shows that most of the organizations have been in business for more than 10 years.

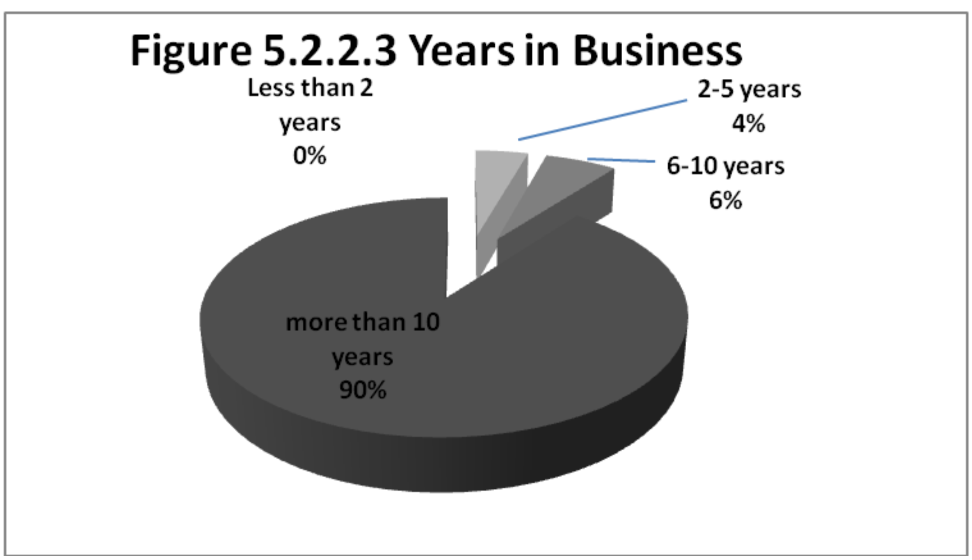

Figure 5.2.2.3 Years in business

Annual Sale

Most of the organizations have annual sales of more than one million in USD. Looking at Figure 5.2.2.4, only 1% of the organizations have annual sales of less than one million USD; 20% of the organizations have annual sales of more than $1 billion; 20% had between $25-50 million; 9% and 11% of the respondents have sales volume between $500-1000 million and between $250-500 million, respectively; 16% of the organizations have annual sales between $20-250 million, while 13% have annual sales of $10-25 million. Finally, 10% of the organizations have annual sales between $1 and $10 million.

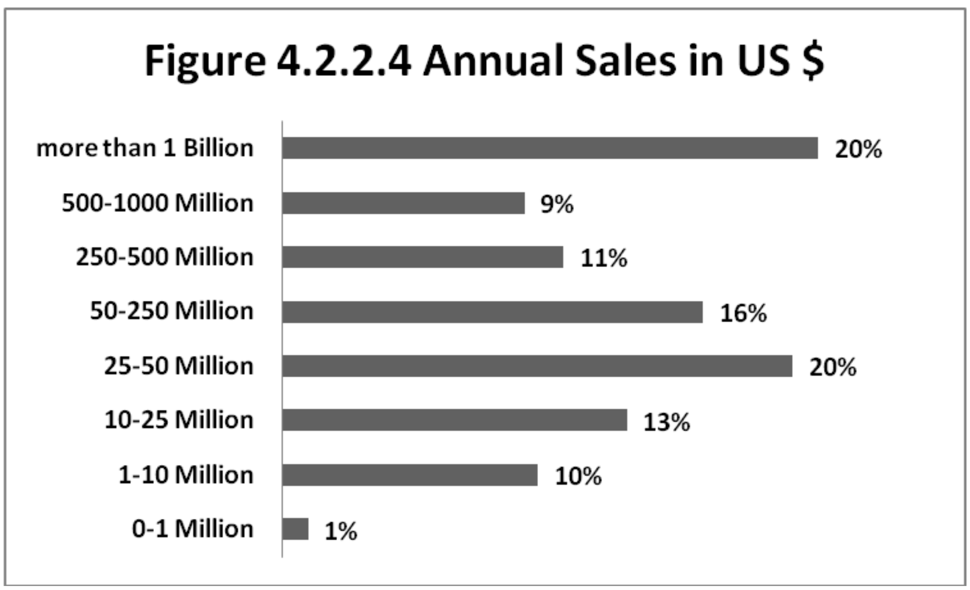

Figure 5.2.2.4 Annual sales in US dollars

Annual Information System Budget

Twenty percent (20%) of the respondents have an annual information systems budget between $1 and $5 million; 20% between $500 thousand and $1 million; 47% of the organizations have annual information systems budget between $0 and $500 thousand:, while 5% have a budget between $5 and $10 million; finally, 8% of the respondents have an annual information systems budget more than $10 million. Figure 5.2.2.5 displays the organizations' annual information systems' budget in US dollars. This clearly shows that organizations in the sample use information technology in their organizations at different intensity.

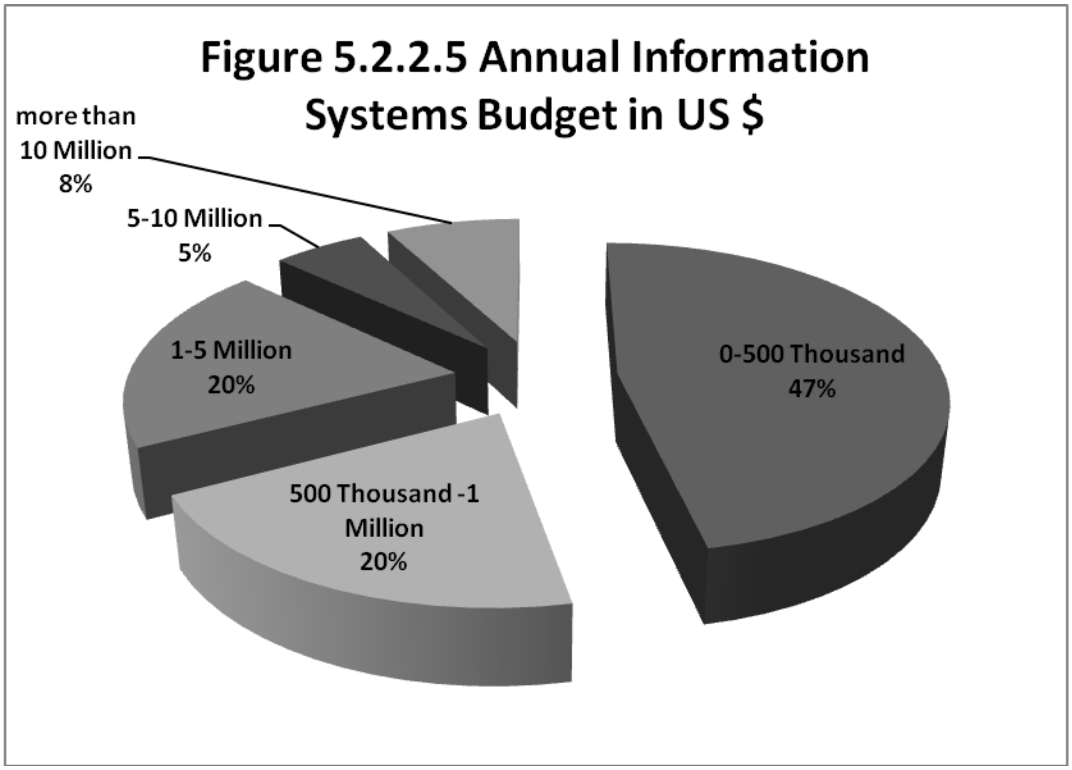

Figure 5.2.2.5 Annual information systems' budgets in US dollars

<u>Annual Information System Budgets as Percentage of Sale</u>

Almost half of the respondents (48%) have annual information systems' budgets of less than 2% as a percentage of their sales, while 24% have an annual information systems budget between 2% and 4% as a percentage of their sales. Eight percent (8%) of the organizations have annual information systems budgets between 4% and 8% as a percentage of their sales and 14% of the organizations have budgets between 8% and 10% of their sales. Three percent (3%) of the respondents have annual information systems' budgets between 8%-10% and another 3% have budgets between 10%-15% as a percentage of their sales. Finally, none of the respondents have annual information systems' budgets over 15% of their sales. Figure 5.2.2.6 displays the organization's annual information systems' budget as a percentage of sales in US dollars.

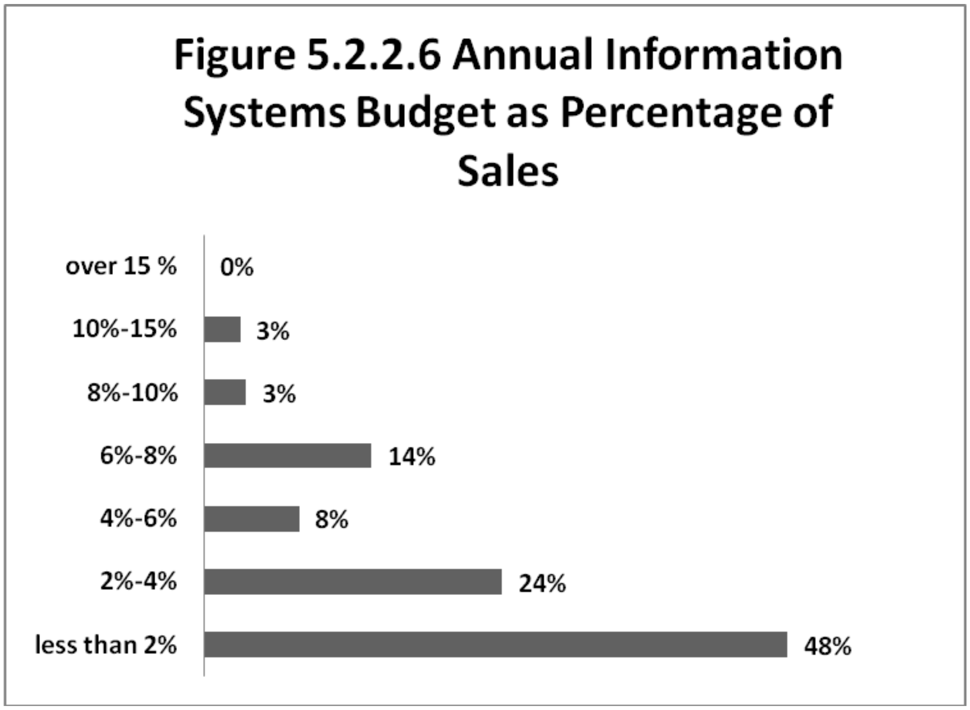

Figure 5.2.2.6 Annual information systems' budget as a percentage of sales in US dollars

Percentage of Electronic Business Transactions with Customers

Twenty percent (20%) of the organizations state that they have done less than 10% of their business transactions electronically with customers, while 24% of the organizations have done 10%-30% of their business transactions electronically with customers, and 23% of the organizations have done 30%-50% of their business transactions electronically with customers. Twenty percent (20%) of the organizations indicate that they do between 50% and 80% of these business transactions electronically.

Finally, 13% indicate that more than 80% of their business transactions with customers are done electronically. Figure 5.2.2.7 displays the percentage of electronic transactions with customers. These numbers clearly show the extent to which the sample companies use information technology when dealing with customers differs from one organization to another.

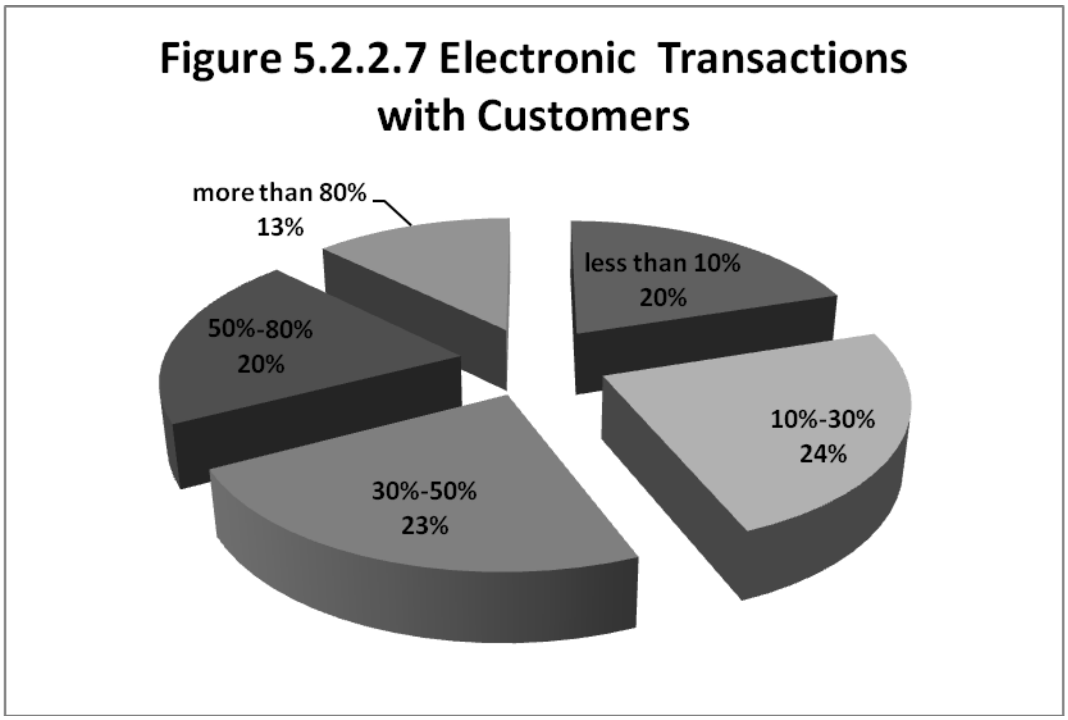

Figure 5.2.2.7 Percentage of electronic transactions with customers

<u>Percentage of Electronic Business Transactions with Suppliers</u>

Figure 5.2.2.8 shows the percentage of business transactions that organizations of done electronically with suppliers: 22% of organizations have done less than 10% of their business transactions electronically with suppliers; 25% have done between 10% and 30% ; between 30% and 50% of the organizations have done 23%; 50% to 80% have done 20% of their business transactions electronically with suppliers; and finally, 10% of the organizations indicate that more than 80% of their business transactions are done

electronically with their suppliers. Again, this also shows the extent to which organizations are using IT when doing business with suppliers.

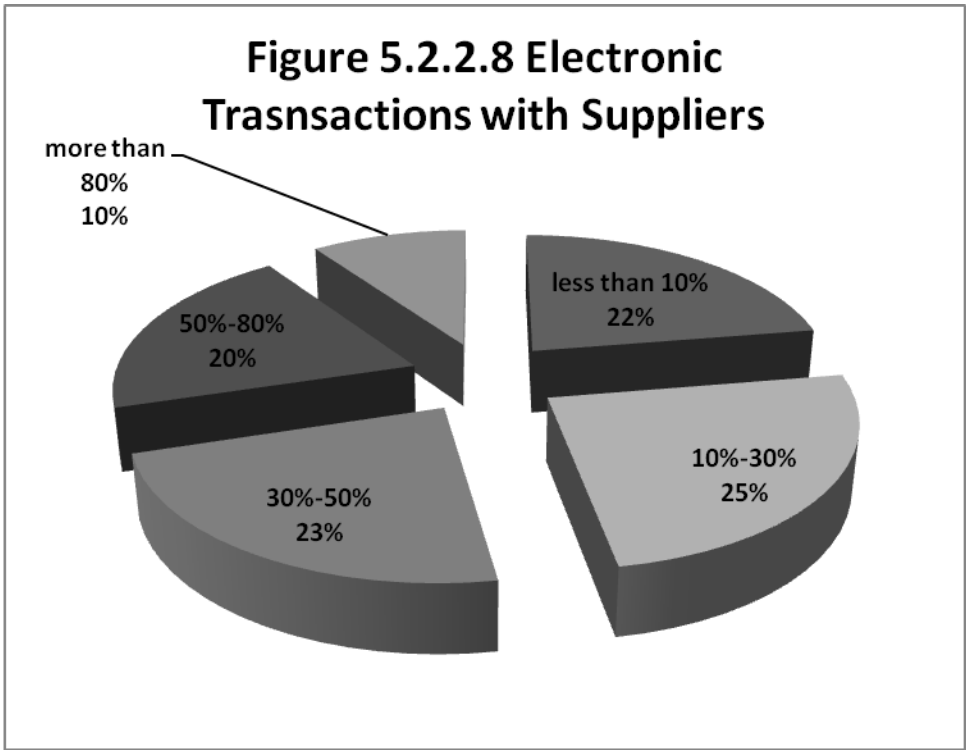

Figure 5.2.2.8 Percentage of electronic transactions with suppliers

<u>Position of an Organization in the Supply Chain</u>

The organization can position itself near the initial source of supply (raw material and component supplier), or it can be positioned near the customer (distributor, wholesaler, and retailer), or somewhere in between the near source of supply and customer (assembler, sub-assembler, and manufacturer). Most of the surveyed organizations are somewhere in between the near source of supply and customer: 83% of the organizations are positioned at the manufacturer area, whereas distributors account for 23% of respondents, and the sub-assemblers account for 15%. The assembler, component supplier, and raw material suppliers account for 22%, 21%, and 10% of respondents, respectively. Finally, retailers and wholesalers account for 11% each. (Note: one company may represent multiple data items; the calculation of the percentage is based on the total sample size of 205). Figure 5.2.2.9 displays the percentage of organizations at each position in the supply chain.

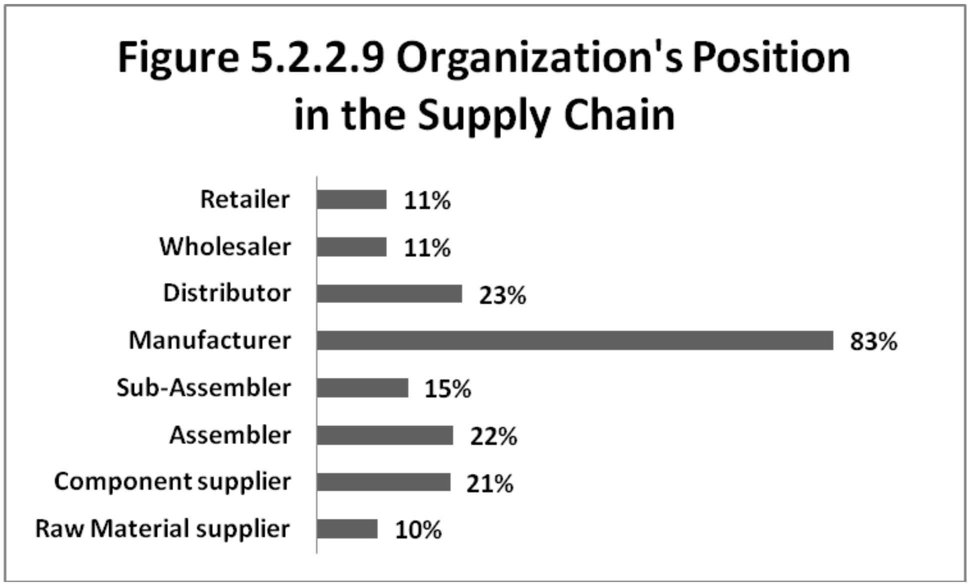

Figure 5.2.2.9 Percentage of organization's position in the supply chain

<u>Embarked-Upon Information Systems Program(s) Aimed Specifically at Implementing Supply Chain Integration</u>

More than half of the organizations surveyed (65%) embarked upon information systems (IS) programs aimed specifically at implementing supply chain integration. This clearly shows that the majority of the organizations surveyed have invested in IS to help in their supply chain integration. One of the things we are investigating in this study is how organizations acquire/develop IS in their supply chains to help in achieving supply chain integration. Sixty-five percent (65%) of the organizations surveyed state that they invest in IS to achieve supply chain integration, while 35% do not. Of the 65% of organizations stating they invest in IS to achieve supply chain integration, 56% of them have used these IS programs for this purpose for less than 5 years, and 29% of the organizations have used them between 5 to 10 years. Finally, 15% of the organizations have utilized IS programs aimed specifically for implementing supply chain integration for more than 10 years. (Note: the calculation of the percentage is based on the total sample size of 134 organizations that did actually embark upon IS programs). Figure 5.2.2.10 displays the percentage of organizations using information systems programs aimed specifically at implementing supply chain integration.

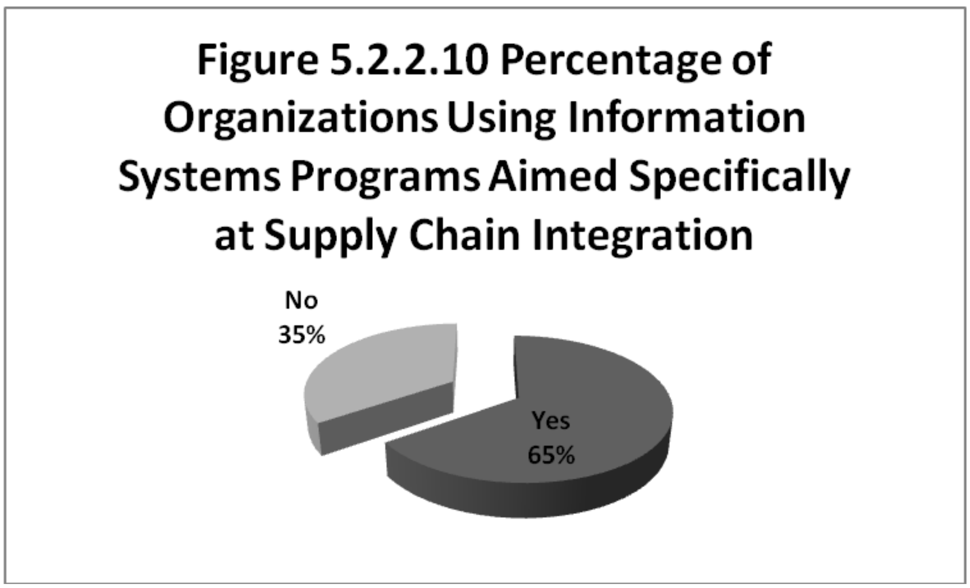

Figure 5.2.2.10 Percentage of organizations using information systems programs aimed specifically at implementing supply chain integration

<u>Technology Application Utilization</u>

Forty-eight percent (48%) of the organizations surveyed stated that the primary technology application that they use in their organizations is EDI, while 19% of the organization report that they use supply chain management software as their primary application. Fourteen percent (14%) of the respondents belong to the “other” category such as (SAP, ERP, JD Edwards, ETQ and Mapics, Custom Software, WMS, Bar Code, Open Systems, Vendor Managed Inventory, Multiple Systems, PMR (Process Monitoring Systems), and Manufacturing Execution Software). Furthermore, 14% of the organizations use extranets, and finally 5% of the organizations surveyed use DSS. Figure 5.2.2.11 displays the percentage of organizations based upon the primary technology application that they use in their firms. (Note: one company may represent multiple data items; the calculation of the percentage is based on the total sample size of 205).

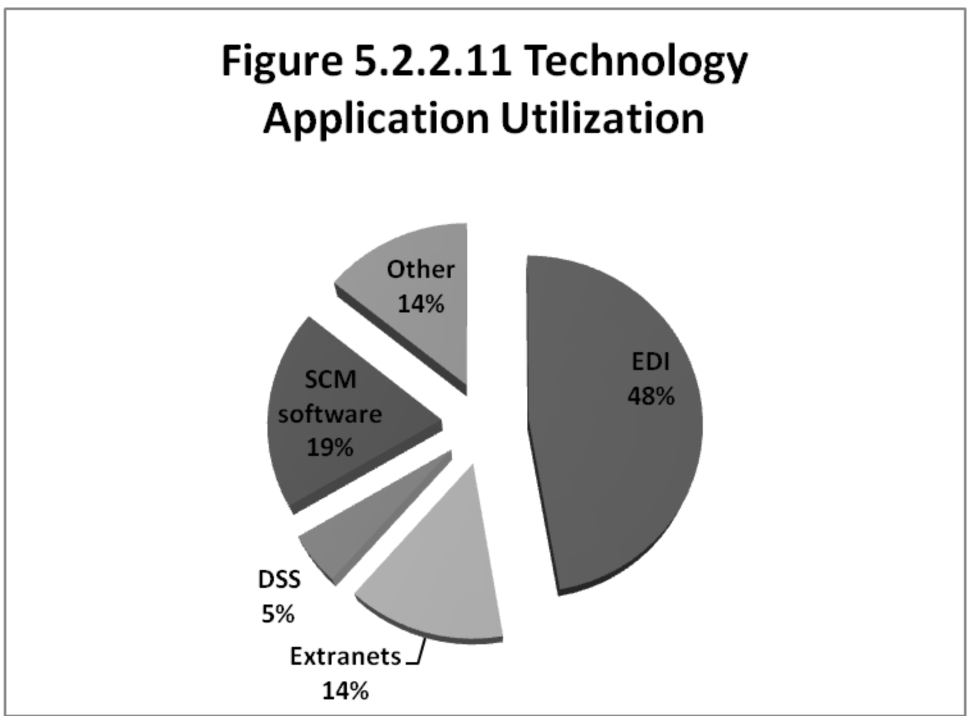

Figure 5.2.2.11 Technology application utilization

5.3 Non-Response Bias

A non-response bias was assessed using a Chi-square test which was conducted between two groups: 1) the respondents who did participate before the $20 incentive was provided, “first wave”; and 2) the respondents who participated after a $20 incentive was offered for each person who completed the survey, “second wave”. The first group has a total of 77 responses; whereas the second group has a total of 128 responses. A non-response bias analysis was conducted to check if there were any significant differences between the two groups based on employment size, annual sales, and job title. The results are shown in Table 5.3.1

Table 5.3.1 Test of non-response bias

Variables	First Wave (77)	First Wave	Second Wave (128)	Second Wave	Chi-square Test
	Observed	Expected Frequency	Observed	Expected Frequency	
	Number of Employees (205)			**Frequency (%)**	
1-50	**5 (6%)**	**4.5 (5.8%)**	**7 (5%)**	**7.5 (5.9%)**	Chi-square = 2.1113 df=5 P (value)=.8335
51-100	**10 (13%)**	**10.1 (13.1%)**	**17 (13%)**	**16.9 (13.2%)**	
101-250	**23 (30%)**	**20.6 (26.7%)**	**32 (25%)**	**34.3 (26.8%)**	
251-500	**15 (20%)**	**13.1 (17%)**	**20 (16%)**	**21.9 (17.1%)**	
501-1000	**4 (5%)**	**4.5 (5.8%)**	**8 (6%)**	**7.5 (5.9%)**	
Over 1000	**20 (26%)**	**24 (31.1%)**	**44 (34%)**	**40 (31.3%)**	
	Annual Sales in Million USD (203) *two respondent did not provide annual sales information from the second wave				
Variables	First Wave (77)	First Wave	Second Wave (126)	Second Wave	Chi-square Test
	Observed	Expected Frequency	Observed	Expected Frequency	
0-1	**1 (1%)**	**.75 (1%)**	**1 (1%)**	**1.2 (1%)**	Chi-square = 5.4005 df=7 P (value)=.6112
1-10	**10 (13%)**	**7.6 (9.8%)**	**10 (8%)**	**12.4 (9.9%)**	
10-25	**8 (10%)**	**10.2 (13.3%)**	**19 (10%)**	**16.8 (13.3%)**	
25-50	**16 (21%)**	**14.4 (18.7%)**	**22 (17%)**	**23.6 (18.7%)**	
50-250	**12 (16%)**	**12.5 (16.3%)**	**21 (16%)**	**20.5 (16.2%)**	
250-500	**11 (14%)**	**8.3 (10.8%)**	**11 (9%)**	**13.7 (10.8%)**	
500-1000	**7 (9%)**	**7.2 (9.4%)**	**12 (10%)**	**11.8 (9.4%)**	

over 1 Billion	**12 (16%)**	**15.9 (20.7%)**	**30 (24%)**	**26 (20.7%)**	
	Job Title (205)				
Variables	First Wave (77)	First wave	Second Wave (126)	Second Wave	Chi-square Test
	Observed	Expected Frequency	Observed	Expected Frequency	
CEO/president	**2 (3%)**	**1.1 (1.4%)**	**1 (1%)**	**1.9 (1.4%)**	Chi-square = 2.9712 df=3 P (value)=.3960
Director	**14 (18%)**	**10.9 (14.1%)**	**15 (12%)**	**18.1 (14.1%)**	
Manager	**39 (51%)**	**42.4 (55.1%)**	**74 (58%)**	**17.6 (55.1%)**	
Other	**22 (28%)**	**22.3 (29.3%)**	**38 (29%)**	**37.5 (29.3%)**	

Based on the results of the Chi-square test provided in Table 5.3.1, we can clearly see that there are no significant differences between the two groups, which suggest that non-response bias is not a concern for this study.

5.4 Large-Scale Instrument Assessment Methodology

The next step is to test for instrument validation. The validation of the instruments was tested with the following objectives: 1) purification of the items; (2) unidimensionality; 3) convergent validity; and 4) discriminant validity. The methods used in analyzing those objectives were: corrected item total correlation (CITC) for purification; exploratory factor analysis for unidimensionality; Cronbach's alpha for reliability; and finally, correlation analysis for convergent and discriminant validity. To validate the instruments means that the degree to which the sets of instruments correctly represent the concept of the study and consequently permit an appropriate interpretation of the results (Hair, Anderson et al., 1995; Gay and Airasian, 2003). Validity needs to be assessed in different levels: content, construct, and criterion-related. Construct validity refers to the degree to which measures of the same construct correlate more highly with each other than they do with measures of other constructs (Cook and Campbell, 1997; Schoenfeldt, 1984). This usually takes the form of convergent and discriminant validity which is explained later in the section. Criterion-related validity deals with finding the presence or absence of one or more criteria considered to represent a construct. This type of validity is assessed through concurrent and predictive validity.

Churchill (1979) suggests that there is a need to purify the items before administrating factor analysis. This will be carried out by eliminating the items if their CITC score is below a threshold value of 0.5. However, an item with a CITC score below the threshold value can be kept if theoretical support and arguments to keep that item can be provided. On the other hand, an item with a CITC score above the threshold value may also be removed from the analysis if the deletion of that item dramatically improves the overall reliability of the specific dimension. The reliability is about the internal consistency of a latent variable. The reliability is determined by examining Cronbach's alpha. Nunnally (1979) suggests that an alpha score of 0.7 or higher indicates a good reliable scale.

The next step after purifying the items is to examine the factor structure through exploratory factor analysis (EFA) to assess convergent validity at the dimension level and discriminant validity at the construct level. The convergent validity is the evidence that the observed items gathered at different levels converge into observed latent variables, whereas the discriminant validity refers to the uniqueness and independence of two different latent variables that are measured by two groups of observed variables (Campbell, 1960). Assessing both (discriminant and convergent validity) will result in measuring the **construct validity**. The **content validity** was explained and assessed in chapter 3 and 4.

The most popular rotation methods used in factor analysis are principal component analysis method and VARIMAX rotation extraction method (Kaiser, 1958). Factor loading with a score greater than 0.5 are considered significant (Hair, Anderson et al., 1995); the score of 0.5 is used as a cut-off score for the items. Any items that are not loading in a particular dimension or having a significant cross loading with other dimensions will be dropped from any further analysis. Thus, items with good measurement properties should exhibit high factor loadings on the intended factor and small factor loadings in other factors (Segars and Grover, 1993).

During the EFA stage, a Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was calculated. Sampling adequacy assures that an effective sample size is found so it can be assessed at the factor analysis stage. The KMO measure indicates that the effective sample size is adequate for the factor analysis. Generally, KMO scores below 0.5 are unacceptable, in the 0.60's are tolerable, in the 0.70's are average, in the 0.80's are very good, and in the 0.90's are outstanding.

5.5 Large-Scale Measurement Results

This section will present the results of the large-scale instrument validation of the six constructs following the steps mentioned in the previous section (section **5.4 large-scale instrument assessment methodology**). The 6 constructs are: SCM Strategy, Information Systems Strategy, SCM practices, IT utilization, SCM Performance, and Firm Performance.

5.5.1 SCM Strategy (SCMS)

<u>Purification of the items (Reliability)</u>

A SCMS construct was initially represented by three dimensions and 17 items, and they are as follows: (1) Lean Supply Chain (LSC) (6 items), (2) Agile Supply Chain (ASC) (6 items), and (3) Hybrid Supply Chain (HSC) (5 items). The original items with the code for each item and the CITC results of SCMS are shown in Table 5.5.1.1

The analysis began with purification using CITC analysis. CITC analysis was done to the three dimensions. All the items in the three dimensions had a score higher than 0.5 except for the item (SCMS_ASC1) which had a score of 0.49. Even though the score was slightly below the threshold, it was decided to keep the item because removing this item did not improve the reliability (Cronbach's alpha score of 0.81) for ASC dimension. Also, removing this item has caused item (SCMS_ASC4) to have a score of 0.33 which means that I need to delete both items (SCMS_ASC1, and SCMS_ASC4). Deleting these two items did not improve the overall reliability, so it was decided to keep item (SCMS_ASC1). The reliability of the three dimensions (LSC, ASC, and HSC) are (0.82, 0.81, and 0.93) respectively.

Table 5.5.1.1 Supply chain management strategy- initial large scale survey items, CITC results, and overall alpha score

Item Code	Survey Item	CITC-1	Alpha
Lean Supply Chain (LSC)			
SCMS_LSC1	Our suppliers deliver what we need	**.51**	**.82**
SCMS_LSC2	Our suppliers deliver when we need	**.54**	
SCMS_LSC3	Our suppliers deliver where we need	**.53**	
SCMS_LSC4	Our suppliers adopt quality practices as per our requirements	**.65**	
SCMS_LSC5	Our suppliers manage quality as per our requirements	**.69**	
SCMS_LSC6	Our suppliers inspect products frequently	**.57**	
Agile Supply Chain (ASC)			
SCMS_ASC1	Our suppliers respond quickly to our changing requirements of cost	**.49**	**.81**
SCMS_ASC2	Our suppliers respond quickly to our changing requirements of delivery time	**.57**	
SCMS_ASC3	Our suppliers respond quickly to our changing requirements of design	**.59**	
SCMS_ASC4	Our suppliers respond effectively to our changing requirements of cost	**.52**	
SCMS_ASC5	Our suppliers respond effectively to our changing requirements of delivery time	**.62**	
SCMS_ASC6	Our suppliers respond effectively to our changing requirements of design	**.65**	
	Hybrid Supply Chain (HSC)		
SCMS_HSC1	Our suppliers customize our products by adding feature models as per our requirements	**.85**	**.93**
SCMS_HSC2	Our suppliers produce modular products	**.83**	
SCMS_HSC3	Our suppliers respond to customization requirements quickly	**.84**	
SCMS_HSC4	Our suppliers delay the product final assembly until customers make an order	**.75**	
SCMS_HSC5	Our suppliers change the design of the product	**.76**	

Factor Analysis

Exploratory factor analysis (EFA) was conducted using principal components as means of extraction and VARIMAX as the method of rotation. EFA was conducted to check the discriminant and convergent validity.

Dimension Level Factor Analysis:

To ensure the convergent validity for each of the three dimensions in the Supply Chain Management Strategy (SCMS) construct, a factor analysis was conducted for each of the three dimensions (LSC, ASC, and HSC). For the dimension LSC, the items did converge into one single factor. Looking carefully at the questions with regards to LSC, the first three questions (Our suppliers deliver what we need, our suppliers deliver when we need, and our suppliers deliver where we need) clearly deals with the delivery aspect of the LSC or the transportation/logistics issue in the LSC. On the other hand, the second set of questions (Our suppliers adopt quality practices as per our requirements, our suppliers manage quality as per our requirements, and our suppliers inspect products frequently) clearly deals with the quality issue in LSC. The initial factor results are shown in Table 5.5.1.2.

Table 5.5.1.2 Dimension –level factor analysis for LSC

	Component
	1
SCMS_LSC5	.892
SCMS_LSC6	.859
SCMS_LSC4	.806
SCMS_LSC3	.895
SCMS_LSC2	.810
SCMS_LSC1	.746

As indicated by Table 5.5.1.2, all factor loadings are greater than 0.76. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy for LSC dimension was 0.74.

For the dimension ASC, the items did not emerge into one single factor. The item codes (SCMS_ASC1 and SCMS_ASC4) created a second factor as shown in Table 5.5.1.3.

Table 5.5.1.3 Dimension–level factor analysis for ASC

	Component	
	1	2
SCMS_ASC3	.840	
SCMS_ASC6	.834	
SCMS_ASC2	.708	
SCMS_ASC5	.707	
SCMS_ASC1		.900
SCMS_ASC4		.886

Looking carefully at those two questions, they clearly deal with the cost issue in the supply chain strategy which was captured in the LSC (the first dimension). The two questions are: (Our suppliers respond quickly to our changing requirements of cost for the code SCMS_ASC1, and our suppliers respond effectively to our changing requirements of cost for the code SCMS_ASC4). Therefore, it was decided to drop these two items from any further analysis. Hence, they are the same items that had a low CITC scores in the purification section. After dropping those two items, another factor analysis was conducted to the remaining 4 factors. The factor results are shown in Table 5.5.1.4 which indicates that a single factor solution emerged for this dimension with all factor loadings greater than 0.77. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy for ASC dimension was 0.56.

Table 5.5.1.4 Dimension –level factor analysis for ASC results (2)

	Component
	1
SCMS_ASC6	.806
SCMS_ASC3	.800
SCMS_ASC5	.786
SCMS_ASC2	.778

Finally, for the dimension HSC, a single factor solution emerged for this dimension with all factor loadings greater than 0.82. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.88. The results are shown in Table 5.5.1.5

Table 5.5.1.5 Dimension–level factor analysis for HSC

	Component
	1
SCMS_HSC3	.908
SCMS_HSC1	.905
SCMS_HSC2	.890
SCMS_HSC5	.840
SCMS_HSC4	.828

Construct Level Exploratory Factor Analysis

The remaining 15 items of the Supply Chain Management Strategy construct were submitted to a construct level exploratory factor analysis to check for discriminant validity. A clear three factors emerged from this analysis. However, two items cross loaded into two dimensions; the items code (SCMS_ASC2, and SCMS_ASC5) loaded into the first dimension which is LSC, and the second dimension which is ASC (where it was initially supposed to load). After carefully reviewing the questions for item codes SCMS_ASC2 and SCMS_ASC5 (Our suppliers respond quickly to our changing requirements of delivery time, and our suppliers respond effectively to our changing requirements of delivery time), these two questions deal with the delivery issue of the supply chain strategy which was captured in the first dimension LSC. Therefore it was decided to delete the two items (SCMS_ASC2, and SCMS_ASC5) from any further analysis. The results are shown in Table 5.5.1.6.

Table 5.5.1.6 Supply chain management strategy-construct level factor analysis results

	Component		
	1	2	3
SCMS_HSC3	.895		
SCMS_HSC2	.895		
SCMS_HSC1	.887		
SCMS_HSC5	.843		
SCMS_HSC4	.825		
SCMS_LSC3		.812	
SCMS_LSC2		.794	
SCMS_LSC1		.714	
SCMS_LSC5		.857	
SCMS_LSC6		.838	
SCMS_LSC4		.751	
SCMS_ASC3			.852
SCMS_ASC6			.790
SCMS_ASC2		.478	.614
SCMS_ASC5		.546	.566

After eliminating the two items, a second level exploratory factor analysis for the remaining 13 items was conducted. Most of the factor loadings were above 0.73 as seen in Table 5.5.1.7.The sample adequacy was very good at 0.78 and the three factors accounted for almost 77% of the total variance.

Table 5.5.1.7 Supply chain management strategy - construct level factor analysis results (2)

	Component		
	1	2	3
SCMS_HSC3	.898		
SCMS_HSC2	.897		
SCMS_HSC1	.888		
SCMS_HSC5	.842		
SCMS_HSC4	.827		
SCMS_LSC5		.870	
SCMS_LSC6		.868	
SCMS_LSC4		.738	
SCMS_LSC3		.871	
SCMS_LSC2		.789	
SCMS_LSC1		.758	
SCMS_ASC3			.910
SCMS_ASC6			.864
Eigen Value	4.169	4.408	1.478
% Variance Explained	32.069	33.899	11.37
Cumulative % of Variance	32.069	56.912	77.346
Kaiser Mayer Orkin (KMO) Measure of sampling adequacy = 0.78			
Cronbach Alpha (α) = 0.82			

5.5.2 Information Systems Strategy (ISS)

Purification of the items (Reliability)

ISS was initially represented by three dimensions and 17 items, and they are as follows: (1) Information Systems for Efficiency (ISE) (5 items), (2) Information System for Flexibility (ISF) (5 items), and finally (3) Information Systems for Comprehensiveness (ISC) (4 items). The CITC results of ISS are shown in Table 5.5.2.1. The results show that all scores for all the CITC items are higher than 0.5. Therefore, there is no need to delete any of the items for the three dimensions. Moreover, the Cronbach's alpha for the ISE, ISF, and ISC are 0.89, 0.88, and 0.94, respectively. The Cronbach's alpha results indicate a very high reliability (internal Cronbach's alpha consistency) of the items.

Table 5.5.2.1 Information systems strategy- initial large scale survey items, CITC results, and overall alpha score

Item Code	Survey Item		CITC-1	Alpha
	Information Systems for Efficiency (ISE)			
ISS_ISE1	The Information Systems (IS) applications we acquire/develop help us to:	Improve the efficiency of operation between our suppliers and us	**.73**	**.89**
ISS_ ISE 2		Manage inventory between our suppliers and us	**.74**	
ISS_ ISE 3		Manage material requirements planning of our facility	**.66**	
ISS_ ISE 4		Manage production control between our suppliers and us	**.76**	
ISS_ ISE 5		Coordinate (production and information) efficiently across suppliers and product lines	**.76**	
	Information Systems for Flexibility (ISF)			
ISS_ ISF1	The Information Systems (IS)	Introduce new product(s) and/or service(s) in our market(s)	**.78**	

ISS _ ISF2	applications we acquire/develop help us to:	Quickly share information within our firm	**.64**	**.88**
ISS _ ISF3		Monitor changes in our market condition	**.68**	
ISS _ ISF4		Respond to changes in the market	**.80**	
ISS _ ISF5		Change the design of our product(s)	**.65**	
	Information Systems for Comprehensiveness (ISC)			
ISS _ISC1	The Information Systems (IS) applications we acquire/develop help us to:	Provide sufficient information to support careful decision making	**.84**	**.94**
ISS _ ISC 2		Provide detailed analysis of major decisions	**.86**	
ISS _ISC3		Provide support for decision making	**.86**	
ISS _ISC4		Adopt a well analyzed view when making major decisions	**.86**	

<u>Dimension Level Factor Analysis:</u>

To assess convergent validity, a dimension–level factor analysis was conducted for each of the three dimensions: Information Systems for Efficiency (ISE), Information Systems for Flexibility (ISF), and Information Systems for Comprehensiveness (ISC) in the Information Systems Strategy (ISS) construct. The five items for ISE were submitted to a factor analysis. A single factor solution emerged with factor loadings above 0.78. Sampling adequacy (KMO) is very good at 0.85. For ISF the five items were submitted to a factor analysis. All items had factor loadings above 0.77 with a single factor solution emerging from this analysis. The sampling adequacy (KMO) is very good at 0.80. Finally, the four items for ISC provided a clear one-factor solution with loadings above 0.91, and sampling adequacy (KMO) of 0.87. The results of the dimension level factor analysis are presented in Table 5.5.2.2.

Table 5.5.2.2 Dimension –level factor analysis for ISE, ISF, and ISC

	Component
	1
ISS_ISE5	.851
ISS_ISE4	.849
ISS_ISE1	.838
ISS_ISE2	.837
ISS_ISE3	.782
	Component
	1
ISS_ISF4	.885
ISS_ISF1	.862
ISS_ISF3	.795
ISS_ISF2	.773
ISS_ISF5	.770
	Component
	1
ISS_ISC2	.928
ISS_ISC4	.925
ISS_ISC3	.921
ISS_ISC1	.909

Construct Level Exploratory Factor Analysis:

To further ensure the discriminant validity of Information Systems Strategy (ISS) dimensions, all 14 items of the ISS construct were submitted to a construct level exploratory factor analysis. Three factors emerged from this analysis as seen in Table 5.5.2.3. However, item code ISS_ISF2 cross loaded into the second dimension (ISF) and the third dimension (ISC). Therefore, it was decided to drop this item from any further analysis.

Table 5.5.2.3 Information systems strategy- construct level factor analysis results

	Component		
	1	2	3
ISS_ISC2	.833		
ISS_ISC3	.808		
ISS_ISC4	.802		
ISS_ISC1	.757		
ISS_ISE3		.747	
ISS_ISE1		.730	
ISS_ISE2		.718	
ISS_ISE4		.717	
ISS_ISE5		.612	
ISS_ISF2		.524	.489
ISS_ISF1			.828
ISS_ISF4			.774
ISS_ISF5			.762
ISS_ISF3			.745

A second exploratory factor analysis was conducted to the remaining 13 items. The results are shown in Table 5.5.2.4 which indicates a clear three-factor solution emerged with all factor loadings greater than 0.61 and no cross loadings, indicating no further revision required for the items. The KMO measure (0.89) indicates an excellent sampling adequacy, the three factors accounted for almost 76% of the total variance, and the overall Cronbach alpha score is 0.82.

Table 5.5.2.4 Information systems strategy--construct level factor analysis results (2)

	Component		
	1	2	3
ISS_ISC2	.838		
ISS_ISC3	.814		
ISS_ISC4	.806		
ISS_ISC1	.764		
ISS_ISE3		.749	
ISS_ISE1		.731	
ISS_ISE4		.722	
ISS_ISE2		.721	
ISS_ISE5		.619	
ISS_ISF1			.824
ISS_ISF4			.778
ISS_ISF5			.758
ISS_ISF3			.754
Eigen Value	7.338	1.539	.969
% Variance Explained	56.449	11.837	7.457
Cumulative % of Variance	56.449	68.628	75.743
Kaiser Mayer Orkin (KMO) Measure of sampling adequacy = 0.89			
Cronbach Alpha (α) = 0.82			

5.5.3 Supply Chain Management (SCM) Practices

Purification of the items (Reliability)

SCM practices were initially represented by six dimensions and 24 items, and they are as follows: (1) Strategic Supplier Partnership (SSP) (4 items), (2) Customer Relationship (CR) (4 items), (3) Internal Lean Practices (LSP) (4 items), (4) Postponement (POS) (4 items), (5) Information Sharing (IS) (3 items), and finally (6) Information Quality (IQ) (5 items). The analysis began with purification using CITC analysis. The CITC scores for each item and its corresponding code name are shown in Table 5.5.3.1

The CITC scores show that all scores for all the CITC items are higher than 0.5 except for the following items (SC_ SSP3 and SC_ SSP4 for the SSP dimension), and (SC_POS3 for the POS dimension). After carefully examining the item SC_ SSP3, (Include our key suppliers in our planning and goal-setting activities), it can be concluded that this item can be constructed as part of SC_ SSP2 (Solve problems jointly with our suppliers). Therefore, it was decided to drop this item from any further analysis. After dropping this item, a second CITC analysis was conducted. The results did slightly improve the CITC score for item SC_SSP4 to 0.50. Therefore, it was decided not to remove this item. Moreover, the Cronbach's alpha for SSP is 0.74 which is above the threshold value of 0.7 which indicates a good reliable scale.

The CITC scores for all items in (SC_CR, SC_LSP, SC_POS, SC_IS, and SC_IQ) are all well above 0.50 with a Cronbach's alpha value of (0.85, 0.84, 0.78, 0.85, and 0.96) respectively.

<u>Dimension Level Factor Analysis:</u>

Dimension level factor analysis was performed to each of the dimensions of the Supply Chain Management Practices construct. For the Strategic Supplier Partnership (SSP), the remaining three items were submitted to a factor analysis and a single-factor solution emerged with factor loadings above 0.74. Sampling adequacy (KMO) is acceptable at 0.67. The four items of Customer Relationship (CR) were submitted to a dimension level factor analysis and a clear one-factor solution emerged. All items had factor loadings above 0.77 and sampling adequacy (KMO) is very good at 0.81.

The four items that comprised the Lean System Practices (LSP) provided a clear one- factor solution with all factor loading greater than 0.77 and the KMO score was 0.78, indicating a good sampling adequacy. For postponement (POS), the four items provided one single factor with all loadings greater than 0.68 and the KMO score was 0.72. Also, one clear factor has emerged from the three items for the Information Sharing (IS) dimension with all factors loading above 0.78 and KMO score of 0.65. Finally, the five items of Information Quality (IQ) were submitted to a dimension level factor analysis and a clear one-factor solution emerged. All items had factor loadings above 0.91 and sampling adequacy (KMO) is excellent at 0.90. The results are summarized in Table 5.5.3.2. This analysis has been done to assess convergent validity at the dimension level for all SCM practices dimensions.

Table 5.5.3.1 Supply chain management practices- initial large scale survey items, CITC results, and overall alpha score

Item Code	Survey Item	CITC-1	CITC-2	Alpha
Strategic Supplier Partnership (SSP)				
SC_ SSP1	Select suppliers based on their quality	**.60**	**.60**	.74
SC_ SSP2	Solve problems jointly with our suppliers	**.65**	**.62**	
SC_ SSP3	Include our key suppliers in our planning and goal-setting activities	**.47**		
SC_ SSP4	Help our suppliers to improve their product quality	**.49**	**.50**	
Customer Relationship (CR)				
SC_CR1	Interact with customers to set reliability, responsiveness, and other standards for us	**.63**		**.85**
SC_CR2	Measure and evaluate customer	**.67**		

	satisfaction			
SC_CR3	Determine future customer expectations	**.73**		
SC _CR4	Facilitate customers' ability to seek assistance from us	**.75**		
	Lean System Practices (LSP)			
SC_LSP1	Reduce manufacturing set-up time	**.59**		**.84**
SC_LSP2	Build and maintain continuous quality improvement program(s)	**.77**		
SC_LSP3	Streamline ordering, receiving and other paperwork from suppliers	**.62**		
SC_LSP4	Push suppliers for shorter lead-times	**.71**		
	Postponement (POS)			
SC_POS1	Delay final product assembly activities until customer orders have actually been received	**.65**		**.78**
SC_POS2	Delay final product assembly activities until the last possible position (or nearest to customers) in the supply chain	**.71**		
SC_POS3	Store our parts/products at distribution points closer to the customer	**.50**		
SC_POS4	Design products for modular assembly	**.51**		
	Information Sharing (IS)			
SC_IS1	Inform our trading partners in advance of our changing needs	**.60**		**.85**
SC_IS2	Mutually share business knowledge of core business processes with our trading partners	**.83**		
SC_IS3	Mutually share proprietary information with our trading partners	**.74**		
	Information Quality (IQ)			
SC_IQ1	Exchange information with our trading partners in a: timely manner	**.87**		**.96**
SC_IQ2	accurate manner	**.92**		
SC_IQ3	complete manner	**.90**		
SC_IQ4	adequate manner	**.91**		
SC_IQ5	reliable manner	**.87**		

<u>Construct Level Exploratory Factor Analysis</u>:

To assess the discriminant validity, all 23 items of the SCM practices construct were submitted to a construct level exploratory factor analysis. Six factors emerged from this analysis as seen in Table 5.5.3.3. However, the item SC_IS1 did cross load into dimension 5 (IS) where it was initially supposed to load, but it unexpectedly also loaded into dimension 6 (IQ). Therefore, it was decided to drop this item from any further analysis. A second construct level exploratory factor analysis was conducted for the 22 remaining items. The results are shown in Table 5.5.3.4 which indicates a clear six factors emerging from this analysis. Most of the factor loadings were above 0.63 with no cross loadings. The KMO measure (0.76) indicates a good sampling adequacy, the variance accounted slightly over 75% and the overall Cronbach alpha score is 0.84.

Table 5.5.3.2 Dimension–level factor analysis for SSP, CR, LSP, POS, IS, and IQ

	Component 1 (SSP)
SC_SSP2	.851
SC_SSP1	.849
SC_SSP4	.745
	Component 1 (CR)
SC_CR4	.866
SC_CR3	.861
SC_CR2	.812
SC_CR1	.771
	Component 1 (LSP)
SC_LSP2	.887
SC_LSP4	.851
SC_LSP3	.794
SC_LSP1	.775
	Component 1 (POS)
SC_POS2	.868
SC_POS1	.836

SC_POS4	.712
SC_POS3	.684
	Component 1 (IS)
SC_IS2	.930
SC_IS3	.887
SC_IS1	.787
	Component 1 (IQ)
SC_IQ2	.951
SC_IQ4	.941
SC_IQ3	.940
SC_IQ1	.924
SC_IQ5	.911

Table 5.5.3.3 Supply chain management practices- construct level factor analysis results

	Component					
	1	2	3	4	5	6
SC_IQ2	.935					
SC_IQ3	.925					
SC_IQ4	.921					
SC_IQ1	.893					
SC_IQ5	.874					
SC_LSP2		.885				
SC_LSP4		.804				
SC_LSP1		.751				
SC_LSP3		.738				
SC_CR4			.866			
SC_CR3			.832			
SC_CR2			.805			
SC_CR1			.702			

SC_POS2				.877		
SC_POS1				.845		
SC_POS4				.689		
SC_POS3				.634		
SC_IS2					.876	
SC_IS3					.859	
SC_IS1	.529				.575	
SC_SSP2						.780
SC_SSP1						.777
SC_SSP4						.642

Table 5.5.3.4 Supply chain management practices- construct level factor analysis results (2)

	Component					
	1	2	3	4	5	6
SC_IQ2	.937					
SC_IQ3	.928					
SC_IQ4	.923					
SC_IQ1	.897					
SC_IQ5	.879					
SC_LSP2		.885				
SC_LSP4		.805				
SC_LSP1		.751				
SC_LSP3		.740				
SC_CR4			.865			
SC_CR3			.832			
SC_CR2			.805			
SC_CR1			.703			
SC_POS2				.873		
SC_POS1				.846		
SC_POS4				.688		

SC_POS3				.635		
SC_SSP2					.789	
SC_SSP1					.785	
SC_SSP4					.633	
SC_IS3						.879
SC_IS2						.872
Eigen Value	5.979	3.406	2.716	1.920	1.314	1.233
% Variance Explained	27.179	15.480	12.344	8.727	5.973	5.606
Cumulative % of Variance	27.179	42.658	55.002	63.729	69.702	75.308
Kaiser Mayer Orkin (KMO) Measure of sampling adequacy = 0.76						
Cronbach Alpha (α) = 0.84						

5.5.4 Information Technology Utilization

Purification of the items (Reliability)

Information Technology Utilization (ITU) was initially represented by three dimensions and 15 items, and they are as follows: (1) External Focus on IT (EIT) (5 items), (2) Internal Focus on IT (IIT) (5 items), and finally (3) Infrastructural Focus on IT (INFRA) (5 items) as well. The CITC scores indicated in Table 5.5.4.1 show that all scores for all the CITC items are higher than 0.5 except for the following items (ITU_ IIT1, and ITU_ IIT2) for the IIT dimension. The CITC score for ITU_ IIT1 was very low at 0.39. On the other hand, The CITC score for ITU_ IIT2 was .49 which is very close to 0.50. After carefully reviewing the item (ITU_ IIT1), (We improve processes inside our firm by using IT to reduce manufacturing set-up time), it was decided to delete this items for a low CITC score. After deleting this item, another reliability test was conducted for the remaining four items. The results in Table 5.5.4.1 show that the CITC score for and ITU_ IIT2 went down dramatically to 0.40 while the CITC score for the other three items had minor changes in its scores. The Cronbach's alpha for (IIT) dimension did not change from test 1 to test 2. Therefore, it was decided to delete item ITU_ IIT2 from any further analysis. A third reliability test was conducted to the remaining three items. The result in Table 5.5.4.1 indicates that all CITC scores are above .05 with a Cronbach's alpha of 0.74. Finally, the CITC scores for the five items of the (INFRA) dimension are well above .05 with a Cronbach's alpha of 0.96 which indicates an excellent reliable scale.

Table 5.5.4.1 Information technology utilization - initial large scale survey items, CITC results, and overall alpha score

Item Code	Survey Item		CITC-1	CITC-2	CITC-3	Alpha
External Focus on IT (EIT)						
ITU _EIT1	We interact with our partners by using IT to:	Solve problems jointly with our suppliers	**.78**			**.89**
ITU _ EIT2		Help our suppliers to improve their product quality	**.66**			
ITU _ EIT3		Include our key suppliers in our planning and goal-setting activities	**.73**			
ITU _ EIT4		Measure and evaluate customer satisfaction	**.74**			
ITU _ EIT5		Facilitate customer service activities	**.76**			
Internal Focus on IT (IIT)						
ITU _ IIT1	We improve processes	Reduce manufacturing set-up time	**.39**			
ITU _ IIT2		Forecast demand	**.49**	**.40**		**.74**

ITU _ IIT3	inside our firm by using IT to	Design products for modular assembly	**.54**	**.56**	**.59**	
ITU _ IIT4		Delay final product assembly activities until customer orders have actually been received	**.60**	**.57**	**.55**	
ITU _ IIT5		Store our parts/products at distribution points close to the customer	**.54**	**.59**	**.55**	
Infrastructural Focus on IT (INFRA)						
ITU_INFRA1	Inside our firm, our IT foundation (platforms, networks, and databases) facilitates	Communication and sharing of business knowledge of core business processes	**.89**			**.96**
ITU_INFRA2		Communication and exchange of timely information	**.90**			
ITU_INFRA3		Communication and exchange of accurate information	**.93**			
ITU_INFRA4		Communication and exchange of complete information	**.91**			
ITU_INFRA5		Communication and exchange of adequate information	**.84**			

<u>Dimension Level Factor Analysis:</u>

To validate the convergent validity of the dimensions in the Information Technology Utilization (ITU) construct, dimension level factor analyses were conducted for each of the three dimensions. Table 5.5.4.2 indicates a single-factor solution for the five items for the EIT dimension with all factor loadings above 0.77. Sampling adequacy (KMO) is very good at 0.81.

Table 5.5.4.2 Dimension–level factor analysis for EIT, IIT, and INFRA

	Component (EIT)
	1
ITU_EIT1	.870
ITU_EIT5	.854
ITU_EIT4	.844
ITU_EIT3	.830
ITU _EIT2	.774
	Component (IIT)
	1
ITU _IIT3	.827
ITU _IIT4	.803
ITU _IIT5	.800
	Component (INFRA)
	1
ITU _INFRA3	.957
ITU _INFRA4	.946
ITU _INFRA2	.936
ITU _INFRA1	.928
ITU _INFRA5	.899

The three remaining items of IIT were submitted to a dimension level factor analysis and a clear one-factor solution emerged. All items had factor loadings above 0.80 and sampling adequacy (KMO) is acceptable at 0.69. Finally, the five items of INFRA dimension were submitted to a dimension level factor analysis and a clear one-factor solution emerged. All items had factor loadings above 0.89 and sampling adequacy (KMO) is excellent at 0.90. The results of the dimension level factor analysis are presented in Table 5.5.4.2.

Construct Level Exploratory Factor Analysis:

To further validate the discriminant validity of the dimensions in the Information Technology Utilization (ITU) construct, dimension level factor analyses was conducted for each of the three dimensions and the results are shown in Table 5.5.4.3. A clear three-factor solution emerged for the (EIT, ITT, and INFRA). No cross-loadings were observed, and all factor loadings have a value of 0.66 or greater. The variance explained by the three factors accounts for 76% of the total variance and the KMO measure of 0.90 indicates an excellent sample adequacy. The reliability was also very high, with a Cronbach alpha score of 0.89.

Table 5.5.4.3 Information technology utilization--construct level factor analysis results

	Component		
	1	2	3
UIT_INFRA4	.913		
UIT_INFRA3	.898		
UIT_INFRA2	.881		
UIT_INFRA1	.869		
UIT_INFRA5	.856		
UIT_ETI4		.798	
UIT_ETI5		.797	
UIT_ETI1		.749	
UIT_ETI3		.697	
UIT_ETI2		.660	
UIT_ITT3			.859
UIT_ITT4			.790
UIT_ITT5			.705

	Component		
	1	2	3
UIT_INFRA4	.913		
UIT_INFRA3	.898		
UIT_INFRA2	.881		
UIT_INFRA1	.869		
UIT_INFRA5	.856		
UIT_ETI4		.798	
UIT_ETI5		.797	
UIT_ETI1		.749	
UIT_ETI3		.697	
UIT_ETI2		.660	
UIT_ITT3			.859
UIT_ITT4			.790
UIT_ITT5			.705
Eigen Value	6.706	2.242	.963
% Variance Explained	51.585	17.224	7.406
Cumulative % of Variance	51.585	68.829	76.235
Kaiser Mayer Orkin (KMO) Measure of sampling adequacy = 0.90			
Cronbach Alpha (α) = 0.89			

5.5.5 Supply Chain Management (SCM) Performance

Purification of the items (Reliability)

Supply Chain Management Performance (SCP) was initially represented by three dimensions and 13 items, and they are as follows: (1) Supply Chain Flexibility (SCF) (6 items), (2) Supply Chain Integration (SCI) (4 items), (3) and Responsiveness to Customers (RC) (3 items). A reliability analysis was done for each of the three dimensions. The CITC score for all items were above the 0.50 threshold. The Cronbach's alpha score for the three dimensions (SCF, SCI, and RC) are 0.86, 0.76, and 0.82 respectively. The results are presented in Table 5.5.5.1.

Table 5.5.5.1 Supply chain management performance - initial large scale survey items, CITC results, and overall alpha score

Item Code	Survey Item		CITC-1	Alpha
Supply Chain Flexibility(SCF)				
SCP_SCF1	Our supply chain is able to	handle difficult nonstandard orders	**.68**	**.86**
SCP_SCF2		meet special customer specification	**.64**	
SCP_SCF3		produce products characterized by numerous features options, sizes and colors	**.68**	
SCP_SCF4		rapidly adjust capacity so as to accelerate or decelerate production in response to changes in customer demand	**.60**	
SCP_SCF5		rapidly introduce large numbers of product improvements/variation	**.73**	
SCP_SCF6		handle rapid introduction of new products	**.60**	
Supply Chain Integration (SCI)				
SCP_SCI1	There is a high level of communication and coordination between all functions in our firm		**.60**	**.76**
SCP_SCI2	Cross-functional teams are frequently used for process design and improvement in our firm		**.52**	
SCP_SCI3	There is a great amount of cross-over of the activities of our firm and our trading partners		**.59**	
SCP_SCI4	There is a high level of integration of information systems in our firm		**.53**	
Responsiveness to Customers (RC)				
SCP_RC1	Our firm fills customer orders on time		**.63**	**.82**
SCP_RC2	Our firm has short order-to-delivery cycle time		**.71**	
SCP_RC3	Our firm has fast customer response time		**.73**	

Dimension Level Factor Analysis

Dimension level factor analysis was performed to each of the three dimensions of the SCP construct. For the Supply Chain Flexibility (SCF), the six items were submitted to a factor analysis and a single factor emerged with factor loadings above 0.72. KMO is very good at 0.83. A clear factor emerged for the four items of (SCI) with all factor loading above 0.73 and a good sampling adequacy of 0.71. Finally, the three items that comprised the RC dimension provided a clear one-factor solution. All factor loadings were greater than 0.83 and the KMO score was good at 0.71. The results of the dimension level factor analysis are presented in Table 5.5.5.2.

Table 5.5.5.2 Dimension–level factor analysis for SCF, SCI, and RC

	Component (SCF)
	1
SCP_SCF5	.820
SCP_SCF1	.791
SCP_SCF3	.790
SCP_SCF2	.760
SCP_SCF4	.723
SCP_SCF6	.722
	Component (SCI)
	1
SCP_SCI1	.797
SCP_SCI3	.788
SCP_SCI4	.742
SCP_SCI2	.731
	Component (RC)
	1

SCP_RC3	.888
SCP_RC2	.874
SCP_RC1	.830

Construct Level Exploratory Factor Analysis

A construct level factor analysis was done for the SCM Performance construct and the results are presented in Table 5.5.5.3. As the results indicate, one factor solution emerged, and all the factor loadings were 0.66 or higher. Furthermore, the one-factor solution accounted for over 63.8% of the total variance. Overall, sampling adequacy score of is very good at 0.81, and the overall reliability of the items is 0.86.

Table 5.5.5.3 Supply chain management performance - construct level factor analysis results

	Component		
	1	2	3
SCP_SCF5	.810		
SCP_SCF3	.808		
SCP_SCF1	.745		
SCP_SCF2	.738		
SCP_SCF4	.677		
SCP_SCF6	.663		
SCP_SCI3		.782	
SCP_SCI2		.744	
SCP_SCI1		.728	
SCP_SCI4		.692	
SCP_RC3			.870
SCP_RC2			.859
SCP_RC1			.727

	Component		
	1	2	3
SCP_SCF5	.810		
SCP_SCF3	.808		
SCP_SCF1	.745		
SCP_SCF2	.738		
SCP_SCF4	.677		
SCP_SCF6	.663		
SCP_SCI3		.782	
SCP_SCI2		.744	
SCP_SCI1		.728	
SCP_SCI4		.692	
SCP_RC3			.870
SCP_RC2			.859
SCP_RC1			.727
Eigen Value	4.883	1.834	1.586
% Variance Explained	37.558	14.111	12.2
Cumulative % of Variance	37.558	51.670	63.869
Kaiser Mayer Orkin (KMO) Measure of sampling adequacy = 0.81			
Cronbach Alpha (α) = 0.86			

5.5.6 Firm Performance

Purification of the items (Reliability)

The Firm Performance (FP) construct is comprised of a single dimension and six items. The CITC scores and the overall alpha score were calculated to assess the reliability of this construct, and the results are shown in Table 5.5.6.1. Overall, the CITC scores are all above 0.71 and the Cronbach alpha score of 0.92 shows high reliability of the measures. Because this construct consisted of a single dimension, no dimension level analysis was conducted.

Table 5.5.6.1 Firm performance--initial large scale survey items, CITC results, and overall alpha score

Item Code	Survey Item	CITC-1	Alpha
Firm Performance (FP)			
FP1	Market Share	**.78**	**.92**
FP2	Return on investment	**.79**	
FP3	The growth of market share	**.75**	
FP4	Growth in return on investment	**.81**	
FP5	Profit margin on sales	**.71**	
FP6	Overall competitive position	**.80**	

Construct Level Exploratory Factor Analysis

The results of the confirmatory factor analysis for the Firm Performance (FP) construct are presented in Table 5.5.6.2. As seen in the table, a single-factor solution emerged from the analysis, and all factor loadings had values of 0.79 or greater. Furthermore, the KMO measure (0.82) indicated a very good result for this construct. Overall, the single-factor solution accounted for almost 72% of the total variance, and the final Cronbach alpha score is 0.92, indicating a very good internal consistency.

Table 5.5.6.2 Firm performance - construct level factor analysis results

	Component
	1
FP4	.872
FP6	.870
FP1	.861
FP2	.852
FP3	.831
FP5	.796
Eigen Value	4.31
% Variance Explained	71.827
Cumulative % of Variance	71.827
Kaiser Mayer Orkin (KMO) Measure of sampling adequacy = 0.82	
Cronbach Alpha (α) = 0.92	

5.6 Chapter Summary

Chapter 5 presented a rigorous empirical examination of all the constructs considered in this research. The purpose of this chapter is to assess the measurement model for each construct and its dimensions by reporting the convergent validity, reliability, discriminant validity for each construct (SCM strategy, ISS, SCM practices, IT utilization, SCM performance, and Firm Performance). From the 89 items that were considered in this chapter, nine items were deleted and 80 are kept for further analysis. Table 5.6.1 presents a summary of the results of construct level analysis. As indicated by this table, all constructs have alpha score of 0.82 or above and KMO scores of 0.76 and above, indicating the high reliability and sampling adequacy of the constructs. Table 5.6.2 presents a summary of the results of dimensional level analysis.

Table 5.6.1 Summary-large scale analysis results (construct level)

Construct Level Results	# of dimensions	alpha	KMO
SCM Strategies	3	0.82	0.78
ISS	3	0.82	0.89
SCM Practices	6	0.84	0.76
IT Utilization	3	0.89	0.90
SCM Performance	3	0.86	0.81
Firm Performance	1	0.92	0.82

Table 5.6.2 Summary-large scale analysis results (dimensional level)

Dimensional Level Results	# of items	alpha	KMO
Lean Supply Chain (LSC)	6	0.82	0.74
Agile Supply Chain (ASC)	2	0.81	0. 56
Hybrid Supply Chain (HSC)	5	0.93	0.88
IS for Efficiency (ISSE)	5	0.89	0.85
IS for Flexibility (ISSF)	4	0.88	0.80
IS for Comprehensiveness (ISSC)	4	0.94	0.87
Strategic Supplier Partnership (SSP)	3	0.74	0.67
Customer Relationship (CR)	4	0.85	0.81
Lean System Practices (LSP)	4	0.84	0.78
Postponement (POS)	4	0.78	0.72
Information Sharing(IS)	2	0.85	0.65
Information Quality(IQ)	5	0.96	0.90
External Focus of IT (EIT)	5	0.89	0.81
Internal Focus of IT (IIT)	3	0.74	0.69
Infrastructural Focus of IT (INFRA)	5	0.96	0.90
Supply Chain Integration (SCI)	4	0.86	0.71
Supply Chain Flexibility (SCF)	6	0.72	0.72
Customer Responsiveness (CR)	3	0.82	0.71
Market and Financial Performance	6	0.92	.082
	80 Total Items		

Chapter 6

Causal Model and Hypotheses Testing

In this chapter, the proposed relationship between the model variables is going to be tested. Structural equation modeling (SEM) framework will be used to test the ten hypotheses proposed in Chapter 3.

In general, SEM is composed of two parts: 1) The measurement model, and 2) the structural model. The measurement model in SEM is used to specify the indicators of each construct and assess the reliability and validity of each construct. On the other hand, the structural model is used to study the complex interrelations among variables (Joreskog and Sorbom, 1977). Since each construct has been validated and checked for reliability through rigorous analysis in Chapter 5, the SEM model described in this chapter will focus on the path analysis using SMART Partial Least Square (PLS) software.

Chin et al. (2003) argue that using PLS to test the interaction (moderating) effects among variables without taking the composite score of each sub-construct will provide better and presumably more accurate path estimates than creating a composite score and using multiple regressions. Since this research is dealing with the interaction effects (moderating alignment) of ISS and SCM strategy and of utilization and SCM practices, this study will not use the composite score of the sub-constructs to build the structural model. Instead, each SCM strategy (lean, agile, and hybrid) will be tested separately with its corresponding ISS (IS for efficiency, IS for flexibility and IS for comprehensiveness) to test the impact of aligning (moderating effect) these strategies on SCM performance and firm performance. These relationships are depicted in Model 1 Figure 6.1.1. The same goes for SCM practices; each pair of SCM practices will be tested separately with its corresponding IT usage to test for the effect of their alignment (moderating effect) on SCM performance and firm performance. These relationships are depicted in Model 2 Figure 6.1.2. The proposed structural model (for Model 1 and Model 2) is going to be explained in section 6.1. In section 6.2, SEM results using PLS are presented, and discussed in section 6.3. Finally, a revised model will be presented in section 6.4 to discuss some new and alternative relationships for the unsupported hypotheses.

6.1 The Proposed Structural Model

In PLS, the strength of the relationship proposed earlier will be tested and analyzed through the values of T-statistic, standardized path (Beta coefficient) and R^2. Statistical level of T-value indicates the significant level of a relationship. A bootstrapping procedure is used to generate t-statistics**.** On the other hand, standardized path (Beta coefficient) indicates the strength of the relationship. Finally, R^2 examines the impact of independent variables on dependent variables (Chin, 1998a and Chin, 1998b). PLS algorithm procedure using *path weighting scheme* technique is used to calculate both the standardized coefficient (Beta coefficient) and R^2.

In this research, two research models are proposed to test the 10 hypotheses discussed in chapter 3, the two research models are described below.

Model 1 (The alignment at the planning/strategic level):

The proposed structural model is depicted in Figure 6.1.1. In this model, the three hypotheses (H1a, H1b, and H1c) will be tested. This model will look at the three types of SCM strategies (lean, agile, and hybrid) and tests how aligning (as moderator) these SCM strategies with three types of IS strategies (IS for efficiency, flexibility, and comprehensiveness) would enhance SCM performance and firm performance. In particular, H1a will test how IS for efficiency will interact with (moderate) the relationship between a lean supply chain and SCM performance to have better SCM performance measured by supply chain integration. Similarly, H1b will test the moderating effect of IS for flexibility on the relationship between an agile supply chain and supply chain flexibility. Finally, H1c will test the moderating effect of IS for comprehensiveness on the relationship between a hybrid supply chain strategy and customer responsiveness. Testing the three hypotheses will address research question 1 which is stated earlier in Chapter 1 (*Can the alignment at the planning/strategic level (SCMS with ISS) have a positive impact on SCM performance and firm performance*?)

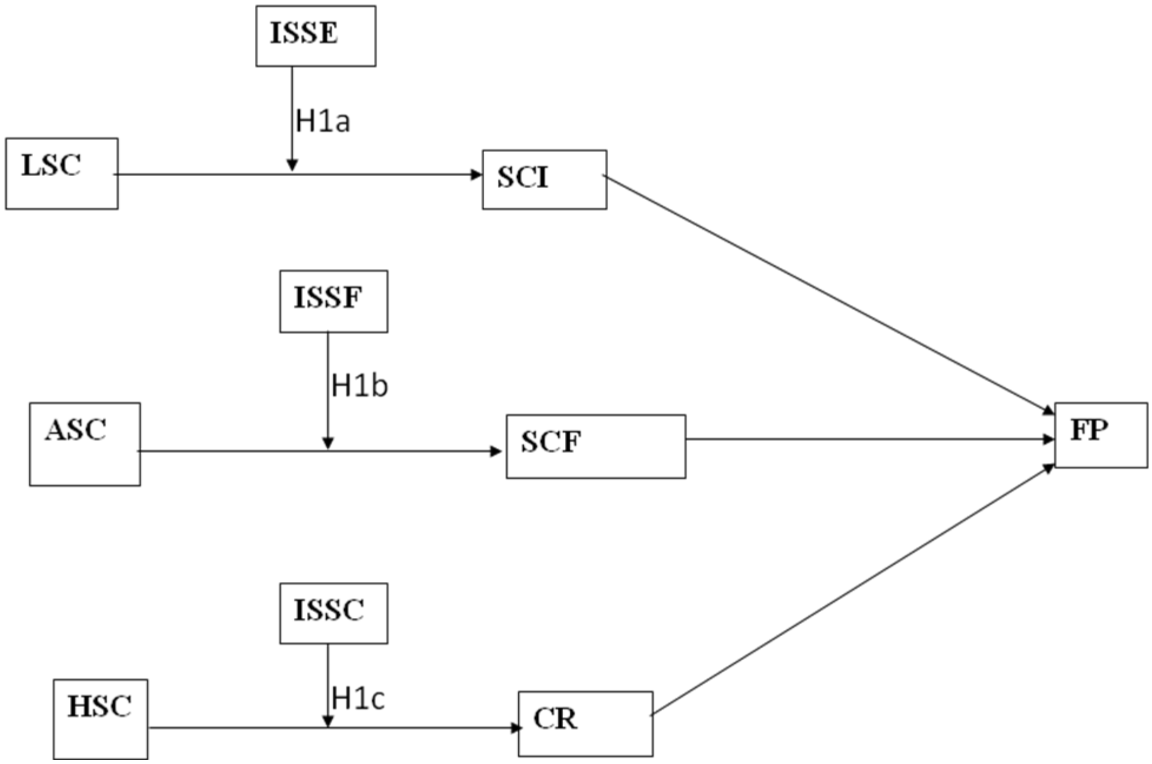

Figure 6.1.1 Proposed structural model (model 1)

LSC: Lean Supply Chain
ASC: Agile Supply Chain
HSC: Hybrid Supply chain
ISSE: IS for Efficiency
ISSF: IS for Flexibility
ISSC: IS for Comprehensiveness
SCI: Supply Chain Integration
SCF: Supply Chain Flexibility
CR: Customer Responsiveness
FP: Firm Performance

Model 2 (The alignment at the practice/operational level):

The proposed structural model is depicted in Figure 6.1.2. This model will test the remaining seven hypotheses (H2a, H2b, H2c, H3a, H3b, H3c, and H4). Thus, this model will look at six SCM practices and align them with the corresponding IT usage and test their impact on SCM performance and firm performance. In particular, H2a will test how the external usage of IT will interact with (moderate) the relationship between two SCM practices (strategic supplier partnership and customer relationship), and SCM performance to have better SCM performance. H2b will test how the moderating effect of internal usage of IT on the relationship between two SCM practices (lean practices and postponement), and SCM performance to have better SCM performance. Finally, H2c will test the moderating effect of IT infrastructure on the relationship between two SCM practices (information quality and information sharing), and SCM performance to have better SCM performance. In hypotheses (H2a, H2b, and H2c), SCM performance is measured by the three performance measurements (SCI, SCF and CR) taken together at the same time. By doing this, we will also measure the direct impact of SCM practices on SCM performance which is captured by (H3a, H3b, and H3c). Finally, H4 will measure how SCM performance impacts firm performance. The seven hypotheses should address research question 2 from my introduction section *(Can the alignment at the practice/operational level (SCM practices with the usage of IT) have a positive impact on SCM performance and firm performance?)*

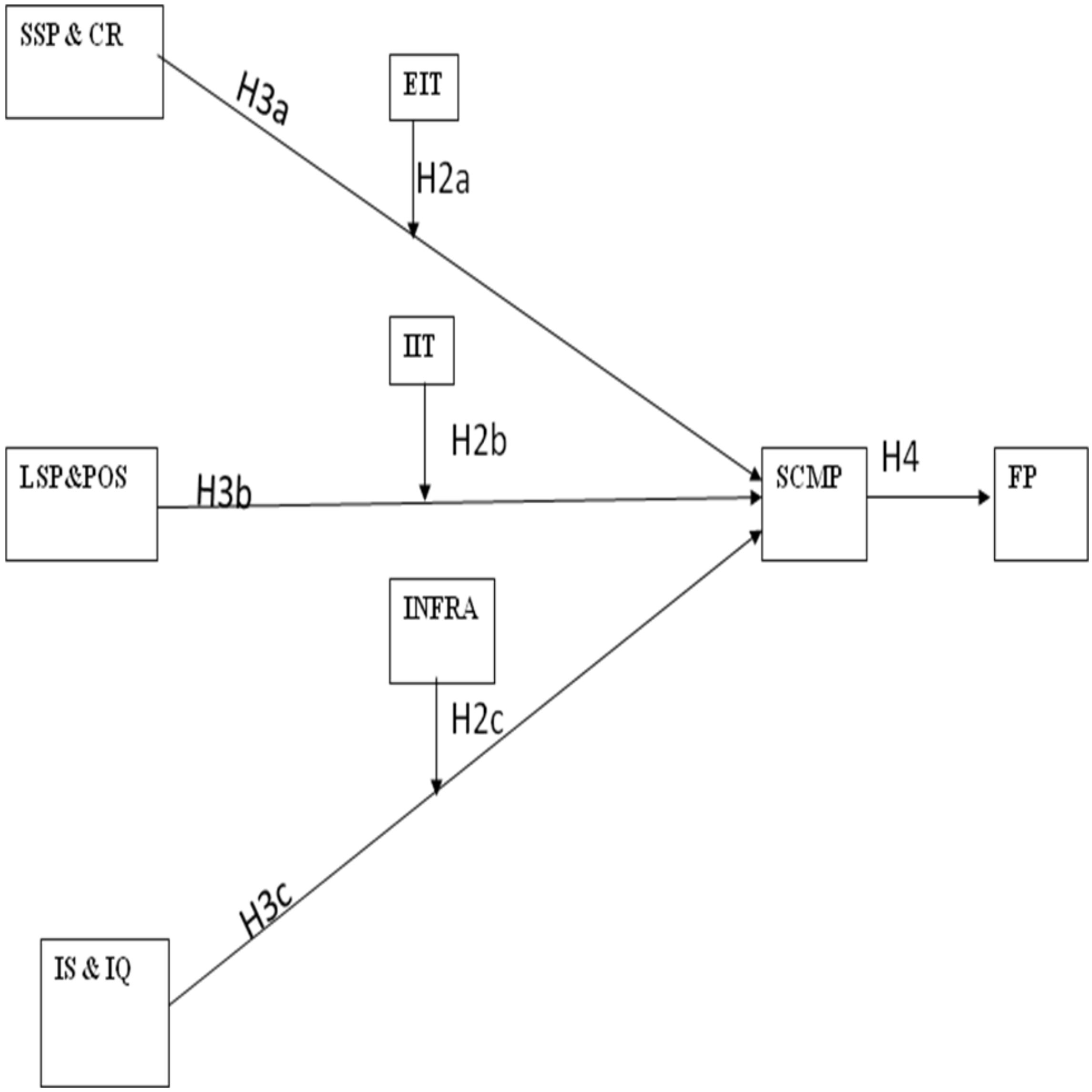

Figure 6.1.2 Proposed structural model (model 2)

SSP: Strategic Supplier Partnership
CR: Customer Relationship
LSP: Lean System Practices
POS: Postponement
IS: Information Sharing
IQ: Information Quality
EIT: External Focus of IT
IIT: Internal Focus of IT
INFRA: Infrastructural Focus of IT
SCMP: Supply Chain Management Performance
FP: Firm Performance

6.2 Structural Equation Model Results Using PLS

Figure 6.2.1 display the results (the t coefficient) of Model 1 resulting from the structural equation modeling (SEM) using SMART PLS. Of the 3 Hypotheses (H1a, H1b, and H1c) proposed in Model 1, two of the hypotheses are significant (H1a, and H1c), whereas H1b is not significant. The detailed findings of the SEM for Model 1 are presented in Table 6.2.1.

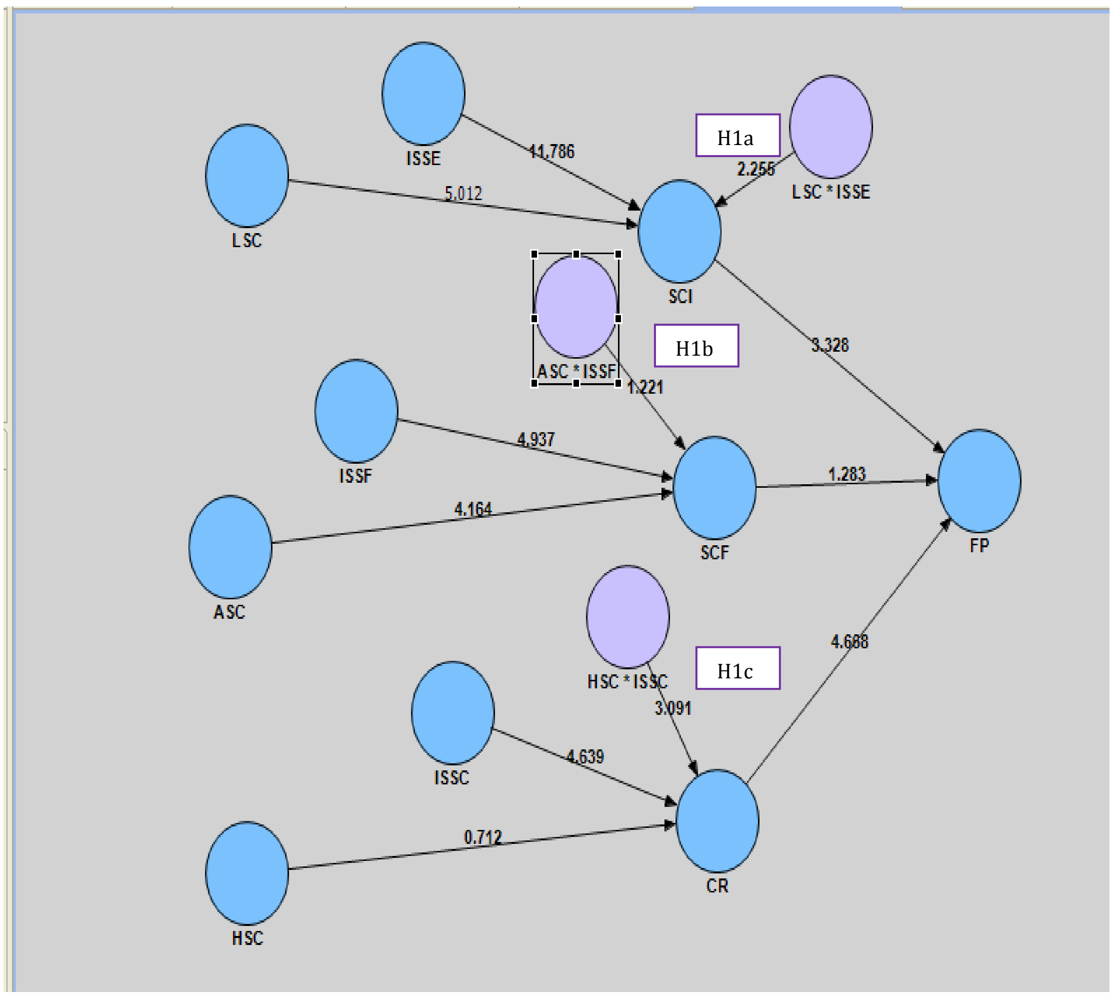

***Figure 6.2.1 Results of initial structural model (model 1)**

*** Note: The items for each construct was hidden for simplicity purposes only**

Table 6.2.1 Initial PLS structural equation modeling results (model 1)

Hypothesis	Relationship	Type	Beta-Coefficient	T-Coefficient	Significant
H1a	LSC*ISSE	Moderation	.182	2.255	Yes
H1b	ASC*ISSF	Moderation	.169	1.221	No
H1c	HSC*ISSC	Moderation	.151	3.091	Yes

For Model 2, the (t coefficient) results from SEM are displayed in Figure 6.2.2. Of the seven hypotheses proposed, six of them are significant and they are (H2a, H2c, H3a, H3b, H3c, and H4). The other hypothesis (H2b) is not significant. The results of SEM for Model 2 are presented in Table 6.2.2. The detailed discussion of each hypothesis is provided in the next section (section 6.3).

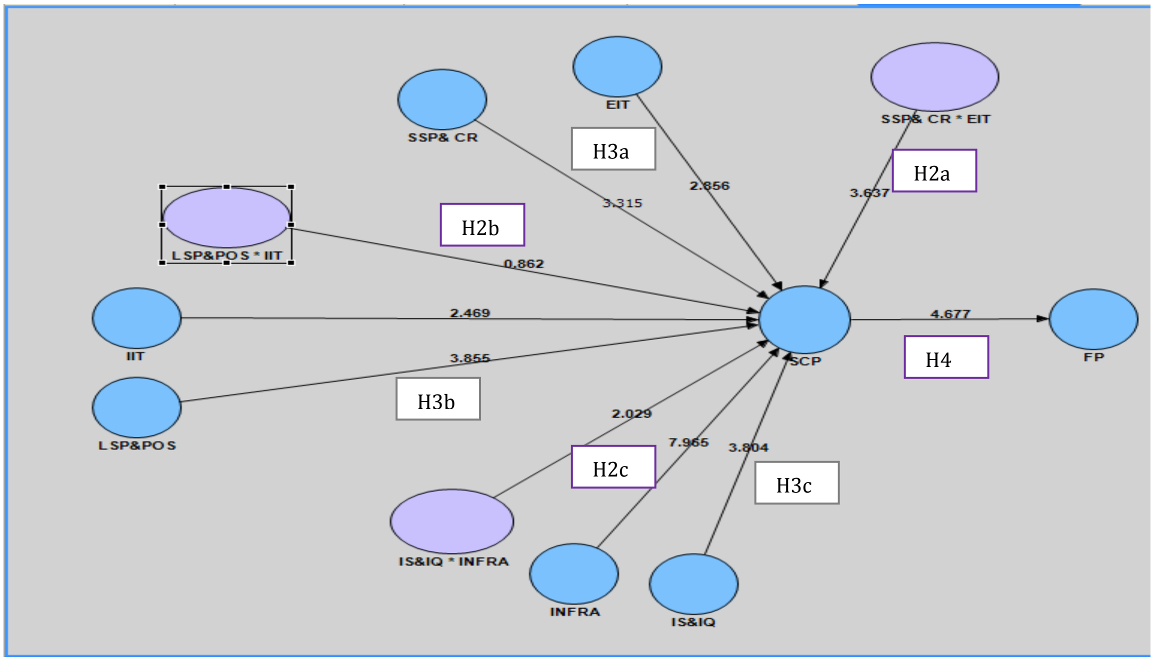

***Figure 6.2.2 Results of initial structural model (model 2)**

***Note: The items for each construct were hidden for simplicity purposes only**

Table 6.2.2 Initial PLS structural equation modeling results (model 2)

Hypothesis	Relationship	Type	Beta-Coefficient	T-Coefficient	Significant
H2a	SSP&CR*EIT	Moderation	1.59	2.255	Yes
H2b	LSP&POS*IIT	Moderation	.095	1.221	No
H2c	IS&IQ*INFRA	Moderation	.131	3.091	Yes
H3a	SSP&CR-SCP	Direct	.135	3.315	Yes
H3b	LSP&POS-SCP	Direct	.123	3.855	Yes
H3c	IS&IQ-SCP	Direct	.129	3.804	Yes
H4	SCP-FP	Direct	.182	4.677	Yes

6.3 Discussion of Structural Equation Model and Hypothesis Testing Results

From Model 1:

H1a: The impact of a lean supply chain on supply chain management performance (as measured by supply chain integration) is positively moderated by IS for efficiency

The result of this hypothesis is found to be significant (t coefficient = 2.255). The R^2 of SCM performance (supply chain integration) = 0.356 indicates a good amount of variance explained by the mode. This indicates that IS for efficiency moderates the relationship between a lean supply chain and supply chain performance measured by supply chain integration. Furthermore, the direct impact of a lean supply chain on supply chain integration (direct relationship) is found to be significant (t coefficient = 5.012). Also, the direct impact of supply chain integration on firm performance is significant (t coefficient = 3.328). What does this mean?

This means that at the strategic planning level IS should support and enhance the long-term objectives and goals of SCM. In particular, if a focal firm is planning to cut its cost by creating the most cost efficiency in its supply chain (i.e. Wal-Mart), then the firm should also plan and invest in IT to support and enable implementing its lean supply chain (LSC) strategy. The fit (interaction) between these two strategies will result in having better supply chain integration which helps the focal firm to reduce its cost and be more efficient. In other words, acquiring specific IS applications that help firms manage, coordinate, and improve production and information sharing will result in better communication and coordination between firms and their suppliers. This alignment between LSC and ISS for efficiency will result in better supply chain integration which could not only benefit the suppliers, but also help the firm to achieve its market and financial goals.

H1b: The impact of an agile supply chain on supply chain management performance (as measured by supply chain flexibility) is positively moderated by IS for flexibility

The relationship for hypothesis 1b is found to be non significant (t coefficient = 1.2). The R^2 of supply chain flexibility is equal to 0.204. The result of this hypothesis indicates that IS for flexibility does not moderate the relationship between an agile supply chain (ASC) and supply chain performance measured by supply chain flexibility. The findings suggest that for those firms, acquiring IS applications for flexibility does not enhance the ability to execute its supply chain agility strategy, and therefore does not help in improving the flexibility of its supply chain. This shows that firms may be lacking the understanding of how to manage the applications that provide flexibility, in their pursuit of supply chain flexibility. In other words, firms that acquire an IS application for flexibility without understanding and analyzing whether this application truly fits the requirements of their agility supply chain strategy or how to manage the implementation of the application will not see the benefits of ASC - IS for flexibility alignment for their supply chain performance. As a good example, when Nike acquired supply chain software from i2 Technologies to help in its agility distribution strategy, Nike moved too quickly into this new technology without analyzing, observing and monitoring the market and without appropriately managing the adoption of the software. In the case of Nike, they had a mismatch between the management and implementation of IS application and its supply chain agility strategy which resulted in a $100 million loss in their revenue (Smith, 2001, McLaren et al., 2004, Sabherwal and Chan, 2001). An alternative relationship will be discussed later in section 6.4.

H1c: The impact of a hybrid supply chain on supply chain management performance (as measured by customer responsiveness) is positively moderated by IS for comprehensiveness

The relationship for hypothesis 1c is found to be significant (t coefficient = 3.091) and R^2= 0.08. The result of this hypothesis indicates that IS for comprehensiveness moderates the relationship between a hybrid supply chain (HSC) and supply chain performance measured by customer responsiveness.

The result suggests that having an ISS that enables comprehensive decisions and quick responses will positively interact with the supply chain strategy that emphasizes achieving mass customization and responsiveness; this interaction will result in better customer satisfaction. Achieving mass customization which is based on assemble-to-order strategy and which also can be achieved by producing a modular design requires responsiveness in understanding and monitoring the market to seek any opportunity to introduce new products. At the strategic level therefore, planning for IS to support comprehensive and quick decisions will enhance the ability of the focal firm to execute a hybrid (assemble-to-order) strategy, and will result in better understanding of customer requirements. This would lead firms to maximize any opportunities they are seeking for market and financial growth.

The statistical results shows that ISS for comprehensiveness moderates the relationship between a hybrid supply chain strategy (HSC) and customer responsiveness (CR), even though the direct impact of HSC on CR is not significant (t coefficient =0.712).

From Model 2:

H2a: The impact of strategic supplier partnerships and customer relationships on SCM performance is positively moderated by external focus of IT

The result of this hypothesis is found to be significant (t coefficient = 3.637). This indicates that for a focal firm, utilizing IT externally to formulate and improve the planning processes of building long term relationships with suppliers and customers will enable faster response from suppliers, better understanding of customer needs, and better integration of activities between the focal firm, its suppliers, and its customers. A good example of this is when Wal-Mart used satellite communication systems to send point-of-sale (POS) data to all its vendors so that they could have a clear picture of all the sales in all of Wal-Mart stores; by sharing this information, suppliers can ship products more quickly to Wal-Mart which reduces the need for safety stock and cuts its cost. This means that utilizing IT externally to support and enhance the supply chain practices of strategic supplier partnerships and customer relationships will result in better SCM performance and firm performance. Furthermore, the direct impact of strategic supplier partnerships and customer relationships (direct relationship) on SCM performance is found to be significant (t coefficient = 3.315) which is going to be discussed later in hypothesis 3a.

H2b: The impact of internal lean practices and postponement on SCM performance is positively moderated by internal focus of IT

The relationship for hypothesis 2b is found to be non-significant (t coefficient = 0.862). This indicates that utilizing IT internally does not moderate the relationship between internal lean practices and postponement, and SCM performance. The findings suggest that for those firms, using IT internally does not enhance the ability of the supply chain to eliminate waste and implement postponement practices, and therefore does not help in improving the supply chain performance. However, eliminating waste and implementing postponement strategy will improve the overall performance of the supply chain (the direct relationship is found to be significant; t=3.855). This will be discussed later in hypothesis 3b.

One reason why utilizing IT internally does not moderate the relationship between internal lean practices and postponement, and SCM performance is that the amount of information processing and communication between the firm and suppliers, and among suppliers must match the level of IT used to improve internal processes such as eliminating waste and increasing mass customization (that are associated with lean and postponement respectively). Thus, internal IT utilization alone may not be sufficient in positively moderating the effect of lean practices and postponement on SCM performance, but that more complete integration of resources and collaboration across the supply chain may be required. This is not really easy to achieve. This could explain why using IT internally does not enable the execution of those practices and therefore the interaction (moderating alignment) does not help in improving the supply chain performance and firm performance.

H2c: The impact of information sharing and information quality on SCM performance is positively moderated by infrastructural focus of IT

The result of this hypothesis is found to be significant (t coefficient = 2.029). This indicates that IT infrastructure will enhance the ability of organizations to share quality information in its supply chain. Having the right IT infrastructure to share information enables the supply chain to have access to any data which allows firms to better collaborate with other supply chain partners and respond more quickly to customers' demands. In other words, if the systems' capabilities in focal firms are compatible with the type of information they need to share with their suppliers, then this will facilitate information sharing and data communication among members of the supply chain. As a result, this will increase the ability of supply chains to react quickly and effectively to sudden changes in the market, and therefore respond faster to customers' requirements which will benefit not only the supply chain, but also the firm as well. Additionally, the direct impact of information sharing and information quality (direct relationship) on SCM performance is found to be significant (t coefficient = 3.804) which is going to be discussed later in H3c.

H3. SCM practices are positively associated with SCM performance

H3a: Strategic supplier partnerships and customer responsiveness are positively associated with SCM performance.

H3b: Internal lean practices and postponement are positively associated with SCM performance.

H3c: Information sharing and information quality are positively associated with SCM performance.

The result of the hypotheses (H3a, H3b, H3c) are found to be significant (t coefficient = 3.315, 3.885, and 3.804) respectively. The R^2 of 0.547 shows a good amount of variance explained by the mode. The results of these hypotheses confirm the empirical conclusions and theoretical justifications found by other researches (Shin et al., 2000; Narasimhan and Jayaram 1998; Tan et al., 1998) which suggest that well managed supply chain practices lead to better SCM performance. In other words, forming partnerships with other suppliers and managing interactions with customers could benefit the focal firm to reduce its level of inventory (cost savings) and better serve its customers. Also, sharing quality information about inventory levels, orders, production, and delivery status through the supply chain will enable the focal firm to react quickly to changes in customers' demand. Finally, elimination of waste and non-value activities in the supply chain will enable the focal firm to operate with more efficiency.

H4. SCM performance is positively associated with firm performance

The result of this hypothesis is found to be significant (t coefficient = 4.667 and R^2 = 0.33). Numerous studies have shown that well managed and well executed SCM practices will directly improve firm performance (Shin et al., 2000; Prasad and Tata, 2000; Tan et al., 1998; Tan, 2002). Since SCM practices lead to better SCM performance (H3), we can conclude that a better SCM performance will result in a better firm performance. So, for instance, if the supply chain is able to respond effectively and react quickly to changes in the market, then the firm will benefit from this by improving its competitive advantage through price, quality, and delivery (Li et al., 2006) which enables the firm to achieve its market and financial goals.

6.4 Revised Structural Model

The non-significant relationships for the two hypotheses (H1b in model 1, and H2b in model 2) will be re-analyzed and discussed through a revised structural model. The revised model will contain only the two hypotheses (H1b, and H2b) that were not significant with a mediating relationship instead of moderating relationship. This mediating relationship will capture the concept of alignment "fit" at the strategic and operation levels.

Venkatraman (1989b) identifies six perspectives of fit as mentioned earlier in section 3.2, chapter 3. One of the six types of alignment is fit as mediation. According to Venkatraman (1989b), fit as mediation is simply viewed as direct vs. indirect effect of variables. In other words, the fit as mediation between two variables (SCM strategy and SCM performance) is determined by their direct relationship as well as through the indirect effect of a third variable (ISS). This implies that if the presence of the ISS is necessary to influence the effect of SCM strategy on SCM performance, then ISS is called a complete mediator. However, if the direct relationship between SCM strategy and SCM performance exists and an indirect effect of ISS between SCM strategy and SCM performance also exists, then ISS is considered as a partial mediator. This means that at the strategic level, the alignment will exist if 1) a firm acquired an IS application (e.g. IS for flexibility) to support the objective of the ASC to have better SCM performance and subsequent to this acquisition, the ACS strategy would not have any direct effect on performance. Or 2) if a firm acquired an IS application (IS for flexibility) to support the objective of the ASC to have better SCM performance and subsequent to this acquisition, the ACS strategy would still have direct effect, as well as an indirect effect mediated by the ISS, on performance. This conceptualization is somewhat different from the moderating alignment concept.

Mediating alignment at the strategic level will be captured by the revised Model 1.1. The same concept will be applied at the operational level, with the alignment between SCM practices (internal lean practices and postponement) and internal usage of IT and on SCM performance. This is going to be captured by the revised Model 2.1.

Revised Model 1.1 (The alignment at the planning/strategic level):

The proposed structural model is depicted in Figure 6.4.1. In this model, only the revised hypothesis H1b will be tested. H1b will test the mediating effect of IS for flexibility between ASC and supply chain flexibility.

Revised H1a*: The impact of a lean supply chain on supply chain management performance (as measured by supply chain integration) is positively mediated by IS for efficiency.*

Revised H1b: *The impact of an agile supply chain on supply chain management performance (as measured by supply chain flexibility) is positively mediated by IS for flexibility.*

Revised H1c: *The impact of a hybrid supply chain on supply chain management performance (as measured by customer responsiveness) is positively mediated by IS for comprehensiveness.*

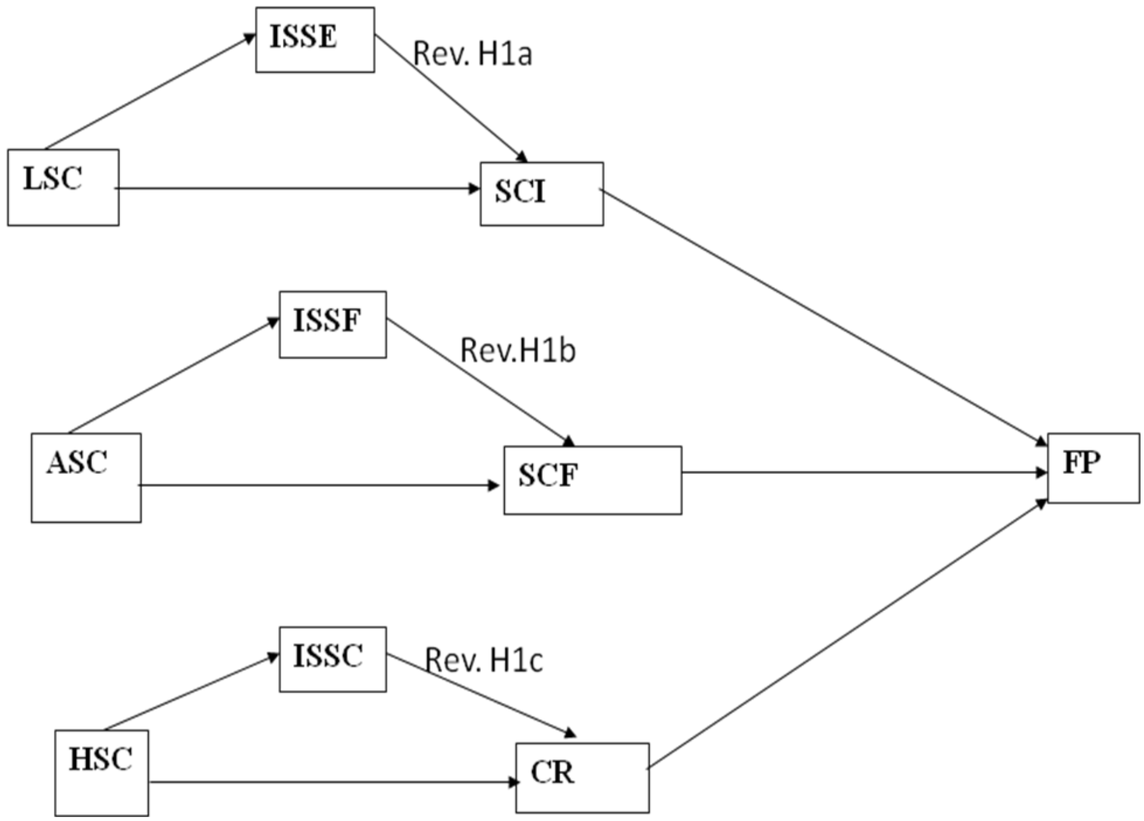

Figure 6.4.1 Revised proposed structural model (model 1.1)

LSC: Lean Supply Chain
ASC: Agile Supply Chain
HSC: Hybrid Supply Chain
ISSE: IS for Efficiency
ISSF: IS for Flexibility
ISSC: IS for Comprehensiveness

SCI: Supply Chain Integration
SCF: Supply Chain Flexibility
CR: Customer Responsiveness
FP: Firm Performance

Revised Model 2.1 (The alignment at the practice/operational level):

Similar to Figure 6.4.1., the proposed structural model is depicted in Figure 6.4.2 will test the revised hypothesis H2b with a mediating, instead of moderating, relationship. Hypotheses (H3a, H3b, H3c, and H4) will have the same hypotheses as stated in chapter 3. Only the revised H2b will be discussed in this section. H2b will test the mediating effect of the internal use of IT on the relation between internal lean practices and postponement on SCM performance.

Revised H2a: *The impact of strategic supplier partnerships and customer relationships on SCM performance is positively mediated by an external focus of IT.*

Revised H2b: *The impact of internal lean practices and postponement on SCM performance is positively mediated by an internal focus of IT.*

Revised H2c*: The impact of information sharing and information quality on SCM performance is positively mediated by an infrastructural focus of IT.*

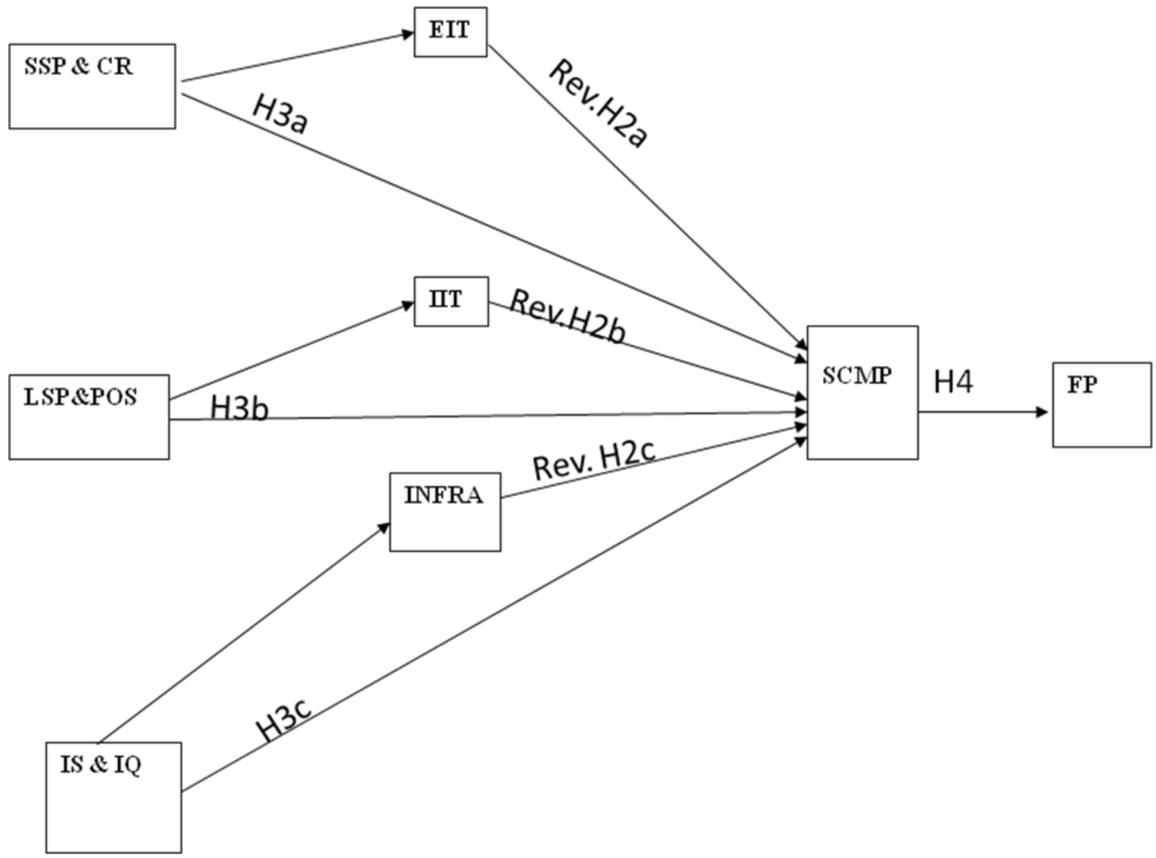

Figure 6.4.2 Revised proposed structural model (model 2.1)

SSP: Strategic Supplier Partnership
CR: Customer Relationship
LSP: Lean System Practices
POS: Postponement
IS: Information Sharing
IQ: Information Quality
EIT: External Focus of IT
IIT: Internal Focus of IT
INFRA: Infrastructural Focus of IT
SCMP: Supply Chain Management Performance
FP: Firm Performance

6.5 Discussion of Revised Structural Equation Model and Hypothesis Testing Results

Revised Model 1.1:

Revised H1b: The impact of an agile supply chain on supply chain management performance (as measured by supply chain flexibility) is positively mediated by IS for flexibility

Figure 6.5.1 indicates that the relationship for the revised H1b is found to be significant (t coefficient = 7.008). The R^2 of supply chain flexibility is equal to 0.189. The result of this hypothesis indicates that IS for flexibility partially mediates the relationship between ASC and SCM performance measured by supply chain flexibility. The findings suggest that acquiring IS applications for flexibility introduces an indirect effect between ASC and supply chain flexibility, through IS for flexibility. This means that IS for flexibility is a partial mediator for the relationship between ASC and Supply Chain flexibility. That is, acquiring IS for flexibility enhances the ability of the focal firm with an agile supply chain to sense any changes in the market which allows it to react quickly to those changes, increasing supply chain flexibility. However, there is also a direct effect from ASC to supply chain flexibility, indicating that even without acquiring applications that enhance flexibility there is some measure of supply chain flexibility that is possible from ASC. Thus, acquiring an ISS for flexibility in a focal firm will indirectly support agility by enhancing the supply chain’s ability to sense and respond quickly and effectively to changes in the market (Overby et al., 2006).

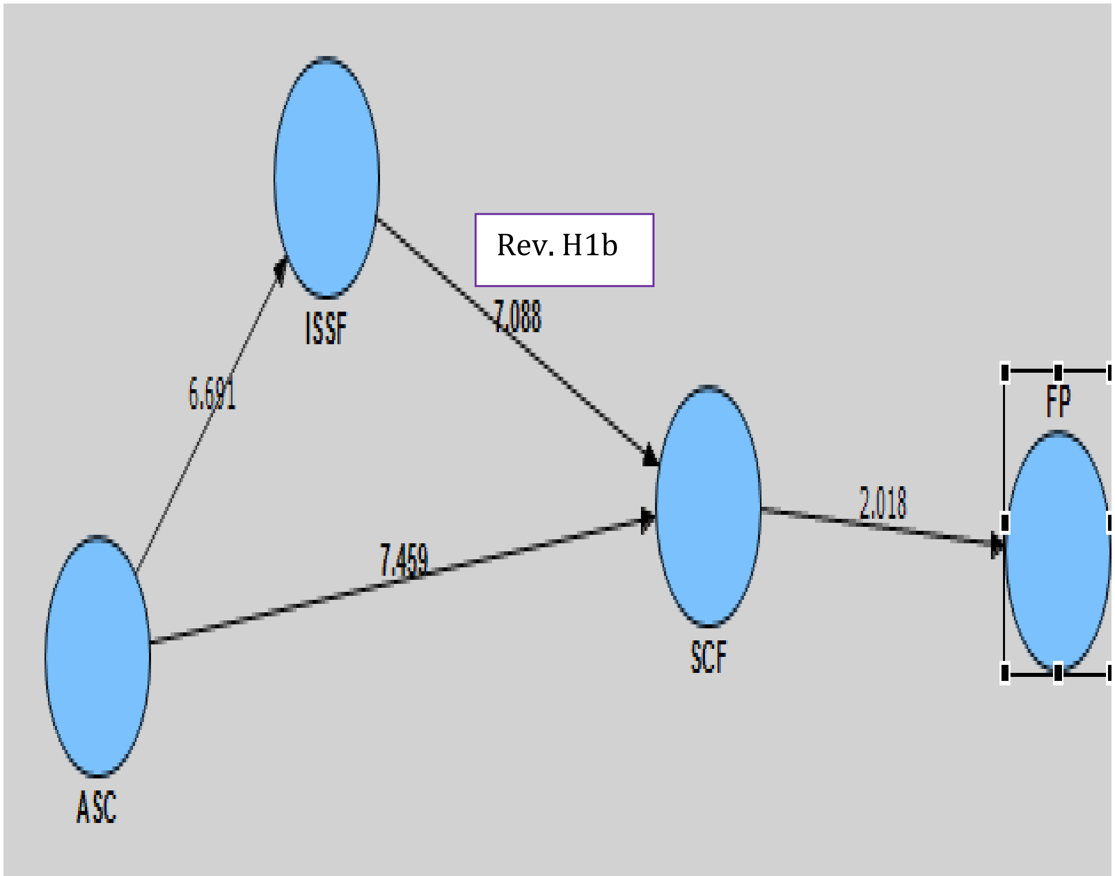

***Figure 6.5.1 Results of revised structural model (model 1.1)**

*** Note: The items for each construct were hidden for simplicity purposes only**

<u>Revised Model 2.1:</u>

Revised H2b: The impact of internal lean practices and postponement on SCM performance is positively mediated by an internal focus of IT

The results of the revised structural model (Model 2.1) are depicted in Figure 6.5.2. The result of revised H2b is found to be significant (t coefficient = 3.123). The R^2 of SCM performance = 0.458 indicates a good amount of variance explained by the mode.

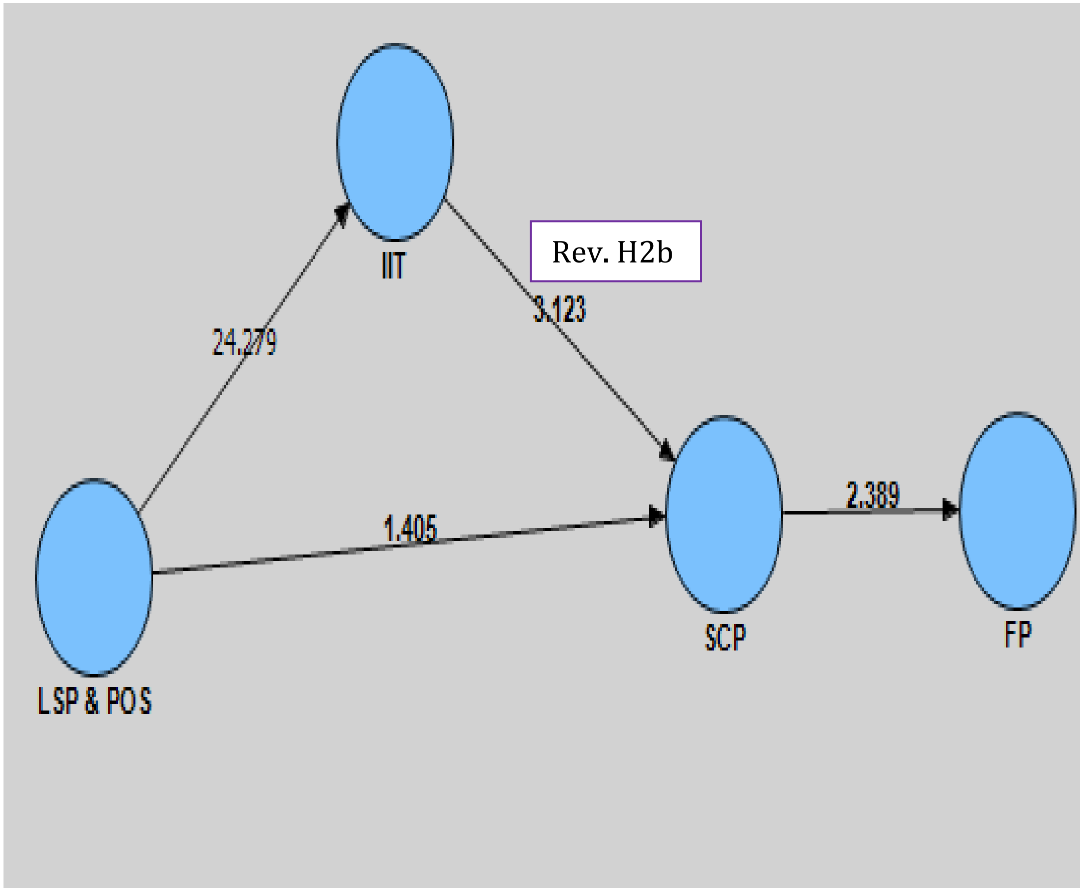

***Figure 6.5.2 Results of revised structural model (model 2.1)**

*** Note: The items for each construct were hidden for simplicity purposes only**

The result of this hypothesis indicates that using IT internally fully mediates the relationship between lean and postponement practices and SCM performance. In other words, using IT internally is necessary to execute lean and postponement practices. Bruun and Mefford (2004) argue that internal IT usage facilitates and allows lean production concepts to be more fully applied. They provided a case study to demonstrate how using IT can help in executing postponement and JIT practices. For instance, Dell allows its customers to place an order and customize their PCs electronically. Once an order is placed, Dell will transmit this order for the appropriate facility to start the production. The suppliers will access this information, adjust their production schedules, and plan ahead for the component needed for production. Sharing this information with suppliers will allow the focal firm to be more responsive to customers' demand. This clearly shows that for a focal firm, using IT internally increases the internal efficiency of the firm through internal integration with their suppliers and customers. This internal integration is essential to improve internal process i.e. enables the execution of lean and postponement practices which results in better SCM and firm performances. Ilebrand et al. (2010) provided an example of a bank to demonstrate the importance of using IT internally to enable lean execution. They argue that poor IT integration and fragmented oversight of IT in the bank meant manual entries, overlapping requirements, and high volumes of paperwork. Poor IT integration resulted in higher costs for the bank, and frustrated potential customers, which resulted in failure of the lean program they implemented.

6.6 Summary of Results

Overall, the results indicate that at a strategic level, aligning SCM strategy with an ISS strategy will result in a better SCM performance and firm performance. At the operational level, aligning SCM practices with the usage of IT will improve SCM performance and firm performance. According to the SEM results, six of the eight hypotheses were supported using the concept of moderating alignment (interaction) at the strategic and operational level. The two unsupported hypotheses were tested using mediating alignment (direct vs. indirect). The results suggest that at the strategic level (through an indirect relationship), aligning SCM strategies with ISS enhances their effectiveness and results in a superior supply chain and firm performance. At the operational level (through an indirect relationship), aligning SCM practices with corresponding IT usages enhances the success of those practices and their effect on supply chain and firm performance. The following chapter (Chapter 7) concludes with the interpretations of the research findings and major contributions, managerial implications, limitations of the research, and recommendations for future research.

Chapter 7

Summary and Recommendations for Future Research

This chapter provides (1) summary and interpretation of the research findings and major contributions, (2) implications for practitioners, (3) limitations of the research, and finally (4) recommendations for future research.

7.1 Summary and Interpretation of Findings

Many organizations believe that effective SCM is the key to building and sustaining competitive advantage in the market. To effectively manage their supply chains, organizations need to adopt appropriate SCM strategies and practices. The research shows that in order to do so, there is a need to integrate IS into the supply chain. This integration should be done by matching IS applications that support and enhance a given SCM strategy (the alignment at the planning/strategic level), and also by corresponding use of appropriate IT with particular SCM practices (the alignment at the practice/operational level).

This research is one of the first large-scale empirical studies to explore the moderating alignment at two levels between SCM and IS, and the impact of this alignment on supply chain performance and firm performance. First, the research looks at different SCM strategies and assesses appropriately-aligned information strategies that would enhance their effectiveness by positively influencing SCM performance and firm performance. Second, it looks at SCM practices and identifies corresponding IS usage that enhances the execution of those SCM practices positively, and thus improves SCM performance and firm performance. Based on the data collected from 205 supply chain managers/directors and purchasing managers/directors, the research hypotheses are tested using the structural equation modeling methodology. The result of this study contributes to our knowledge of SCM and IS in many ways.

First, this research provides a theoretical framework for a contingency-based approach for understanding how the alignment between supply chain *strategies* and IS strategies impacts SCM performance and firm performance, and how alignment between SCM *practices* and usage of IT impacts SCM performance and firm performance. We used the moderating and mediating definitions of alignment. This research framework provides a foundation for future research to test this model with different types of alignments such as fit as gestalts, fit as profile deviation, and fit as covariation.

Second, this research makes a contribution in the IS domain as well as the SCM domain. In the IS domain, this research looks at specific ways in which IS can support and enhance supply chains by understanding specific alignments at the strategic and usage levels, thus extending the IT alignment literature. In the SCM domain, this research demonstrates that 1) SCM strategies require corresponding IS strategies to be effective, and 2) that in order for SCM practices to be effectively executed, they require the presence of appropriate IT usage.

Third, the research develops and validates reliable measures for the following constructs: (1) supply chain management strategy (SCMS), (2) information systems strategy (ISS), (3) information technology (IT) utilization, (4) the alignment between SCMS and ISS, and (5) the alignment between SCM practices and the usage of IT. All measurements have been tested through a rigorous statistical process, which included a pilot test, factor analysis (construct and dimensional levels analysis), reliability, convergent validity, and discriminant validity. This will allow researchers to use and build on these measurements in their future research.

Fourth, the results from the structural model indicate several important relationships at the strategic level. The outcome of this study suggests that aligning SCM strategy with ISS strategy will result in better SCM performance and firm performance. This means that IS should support and enhance the long-term objectives and goals of SCM; this will result in superior supply chain performance and firm performance. In other words, if the organization's goal is to cut its cost through a cross-docking strategy, for example, then the SCM strategy should be derived from its organizational strategy and help the organization achieve its goal. At the same time, the organization should acquire an IT application (e.g., electronic data interchange (EDI)) which reduces information lead times between the focal firm and its suppliers. Thus, this application will also reduce the time it takes to produce and ship the items to the stores; as a result the ISS enhances the organization's ability and its supply chain's ability to achieve its goals. Having these three strategies aligned together will result in better supply integration and better firm performance (the results of H1a). On the other hand, if the organization implements an assemble-to-order strategy, then this requires a supply chain that holds components in a generic form (parts ready in stocks) to delay the point of product differentiation, then responds quickly by having the final assembly of products completed once customer orders have been received. In order to do so, the organization should acquire certain supply chain applications (i.e., application of strategic information systems planning (SISP)) that enables them to implement this type of strategy. Aligning those strategies will enable organizations to achieve mass customization and therefore respond faster to customer needs (the results of H1c). Finally, if the organization's strategy is to respond faster to its customers, then the supply chain strategy should focus on being flexible and enable it to respond quickly and effectively to the organization's requirements. As shown by the revised mediating hypothesis (revised H1b), acquiring/developing an appropriate supply chain application (i.e., i2e technologies) for this type of strategy will indirectly support the agility strategy adopted by the supply chain, which enables the supply chain to meet specific requirements and respond faster to changes in customers' demand.

Fifth, the results from the structural model indicate several important relationships at the operational level. The outcome of this study suggests that aligning SCM practices with the usage of IT will improve SCM performance and firm performance. In other words, this study looks at different SCM practices and identifies corresponding IS usage practices that enhance the success of those SCM practices. For instance, if the organization wants to build a strategic partnership with its suppliers and wants to have a better customer relationship, then certain supply chain software (e.g. Customer Relationship Management (CRM) software) needs to be used to enable the organization to interact with its partners and customers (this is the results of H2a). In other words, using the right application for the right practice will result in a superior SCM performance and firm performance. On the other hand, if the organization wants to share quality information with its suppliers, then the organization must have the right infrastructure (platforms, networks, and databases) that is compatible with the type of software its suppliers are using, and compatible with the type of information they are exchanging. This will allow for a smooth flow/transaction of information between the organization and its suppliers (the results of H2c). Finally, in the case of lean and postponement practices, organizations must use the appropriate supply chain application to execute lean and postponement practices, without which the ability to increase supply chain benefits would be limited (the results of revised H2b).

7.2 Implications for Practitioners

The results of this study have several important implications for practitioners. First, since effective supply management has become the way organizations improve performance (since competition is no longer between organizations but among suppliers), many organizations are increasingly adapting SCM strategies and practices in order to sustain their competitive advantage in the market. The findings of this research reveal to practitioners 1) the importance of adapting an IS strategy in their organizations that matches their SCM strategy and 2) using the appropriate IT applications that match with their SCM practices. This will have an impact on improving their performances. As shown by the particular cases of external use of IT (in the case of practice-level alignment) and IS for agility and comprehensives (in the case of strategy-level alignment), managers should take into consideration the types of IT applications their suppliers are using when making decisions on what applications they need to acquire and use in their organizations

Second, the findings of this study help managers position, structure, and utilize their IS applications in line with SCM strategies and practices. The results of this study are expected to be useful for strategic decision making, especially with regards to investment decisions concerning acquisition and use of IT in supply chains.

Third, organizations striving to implement lean and postponement practices must achieve a corresponding use of IT to improve their internal processes, without which these practices may not yield the desired benefits (the result revised hypothesis H2b). The difference between lean and postponement practices and the other SCM practices (strategic practices with suppliers and customers, and sharing quality information) is that, using the appropriate IT application is not essential, but will enhance their ability to execute those practices and improve their performances. However, in the case of lean and postponement practices, it is necessary to use the appropriate IT applications to yield supply chain benefits from these practices.

7.3 Limitations of the Research

Even though this research makes several academic and practitioner contributions, there are several limitations that need to be addressed.

First, this study is done at the firm level with one person from each organization responding to the survey. A single respondent was asked complex questions about SCM issues dealing with strategy, applications, and practices. Although the respondent was a senior purchasing manager/ director, or supply chain manager/director, no one person in an organization is in charge of the entire supply chain.

Second, some of the questions deal with IS strategy and utilizing IT in the supply chain. Some of the respondents may not have been in an appropriate position to answer these IS-related questions; since the main area of manufacturing is production, they may not have enough knowledge of their suppliers IS strategy and the IT applications that they use to answer these questions accurately.

Third, the research design and method employed may constrain the results found and the implications of this research. Thus, a sample size with 205 responses may not be sufficient to handle a complex model that consists of both strategic and operational levels.

7.4 Recommendations for Future Research

Future research should apply multiple methods to test this model using different types of alignment. For example, the alignment can be tested with different perspectives such as fit as gestalts, fit as profile deviation, and fit as covariation. By doing that, we can see if the results will hold to generalize that the concept of alignment is important and will improve performances.

Future research should try to see if there is a relation between SCM strategy and SCM practices. It would be a good idea to see if the alignment between strategy and practices will have an impact on performance. For example future research could, 1) explore the alignment between lean supply chain and strategic supplier partnership and customer relationship practices and its impact on performance; 2) explore the alignment between agile supply chain and lean and postponement practices in the supply chain and its impact on performance; 3) and finally, explore the alignment between hybrid supply chains and information sharing and information quality practices in the supply chain, and their impact on performance.

The result of this study is expected to help managers to anticipate certain alignment patterns required to have better outcomes in certain industries. For instance, lean-efficiency alignment is better suited in a general retail industry e.g. Wal-Mart, and Costco. However, an agile-flexibility alignment is expected to be needed in a high fashion, retail industry such as Zara. Finally, a hybrid-comprehensiveness alignment is expected to be needed in a mass market industry like the car industry. With regards to the practice-usage level, partnerships and customer relationships-external alignment is best-suited to the consumer goods industry e.g. Procter and Gamble, while lean and postponement-internal alignment is better suited in a computer manufacturing company such as Dell and HP. Finally, information sharing and quality information-infrastructure is expected to be found in high-tech industries. However, to the best of our knowledge, there is no research that investigates why these patterns can be expected. Therefore, future research should investigate 1) if these patterns really exist; and if so 2) why.

Future research should revalidate the measurement scales developed in this study, especially for the alignment constructs by choosing respondents from different fields such as IS functional managers and IS users; this validation will confirm the instrument proposed in this research and create generalizability for those instruments. Use of multiple respondents i.e. in SC and IS fields will help in increasing the generalizability of the results.

There are many other supply chain practices such as outsourcing, reduced cycle times, purchasing, quality, logistics, JIT, cross functional team, etc..., and many other performance measures such as customer service, inventory level, service level, throughput efficiency, suppliers' performance, time, assets, information and material flow integration, and delivery performance, to name a few, that are important and were not considered in this study. Therefore, there is an opportunity for researchers to test the same model with different supply chain practices and different performance measures, and perhaps test the same model using other SEM techniques such as LISREL or AMOS.

Future research can also expand on the current theoretical framework by integrating new constructs and expanding it to take a global perspective. For example, it would be interesting to test this model from the perspective of a global supply chain. Global supply chains are more complex in that they have to deal with suppliers and customers from different geographical regions that vary in terms of infrastructure, market demands, supplier sophistication, and IT sophistication. Aligning SC strategies and practices with corresponding IS strategies and IT usage is thus expected to present greater challenges that would require additional theoretical and empirical examination.

References

Agarwal, A., Shankar, R., & Tiwari, M.K. (2007). Modeling agility of supply chain. *Industrial Marketing Management*, 36 (4), pp. 443-457.

Aggarwal, S. (1997). Flexibility management: the ultimate strategy. *Industrial Management*, 39 (1), pp.26-31.

Allen, B. R., & Boynton, A. C. (1991). Information architecture: In search of efficient flexibility. *MIS Quarterly*, 15(4), pp.435–445.

Alvarado, U.Y. & Kotzab, H. (2001). Supply chain management: the integration of logistics in marketing", *Industrial Marketing Management*. 30 (2), pp.183-98.

Bakos, J. Y, & Brynjolfsson, E. (1993). Information technology, incentives, and the optimal number of suppliers. *Journal of Management Information Systems*, 10 (2), pp.37-53.

Bakos, J. Y., & Treacy, M. E. (1986). Information technology and corporate strategy: A research perspective. *MIS Quarterly*, 10 (2), pp.107-119.

Barnes, D., Mieczkowska, S., & Hinton, M. (2003). Integrating operations and information strategy in e-Business. *European Management Journal*, 21 (5), pp. 626-634.

Bassellier, G., & Benbasat, I. (2004). Business competence of information technology professionals: Conceptual development & influence on IT-business partnerships. *MIS Quarterly*, 28 (4), pp. 673–694.

Batagelj, Z. and Vehovar, V. (1998). Technical and Methodological Issues In WWW Surveys. *Proceedings of the 53rd Annual Conference of the American Association for Public Opinion Research* (AAPOR), St. Louis, MO.

Beamon, B.M. (1998). Supply chain design and analysis: Models and methods. *International Journal of Production Economics*, 55 (3), pp.281-294.

Beamon, B.M. (1999). Measuring supply chain performance. *International Journal of Operations and Production Management*, 19 (3), pp.275–292.

Belardo, S., Duchessi, P., & Coleman, J. R. (1994). A strategic decision support system at Orell Fussli. *Journal of Management Information Systems*, 10 (4), pp.135-157.

Benjamin, R.I., Rockart, J.F., Scott Morton, M.S., & Wyman, J. (1984). Information Technology: A Strategic Opportunity. *Sloan Management Review*, spring, pp.3-10.

Boynton, A.C., Zmud, R.W., & Jacobs, G.C. (1994). The Influence of IT Management Practice on IT Use in Large Organizations. *MIS Quarterly*, 18 (3), pp.299-318.

Brandyberry, A., Rai, A., & White, G. P. (1999). Intermediate performance impacts of advanced manufacturing technology systems: An empirical investigation. *Decision Sciences*, 30 (4), pp.993-1020.

Brown, C., and Magill, S. (1994). Alignment of IS functions with the enterprise: Toward a model of antecedents. *MIS Quarterly,* 18 (4), pp.371-403.

Brunn, P., Mefford, R.N., (2004). Lean production and the Internet. *International Journal of Production Economics,* 89(3), pp.247–260.

Burgess, K., Singh, P.J. and Koroglu, R. (2006). Supply chain management: a structured literature review and implications for future research. *International Journal of Operations & Production Management*, 26 (7), pp.703-29.

Burns, T., & Stalker, G. M. (1961). *The Management of Innovation*. London: Tavistock.

Byrd, T. A., & Davidson, N. W. (2003). Examining possible antecedents of IT impact on the supply chain & its effect on firm performance. *Information and Management*, 41 (2), pp. 243-255.

Camillus, J.C. and Lederer, A.L. (1985). Corporate strategy and design of computerized information systems. *Sloan Management Review*, 26 (3), pp.35-42.

Campbell, D. T. (1960). Recommendations for APA test standards regarding construct, trait, or discriminant validity. *The American Psychologist*, 15(8), pp.546-553.

Cash Jr., J. I., & Konsynski, B. R. (1985). IS redraws competitive boundaries. *Harvard Business Review*, 63 (2), pp.134-142.

Chan, Y., Huff, S., Barclay, D., & Copeland, D. (1997). Business strategic orientation, information systems strategic orientation, and strategic alignment. *Information Systems Research*, 8 (2), pp.125-150.

Chandler, A. D. (1962). *Strategy and Structure*. Cambridge, MA.: MIT Press

Chen, I.J. & Paulraj, A. (2004). Towards a theory of supply chain management: the constructs and measurements. *Journal of Operations Management*, 22 (2), pp.119-50.

Chen, I.J., Paulraj, A., & Lado, A. (2004). Strategic purchasing, supply management, and performance. *Journal of Operations Management*, 22 (5), pp.505-523.

Chin, W. W. (1998a). Issues and Opinion on Structural Equation Modeling. *MIS Quarterly*, 22(1), pp. 7-16.

Chin, W. W. (1998b). The Partial Least Squares Approach to Structural Equation Modeling. In Marcoulides, G. A. (Eds.), *Modern Methods for Business Research,* pp. 295-336. Lawrence Erlbaum Associates, Hillsdale, NJ.

Chin, W. W., Marcolin, B. L., and Newsted, P. R. (2003). A Partial Least Squares Latent Variable Modeling Approach for Measuring Interaction Effects: Results from a Monte Carlo Simulation Study and an Electronic Mail Emotion/Adoption Study. *Information Systems Research*, 14(2), pp. 189-217.

Chopra, S., & Meindl, P. (2001). *Supply Chain Management: Strategy, Planning, & Operation*. NJ: Prentice-Hall. Inc.

Christopher, M. (2000). The agile supply chain competing in volatile markets. *Industrial Marketing Management*, 29 (1), pp. 37-44.

Christopher, M., & Towill, D. R. (2000). Supply chain migration from lean & functional to agile & customized. *Supply Chain Management: An International Journal*, 5 (4) pp. 206-213.

Chung, S. H., Byrd, T.A., Lewis, B. R., and Ford, F. N. (2005). An empirical study of the relationships between IT infrastructure flexibility, mass customization, and business performance. *ACM SIGMIS Database*, 36 (3), pp.26-44.

Churchill, G. A. (1979). A paradigm for developing better measures of marketing constructs. *Journal of Marketing Research*, 16(1), pp.12-27.

Clark, T.H., & Stoddard, D.B. (1996). Interorganizational business process redesign: Merging technological and process innovation. *Journal of Management Information Systems,* 13 (2), pp.9-29.

Claycomb, C., Droge, C., & Germain, R. (1999). The effect of just-in-time with customers on organizational design and performance. *International Journal of Logistics Management,* 10 (1), pp.37–58.

Clemons, E. K., Reddi, S. P., & Row, M. C. (1993). The impact of information technology on the organization of economic activity: The "move to the middle" hypothesis. *Journal of Management Information Systems*, 10 (2), pp.9-35.

Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement*, 20, pp.37–46.

Cohen, S., & Roussel J. (2005). *Strategic Supply Chain Management: The Five Disciplines for Top Performance*. New York: McGraw-Hill.

Cook, T. D. and. Campbell, D. T. (1979). *Quasi-Experimentation: Design & Analysis Issues for Field Settings*. Chicago, Rand McNally College Pub. Co.

Cooper, J.C., (1993). Logistics strategies for global business. *International Journal of Physical Distribution and Logistics Management*, 23 (4), pp.12–23.

Daugherty, P.J., Ellinger, A.E., & Rogers, D.S. (1995). Information accessibility: Customer responsiveness and enhanced performance. *International Journal of Physical Distribution and Logistics Management*, 25 (1), pp.4-17.

Donaldson, L. (2001). *The Contingency Theory of Organizations*. Thousand Oaks, London: Sage Publications.

Donlon, J.P. (1996). Maximizing value in the supply chain. *Chief Executive*, 117, pp.54-63.

Duclos, L.K., Vokurka, R.J., & Lummus, R.R. (2003). A Conceptual Model of Supply Chain Flexibility. *Industrial Management and Data Systems*, 103 (6), pp.446-456.

Duncan, N.B. (1995). Capturing flexibility of information technology infrastructure: a study of resource characteristics and their measure. *Journal of Management Information Systems*, 12 (2), pp. 37 – 57.

Dyer, J. H., Dong, S. C., & Wujin, C. (1998). Strategic supplier segmentation: The next „best practice' in supply chain management. *California Management Review*, 40 (2), pp.57-77.

Earl, M. J. (1989). *Management Strategies for Information Technology*. New York: Prentice Hall.

Evans, R., and Danks, A. (1998). Strategic supply chain management: Creating shareholder value by aligning supply chain strategy with business strategy. In Gattorna, J.

(Eds), *Strategic supply chain alignment: Best practice in supply chain management* (pp.494-508). Aldershot, England: Gower.

Fawcett, S. E., Osterhaus, P., Magnan, G., Brau, J. C., & McCarter, M. W. (2007). Information sharing and supply chain performance: the role of connectivity and willingness *Supply Chain Management: An International Journal*, 12 (5), pp.358-368.

Fisher, M. L. (1997). What is the Right Supply Chain for Your Product? *Harvard Business Review*, 75 (2), pp.105-116.

Frazier, G.L., Spekman, R.E., & O'Neal C.R. (1988). Just-in- time exchange relationships in industrial markets. *Journal of Marketing*, 52(4), pp.52-67.

Frohlich, M.T., & Westbrook, R. (2001). Arcs of integration: an international study of supply chain strategies. *Journal of Operations Management*, 19 (2), pp.185-200.

Galbraith, J. (1973). *Designing Complex Organizations*. Reading, MA: Addison-Wesley.

Gay, L. R. and Airasian, P. (2003). *Educational Research: Competencies for Analysis and Applications*. Upper Saddle River, N.J., Merrill/Prentice Hall.

Goodpasture, V. (1995). Easton steps up to the plate. *Manufacturing Systems*, 13 (9), pp. 58-64.

Graham, S. T., Daugherty, P.J., & Dudley, W. N. (1994). The long-term strategic impact of purchasing partnerships. *Journal of Supply Chain Management*, 30 (4), pp.12-13.

Green Jr., K. W., Whitten, D., & Inman, R. A. (2008). The impact of logistics performance on organizational performance in a supply chain context. *Supply Chain Management*, 13 (4), pp.317-327.

Gunasekaran, A., & Ngai, E. W. T. (2004). Information systems in supply chain integration & management. *European Journal of Operational Research*, 159 (2), pp.269-295.

Gunasekaran, A., Lai, K., & Cheng, E. (2008). Responsive supply chain: A competitive strategy in a networked economy. *Omega*, 36 (4), pp.549-564.

Gunasekaran, A., Patel, C., &Tirtiroglu, E. (2001). Performance measures and metrics in a supply chain environment. *International Journal of Operations and Production Management*, 21, (1-2), pp.71-87.

Gupta, Y., Karimi, J., & Somers, T. M. (1997). Alignment of a firm's competitive strategy & information technology management sophistication: the missing link. *IEEE Transactions on Engineering Management*, 44 (4), pp.399-413.

Hair, J. F., Anderson, R. E. (1995). *Multivariate Data Analysis*. Upper Saddle River, New Jersey, Prentice Hall.

Handfield, R.B., & Nichols Jr., E.L. (1999). *Introduction to Supply Chain Management*. Upper Saddle River, NJ: Prentice-Hall.

Hax, A.C., & Majluf, N.S. (1984).The corporate strategic planning process. Interfaces, 14 (1), pp.47-60.

Henderson, J., & Venkatraman, N. (1993). Strategic alignment: leveraging information technology for transforming organizations. *IBM Systems Journal*, 32(1), pp.4-16.

Holmberg, S. (2000). A systems perspective on supply chain measurements. *International Journal of Physical Distribution and Logistics Management*, 30 (10), pp.847-868.

Huang, S.H., Uppal, M., & Shi, J. (2002). A product driven approach to manufacturing supply chain selection. *Supply Chain Management: An International Journal*, 7 (2), pp.189-199.

Ilebrand, N., Mesøy, T., and Vlemmix, R. (2010). Using IT to enable a lean transformation. *McKinsey Quarterly*, 18 Winter, pp.1–3.

Jacobs, F. R., & Chase, R. B. (2008). *Operations and Supply Management: The Core*. New York, NY: McGraw-Hill.

Jarrell, J.L. (1998). Supply chain economics. *World Trade*, 11(11), pp.58–61.

Jarvenpaa, S.L. (1989). The Effect of Task Demands and Graphical Format on Information Processing Strategies. *Management Science*, 35(3), pp. 285-303.

Jones, P., Clarke-Hill, C., Hillier, D. & Comfort, D. (2005).The benefits, challenges & impacts of radio frequency identification technology (RFID) for retailers in the UK. *Marketing Intelligence & Planning*, 23 (4), pp. 395-402.

Joreskog, K. G., & Sorbom, D. (1989). *LISREL 7 users reference guide*. Chicago, IL:

Scientific Software Inc.

Kaiser, H. F. (1958). The varimax criterion for analytic rotation in factor analysis. *Psychometrika,* 23 pp.187-200.

Kearns, G., & Lederer, A. (2003). A resourced-based view of strategic IT alignment: How knowledge sharing creates competitive advantage. *Decision Sciences*, 34 (1), pp.1-29.

Kearns, G.S., & Sabherwal, R. (2006/2007). Strategic alignment between business and information technology: A knowledge-based view of behaviors, outcome, and consequences. *Journal of Management Information Systems*, 23 (3), pp.129-162.

Kiefer, A. W., & Novack, R. A. (1999). An empirical analysis of warehouse measurement systems in the context of supply chain implementation. *Transportation Journal*, 38 (3), pp.18-27.

Kim, D., Cavusgil, T.S., & Calantone, R.J. (2006). Information systems innovations and supply chain management: Channel relationships and firm performance. *Journal of Academy of Marketing Science*, 34(1), pp.40-54.

Kim, S. W., & Narasimhan, R. (2002). Information system utilization in supply chain integration efforts. *International Journal of Production Research*, 40 (18), pp.4585-4609.

King, W. R. (1978). Strategic planning for management information systems. *MIS Quarterly*, 2 (1), pp.27-37

Koh, S.C., Demirbag, M., Bayraktar, E., Tatoglu, E., & Zaim, S. (2007). The impact of supply chain management practices on performance of SMEs. *Industrial Management and Data Systems*, 107 (1), pp.103-124.

Kumar, V., Fantazy, K., Kumar, U., & Boyle, T. A. (2006). Implementation and management framework for supply chain flexibility. *Journal of Enterprise Information Management*, 19 (3), pp.303-319.

Kyobe, M. E. (2004). Investigating the Strategic Utilization of IT Resources in the Small and Medium-Sized Firms of the Eastern Free State Province. *International Small Business Journal*, 22 (2), pp.131-158.

Lawrence, P.R., & Lorsch, J.W. (1967). *Organizations and Environment: Managing Differentiation and Integration*. Cambridge, MA.: Harvard University Press.

Lee H., & Billington, C. (1992). Managing Supply Chain Inventories: Pitfalls and Opportunities. *Sloan Management Review*, 33(3), pp.65-73.

Lee, H. L. (2002). Aligning supply chain strategies with product uncertainties. *California Management Review*, 44 (3), pp.105-119.

Lee, H.L. (2000). Creating value through supply chain integration. *Supply Chain Management Review*, 4 (4), pp.30-36.

Li, S. & Lin, B. (2006). Accessing information sharing and information quality in supply chain management. *Decision Support Systems*, 42 (3), pp.641-1656.

Li, S., Ragu-Nathan, B., Ragu-Nathan, T.S. & Rao, S. S. (2006).The impact of supply chain management practices on competitive advantage and organizational performance. *Omega*, 34 (2), pp.107-124.

Li, S., Rao, S. S., Ragu-Nathan, T.S., & Ragu-Nathan, B. (2005). Development and validation of a measurement instrument for studying supply chain management practices. *Journal of Operations Management*, 23 (6), pp.618-641.

Lin, C., Chiu, H., & Chu, P. (2006). Agility index in the supply chain. *International Journal of Production Economics*, 100 (2), pp.285-299.

Lockamy, A. and McCormack, K. (2004). Linking SCOR planning practices to supply chain performance. *International Journal of Operations and Production Management*, 24 (12), pp.1192-1218.

McLaren, T. S., Head M. M., and Yuan, Y. (2004). Using competitive strategy patterns to determine ideal supply chain management information systems capabilities. *International Journal of Internet and Enterprise Management*, 2(1), pp.45-61.

Magretta, J. (1998). The power of virtual integration: an interview with Dell Computer's Michael Dell. *Harvard Business Review*, 76 (March–April), pp.72-85.

Maloni, M. J., & Benton, W.C. (1997). Supply chain partnerships: Opportunities for operations research. *European Journal of Operational Research*, 101 (3), pp.419-429.

Mason-Jones, R., & Towill, D.R. (1997). Information enrichment: Designing the supply chain for competitive advantage. *Supply Chain Management,* 2 (4), pp.137-148.

Mason-Jones, R., Naylor, B., & Towill, D. R. (2000). Lean, agile or leagile? Matching your supply chain to the marketplace. *International Journal of Production Research*, (38), pp. 4061-4070.

McFarlan, F.W., & McKenney, J. L. (1983) *Corporate Information Systems Management: The Issue Facing Senior Executive*. Dow Jones: Irwin.

McIvor, R. (2001). Lean supply: the design and cost reduction dimensions. *European Journal of Purchasing & Supply Management*, 7 pp.227-242.

McKay, D. T. & Brockway, D. W. (1989). Building I/T Infrastructure for the1990s. *Stage by Stage,* 9 (3), pp.1-11.

McLaren, T. S., Head, M. M., & Yuan, Y. (2004). Supply chain management information systems capabilities. An exploratory study of electronics manufacturers. *Information Systems and e-Business Management*, 2 (2-3), pp.207-222.

Mikkola, J. H., & Skjøtt-Larsen, T. (2004). Supply-chain integration– implications for mass customization, modularization and postponement strategies. *Production Planning & Control*, 15(4), pp.352–361.

Miles, R. E., & Snow, C. C. (1978). *Organizational Strategy, Structure, and Process*. New York: McGraw-Hill.

Min, S., & Mentzer, J.T. (2004). Developing and measuring supply chain management concepts. *Journal of Business Logistics*, 25 (1), pp.63-99

Mintzberg, H. (1981). Organization design: Fashion or fit? *Harvard Business Review*, 59 (1), pp.103-116.

Moberg, C. R., Cutler, B. D., Gross, A., & Speh, T.W. (2002). Identifying antecedents of information exchange within supply chains. *International Journal of Physical Distribution and Logistics Management*, 32 (9), pp.755-770.

Mohr, J., & Spekman, R. (1994). Characteristics of partnership success: partnership attributes, communication behavior and conflict resolution techniques. *Strategic Management Journal*, 15 (2), pp.135-152.

Monczka, R. M., Petersen, K. J., Handfield, R. B., & Ragatz, G. L. (1998). Success factors in strategic supplier alliances: The buying company perspective. *Decision Sciences*, 29 (3), pp.553-577.

Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research*, 2 (3), pp.192-222.

Morgan, C. (2004). Structure, speed and salience: performance measurement in the supply chain. *Business Process Management Journal*, 10 (5), pp.522-36.

Nahm, A. Y., Solis-Galvan, L. E., Rao, S. S., Ragu-Nathan, T.S. (2002). The Q-Sort Method: Assessing Reliability and Construct Validity of Questionnaire Items at a Pre-Testing Stage. *Journal of Modern Applied Statistical Methods,* 1(1), pp.114-125.

Narasimhan, R. (1997). Strategic supply management: a total quality management imperative. *Advances in the Management of Organizational Quality*, 2, pp. 39-86.

Narasimhan, R., & Jayaram, J. (1998). Causal linkages in supply chain management: an exploratory study of north american manufacturing firms. *Decision Sciences*, 29 (3), pp.579-605.

Narasimhan, R., & Kim, S. W. (2001). Information system utilization strategy for supply chain integration. *Journal of Business Logistics*, 22 (2), pp.51-75.

Narasimhan, R., & Kim. S. W. (2002). Effect of supply chain integration on the relationship between diversification and performance: evidence from Japanese and Korean firms. *Journal of Operations Management*, 20 (3), pp.303-323.

Naylor, B. J., Naim, M. M. & Berry, D. (1999). Leagility: Integrating the lean & agile manufacturing paradigms in the total supply chain. *International Journal of Production Economics*, 62 (1-2), pp.107-118.

Nickles, T., Mueller, J., & Takacs, T. (1998). Strategy, information technology & the supply chain: Managing information technology for success, not just survival. In Gattorna, J. (Eds), *Strategic supply chain alignment: Best practice in supply chain management* (pp.494-508). Aldershot, England: Gower.

Nunnally, J. (1978). *Psychometric theory*. New York: McGraw-Hill.

Owens, G., & Richmond, B. (1995). Best Practices in Retailing: How to Reinvent Your Supply Chain: What Works, What doesn't. *Chain Store Age*, 71 (11), pp.96-98.

Overby, E., Bharadwaj, A., and Sambamurthy, V. (2006). Enterprise agility and the enabling role of information technology. *European Journal of Information Systems*, 15, pp.120–131.

Pagh, J.D., & Cooper, M.C., (1998). Supply chain postponement and speculation strategies: how to choose the right strategy. *Journal of Business Logistics*, 19 (2), pp.13-33.

Parsons, G.L. (1983). Information technology: a new competitive weapon. *Sloan Management Review*, 25 (1), pp.3-14.

Philip, G., & Booth, M. E. (2001). A new six 'S' framework on the relationship between the role of information systems (IS) and competencies in 'IS' management. *Journal of Business Research*, 51, pp.233-24.

Porter, M. E. & Millar, V. E. (1985). How information gives you a competitive advantage. *Harvard Business Review*, 63 (4), pp.149-160.

Porter, M. E. (1990). *The Competitive Advantage of Nations*. New York, NY: The Free Press.

Power, D.J., Sohal, A., & Rahman, S.U. (2001). Critical success factors in agile supply chain management: an empirical study. *International Journal of Physical Distribution & Logistics Management*, 31(4), pp.247–65.

Prasad, S., & Tata, J. (2000). Information investment in supply chain management. *Logistics Information Management*, 13 (1), pp.33-38.

Prats, L. M., (2003). The adaptive Supply Chain: Postponement for Profitability, Oracle Corporation and Cap Gemini Ernst & Young. Retrieved December 2, 2008, from http://www.oracle.com/applications/postponement-for-profitability-brochure.pdf

Puckridge, D. S. & Woolsey, I. (2003). Information systems strategy for supply chains. In Gattorna, J. (Eds), *Gower Handbook of Supply Chain Management* (pp.406-425). Aldershot, England: Gower.

Quinn, F.J. (1997). Team up for supply chain success. *Logistics Management*, (36) pp.39-41.

Rai, A., Patnayakuni, R., & Seth, N. (2006). Firm performance impacts of digitally enabled supply chain integration capabilities. *MIS Quarterly*, 30 (2), pp.225-246.

Rich, N., & Hines, P. (1997). Supply chain management and time based competition: The role of the supplier association. *International Journal of Physical Distribution & Logistics Management,* 27 (3/4), pp.210-225.

Richmond, B., Burns, A., Mabe, J., Nuthall, L., & Toole, R. (1998). Supply chain management tools minimizing the risks: maximizing the benefits. In Gattorna, J. (Eds), *Strategic supply chain alignment: Best practice in supply chain management* (pp.509-520). Aldershot, England: Gower.

Rockart, J. F. & Morton, M. S. (1984). Implications of changes in Information technology for Corporate Strategy. *Interfaces*, 14 (1) pp.84-95.

Sabherwal, R., & Chan, Y. E. (2001). Alignment between business & IS strategies: a study of prospectors, analyzers, & defenders. *Information Systems Research*, 12 (1), pp.11-33.

Sabherwal, R., & Kirs, P. (1994). The alignment between organizational critical success factors and information technology capability in academic institutions. *Decision Sciences*, 25 (2), pp.301-330.

Schoenfeldt, L. F. (1984). Psychometric Properties of Organizational Research Instruments. In Bateman, T. S. and Ferris. G. R. (Eds), *Method and Analysis in Organizational Research*. Reston, Va. Reston Publishing Company.

Sanders, N.R. (2008). Pattern of information technology use: the impact on buyer-suppler coordination and performance. *Journal of Operations Management*, 26 (3), pp.349-67.

Sarkis, J., & Talluri, S. (2002). A model for strategic supplier selection. *Journal of Supply Chain Management*, 38 (1), pp.18-28.

Segars, A. H. and Grover, V. (1993). Re-examining perceived ease of use and usefulness: A confirmatory factor analysis. *MIS Quarterly,* 17(4), pp. 517-525.

Shah, R. &. Ward, P.T. (2003). Lean manufacturing: context, practice bundles, and performance. *Journal of Operations Management*, 21 (2), pp.129-149.

Shah, R., Goldstein, S. M., & Ward, P. T. (2002). Aligning supply chain management characteristics & inter-organizational information system types: An exploratory study. *IEEE Transactions on Engineering Management*, 49 (3), pp.282-292.

Shapiro, C., & Varian, H.R. (1999). *Information Rules*. Boston, MA: Harvard Business School Press.

Shin, H., Collier, D.A., & Wilson, D.D. (2000). Supply management orientation and supplier/buyer performance. *Journal of Operations Management*, 18, pp.317-333.

Simchi-Levi, D. (2005). Tactical planning for reinventing the supply chain. In Harrison, T.P., Lee, H.L., and Neale, J.J. (Eds), *The practice of supply chain management: Where Theory and Application Converge* (pp 15-30). Springer Science & Business Media, USA.

Simchi-Levi, D., Kaminsky, P., & Simchi-Levi, E. (2003). *Designing and Managing the Supply Chain: Concepts, Strategies, and Case studies*. Boston: Irwin/McGraw-Hill.

Spekman, R.E, Kamauff Jr., J.W., & Myhr, N. (1998). An empirical investigation into supply chain management: a perspective on partnerships. *Supply Chain Management*, 3(2), pp.53-67.

Smith, T. (2001). Call this Efficient? Supply Chain isn't Place to Experiment', in *Internetweek*.

Staff, (1999). Survey says supply chain not meeting needs. *Modern Materials Handling*, 45, (4), p.27.

Stalk, G., & Hout, T. M. (1990). *Competing Against Time: How Time-based Competition is Reshaping Global Markets*. New York, NY: The Free Press.

Stevens, G. C. (1990). Successful supply-chain management. *Management Decision*, 28 (8), pp.25-30.

Stock, G.N., Greis, N.P, & Kasarda, J.D. (2000). Enterprise logistics and supply chain structure: the role of fit. *Journal of Operations Management*, 18 (5), pp.531-47.

Stock, G.N.; Greis, N.P. & Kasarda, J.D. (1998). Logistics, strategy and structure: A conceptual framework. *International Journal of Operations and Production Management*, 18 (1), pp.37-52.

Stuart, F.I., 1993. Supplier Partnerships: Influencing Factors and Strategic Benefits. *Journal of Supply Chain Management*, 29 (4), pp.21-29.

Subramani, M., & Venkatraman, N. (2003). Safeguarding investments in asymmetric interorganizational relationships: Theory and evidence. *Academy of Management Journal,* (46) 1, pp.46-62.

Suzaki, K. (1987). *The New Manufacturing Challenge*. New York: The free Press.

Swafford, P.M., Ghosh, S. and Murthy, N. (2006). The antecedents of supply chain agility of a firm: scale development and model testing. *Journal of Operations Management*, 24, pp.170-88.

Tan, K. C., Kannan, V.R., & Handfield, R. B. (1998). Supply chain management: supplier performance and firm performance. *International Journal of Purchasing and Materials Management*, 34 (3), pp.2-9.

Tan, K. H., Lyman, S. B., & Wisner, J. D. (2002). Supply chain management: a strategic perspective. *International Journal of Operations & Production Management*, 22 (6), pp.614-631.

Tan, K.C., Kannan, V.J., Handfield, R.B., & Ghosh, S. (1999). Supply chain management: an empirical study of its impact on firm performance. *International Journal of Operations and Production Management,* 19 (10), pp.1034-1052.

Tan, K.H. (2001). A framework of supply chain management literature. *European Journal of Purchasing & Supply Management*, 7 (1), pp.39-48.

Tarafdar, M., & Qrunfleh, S. (2009). IT-Business Alignment: The Two level Decision. *Information Systems Management*, 26(4), pp.338-349.

Taylor, D.H., (1999.) Supply chain improvement: the lean approach. *Logistics Focus* 7 (January–February (1), 14–20.

Towill, D., & Christopher, M. (2002). The supply chain strategy conundrum: To be lean or agile or to be lean & agile? *International Journal of Logistics: Research & Applications*, 5 (3), pp.299-309.

Tu, Q., Vonderembse, M. A., Ragu-Nathan, T. S., &Ragu-Nathan, B. (2004). Measuring Modularity-Based Manufacturing Practices and Their Impact on Mass Customization Capability: A Customer-Driven Perspective. *Decision Sciences*, 35 (2), pp.147-168.

Tunc, E.A., & Gupta, J.N.D. (1993). Is time a competitive weapon among manufacturing firms? *International Journal of Operations and Production Management*, 13 (3), pp.4-12.

Turner, J.R. (1993). Integrated supply chain management: what's wrong with this picture? Industrial Engineering, 25 (12), pp.52-55.

Ulusoy, G. (2003). An assessment of supply chain and innovation management practices in the manufacturing industries in Turkey. International Journal of Production Economics, 86, pp.251-70.

van Hoek, R.I. (1998). Measuring the unmeasurable—measuring and improving performance in the supply chain. *Supply Chain Management: an International Journal*, 3 (4), pp.187-192.

van Hoek, R.I. (1999). Postponement and the reconfiguration challenge for food supply chains. *Supply Chain Management: an International Journal*, 4(1), pp.18-34.

van Hoek, R.I., Harrison, A., & Christopher, M. (2001). Measuring agile capabilities in the supply chain. *International Journal of Operations & Production Management*, 21 (1-2), pp. 126-148.

Venkatraman, N. (1989a). Strategic orientation of business enterprises: the construct, dimensionality, and measurement. *Management Science*, 35 (8), pp.942-962.

Venkatraman, N. (1989b). The Concept of Fit in Strategy Research: Toward Verbal and Statistical Correspondence. *The Academy of Management Review*, 14 (3), pp. 423-444.

Venkatraman, N., & Ramanujam, V. (1986). Measurement of business performance in strategy research: A comparison of approaches. *Academy of Management Review*, 11, pp.801-814.

Vessey, I. (1984). An Investigation of the Psychological Processes Underlying the Debugging of Computer Programs. *Unpublished Ph.D. dissertation, Department of Commerce*, The University of Queensland, Queensland, Australia.

Vickery, S. K., Jayaram, J., Droge, C., & Calantone, R. (2003). The effects of an integrative supply chain strategy on customer service and financial performance: an analysis of direct versus indirect relationships. *Journal of Operations Management*, 21 (5), pp.523-539.

Vickery, S., Calantone, R., & Droge, C. (1999). Supply chain flexibility: an empirical study. *Journal of Supply Chain Management*, 35 (3), pp.16-24.

Vijayasarathy, L. R., & Robey, D. (1997). The effect of EDI on market channel relationships in retailing. *Information & Management*, 33 (2), pp.73-86.

Vitasek, K., Manrodt, K. B., & Abbott, J., (2005).What makes a lean supply chain? *Supply Chain Management Review*, 9 (7), pp.39-45.

Vonderembse, M. A., Uppal, M., Huang, S. H., & Dismukes, J. P. (2006). Designing supply chains: Towards theory development. *International Journal of Production Economics*, 100 (2), pp.223-238.

Vonderembse, M.A., & Tracey, M. (1999). The impact of supplier selection criteria and supplier involvement on manufacturing performance. *The Journal of Supply Chain Management: a Global Review of Purchasing and Supply,* 35 (3), pp.33-39.

Waller, M. A., Dabholkar, P. A. & Gentry, J. J. (2000). Postponement, product customization, and market-oriented supply chain management. *Journal of Business Logistics*, 21 (2), pp.133-160.

Wang, G., Huang, S. H., & Dismukes, J. P. (2004). Product-driven supply chain selection using integrated multi-criteria decision-making methodology. *International Journal of Production Economics*, 91 (1), pp.1-15.

Ward, J.M. (1987). Integrating information systems into business strategies. *Long Range Planning*, 20 (3), pp.19-29.

Weerakkody, V. J. P. & Hinton, C. M. (1999). Exploiting information systems and technology through business process improvement. *Knowledge and Process Management*, 6 (1), pp.17-23.

Weill, P. (1990). Strategic investment in information technology: An empirical study. *Information Age*, 12 (3), pp.141-147.

Weill, P. (1993). The role and value of information technology infrastructure: Some empirical observations. In Banker R, Kaufftnan R., & Mahmood M.A. (Eds), *Strategic Information Technology Management: Perspectives on Organizational Growth and Competitive Advantage* (pp.547-572). Middleton, PA: Idea Group.

Williamson, P. (1991). Supplier strategy and customer responsiveness managing the links. *Business Strategy Review*, 2 (2), pp.75-90.

Wines, L. (1996). High order strategy for manufacturing. *The Journal of Business Strategy*, 17(4), pp.32-3.

Wiseman, C. (1988). *Strategic Information Systems*. Homewood, Illinois: Irwin.

Wisner, J.D. (2003). A structural equation model of supply chain management strategies and firm performance. *Journal of Business Logistics*, 24 (1), pp.1-26.

Womack, J., Jones, D. (1996). *Lean Thinking*. New York: Simon and Schuster.

Wong, C.Y., Arlbjorn, J. S., & Johansen, J. (2005). Supply chain management practices in toy supply chains. *Supply Chain Management: An International Journal*, 10 (5), pp.367-378.

Yamin, S., Gunasekruan, A., & Mavondo, F.T. (1999). Relationship between generic strategy, competitive advantage and firm performance: an empirical analysis. *Technovation,* 19 (8), pp.507-18

Yang, B., & Burns, N.D. (2003). Implications of postponement for the supply chain. International Journal of Production Research, 41 (9), pp.2075-90.

Yang, B., Burns, N.D. and Backhouse, C.J (2004). Postponement: A Review and Integrated Framework. *International Journal of Operations & Production Management*, 24 (5), pp.468-487.

Yu, Z., Yan, H., & Cheng, T. E. (2001). Benefits of information sharing with supply chain partnerships. *Industrial Management & Data Systems*, 101 (3), pp.114-121.

Zeng, Y., Chiang, R. H. L. &Yen, D. C. (2003). Enterprise integration with advanced information technologies: ERP and data warehousing. *Information Management & Computer Security*, 11 (3), pp.115-122.

Zhang, M. J., & Lado, A. A. (2001). Information systems and competitive advantage: a competency-based view. *Technovation*, 21 (3), pp.147-156.

Zhou, H., & Benton, W.C. (2007). Supply chain practice and information sharing. *Journal of Operations Management*, 25 (6), pp.1348-1365.

Zielke, A., & Pohl, M. (1996). Virtual vertical integration: The key to success. *McKinsey Quarterly*, 3, pp.160-163.

Zinn,W., & Bowersox, D.J., (1988). Planning physical distribution with the principle of postponement. *Journal of Business Logistics*, 9 (2), pp.117-137.

Appendix A

Measurement Items Entering First Q-Sort Analysis

SCM STRATEGY

Lean Supply Chain

Our suppliers help us to reduce our costs by delivering what we need.
Our suppliers help us to reduce our costs by delivering when we need.
Our suppliers help us to reduce our costs by delivering into the production line (and not at a receiving dock).
Our suppliers help us to reduce our costs by delivering frequently as per our requirements.
Our suppliers help us to reduce our costs by adopting quality practices as per our requirements.
Our suppliers help us to reduce our costs by managing their quality as per our requirements.
Our suppliers help us to reduce our costs by inspecting their products frequently as per our requirements.

Agile Supply Chain

Our suppliers help us to be responsive and flexible by reducing lead-times.

Our suppliers help us to be responsive and flexible by reducing product development cycle times.
Our suppliers help us to be responsive and flexible by quickly responding to our changing requirements of cost.
Our suppliers help us to be responsive and flexible by quickly responding to our changing requirements of volume.
Our suppliers help us to be responsive and flexible by quickly responding to our changing requirements of delivery time.
Our suppliers help us to be responsive and flexible by quickly responding to our changing requirements of design.
Our suppliers help us to be responsive and flexible by quickly responding to our changing requirements of customization.
Our suppliers help us to be responsive and flexible by effectively responding to our changing requirements of cost.

Our suppliers help us to be responsive and flexible by effectively responding to our changing requirements of volume.
Our suppliers help us to be responsive and flexible by effectively responding to our changing requirements of delivery time.
Our suppliers help us to be responsive and flexible by effectively responding to our changing requirements of design.
Our suppliers help us to be responsive and flexible by effectively responding to our changing requirements of customization.

Hybrid Supply Chain

Our suppliers help us to achieve assemble-to-order strategy by customizing our products by adding feature modules as requested by us.
Our suppliers help us to achieve assemble-to-order strategy by responding to customization requirements quickly.
Our suppliers help us to achieve assemble-to-order strategy by producing modular products as requested by us.
Our suppliers help us to achieve assemble-to-order strategy by delaying the product final assembly until we place an order.
Our suppliers help us to achieve assemble-to-order strategy by changing the design of the product as requested by us.

IS STRATEGY

The applications we acquire help us to improve the efficiency of our supplier operations.
The applications we acquire help us to facilitate negotiation with our suppliers.
The applications we acquire help us to monitor performance of our suppliers.
The applications we acquire help us to manage inventory between our suppliers and us.
The applications we acquire help us to manage material requirement planning of our facility.
The applications we acquire help us to manage production control between our suppliers and us.
The applications we acquire help us to coordinate (production and information) across suppliers and product lines.

The applications we acquire help us to introduce new product and/or service in our markets.
The applications we acquire help us to share information within our firm.
The applications we acquire help us to share information with our suppliers.
The applications we acquire help us to monitor changes in our market condition.
The applications we acquire help us to respond to changes in the market.

The applications we acquire help us to model possible future outcomes and identify alternative courses of action.
The applications we acquire help us to change the design of the product.

The applications we acquire help us to interact with customer.
The applications we acquire help us to interact with suppliers.
The applications we acquire help us to provide sufficient detailed information to support careful decision making.
The applications we acquire help us to provide detail analysis of major supplier's decision.
The applications we acquire help us to provide support for decision making.
The applications we acquire help us to adopt a rather conservative view when making major decisions.

ALIGNMENT BETWEEN SUPPLY CHAIN MANAGEMENT STRATEGY AND IS STRATEGY

The applications we have enhance the ability to deliver frequently.
The applications we have enhance the ability to deliver what we need.
The applications we have enhance the ability to deliver when we need.
The applications we have enhance the ability to deliver into the production line (and not at a receiving dock).
The applications we have enhance the ability to adopt quality practices.
The applications we have enhance the ability to manage quality.
The applications we have enhance the ability to inspect products frequently.

The applications we have enhance the ability to reduce lead-times.
The applications we have enhance the ability to reduce product development cycle times.
The applications we have enhance the ability to respond quickly to our changing requirements of cost.
The applications we have enhance the ability to respond quickly to our changing requirements of volume.
The applications we have enhance the ability to respond quickly to our changing requirements of delivery time
The applications we have enhance the ability to respond quickly to our changing requirements of design.
The applications we have enhance the ability to respond quickly to our changing requirements of customization.
The applications we have enhance the ability to respond effectively to our changing requirements of cost.
The applications we have enhance the ability to respond effectively to our changing requirements of volume.

The applications we have enhance the ability to respond effectively to our changing requirements of delivery time. The applications we have enhance the ability to respond effectively to our changing requirements of design.
The applications we have enhance the ability to respond effectively to our changing requirements of customization.

The applications we have enhance the ability to customize our products by adding feature modules as requested.
The applications we have enhance the ability to produce modular products.
The applications we have enhance the ability to respond to customization requirements quickly.
The applications we have enhance the ability to delay the product final assembly until customers make an order
The applications we have enhance the ability to change the design of the product.

IT UTILIZATION

External Focus of IT

In our firm, we use IT for selecting suppliers.
In our firm, we use IT for solving problems jointly with our suppliers.
In our firm, we use IT for helping our suppliers to improve their product quality.
In our firm, we use IT for building continuous improvement programs that include our key suppliers.
In our firm, we use IT for including our key suppliers in our planning and goal-setting activities.
In our firm, we use IT for interacting with customers to set reliability, responsiveness, and other standards for us.
In our firm, we use IT for measuring and evaluating customer satisfaction.
In our firm, we use IT for determining customer feedback about our products/services.
In our firm, we use IT for facilitating customers' ability to seek assistance from us.
In our firm, we use IT for facilitating customer service activities.
In our firm, we use IT for monitoring supplier performance
In our firm, we use IT for order placing and purchasing
In our firm, we use IT for communicating product specifications

Internal Focus of IT

In our firm, we use IT for reducing manufacturing set-up time.
In our firm, we use IT for building and maintaining continuous quality improvement program.
In our firm, we use IT for using a "Pull" production system.
In our firm, we use IT for demand forecasting.
In our firm, we use IT for designing products for modular assembly.

In our firm, we use IT for delaying final product assembly activities until customer orders have actually been received.
In our firm, we use IT for delaying final product assembly activities until the last position (or nearest to customers) in the supply chain.
In our firm, we use IT for storing our parts/products at appropriate distribution points close to the customer

Infrastructural Focus of IT

In our firm, we use IT for informing trading partners in advance of changing needs.
In our firm, we use IT for sharing proprietary information with our trading partners.
In our firm, we use IT for sharing business knowledge of core business processes with our trading partners.
In our firm, we use IT for sharing our proprietary information with our trading partners
In our firm, we use IT for exchanging timely information between our trading partners and us.
In our firm, we use IT for exchanging accurate information between our trading partners and us.
In our firm, we use IT for exchanging complete information between our trading partners and us.
In our firm, we use IT for exchanging adequate information between our trading partners and us.
In our firm, we use IT for exchanging reliable information between our trading partners and us.

ALIGNMENT BETWEEN SUPPLY CHAIN MANAGEMENT PRACTICES AND USAGE OF IT

The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to select suppliers based on their quality.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to solve problems jointly with our suppliers.

The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to build continuous improvement programs that include our key suppliers.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to Include our key suppliers in our planning and goal-setting activities.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to interact with customers to set reliability, responsiveness, and other standards for us.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to measure and evaluate customer satisfaction.

The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to determine future customer expectations.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to facilitate customers' ability to seek assistance from us.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to periodically evaluate the importance of our relationship with our customers.

The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to inform our trading partners in advance of changing needs.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to share proprietary information of our trading partners with us.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to share business knowledge of core business processes with our trading partners.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to share our proprietary information with our trading partners .
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to exchange information with our trading partners in a timely manner.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to exchange information with our trading partners in a accurate manner.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to exchange information with our trading partners in a complete manner.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to exchange information with our trading partners in a adequate manner.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to exchange information with our trading partners in a reliable manner.

The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to Reduce manufacturing set-up time.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to Build and maintain continuous quality improvement program.

The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to Use a "Pull" production system.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to Push suppliers for shorter lead-times.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to Design products for modular assembly.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to Delay final product assembly activities until customer orders have actually been received.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to Delay final product assembly activities until the last possible position (or nearest to customers) in the supply chain.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to Store our parts/products at appropriate distribution points close to the customer.

Appendix B

Cohen’s Kappa and Moore and Benbasat Coefficient

The Q-sort method is an iterative process in which the degree of agreement between judges forms the basis of assessing construct validity and improving the reliability of the constructs. The Q-sort method was devised by Nahm et al. (2002) as a method of assessing reliability and construct validity of questionnaire items that are generated for survey research. This method is applied as a pilot study, which comes after the pre-test and before administering the questionnaire items as a survey (Nahm et al., 2002). The method is simple, cost efficient and accurate and provides sufficient insight into potential problem areas in the questionnaire items that are being tested. The method consists of two stages. In the first stage, two judges are requested to sort the questionnaire items according to different constructs, based on which the inter-judge agreement is measured. In the second stage, questionnaire items that were identified as being too ambiguous, as a result of the first stage, are reworded or deleted, in an effort to improve the agreement between the judges. The process is carried out repeatedly until a satisfactory level of agreement is reached.

The following example describes the theoretical basis for the Q-sort method and the two evaluation indices to measure inter-judge agreement level: Cohen’s Kappa (Cohen, 1960) and Moore and Benbasat’s „Hit Ratio” (Moore and Benbasat, 1991). Let us assume that two judges independently classified a set of N components as either acceptable or rejectable. After the work was finished the following table was constructed:

	Judge 1			
		Acceptable	Rejectable	Totals
Judge 2	Acceptable	X_{11}	X_{12}	X_{1+}
	Rejectable	X_{21}	X_{22}	X_{2+}
	Totals	X_{+1}	X_{+2}	N

Xij = the number of components in the i^{th} row and j^{th} column, for i,j = 1,2.

The above table can also be constructed using percentages by dividing each numerical entry by N. For the population of components, the table will look like:

Judge 1				
Judge 2		Acceptable	Rejectable	Totals
	Acceptable	P_{11}	P_{12}	P_{1+}
	Rejectable	P_{21}	P_{22}	P_{2+}
	Totals	P_{+1}	P_{+2}	100

Pij = the percentage of components in the i^{th} row and j^{th} column.

We will use this table of percentages to describe the Cohen's Kappa coefficient of agreement. The simplest measure of agreement is the proportion of components that were classified the same by both judges, i.e., Σi Pii = P11 + P22. However, Cohen suggested comparing the actual agreement, Σi Pii, with the chance of agreement that would occur if the row and columns are independent, i.e., Σi Pi+P+i. The difference between the actual and chance agreements, Σi Pii - Σi Pi+P+i, is the percent agreement above that which is due to chance. This difference can be standardized by dividing it by its maximum possible value, i.e., 100% - Σi Pi + P+I = 1 - Σi Pi +P+i. The ratio of these is denoted by the Greek letter kappa and is referred to as Cohen's kappa.

$$k = \frac{\Sigma_i P_{ii} - \Sigma_i(P_{i+} P_{+i})}{1 - \Sigma_i(P_{i+} P_{+i})}$$

Thus, Cohen's Kappa is a measure of agreement that can be interpreted as the proportion of joint judgment in which there is agreement after chance agreement is excluded. The three basic assumptions for this agreement coefficient are: 1) the units are independent, 2) the categories of the nominal scale are independents, mutually exclusive, and 3) the judges operate independently. For any problem in nominal scale agreement between two judges, there are only two relevant quantities:

po= the proportion of units in which the judges agreed
pc= the proportion of units for which agreement is expected by chance

Like a correlation coefficient, k=1 for complete agreement between the two judges. If the observed agreement is greater than or equal to chance $K <= 0$. The minimum value of k occurs when ΣPii =0, i.e.

$$\min(k) = \frac{- \Sigma_i(P_{i+} P_{+i})}{1 - \Sigma_i(P_{i+} P_{+i})}$$

When sampling from a population where only the total N is fixed, the maximum likelihood estimate of k is achieved by substituting the sample proportions for those of the population. The formula for calculating the sample kappa (k) is:

$$k = \frac{N_i Xii - \Sigma_i(X_{i+} X_{+i})}{N^2 - \Sigma_i(X_{i+} X_{+i})}$$

For kappa, no general agreement exists with respect to required scores. However, recent studies have considered scores greater than 0.65 to be acceptable (e.g. Vessey, 1984; Jarvenpaa 1989; Solis-Galvan, 1998). Landis and Koch (1977) have provided a more detailed guideline to interpret kappa by associating different values of this index to the degree of agreement beyond chance. The following guideline is suggested:

Value of Kappa	Degree of Agreement Beyond Chance
.76 - 1.00	Excellent
.40 - .75	Fair to Good (Moderate)
.39 or less	Poor

A second overall measure of both the reliability of the classification scheme and the validity of the items was developed by Moore and Benbasat (1991). The method required analysis of how many items were placed by the panel of judges for each round within the target construct. In other words, because each item was included in the pool explicitly to measure a particular underlying construct, a measurement was taken of the overall frequency with which the judges placed items within the intended theoretical construct. The higher the percentage of items placed in the target construct, the higher the degree of inter-judge agreement across the panel that must have occurred.

Moreover, scales based on categories that have a high degree of correct placement of items within them can be considered to have a high degree of construct validity, with a high potential for good reliability scores. It must be emphasized that this procedure is more a qualitative analysis than a rigorous quantitative procedure. There are no established guidelines for determining good levels of placement, but the matrix can be used to highlight any potential problem areas. The following exemplifies how this measure works.

Item Placement Scores:

CONSTRUCTS		ACTUAL						
		A	B	C	D	N/A	Total	% Hits
THEORETICAL	A	26	2	1	0	1	30	87
	B	8	18	4	0	0	30	60
	C	0	0	30	0	0	30	100
	D	0	1	0	28	1	30	93

Item Placements: 120 Hits: 102 Overall "Hit Ratio": 85%

The item placement ratio (The Hit Ratio) is an indicator of how many items were placed in the intended, or target, category by the judges. As an example of how this measure could be used, consider the simple case of four theoretical constructs with ten items developed for each construct. With a panel of three judges, a theoretical total of 30 placements could be made within each construct. Thereby, a theoretical versus actual matrix of item placements could be created as shown in the table above (including an ACTUAL “N/A: Not Applicable” column where judges could place items which they felt fit none of the categories).

Examination of the diagonal of the matrix shows that with a theoretical maximum of 120 target placements (four constructs at 30 placements per construct), a total of 102 “hits” were achieved, for an overall “hit ratio” of 85%. More important, an examination of each row shows how the items created to tap the particular constructs are actually being classified. For example, row C shows that all 30-item placements were within the target construct, but that in row B, only 60% (18/30) were within the target. In the latter case, 8 of the placements were made in construct A, which might indicate the items underlying these placements are not differentiated enough from the items created for construct A. This finding would lead one to have confidence in scale based on row C. However, one must be hesitant about accepting any scale based on row B. An examination of off-diagonal entries indicates how complex any construct might be. Actual constructs based on columns with a high number of entries in the off diagonal might be considered too ambiguous, so any consistent pattern of item misclassification should be examined.

Appendix C

Measurement Items Entering Third Q-Sort Analysis

SCM STRATEGY

Lean Supply Chain

Our suppliers help us to reduce our costs by delivering what we need.
Our suppliers help us to reduce our costs by delivering when we need.
Our suppliers help us to reduce our costs by delivering where we need (straight at the production line).
Our suppliers help us to reduce our costs by delivering frequently as per our requirements.
Our suppliers help us to reduce our costs by adopting quality practices as per our requirements.
Our suppliers help us to reduce our costs by managing their quality as per our requirements.
Our suppliers help us to reduce our costs by inspecting their products frequently as per our requirements.

Agile Supply Chain

Our suppliers help us to be responsive and flexible by quickly responding to our changing requirements of cost.
Our suppliers help us to be responsive and flexible by quickly responding to our changing requirements of volume.
Our suppliers help us to be responsive and flexible by quickly responding to our changing requirements of delivery time.
Our suppliers help us to be responsive and flexible by quickly responding to our changing requirements of design.
Our suppliers help us to be responsive and flexible by effectively responding to our changing requirements of cost.
Our suppliers help us to be responsive and flexible by effectively responding to our changing requirements of volume.
Our suppliers help us to be responsive and flexible by effectively responding to our changing requirements of delivery time.
Our suppliers help us to be responsive and flexible by effectively responding to our changing requirements of design.

Hybrid Supply Chain

Our suppliers help us to achieve assemble-to-order strategy by customizing our products by adding feature modules as requested by us.
Our suppliers help us to achieve assemble-to-order strategy by responding to customization requirements quickly.
Our suppliers help us to achieve assemble-to-order by producing modular products as requested by us.
Our suppliers help us to achieve assemble-to-order by delaying the product final assembly until we place an order.
Our suppliers help us to achieve assemble-to-order by changing the design of the product as requested by us.

IS STRATEGY

The Information Systems (IS) applications we acquire help us to improve the efficiency of our supplier operations.
The Information Systems (IS) applications we acquire help us to monitor the efficiency of our suppliers.
The Information Systems (IS) applications we acquire help us to manage inventory between our suppliers and us.
The Information Systems (IS) applications we acquire help us to manage material requirement planning of our facility.
The Information Systems (IS) applications we acquire help us to manage production control between our suppliers and us.
The Information Systems (IS) applications we acquire help us to coordinate efficiently (production and information) across suppliers and product lines.
The Information Systems (IS) applications we acquire help us to introduce new product and/or service in our markets.
The Information Systems (IS) applications we acquire help us to quickly share strategic information within our firm.
The Information Systems (IS) applications we acquire help us to quickly share strategic information with our suppliers
The Information Systems (IS) applications we acquire help us to monitor changes in our market condition.
The Information Systems (IS) applications we acquire help us to respond to changes in the market.
The Information Systems (IS) applications we acquire help us to change the design of the product.
The information systems (IS) applications we acquire help us to provide sufficient information to support careful decision making.
The information systems (IS) applications we acquire help us to detailed analysis of major supplier's decision.
The information systems (IS) applications we acquire help us to provide support for decision making.

The information systems (IS) applications we acquire help us to adopt a well analyzed view when making major decisions.

ALIGNMENT BETWEEN SUPPLY CHAIN MANAGEMENT STRATEGY AND IS STRATEGY

The supply chain applications we have enhance our ability to schedule delivery.
The supply chain applications we have enhance our ability to manage quality.
The supply chain applications we have enhance our ability to inspect products frequently.
The supply chain applications we have enhance our ability adopt quality practices.

The supply chain applications we have enhance our ability to respond quickly to our changing requirements of cost.
The supply chain applications we have enhance our ability to respond quickly to our changing requirements of volume.
The supply chain applications we have enhance our ability to respond quickly to our changing requirements of delivery time.
The supply chain applications we have enhance our ability to respond quickly to our changing requirements of design.
The supply chain applications we have enhance our ability to respond effectively to our changing requirements of cost.
The supply chain applications we have enhance our ability to respond effectively to our changing requirements of volume.
The supply chain applications we have enhance our ability to respond effectively to our changing requirements of delivery time.

The supply chain applications we have enhance our ability to customize our products by adding feature modules as requested.
The Supply chain applications we have enhance our ability to produce modular products.
The Supply chain applications we have enhance our ability to respond to customization requirements quickly.
The Supply chain applications we have enhance our ability to delay the product final assembly until customers make an order.
The supply chain applications we have enhance our ability to change the design of the product.

IT UTILIZATION

External Focus of IT

In our firm, we use IT in interacting with our partners by solving problems jointly with our suppliers.

In our firm, we use IT in interacting with our partners by helping our suppliers to improve their product quality.
In our firm, we use IT in interacting with our partners by building continuous improvement programs that include our key suppliers.
In our firm, we use IT in interacting with our partners by including our key suppliers in our planning and goal-setting activities.
In our firm, we use IT in interacting with our partners by communicating with customers to set reliability, responsiveness, and other standards for us.
In our firm, we use IT in interacting with our partners by measuring and evaluating customer satisfaction.
In our firm, we use IT in interacting with our partners by determining customer feedback about our products/services.
In our firm, we use IT in interacting with our partners by facilitating customers' ability to seek assistance from us.
In our firm, we use IT in interacting with our partners by facilitating customer service activities.
In our firm, we use IT in interacting with our partners by monitoring supplier performance .
In our firm, we use IT in interacting with our partners by placing order and purchasing.
In our firm, we use IT in interacting with our partners by communicating product specifications.

Internal Focus of IT

We use IT to improve processes inside our firm by reducing manufacturing set-up time.
We use IT to improve processes inside our firm by building and maintaining continuous quality improvement program.
We use IT to improve processes inside our firm by using a "Pull" production system.
We use IT to improve processes inside our firm by demand forecasting.
We use IT to improve processes inside our firm by designing products for modular assembly.
We use IT to improve processes inside our firm by delaying final product assembly activities until customer order have actually been received.
We use IT to improve processes inside our firm by delaying final product assembly activities until the last position (or nearest to customers) in the supply chain.
We use IT to improve processes inside our firm by storing our parts/products at appropriate distribution points close to the customer

Infrastructural Focus of IT

In our firm, our IT foundation (platforms, networks, and databases) facilitates communicating and sharing proprietary information.
In our firm, our IT foundation (platforms, networks, and databases) facilitates communicating and sharing business knowledge of core business processes.

In our firm, our IT foundation (platforms, networks, and databases) facilitates communicating and exchanging timely information.

In our firm, our IT foundation (platforms, networks, and databases) facilitates communicating and exchanging accurate information.
In our firm, our IT foundation (platforms, networks, and databases) facilitates communicating and exchanging complete information.
In our firm, our IT foundation (platforms, networks, and databases) facilitates communicating and exchanging adequate information.
In our firm, our IT foundation (platforms, networks, and databases) facilitates communicating and exchanging reliable information.

ALIGNMENT BETWEEN SUPPLY CHAIN MANAGEMENT PRACTICES AND USAGE OF IT

The IT we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to select suppliers based on their quality.
The IT we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to solve problems jointly with our suppliers.
The IT we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to Build continuous improvement programs that include our key suppliers.
The IT we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to Include our key suppliers in our planning and goal-setting activities.
The IT we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to Interact with customers to set reliability, responsiveness, and other standards for us.
The IT we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to measure and evaluate customer satisfaction.
The IT we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to determine future customer expectations.
The IT we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to facilitate customers' ability to seek assistance from us.
The IT we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to periodically evaluate the importance of our relationship with our customers.

The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to inform our trading partners in advance of changing needs.

The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to share proprietary information with our trading partners.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventor management etc.) enhances our ability to share business knowledge of core business processes with our trading partners.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to exchange information with our trading partners in a timely manner.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventor management etc.) enhances our ability to exchange information with our trading partners in an accurate manner.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to exchange information with our trading partners in a complete manner.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventor management etc.) enhances our ability to exchange information with our trading partners in an adequate manner.
The Information Technology (IT) we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to exchange information with our trading partners in a reliable manner.

The IT we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to reduce manufacturing set-up time.
The IT we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to build and maintain continuous quality improvement program.
The IT we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to use a "Pull" production system.
The IT we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to push suppliers for shorter lead-times.
The IT we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to design products for modular assembly.
The IT we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to delay final product assembly activities until customer orders have actually been received.
The IT we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to delay final product assembly activities until the last possible position (or nearest to customers) in the supply chain.
The IT we use in our supply chain activities (purchasing, order taking, inventory management etc.) enhances our ability to store our parts/products at appropriate distribution points close to the customer.

Appendix D

Large-Scale Survey Questionnaire

ALIGNMENT OF INFORMATION SYSTEMS WITH SUPPLY CHAINS:
IMPACTS ON SUPPLY CHAIN PERFORMANCE AND ORGANIZATIONAL PERFORMANCE

THE UNIVERSITY OF TOLEDO

URBAN AFFAIRS CENTER

General Instructions and Information

- This survey is being conducted by Sufian Qrunfleh, a Ph.D. candidate at the University of Toledo
- This research will examine the effect of alignment between supply chain and information systems on supply chain and firm performance. The study is intended to help managers identify appropriate supply chain applications that may be required for successfully implementing particular supply chain strategies and practices. (It draws from literature on supply chain management and IT management).
- There are **6 pages** included in this survey, and it typically takes about 15 minutes to complete.
- Please answer **all** questions. There is no right or wrong answer. Please provide your best estimate. I am interested only in **your perceptions**.
- Should you be interested in the results of this study, please indicate so in the questionnaire. I **assure** you that I will share the results of this study with you.
- Your responses will be kept **anonymous** and will be treated in strict confidence. The results will be used **only** for statistical analysis and for academic purposes.
- In case you are too busy to answer the survey, please forward it to a qualified employee who can answer it.
- Thank you for your cooperation. With your assistance, this study can be useful for strategic decision making, especially with regards to investment decisions concerning IT applications in supply chains.

Note: you must have scripting enabled to complete this survey.

- Fields requiring numeric answers will allow *numbers only* to be entered; dollar amounts allow numbers or decimal points ('.') only.
- Click the "Continue" button at the end of a page to go to the next page, or click the "Go Back" button to review a previous page.
- Click the "Submit Responses" button on the last page to send responses for the survey.
- **If you press the Enter or Return key you may be prompted to submit the form!** You can always click "Cancel" in the confirmation dialog box to skip submitting the form and return to data entry.

If you have any questions, please contact:

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Continue

Section 1 [Page 1 of 6]

The following questions describe your **supply chain management strategies** and applications **acquired/developed** in your supply chain.

*With regard to **cost reduction** in our supply chain, our suppliers:* | *The supply chain applications we have **enhance our ability to:***

Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]		Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]
○	○	○	○	○	○	**<- Deliver what we need ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- Deliver when we need ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- Deliver where we need ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- Adopt quality practices as per our requirements ->**	◉	○	○	○	○	○
○	○	○	○	○	○	**<- Manage quality as per our requirements ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- Inspect products frequently ->**	○	○	○	○	○	○

*With regard to **responsiveness and flexibility** in our supply chain, our suppliers:* | *The supply chain applications we have **enhance our ability to:***

Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]		Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]
						Respond *quickly* to our changing requirements of:						
○	○	○	○	○	○	**<- cost ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- delivery time ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- design ->**	○	○	○	○	○	○
						Respond *effectively* to our changing requirements of:						
○	○	○	○	○	○	**<- cost ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- delivery time ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- design ->**	○	○	○	○	○	○

*With regard to **assemble-to-order** strategy in our supply chain, our suppliers:* | *The supply chain applications we have **enhance our ability to:***

Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]		Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]
○	○	○	○	○	○	**<- Customize our products by adding feature modules as per our requirements ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- Produce modular products ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- Respond to customization requirements quickly ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- Delay the products final assembly until customers make an order ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- Change the design of a product ->**	○	○	○	○	○	○

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ALIGNMENT OF INFORMATION SYSTEMS WITH SUPPLY CHAINS:
IMPACTS ON SUPPLY CHAIN PERFORMANCE AND ORGANIZATIONAL PERFORMANCE

Section 2 [page 2 of 6]

With regard to **Information Systems** (IS) in your firm, please indicate the choice that accurately reflects your firm's **present** conditions.

With regard to **efficiency**, the Information Systems (IS) applications we **acquire/develop** help us to:

	Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]
Improve the efficiency of operation between our suppliers and us	○	○	○	○	○	○
Manage inventory between our suppliers and us	○	○	○	○	○	○
Manage material requirement planning of our facility	○	○	○	○	○	○
Manage production control between our suppliers and us	○	○	○	○	○	○
Coordinate (production and information) efficiently across suppliers and product lines	○	○	○	○	○	○

With regard to **flexibility**, the Information Systems (IS) applications we **acquire/develop** help us to:

	Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]
Introduce new product(s) and/or service(s) in our market(s)	○	○	○	○	○	○
Quickly share information within our firm	○	○	○	○	○	○
Monitor changes in our market condition	○	○	○	○	○	○
Respond to changes in the market	○	○	○	○	○	○
Change the design of our product(s)	○	○	○	○	○	○

With regard to **comprehensiveness decisions**, the Information Systems (IS) applications we **acquire/develop** help us to:

	Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]
Provide sufficient information to support careful decision making	○	○	○	○	○	○
Provide detailed analysis of major decisions	○	○	○	○	○	○
Provide support for decision making	○	○	○	○	○	○
Adopt a well analyzed view when making major decisions	○	○	○	○	○	○

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Section 3 [page 3 of 6]

The following questions describe your **supply chain management practices** and applications **used** in your supply chain.

*With regard to **partnerships** with our suppliers, we:* / *The information technology applications **used** in our supply chain enhance our ability to:*

Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]		Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]
○	○	○	○	○	○	**<- Select suppliers based on their quality ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- Solve problems jointly with our suppliers ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- Include our key suppliers in our planning and goal-setting activities ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- Help our suppliers to improve their product quality ->**	○	○	○	○	○	○

*With regard to our **customer relationship practices**, we:* / *The information technology applications **used** in our supply chain enhance our ability to:*

Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]		Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]
○	○	○	○	○	○	**<- Interact with customers to set reliability, responsiveness, and other standards for us ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- Measure and evaluate customer satisfaction ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- Determine future customer expectations ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- Facilitate customers' ability to seek assistance from us ->**	○	○	○	○	○	○

*With regard to our **lean system practices**, we:* / *The information technology applications **used** in our supply chain enhance our ability to:*

Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]		Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]
Agree [1]	[2]	[3]	[4]	Disagree [5]	[6]		Agree [1]	[2]	[3]	[4]	Disagree [5]	[6]
○	○	○	○	○	○	**<- Reduce manufacturing set-up time ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- Build and maintain continuous quality improvement program(s) ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- Streamline ordering, receiving and other paperwork from suppliers ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- Push suppliers for shorter lead-times ->**	○	○	○	○	○	○

*With regard to our **postponement practices**, we:* / *The information technology applications **used** in our supply chain enhance our ability to:*

Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]		Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]
○	○	○	○	○	○	**<- Delay final product assembly activities until customer orders have actually been received ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- Delay final product assembly activities until the last possible position (or nearest to customers) in the supply chain ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- Store our parts/products at distribution points closer to the customer ->**	○	○	○	○	○	○
○	○	○	○	○	○	**<- Design products for modular assembly ->**	○	○	○	○	○	○

*With regard to our **Information sharing** practices, we:*							*The information technology applications **used** in our supply chain enhance our ability to:*					
Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]		Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]
						<- Inform our trading partners in advance of our changing needs ->						
						<- Mutually share business knowledge of core business processes with our trading partners ->						
						<- Mutually share proprietary information with our trading partners ->						

*With regard to our **Information quality** practices, we:*							*The information technology applications **used** in our supply chain enhance our ability to:*					
Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]		Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]
						Exchange information with our trading partners in a:						
						<- timely manner ->						
						<- accurate manner ->						
						<- complete manner ->						
						<- adequate manner ->						
						<- reliable manner ->						

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Section 4 [page 4 of 6]

With regard to usage of **IT** in your firm, please indicate the choice that accurately reflects your firm's **present** conditions.

We **interact** with our partners by using IT to:

	Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]
Solve problems jointly with our suppliers	○	○	○	○	○	○
Help our suppliers to improve their product quality	○	○	○	○	○	○
Include our key suppliers in our planning and goal-setting activities	○	○	○	○	○	○
Measure and evaluate customer satisfaction	○	○	○	○	○	○
Facilitate customer service activities	○	○	○	○	○	○

We **improve processes inside** our firm by using IT to:

	Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]
Reduce manufacturing set-up time	○	○	○	○	○	○
Forecast demand	○	○	○	○	○	○
Design products for modular assembly	○	○	○	○	○	○
Delay final product assembly activities until customer orders have actually been received	○	○	○	○	○	○
Store our parts/products at distribution points close to the customer	○	○	○	○	○	○

Inside our firm, our **IT foundation (platforms, networks, and databases)** facilitates:

	Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]
Communication and sharing of business knowledge of core business processes	○	○	○	○	○	○
Communication and exchange of **timely** information	○	○	○	○	○	○
Communication and exchange of **accurate** information	○	○	○	○	○	○
Communication and exchange of **complete** information	○	○	○	○	○	○
Communication and exchange of **adequate** information	○	○	○	○	○	○

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Section 5 [page 5 of 6]

With regard to **Performance** of your supply chain management in your firm, please indicate the choice that accurately reflects your firm's **present** conditions.

Supply Chain Flexibility- our supply chain is able to:

	Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]
handle difficult nonstandard orders	○	○	○	○	○	○
meet special customer specification	○	○	○	○	○	○
produce products characterized by numerous features options, sizes and colors	○	○	○	○	○	○
rapidly adjust capacity so as to accelerate or decelerate production in response to changes in customer demand	○	○	○	○	○	○
rapidly introduce large numbers of product improvements/variation	○	○	○	○	○	○
handle rapid introduction of new products	○	○	○	○	○	○

Supply Chain Integration

	Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]
There is a high level of communication and coordination between all functions in our firm.	○	○	○	○	○	○
Cross-functional teams are frequently used for process design and improvement in our firm.	○	○	○	○	○	○
There is a great amount of cross-over of the activities of our firm and our trading partners.	○	○	○	○	○	○
There is a high level of integration of information systems in our firm.	○	○	○	○	○	○

Responsiveness to Customers- our firm:

	Strongly Agree [1]	Agree [2]	Neutral [3]	Disagree [4]	Strongly Disagree [5]	N/A [6]
fills customer orders on time	○	○	○	○	○	○
has short order-to-delivery cycle time	○	○	○	○	○	○
has fast customer response time	○	○	○	○	○	○

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As a result of the acquisition/development and use of supply chain applications, please indicate the choice that accurately reflects your firm's overall performance.

	Significant Decrease [1]	Decrease [2]	Same As Before [3]	Increase [4]	Significant Increase [5]	N/A [6]
Market Share	○	○	○	○	○	○
Return on investment	○	○	○	○	○	○
The growth of market share	○	○	○	○	○	○
Growth in return on investment	○	○	○	○	○	○
Profit margin on sales	○	○	○	○	○	○
Overall competitive position	○	○	○	○	○	○

General information about your firm: for the following questions, please check the appropriate response.

Number of employees in your company: ○ 1-50 ○ 51-100 ○ 101-250 ○ 251-500 ○ 501-1000 ○ >1000

Please indicate the industry category that best describes your primary business:
- ○ Manufacturing
- ○ Process industry
- ○ Service
- ○ Other (specify): ______

Your company has been in business for: ○ <2 years ○ 2-5 years ○ 6-10 years ○ >10 years

Please indicate the range of your annual sales (in US$):
- ○ <1 million
- ○ 1-10 million
- ○ 10-25 million
- ○ 25-50 million
- ○ 50-250 million
- ○ 250-500 million
- ○ 500-100 million
- ○ >1 billion

Your present job title:
- ○ CEO/President
- ○ Director
- ○ Manager
- ○ Other (specify): ______

Your present job function (check all that apply):
- ☐ Corporate Executive
- ☐ Purchasing
- ☐ Manufacturing Production
- ☐ Distribution
- ☐ Transportation
- ☐ Sales

The years you have stayed at this organization: ○ <2 years ○ 2-5 years ○ 6-10 years ○ >10 years

Please indicate the approximate range of your annual information systems budget (in US$): ○ <500 thousand ○ 500 thousand-1 million ○ 1-5 million ○ 5-10 million ○ >10 million

Please indicate the approximate range of your annual information systems budget as a percentage of your sales:
- ○ <2%
- ○ 2%-4%
- ○ 4%-6%
- ○ 6%-8%
- ○ 8%-10%
- ○ 10%-15%
- ○ >15%

What percentage of your business transactions is done with your customers electronically ○ <10% ○ 10%-30% ○ 30%-50% ○ 50%-80% ○ >80%

What percentage of your business transactions is done with your suppliers electronically	○ <10%	○ 10%-30%	○ 30%-50%	○ 50%-80%	○ >80%

Please mark the position of your company in the supply chain (check all that apply):

- ☐ Raw material supplier
- ☐ Component supplier
- ☐ Assembler
- ☐ Sub-assembler
- ☐ Manufacturer
- ☐ Distributor
- ☐ Wholesaler
- ☐ Retailer

Has your organization embarked upon information systems program (s) aimed specially at implementing "supply chain integration"

- ○ No
- ○ Yes (specify # years): ______

Please check mark against one or more of the following technology applications you are primarily (heavily) using in your firm?

- ☐ EDI
- ☐ Extranets
- ☐ DSS
- ☐ SCM software
- ☐ Other (please indicate:) ______

If you would like to receive a copy of the survey results, please provide the following information, or write to me separately:

Name: ______

Company: ______

Street: ______

City: ______ State: ______ Zip: ______

Click the "Submit Responses" button to send your answers, or click "Go Back" to return to the previous page

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