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AN INTEGRATED MODEL FOR SUPPLY CHAIN MANAGEMENT PRACTICE, PERFORMANCE AND COMPETITIVE ADVANTAGE

by

Suhong Li

Submitted as partial fulfillment of requirements for

the Doctor of Philosophy degree in

Manufacturing Management

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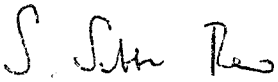

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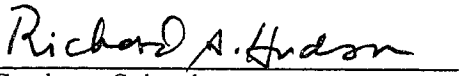

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An Abstract of

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This research represents one of the first large-scale empirical efforts to explore the complex causal relationships within the entire supply chain. An integrated supply chain management (SCM) model is developed and tested using structural equation modeling methodology in this research.

Valid and reliable measures of SCM practice, SCM performance, SCM strategy process, and partner relationship were developed. The instrument development process involved structured interviews, a pilot study, and a large-scale survey. The large-scale survey yielded 196 responses from purchasing/manufacturing/materials executives. Rigorous statistical methods were used to assess and validate the constructs. The

methods used were: correlation analysis (for purification), exploratory factory analysis (for factor structure and initial validity), structural equation modeling (measurement models for unidimensionality), and reliability analysis.

The research findings support the notion that higher levels of SCM practice will lead to improved SCM performance, and improved SCM performance will bring about enhanced competitive advantage, leading to better organizational performance. Moreover, the findings reveal that effective SCM strategy process and good partner relationship will facilitate SCM practice. However, the findings did not support the direct impact of environmental uncertainty, top management support (TMS), and the usage of information technology (IT) tools on SCM practice. An alternative model suggests that TMS and the usage of IT tools have an indirect effect on SCM practice.

The results of this study have several important implications for practitioners. First, this research identifies the key dimensions of SCM practice that an organization can adopt; second, the research provides a set of valid and reliable measurements for evaluating an organization's level of SCM performance by benchmarking and comparing SCM performance across different organizations; third, the research identifies the facilitating factors (top management support, usage of IT tools, partner relationship, and SCM strategy process) for the implementation of SCM.

Directions and recommendations for future research include refinement of construct definition and measurement items for environmental uncertainty; revalidation of the instruments; factorial invariance tests across industries, organization size, and supply chain structure; and tests of hypothesized relationships by performance level.

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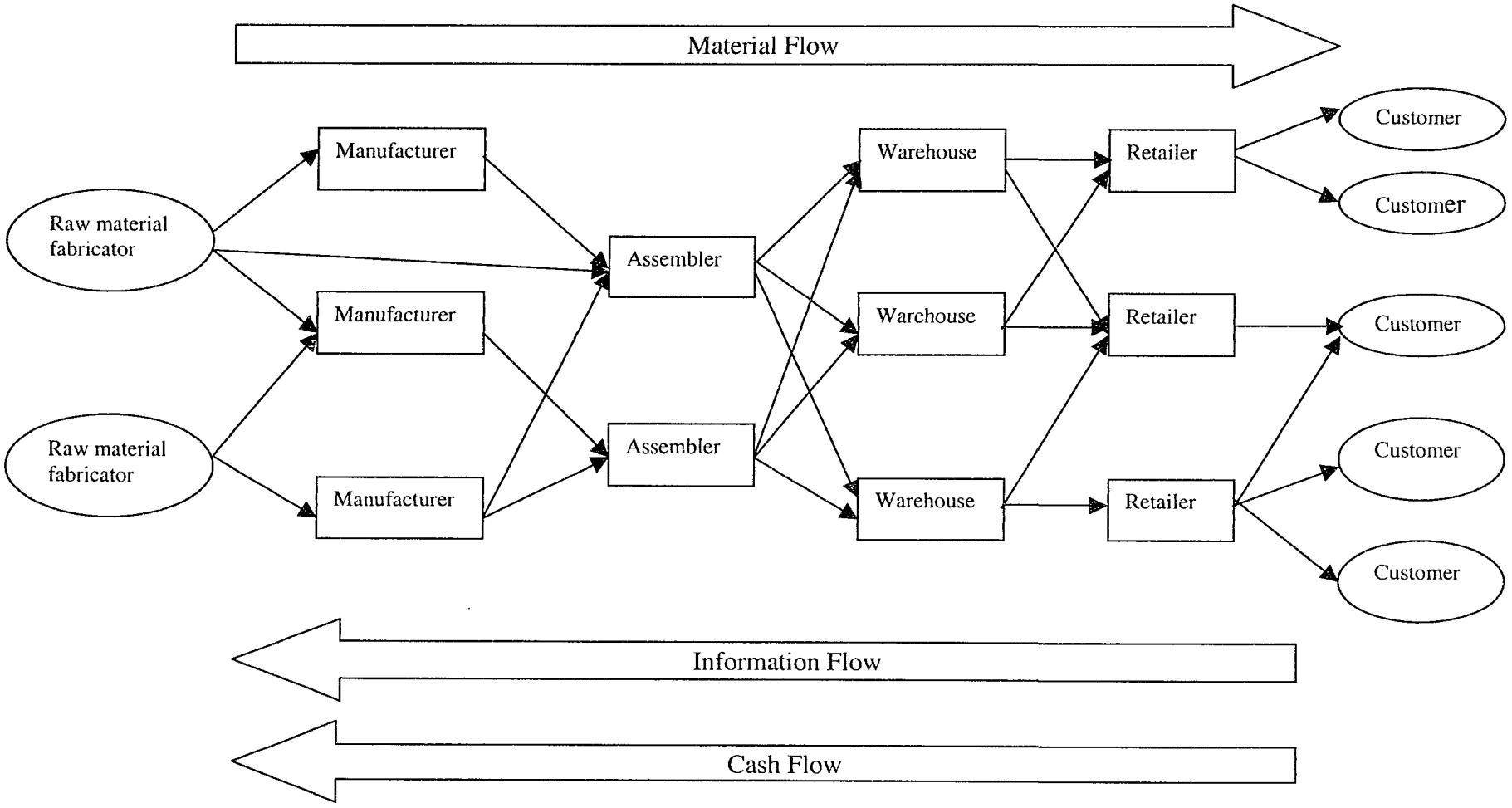
CHAPTER 1: INTRODUCTION

The supply chain encompasses every effort involved in producing and delivering a final product, from suppliers' supplier to customers' customer. Four basic processes- plan, source, make, deliver- broadly define these efforts, which include managing supply and demand, sourcing raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order enter and order management, distribution across all channels, and delivery to the customers (Supply-Chain Council, 1997). American Production and Inventory Control Society (APICS) defines the supply chain as the processes from the initial raw materials to ultimate consumption of the finished product linking across supplier-user companies. The supply chain encompasses all the functions within and outside a company that enable the value chain to make products and provide service to the customers. Lummus et al. (2001) clarify this definition by including the information systems necessary to monitor all of those activities. This conceptualization is consistent with Alber and Walker (1998), who define supply chain as the global network used to deliver products and services from raw materials to end customers through an engineered flow of information, physical distribution, and cash flow. Figure 1.1 provides a conceptual model of the supply chain.

Managing a supply chain is becoming the watchword for organizations. As pointed out by numerous researchers, competition is no longer between organizations, but among supply chains (Spekman et al., 1994; Noble, 1997; Burgess, 1998; Monczka & Morgan, 1998; Vickery et al, 1999a; Cox, 1999; Lambert & Cooper, 2000; Claycomb et

Figure 1.1 Illustration of a Generic Supply Chain



Source: Thomas & Griffin (1996) with modification

al., 1999). In today's competing business environments, it is no longer an option to better manage and integrate the supply chain; it is a must (Spekman et al., 1998; O'Connell, 1999). SCM has received increasing attention from academicians, consultants and business managers alike (van Hoek, 1998; Tan et al., 1998; Croom, et al., 2000).

SCM practices are expected to create added value in numerous ways: reduced paperwork, reduced inventory cost, increased customer service (Balsmeier and Voisin, 1996; Sengupta and Turnbull, 1996), improved quality, faster delivery, better availability, stronger competitive advantage (Patterson, 1995), and increased agility of an organization (Prater et al., 2001). Advanced Manufacturing Research (AMR) in Boston, expects sales of SCM software to reach $14 billions in four years (Gibson, 1998). Many organizations are now beginning to recognize that SCM is the key to building sustainable competitive edge for their products or services in an increasingly crowded marketplace (Jones, 1998). According to a recent Deloitte Consulting survey, ninety-one percent of North American manufacturers rank SCM as important or critical to their organizations' successes (Thomas, 1999). Dell Company, Wal-Mart, Digital Equipment Corporation, Hewlett Packard, Allied Signal, and Siemens are examples of organizations that have attempted to implement SCM strategy with varying degrees of success in their respective industries (Narasimhan and Jayaram, 1998; Alvarado and Kotzad, 2001).

The literature is replete with buzzwords such as: integrated purchasing strategy, integrated logistics, supplier integration, buyer-supplier partnerships, supply base management, strategic supplier alliances, supply chain synchronization and supply chain management, to address elements of stages of this new management philosophy of SCM (Tan, 2001). While each term addresses elements of phenomenon, typically focusing on

immediate suppliers of an organization, SCM is the most widely used (but abused) term to describe this philosophy. Unfortunately, there is a confusing profusion of overlapping terminology and meanings of SCM. This is in part due to the way that the concept of SCM has been developed. Originally, the development and evolution of SCM followed two separate paths: purchasing and supply management, and transportation and logistics management (Tan et al., 1998), which eventually merged into a holistic SCM that encompasses all the value-adding activities across the supply chain.

Most literature on SCM follows purchasing and supply perspective. According to this perspective, SCM is synonymous with the integration of supply base that evolved from the traditional purchasing and materials functions. It is a management philosophy that extends traditional intra-enterprise activities by bringing trading partners together with a common goal of optimization and efficiency. This perspective on SCM focuses on the manufacturing industry and its upstream activities and has little to do with the downstream activities of transportation and logistics. A transportation and logistics perspective in the wholesaling and retailing industry focuses on location and logistics issues more often than production. In this perspective, SCM is synonymous with integrated logistics systems. An integrated logistics system encompasses the integration of processes, systems, and organizations that control the movement of goods from the suppliers to satisfied customers while minimizing waste. Thus, an integrated logistics includes inventory management system, vendor relationships, transportation, distribution, warehousing, and delivery services.

Eventually, these two perspectives evolved into an integrated SCM perspective that integrates all the activities along the supply chain (Tan, 2001). The goal of SCM is to

create manufacturing processes and logistics functions seamlessly across the supply chain as an effective competitive weapon that cannot be easily duplicated by competitors. The ways in which SCM differs from integrated logistic management, and purchasing and supply management is the scope and the processes/activities they refer to. SCM has developed into a holistic approach to manage across organizational boundaries, including upstream side of purchasing and supply management, and the downstream side of physical distribution and logistics (Slack et al., 1998). On the other hand, SCM goes beyond integrated logistics because it aims to integrate all the business processes, from final customers to original suppliers, which provide products, services, and information that add value for the customers (Cooper et al., 1997). From this point of view, SCM involves not only logistics activities (e.g. inventory management, transportation, warehousing, order processing, etc)- even if extended to the whole supply network- but also other processes (e.g. customer relationship management, demand management, order fulfillment, procurement, product development and commercialization, etc) (Romano and Vinelli, 2001).

The definitions of SCM can be classified into three categories: integrated logistics management, purchasing and supply management, and integrated SCM (Table 1.1). The definitions under the category of integrated logistics management emphasize the importance of physical distribution and integrated logistics, whether they involve logistics activities within an organization (see the definitions of Houlihan, 1988; Oliver &Webber, 1982; Stevens, 1989; Saunders, 1994; and Jones & Riley, 1985) or extend to include upstream suppliers and downstream customers (Thomas and Griffin, 1996; Ellram, 1991; and Tan et al. 1998); while the definitions related to purchasing and supply

Table 1.1 Definitions of SCM in the Literature

Authors	Definition
	Integrated Logistics Management
Houlihan, 1988.	SCM is the integration of the various functional areas within an organization to enhance the flow of goods from immediate strategic suppliers through manufacturing, and distribution chain to the end users.
Stevens, 1989; Saunders, 1994; Jones & Riley, 1985; Oliver &Webber,1982.	The internal supply chain that integrates business functions involved in the flow of materials and information from inbound to outbound ends of the business.
Thomas & Griffin, 1996.	SCM is the management of materials and information flow both in and between facilities, such as vendors, manufacturing and assembly plants and distribution centers.
Ellram, 1991; Tan et al. 1998.	SCM represents a network of firms interacting to deliver a product or service to end customer, linking flows from raw material supply to final delivery.
	Purchasing and Supply Management
Berry et al., 1994.	Supply chain management aims at building trust, exchanging information on market needs, developing new products, and reducing the supplier base to a particular OEM (original equipment manufacturer) so as to release management resources for developing meaningful, long-term relationship.
Christopher & Juttner, 2000.	SCM is concerned to achieve a more cost-effective satisfaction of end-customer requirements through buyer-supplier integration.
Scott &Westbrook, 1991, New & Payne, 1995.	SCM as the chain linking each element of the manufacturing and supply process from raw materials to the end user, encompassing several organizational boundaries.

Table 1.1 Definitions of SCM in the Literature (continued from previous page)

Authors	Definition
	Integrated SCM
Simchi-Levi et al., 2000.	A set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimize system-wide costs while satisfying service level requirements.
Narasimhan & Kim, 2001.	SCM deals with the control of material and information flows, the structural and infrastructural processes relating to the transformation of the materials into value added products, and the delivery of the finished products through appropriate channels to customer and markets so as to maximize customer value and satisfaction.
Cooper et al., 1997.	SCM is a philosophy for integrating all the activities in the life of a product or a service from the earliest source of raw materials to the ultimate customer, and beyond to disposal.
Monczka and Morgan, 1997.	Integrated supply chain management is about going from the external customer and then managing all the processes that are needed to provide the customer with value in a horizontal way.
Vickery et al., 1999a.	SCM seeks to enhance competitive performance by closely integrating the internal functions within a company, and effectively linking them with the external operations of suppliers and channel members.
Tracey & Smith-Doerflein, 2001; Vokurka & Lummus, 2000.	SCM is the integration of key business processes from suppliers through to the end user that provides products, services and information that add value.
Saunders, 1994.	External Chain is the total chain of exchange from original source of raw materials, through the various firms involved in extracting and processing raw materials, manufacturing, assembling, distributing and retailing to ultimate end customers.
Lee & Billington, 1992.	Networks of manufacturing and distribution sites that produce raw materials, transform them into intermediate and finished products, and distribute the finished products to customers.
Christopher, 1992.	The network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer.
Tan et al., 1999.	The simultaneous integration of customer requirement, internal processes, and upstream supplier performance.
Alvarado & Kotzab 2001.	The integration of business processes among channel members and with the goal of better performance for the entire channel system.
Spekman et al, 1998.	A process for designing, developing, optimizing and managing the internal and external components of the supply chain system, including material supply, transforming materials and distributing finished products or services to customers.
CLM, 1998; Mentzer 1999; Mentzer et al., 2000.	*The systemic, strategic coordination of the traditional business functions and tactics across these business functions within a particular organization and across businesses within the supply chain for the purposes of improving the long-term performance of the individual organizations and the supply chain as a whole.*

management focus on integrating and partnering with suppliers to more efficiently manage the purchasing and supply functions (Berry et al., 1994; Christopher & Juttner, 2000; Scott &Westbrook, 1991, New & Payne, 1995). All definitions of integrated SCM simultaneously consider both upstream and downstream sides, but most of them only address certain aspects of integrated SCM. For example, some focus on the description of the supply chain processes from original source of raw material to ultimate end customers (Saunders, 1994; Lee & Billington, 1992; Christopher, 1992; Spekman et al, 1998), while others focus on the control, management or integration of all the functions across the supply chain (Simchi-Levi et al., 2000; Narasimhan & Kim, 2001; Cooper et al., 1997; Monczka and Morgan, 1997; Vickery et al., 1999a; Tracey & Smith-Doerflein, 2001; Vokurka & Lummus, 2000; Tan et al., 1999; Alvarado & Kotzab 2001). In addition, some definitions discuss the purpose of SCM, such as minimizing system-wide costs while satisfying service level requirements (Simchi-Levi et al., 2000), maximizing customer value and satisfaction (Narasimhan & Kim, 2001), enhancing competitive performance (Vickery et al., 1999a), or improving performance for the entire channel system (Alvarado & Kotzab, 2001).

The definition given by the Council of Logistics Management (CLM) provides a complete and concise summary of above definitions. Moreover, unlike other definitions, this definition explicitly describes the strategic nature of coordination between trading partners and explains the dual purpose of SCM: to improve the performance of an individual organization as well as that of the whole supply chain. This definition is also used in the study of Mentzer (1999) and Mentzer et al. (2000). Therefore, it is decided to adopt this definition in this research. SCM is defined here as *the systemic, strategic*

coordination of the traditional business functions and tactics across these businesses functions within a particular organization and across businesses within the supply chain for the purposes of improving the long-term performance of the individual organizations and the supply chain as a whole (CLM, 1998).

This above definition reveals several meanings: 1) SCM includes the intra-functional coordination, coordination of inter-functional activities, and coordination of inter-organizational supply chain activities (Ballou et al., 2000); 2) to be successful in the implementation of SCM, organizations will not seek to achieve cost reductions or profit improvement at the expense of their supply chain partners, but rather seek to make the supply chain as a whole more competitive; 3) the goal of the SCM is the optimization of the total supply chain in serving the end customer (the source of income), rather than the various parts of it (Burgess, 1998); and therefore 4) it can be inferred that the ultimate success of the single business will depend on management's ability to integrate the organization's intricate network of business relationship (Handfield and Nichols, 1999; Lambert and Cooper, 2000). Moreover, SCM should align its strategy with business strategy and emphasize leveraging the skills, expertise, and capabilities of the organizations along the supply chain (Spekman et al., 1998).

Regardless of the increased attention to and numerous expectations from SCM, many problems still exist in the implementation of SCM by organizations. Boddy et al. (1998) conducted a questionnaire survey of 100 organizations that had attempted to introduce supply chain partnering and found that less than half of the respondents considered that their organizations had been successful in implementing such change. This is consistent with the observation by Spekman et al. (1998) that 60% of all alliances

will fail. The Deloitte Consulting survey reported only 2 percent of the manufacturers ranked their supply chains as world class (Thomas, 1999). Tan et al. (1999) point out that although the popular press is replete with reports of organizations that developed strategic supplier-buyer partnerships, outsourced non-core competencies, and adopted customer relationship practice, few organizations have succeeded simultaneously on all these fronts.

The failure of SCM practice may result from the complexity of SCM, more importantly, it may result from conceptual confusion in SCM and lack of a theoretical framework in guiding SCM. Up till now, SCM phenomenon has not been well understood in the literature. After conducting extensive literature review, Croom et al. (2000) conclude that very little theoretical work has been done in the field of SCM when compared to empirical based studies and they highlight the necessity of clear definitional constructs and conceptual frameworks in SCM. Many studies still tend to consider SCM as being the same as integrated logistics management, focusing on inventory reduction both within and across organizations in the supply chain (van Hoek, 1998, Romano and Vinelli, 2001; Bechtel and Jayaram, 1997; Alvarado and Kotzab, 2001). Some researchers use the term SCM either to mean the management of the supplier network (or upstream network) or as a synonym of integration with suppliers, thus considering it as just the development of the traditional purchasing and supplier management activities (Lamming, 1996; Banfield, 1999).

The conceptual confusion and lack of theoretical framework in SCM are also reflected in the empirical research. Careful literature review finds that most of current empirical SCM research just focuses on the upstream or the downstream side of the

supply chain, with a heavy emphasis on the upstream (supply or purchasing) side. Numerous empirical studies have addressed a variety of topics in the supplier side, such as supplier selection, supplier involvement, and manufacturing performance (Choi and Hartley, 1996; Vonderembse and Tracey, 1999), the influences of supplier alliance on organization (Stuart, 1997), success factors in strategic supplier alliances (Narasimhan and Jayaram, 1998; Monczka et al., 1998; Stuart, 1997), and supply (supplier) management orientation and supplier/buyer performance (Shin et al., 2000). On the other hand, there are several studies focusing on downstream link between manufacturers and retailers (Clark and Lee, 2000; Alvarado and Kotzab, 2001). Only a few recent studies begin to consider both upstream and downstream sides of the supply chain simultaneously, for example, Tan et al. (1998) explore the relationships between supplier management practices, customer relations practices and organizational performance; Frohlich and Westbrook (2001) investigate the effects of the supplier and customer integration on performance improvement. Even though the study of Tan et al. and Frohlich and Westbrook have considered the entire supply chain, their studies focused only on part of SCM issues and did not consider SCM from an integrated view. Moreover, few empirical studies have addressed the following three basic, but very important questions, in SCM (Kiefer and Novack, 1999): 1) what are the key dimensions of SCM practice, 2) how to measure the SCM performance, and 3) what factors influence the implementation of SCM practice. Furthermore, no studies have simultaneously considered the causal relationships among these constructs: facilitating factors for SCM practice, SCM practice, SCM performance, competitive advantage, and organizational performance.

The current research represents an attempt in addressing above problems appearing in the literature. Through an extensive literature review, the study identifies six dimensions of SCM practice (strategic supplier partnership, customer relationship, information sharing, information quality, lean system and postponement), five measurements of SCM performance (supply chain flexibility, supply chain integration, customer responsiveness, supplier performance, and partnership quality), and five facilitating factors for SCM practice (environmental uncertainty, top management support for SCM, SCM strategy process, usage of IT tools, and partner relationships). To respond to the lack of a theoretical framework in SCM, an integrated model is developed to explore the complex causal relationships in the entire supply chain, including both upstream suppliers and downstream customers. The model is then tested based on the responses from a large-scale sample. The important relationships to be tested include: (1) the direct impact of environmental uncertainty on the implementation of SCM practice, (2) the direct impact of top management support on the implementation of SCM practice, (3) the direct impact of effective partner relationship on the implementation of SCM practice, (4) the direct impact of effective partner relationships on the performance of SCM, (5) the direct impact of usage of IT tools on the implementation of SCM practice, (6) the direct impact of the effectiveness of SCM strategy process on the implementation of SCM practice, (7) the direct impact of SCM practice on the performance of SCM, (8) the direct impact of SCM practice on the organizational performance, (9) the direct impact of SCM performance on competitive advantage, and (10) the direct impact of competitive advantage on organizational performance.

As in any empirical study, it will not be possible to test a relationship without valid and reliable measurement instruments for the constructs involved in the relationships. Therefore, a major contribution of the current research is the development of valid and reliable measurement instruments for 1) SCM practice, 2) SCM performance, 3) SCM strategy process, and 4) partner relationships. The measurement instruments for the other constructs in the proposed model are adopted with modification from earlier studies.

From a practitioner's point of view, this research provides important guidelines for an organization in better understanding SCM issues and for more effective implementation of SCM practice. This research identifies different SCM practices that organizations can adopt and the factors for facilitating the implementation of SCM practice. Moreover, the measures from SCM performance developed in this research provide a valuable tool for organizations to evaluate and benchmark their supply chain system.

Chapter 2 is the literature review on the theoretical foundation and various constructs of SCM. The overall framework that depicts the relationships between the constructs and the development of hypotheses are presented in Chapter 3. The research methodology for generating items for measurement instruments appears in Chapter 4. This methodology includes pre-testing with practitioners and academicians, a pilot study using the Q sort method. Large-scale survey, reliability, and validity results are reported in Chapter 5. In Chapter 6, the results of hypotheses testing are shown, using structural equation modeling methodology. Chapter 7 concludes with the summary of research

findings and major contributions, implications for managers, limitations of the research, and recommendations for future research.

CHAPTER 2: LITERATURE REVIEW ON SUPPLY CHAIN MANAGEMENT

As competition in the 1990s intensified and markets became global, so did the challenges associated with getting a product and service to the right place at the right time at the lowest cost. Organizations are realizing that it is not enough to improve efficiencies within an organization, but the whole supply chain has to be competitive. Developing close, long-term relationships with both customers and suppliers can take significant wastes out of the supply chain, and is a potentially valuable way of securing competitive advantage (Porter, 1985; Spekman et al., 1998a). Understanding and practicing SCM have become an essential prerequisite to staying in the competitive global race and to growing profitably (Garwood, 1999). As stated by strategic planning director of Hewlett-Packard Corporation: "we need to become expert at working with partners efficiently to manage our assets. SCM skills are critical for us to achieve our profit growth and market share objectives" (O'Connell, 1999).

Coordination of complex global networks of organizational activities is becoming a prime source of competitive advantage in which suppliers and customers are linked throughout the entire sequences of events that bring raw material from its source of supply, through different value-adding activities, to the ultimate customers.

In order to further understand the intricacies of SCM, different theories have offered insights into how and why different SCM practices emerge and for

understanding the consequences of these practices for the efficiency and competitiveness of an organization. This chapter will first discuss the theories addressing the rationale of SCM issues, followed by the identification and discussion of various constructs of SCM.

2.1 SCM in Theory

SCM has evolved from the field of logistics. Its development was initially along the lines of physical distribution and transportation (Lamming, 1996). Of late, SCM has extended its focus on the need for closer relationships between customers, suppliers, carriers, and other relevant parties, in search of competitive advantage. Research has posited theories addressing the reasons why organizations enter into closer business relationships. Industrial organization and associated transaction cost analysis (Williamson, 1975; Ellram, 1990), competitive strategy (Porter, 1980), and social-political perspective (Stern & Reve, 1980; Stern & El-Ansary, 1982) can be used as the basis for explaining the rationale of SCM. Each makes predictions about when partnerships will be formed.

Industrial organization is a hybrid field, combing organizational theory with economics, to develop a theory of competition (Ellram, 1990). The methods of competitively organizing that come closest to the concept of SCM in the industrial organization literature are vertical integration and contractual relationship, which Williamson (1985) defines as "obligational contracting". Organizations in the value-chain have traditionally relied on vertical integration in order to maintain control over the critical resources necessary for their success. Transaction cost perspective (Williamson, 1985; 1986) suggests that vertical integration be preferred over market exchange when

the transaction cost of market exchange exceeds those of vertical integration. The rationale behind this proposition is that bounded rationality and opportunism of trading partners, together with environmental conditions, make transaction costs much higher than production costs (Clark & Lee, 2000).

Williamson further discusses the conditions for vertical integration and obligational contracting in terms of his three critical dimensions of transaction, including uncertainty associated with the transaction (cost, time and so on), the degree to which specialized assets or investments are involved in the transaction, and the frequency of transaction. These dimensions determine the way an organization should be structured in order to be more effective in bringing the organization's product to market. Williamson argues that as assets become more specific to a single use there is no advantage to purchase outside. Vertical integration can realize the same economies of scale without the associated risk of opportunism. Vertical integration can also provide the organization with more flexibility in uncertain situations. Thus, Williamson argues that vertical integration is most likely for recurrent transaction which requires very specialized, narrowly usable assets, while obligational contracts fit best when transactions are recurrent, and assets needed for production are highly specialized, yet not limited to one use. The existence of specialized assets and recurrent transactions creates a mutual dependence and benefit between trading partners, which increases the likelihood of long-term commitment. Vertical integration can be viewed as an alternative to SCM, in that it attempts to manage and to control channel efficiency through ownership, while obligational contracting can be viewed as one form of SCM, in that it attempts to manage part of channels through formal agreements (Ellram, 1990).

Extending the work of Williamson, Ellram (1990) summarizes three conditions conducive to SCM: 1) recurrent transactions requiring moderately specialized assets; 2) recurrent transaction requiring highly specialized assets; and 3) operating under moderately high to high uncertainty. The following paragraphs will discuss each condition in more detail.

Recurrent transactions requiring moderately specialized assets. This condition is consistent with the condition for obligational contracts. Obligational contracts would be ideal for SCM because both parties benefit from cooperation. The specialized nature of the relationship should draw organizations closer together through mutual interdependence. It is also probable that the supply of the component or materials is a significant part of the product. The technology is likely to be in the product and manufacturing process which again promotes a closer relationship. However, the commitment does not need to be so great that it could not be changed if circumstances altered. For this reason vertical integration is generally not going to be the appropriate solution.

Recurrent transaction requiring highly specialized assets. SCM relationships may also be attractive in this situation that Williamson identified for vertical integration. Williamson feels that contractual relationships offer no advantage over vertical integration in this situation, since assets are used solely for one organization. The argument is put forth that the organization can produce to satisfy its own needs just as easily as it can those of an outside party. Williamson's argument is strictly an economic argument, which does not address the benefits of specialization and the limits on an organization's effective span of control. By using an outside party to perform a task, the

organization can concentrate on its core activities, enjoy potential synergies from the outside party's knowledge of similar tasks, or access to markets and resources. The risk of asset ownership is also shifted. Since the assets are required would be for exclusive use, the parties involved would be mutually dependent and mutually benefit from cooperation.

Operating under moderately high to high uncertainty. Harrigan (1985) states that organizations should not vertically integrate if there is much uncertainty or market volatility. Vertical integration is too risky in terms of concentrating asset investments in an uncertain environment. However, SCM could be beneficial in these situations, because all parties desire to reduce risk and uncertainty. SCM relationships can benefit all parties via improving performance and reducing risk through information sharing and cooperation. Willamson sees uncertainty as inhibiting commitment in contractual relations, because bounded rationality makes it too difficult to plan for uncertainty. However, uncertainty can be addressed by writing flexible contracts and leaving opportunities for negotiation. In these situations, it is likely that multiple sourcing will be used so as to reduce risk in supply (Berry et al., 1994).

In summary, according to Ellram (1990), SCM as a competitive form brings together advantages of obligational contracts and vertical integration. Building on the participants' strength, SCM positions each organization to do what it does best, while spreading the risk of assets ownership, and reducing market risk through improved communication and coordination.

Porter (1980) also offered an economic justification of supply chain partnership from the perspective of competitive strategy. He suggested that cooperation might enable

partners to achieve a stronger position together than they could achieve independently. Cooperation is attractive, when performing an activity with a partner is superior to performing it either internally, in a market transaction, or through merger. Kay (1993) argues that the architecture of relationships is a principle source of competitive advantage, while Ford (1998) and Colombo (1998) also stress the importance of effective networks of relationships to performance. Clark and Lee (2000) state that organizations in competitive environments should focus on their core competence, because "full vertical integration ties up capital resources and creates considerable management problems as the organization gets involved in successive stages of production or distribution where it has very little experience". Because extensive vertical integration may create an inflexible commitment to assets and capabilities, at the risk of losing an organization's value as circumstances change, an organization should instead focus on a strategic core- a set of assets and capabilities that are highly specific and necessary to attain the organization's strategic goals.

On the other hand, the social-political stream argues that an organization forms inter-organizational linkages primarily to gain control over critical resources and thereby reduce uncertainty in their acquisition. Organizations use various forms of power to control such linkages (Stern & El-Ansary, 1982). Therefore, social-politically oriented researchers consent that inter-organizational relationship could exist even if they are not cost efficient because of other social and political forces (Pfeffer, 1982).

Reve (1990), developing on Williamson's work, sees the organization as a nexus of economic contracts. Organizations will seek to reduce transaction cost by searching for the most efficient boundary of the organization. Moreover, Cox (1996) argues that the

efficient boundary of the organization will also change over time and can never be taken as a given. He says " It will always be that organizational form of economic governance that links internal and external skills and expertise in such a way as to sustain the organization's ability to generate a margin (profit) within a supply and value chain." Hall (1999) states that a fundamental reason for organizations to enter strategic partnerships is to create new distinct capabilities from current capabilities. This process will involve developing the knowledge bases that underpin each partner's distinctive capabilities. As these knowledge bases usually contain significant tacit knowledge content, it will be necessary for the partners to communicate and enhance this tacit knowledge.

Above discussions provide the theoretical justification of SCM and support the notion that SCM is a very effective form of organizing in today's competing environment and will provide sustainable competitive advantage for an organization.

2.2 The Constructs of SCM

To better understand the antecedences and consequences of SCM, nine constructs have been identified through a comprehensive literature review. A research framework is then developed that depicts the various causal relationships between these constructs.

The nine proposed constructs in the model include: 1) *Environmental Uncertainty*. The source of events and changing trends which create opportunities and threats for individual organization. This construct is identified as the external driving force for SCM practice; 2) *Top Management Support for SCM*. The degree of top manager's understanding of the specific benefits of and supports for collaboration with trading partners. This construct is identified as the internal driving force for SCM

practice; 3) *SCM Strategy Process*. SCM strategy is a design and blueprint for the SCM that forms the acquisition and development of supply chain capability into the future. This paper focuses on the process of SCM strategy, that is, how well SCM strategy is aligned and implemented in an organization; 4) *Partner Relationship*. The degree of trust, commitment, and shared vision between trading partners; 5) *Usage of IT Tools*. Information technology used to facilitate SCM practices; 6) *SCM Practice*. A set of intra/inter-organizational practices aimed to improve the performance of the whole supply chain; 7) *SCM Performance*. The overall efficiency and effectiveness of SCM; 8) *Competitive Advantage*. The extent to which an organization is able to create a defensible position over its competitors; and 9) *Organizational Performance*. How well an organization fulfills its market and financial goals. Table 2.1 summarizes these constructs and their literature basis.

Among all the constructs, except top management support for SCM, SCM strategy process, and organizational performance, the other six constructs are higher-level constructs that are represented by several sub-constructs. Environmental uncertainty includes four sub-constructs (customer uncertainty, supplier uncertainty, competitor uncertainty, and technology uncertainty); usage of IT tools includes three sub-constructs (communication tools, resource planning tools, and supply chain management tools); partner relationship includes three sub-constructs (trust in trading partners, commitment of trading partners, and shared vision between trading partners); SCM practice consists of six sub-constructs (strategic supplier partnership, customer relationship, information sharing, information quality, lean system, and postponement); SCM performance contains five sub-constructs (supply chain flexibility, supply chain integration, customer

Table 2.1 Construct Definitions and Literature Support

Construct	Definition	Literature
Environmental Uncertainty	The source of events and changing trends which create opportunities and threats for individual organization.	Lenz, 1980; Turner, 1993; Chen et al, 1992; Burgess, 1998; Tan et al., 1998; Thomas & Griffin, 1996; Krause et al., 1998; Aldrich, 1979; Paswan et al.,1998; Milliken, 1987; Oswald et al., 1997; Miller and Droge, 1986; Nahm, 2000.
Top Management Support for SCM	Degree of top manager's understanding of the specific benefits of and support for collaboration with trading partners.	Lee and Kim, 1999; Balsmeier and Voisin, 1996; Tompkins 1998; Burnell. 1999; Dale, 1999; Hamel and Prahalad, 1989; Hitt et al., 1999; Mentzer, 1999; Burgess, 1998.
SCM Strategy Process	How well SCM strategy is aligned and implemented in an organization.	Sheridan, 1998; Towell, 1997; Claycomb et al., 1999; Ayers, 1999; Spekman, et al., 1998a; McAdam and McCormack, 2001; Lummus & Vokurka, 1999; Vokurka and Lummus, 2000; Tamas, 2000.
Partner Relationship	The degree of trust, commitment, and shard vision between trading partners.	Spekman et al., 1998a; Tan et al., 1998; Handfield and Nichols, 1999; Stein and Sweat, 1998; Sheridan, 1998; Sengupta, 1993.
Usage of IT Tools	Information technology used to facilitate SCM practices.	Chizzo, 1998; Clark and Lee, 2000; Malone and Laubacher, 1998; Humphreys et al., 2001; Bensaou et al.,1996; Spekman et al., 1998a; Magretta, 1998a; Burgess, 1998; Bowe-Sox and Daugherty, 1995; Lee and Billington, 1995; Kaufman et al., 2000; Power et al., 2001; Lancioni et al., 2000; Turner, 1993.
SCM Practices	A set of intra/inter-organization practices aimed to improve the performance of the whole supply chain.	Zielke and Pohl, 1996; Walton, 1996; Donlon, 1996; Tan et al., 1998; Alvarado and Kotzad, 2001; Tan 2001; Monczka et al., 1998; Balsmeier and Voisin, 1996; Noble, 1997; Sheridan, 1998.
SCM Performance	The overall efficiency and effectiveness of SCM.	Beamon, 1998; 1999; Harland, 1996; Garwood, 1999; Gunasekarn et al., 2001; Holmberg, 2000; Tompkins and Ang 1999; van Hoek, 1998; Bechtel and Jayaram, 1997; Kiefer & Novack, 1999; Narasimhan and Jayaram, 1998; Hewitt, 1999; Spekman et al., 1998a.
Competitive Advantage	The extent to which an organization is able to create a defensible position over its competitors.	Porter, 1985; McGinnis & Vallopra, 1999; Tracey et al., 1999; White, 1996b; Skinner, 1985; Roth and Miller, 1990; Koufteros et al., 1997; Cleveland et al., 1989; Safizadeh et al., 1996; Vickery et al,1997; Solis-Galvan, 1997; Rondeau et al., 2000.
Organizational Performance	How well an organization fulfills its market and financial goals.	Yamin et al., 1999; Tan et al, 1998; Holmberg, 2000; Stock et al., 2000.

responsiveness, supplier performance, and partnership quality); and competitive advantage is represented by five sub-constructs (price, quality, delivery dependability, time-to-market, and product innovation). For descriptive purpose, all of them, including high-level constructs and sub-constructs, are called constructs in later discussion.

Before developing measures for these variables and testing their relationships, it is rational to first define and discuss these constructs. The following section will present a detailed review of existing literature concerning each of the nine constructs proposed above. In next chapter, ten research hypotheses are then developed based on this review.

2.2.1 Driving Forces for SCM

Designing and managing supply chain is a complex managerial challenge in today's competitive business environment. Globalization, deregulation, more demanding customers, and the advances in information technology all contribute to this complexity. The modern supply chain has to respond to a greater uncertainty of demand and variety, higher product quality, and much shorter response time at least possible cost (Kumar, 2001). Organizations need innovative SCM to meet these challenges. At the same time, the adoption and implementation of SCM need top management vision and support (Hamel and Prahalad, 1989; Dale, 1999). External environmental uncertainty and internal top management support, which are defined as driving forces for SCM practice in this study, will impel an organization to implement various SCM practices. Table 2.1 provides the definitions and supporting literature for these two constructs.

2.2.1.1 Environmental Uncertainty

Environmental uncertainty is defined as the source of events and changing trends that create opportunities and threats for individual organizations (Lenz, 1980; Turner, 1993). In today's competitive environment, markets are becoming more international, dynamic, and customer driven; customers are demanding more variety, better quality, higher reliability and faster delivery (Thomas and Griffin, 1996); product life cycle is shortening and product proliferation is expanding; technological developments are occurring at a faster pace, resulting in new product innovations and improvements in manufacturing processes. The resulting competitive environment requires new business and manufacturing strategies (Krause et al., 1998). To respond to such uncertain environment, organizations have increased their level of outsourcing and cooperation with their customers and suppliers (Krause et al., 1998; Ellram, 1990; Fliedner and Vokurka, 1997). Environmental uncertainty has acted as a critical external force driving the implementation of SCM.

In operationalizing environmental uncertainty, there is no consisteny in the literature. Most of operationalization of environmental uncertainty is rooted in the work of Aldrich (1979). In terms of state of uncertainty, Aldrich proposes five sub-dimensions of environmental uncertainty: 1) capacity, 2) homogeneity-heterogeneity, 3) stability-instability, 4) concentration-dispersion, and 5) turbulence. Based on the work of Aldrich (1979) and Achrol and Stern (1988), Paswan et al. (1998) operationalizes environmental uncertainty in terms of the four sub-dimensions: diversity (among consumers), dynamism, concentration, and capability. Extending the work of Aldrich (1979), Milliken (1987) and Oswald et al. (1997) classify environmental uncertainty into the following

dimensions: stable-turbulent, simple-complex, predictable-unpredictable, static-dynamic, non-threatening- threatening, exciting-dull, and certain-uncertain.

On the other hand, some researchers classify environmental uncertainty in terms of source of uncertainty. For example, Miller and Droge (1986) and Vickery et al. (1999b) evaluate environmental uncertainty using the following dimensions: volatility in marketing practices, product obsolescence rate, unpredictability of competitors, unpredictability of demands and tastes, and change in production or service modes. Gupta & Wilemon (1990) consider perceived environmental uncertainties coming from the following four factors: 1) increased global competition, 2) continuous development of new technologies that quickly cause existing products to be obsolete, 3) changing customer demand needs and requirements which truncate product life cycles, and 4) increasing need for involvement of external organizations such as suppliers and customers. Ettlie & Reza (1992) view perceived environmental uncertainty as unexpected changes of customers, suppliers, competitors, and technology. The same classification about environmental uncertainty is adopted in Zhang's (2001) study of value chain flexibility. Consistent with this perspective, environmental uncertainty in this study is defined as including the uncertainty from customers, suppliers, competitors, and technology. This classification allows identifying and analyzing the influence of uncertainty from each player/force in SCM practice. The following section will discuss each of these four uncertainties respectively. The list of sub-constructs for environmental uncertainty, along with their definitions and supporting literature, are provided in Table 2.2.

Table 2.2 List of Sub-Constructs for Environmental Uncertainty

Constructs	Definitions	Literature
Customer Uncertainty	The extent of the change and unpredictability of the customer's demands and tastes.	Burgess, 1998; van Hoek et al., 1999; Scott and Westbrook, 1991; Tan et al.,1998; Wines, 1996.
Supplier Uncertainty	The extent of change and unpredictability of the suppliers' product quality and delivery performance.	Lee and Billington, 1992; Davis, 1993; Yu et al., 2001; Power et al., 2001; Shin et al., 2000.
Competitor Uncertainty	The extent of change and unpredictability of the competitors' actions.	Narasimhan and Jayaram, 1998; Mentzer et al., 2000; Noble; 1997; Lummus and Vokurka, 1999; Mentzer et al., 2000; Balsmeier and Voisin, 1996.
Technology Uncertainty	The extent of change and unpredictability of technology development in an organization's industry.	Evan et al., 1993; Turner, 1993; van Hoek et al., 1999; Tan et al., 1998; Tattum, 1999.

Customer Uncertainty is defined as the extent of the change and unpredictability of the customer's demands and tastes. The traditional seller market, where demand outstripped supply, has been replaced by fast moving, sophisticated, customer-led competition. The customer demands for products and services are becoming increasingly volatile and uncertain in terms of volume, mix, timing, and place. Customers today want more choice, better service, higher quality, and faster delivery (Burgess, 1998; van Hoek et al., 1999). Moreover, competitive pressure in a global marketplace has greatly altered the traditional nature of the customer choice. Japanese producers have shown that it is possible, indeed essential, to compete on price, quality, delivery, lead-time, and reliability simultaneously, and that the reward for doing so is vastly increased market share (Scott and Westbrook, 1991).

Tan et al. (1998) point out that as customers require even more specialized and customized products and services to meet their needs, the need for mass customization

and flexibility is growing. Make-to-order and assemble-to-order manufacturers are under increasing pressure for smaller lot sizes and shorter delivery lead-time. As a result, mass customization strategies that emphasize flexibility, low cost, high quality, and efficient small batch production are rapidly gaining ground. The growth of customization and personalized services is leading to an era in which relationships with both customers and suppliers are crucial for corporate financial survival (Wines, 1996). Many organizations have embraced SCM with the hope of reducing costs and improving efficiency throughout the supply chain. To satisfy customers' changing needs, effective SCM is needed.

Supplier Uncertainty is defined as the extent of change and unpredictability of the suppliers' product quality and delivery performance. There are many sources of supplier uncertainties: supplier's engineering level, supplier's lead-time, supplier's delivery dependability, quality of incoming materials, and so on (Lee and Billington, 1992). Uncertainty caused by suppliers, such as delayed or broken materials, will postpone or even stop an organization's production process. Furthermore, these uncertainties will propagate through the supply chain in the forms of amplification of ordering variability, which leads to excess safety stock, increased logistics costs, and inefficient use of resources (Davis, 1993; Yu et al., 2001). A manufacturer with key suppliers that have poor quality and delivery records will find it very difficult to provide high levels of customer service even in a stable environment. If placed in a rapidly changing environment, this manufacturer will be eliminated from participation in the competitive game (Power et al., 2001).

Traditionally, the relationship between the suppliers and manufacturers are adversarial and manufacturers usually select suppliers based on price. To reduce the uncertainty from the suppliers, organizations usually hold a large amount of inventory, but this strategy will increase the overall production cost and put an organization at a competitive disadvantage in today's competing business environment. To respond to such challenge, organizations have begun to build long-term strategic relationships with a limited number of qualified suppliers. By involving suppliers in the process and sharing critical information with the suppliers, organizations can improve their customer service dramatically. Through a well-developed long-term relationship, suppliers become part of a well-managed supply chain and this relationship will have a lasting effect on the competitiveness of the entire supply chain (Shin et al., 2000).

Competitor Uncertainty is defined as the extent of change and unpredictability of the competitors' actions. Globalization, demanding customers, and rapid technology development will make competitors' actions even more unpredictable. Globalization increases the range of opportunities to compete. Organizations once focusing on domestic markets must also be able to understand foreign rivals that penetrate their markets. But as organizations globalize, regardless of their size, they lack the total resources required for success and thus recognize the necessity of partnering with other organizations (Mentzer et al., 2000).

The growing competitiveness of the business environment is likely to continue into the future. To respond to such intense competition, organizations are facing simultaneous pressures to reduce costs and time to market, and increase product quality and variety (Narasimhan and Jayaram, 1998; Mentzer et al., 2000). Under this

competitive pressure, business will be forced to seek improved methods of delivering goods to market as quickly and cost efficiently as possible. SCM offers too many possibilities to be ignored. By focusing on its "core competence", that is, on what it can do the best and outsourcing other activities, an organization can achieve a competitive advantage (Noble; 1997; Lummus and Vokurka, 1999). Organizations that maintain their "traditional view" of supply chain will ultimately become noncompetitive (Balsmeier and Voisin, 1996).

Technology Uncertainty is defined as the extent of change and unpredictability of technology development in an organization's industry. The development of IT provides numerous opportunities for organizations. For example, the breakthroughs in IT have fueled the movement toward supply chain and business process integration (Chizzo, 1998), brought out many benefits to an organization and made true supply chain integration possible (Turner, 1993). The advanced information systems reduce the transaction costs associated with the control of goods flow and make a quick response to customer orders; the development in IT enables organizations to achieve a high degree of control in international supply chains that was virtually unimaginable only a few years ago.

IT development provides not only opportunities, but also threats, for individual organizations. For example, the development of IT will increase the competition base through easy access to global organizations of suppliers; hence, competition is no longer local but international (Evan et al., 1993). Given the quick obsolescence of components in the computer industry, organizations need to periodically invest in new systems (Prasad & Tata, 2000). In addition, IT is changing the level of customer intimacy within

the supply chain and increasing customer and consumer expectations, for example, from "during business hours with a two to three day business delivery" has become "24 hours by 7 days with immediate or same day delivery". Therefore, IT is accelerating the shift in power from producers to the consumer's demands for responsiveness and flexibility (Tattum, 1999).

The rapid development of IT continuously adds the pressure on organizations to invest in new information systems, if they want to survive global competition and to obtain competitive advantage. Consequently, the adoption and implementation of new technology requires an organization to change its culture, structure, process, and/or inter-organizational relationships.

2.2.1.2 Top Management Support for SCM

Top management support for SCM is defined as the degree of top manager's understanding of the specific benefits of and support for collaboration with supply chain partners (Lee and Kim, 1999). A number of researchers (Hamel and Prahalad, 1989; Dale, 1999; Balsmeier and Voisin, 1996) have regarded top management support as the most important driver for any successful change in the organization. Top management vision plays a critical role in shaping an organization's values and orientation. To implement SCM successfully, top management must understand and embrace the significant operational and market impacts of partnering and develop a good understanding of their potential partners and their top management (Hitt et al., 1999; Mentzer, 1999).

Top management support is needed in integrating SCM into an organization's business strategy and getting the resources required for the implementation of SCM practice (Burgess, 1998). Furthermore, achieving integrated SCM requires the guidance of a champion who will shepherd his/her organization through the goal setting process that helps make sure those goals are in synchronization with those of their channel partners.

But most CEOs are simply unwilling to risk making the changes necessary for SCM practice unless they are forced into a position where the environment requires such actions (Balsmeier and Voisin, 1996). According to a 1999 study by Warehouse Education and Research Council and Andersen Consulting, SCM projects sponsored by a vice president have a higher "very successful" rating than projects sponsored by directors, which in turn have a higher success rating than projects sponsored by managers (Burnell. 1999), but only 7% of SCM projects were sponsored by a chief officer.

2.2.2 SCM Strategy Process

SCM strategy is defined as a design and blueprint for SCM that forms the acquisition and development of supply chain capability into the future (Sheridan, 1998; Towell, 1997). This discussion focuses on the process of SCM strategy, that is, how well SCM is aligned with business strategy and how well it is implemented in an organization. SCM relies on strategic decision-making because it is a proactive response to create value for the customers (Claycomb et al., 1999). Any initiation of SCM practice should begin with the strategy, which requires cross-functional thinking that is uncommon in most organizations (Ayers, 1999); the remaining tasks need to align with these strategies. A

good SCM strategy should consider all activities centered in the supply chain as one entity. It involves understanding and accommodating local variations and cultures, striving for open "world" standards and understanding international issues (McAdam and McCormack, 2001).

Furthermore, to realize the full potential of SCM, the role of the supply chain in achieving business strategy must be identified and aligned with the overall organization strategy (Lummus & Vokurka, 1999; Spekman, et al., 1998a). Corporate strategy statements cannot be a compilation of functional strategies and nothing more. The overall strategy and supporting supply chain strategy must be cross-functional and integrative (Vokurka and Lummus, 2000). Moreover, objectives and strategies of SCM should be communicated to every employee.

But it has been pointed out in the literature, many organizations do not have a clearly defined SCM strategy; they think they should implement SCM since other organizations are. According to a survey conducted by Anderson Consulting (Jones, 1998), less than a quarter of the organizations surveyed have a logistics/supply chain strategy in place, and only 45 percent know their current logistics costs, although half of the respondents indicate that they are developing a strategy. Another survey sponsored by Ernst & Young LLP and Stevens Institute of Technology, reveals that only 13 percent of the 80 respondents believe that their organization's supply chain strategy are fully aligned with their business unit strategy (Tamas, 2000). Stuart (1997) uses data from a longitudinal study of buyer-supplier relationships and finds that alliances did not lead to any appreciable improvement in status of and respect for the role of supply management in developing corporate strategy. Since SCM strategy issue has not received enough

attention from practitioners, it is of great interest to investigate the role of SCM strategy process in the implementation of SCM. Therefore, the process of SCM strategy is considered an important construct in this research.

In this study, we define an effective SCM strategy process, that is, a well aligned and implemented SCM strategy, using the following indicators, such as having an SCM strategy that is long-range, having a formal process for the implementation of SCM, having a regular system for monitoring SCM performance, having translated business strategy into SCM terms, having derived competitive advantage through SCM, and having communicated SCM strategy to all employees. An SCM strategy process may be considered effective if it exhibits all or most of the characteristics described above. On the other hand, an SCM strategy process may be ineffective (poorly aligned and implemented) if it exhibits few of the characteristics described above. In a large-scale survey, responses of managers to above questions can be collected. Through analyzing the responses, the effectiveness of SCM strategy process in an organization can be measured. Such methodology has been used by Bates et al. (1995) to evaluate the process of manufacturing strategy in organizations.

2.2.3 Partner Relationship

Partner relationship refers to the degree of trust, commitment, and shared vision between trading partners. IT can be used to easily link physical supply chain processes, but not inter-organizational relationships. Trust and commitment are needed to build long-term cooperative relationships between trading partners (Spekman et al., 1998a; Tan et al., 1998). Without a foundation of effective partner relationship, any effort to manage

the flow of the information or materials across the supply chain is likely to be unsuccessful (Handfield and Nichols, 1999). The biggest challenge for SCM implementation is people issues, not technology issues; as pointed out by Andraski (1994), the implementation of SCM practice is "20% technology problems, 80% people problems".

True partnership requires trust, open communication, fairness, consideration of the self-interest of both partners, a balance in the reward/risk equation (Sheridan, 1998), and a common vision for the future. Furthermore, when supply chain members become dependent on each other, this dependency can cause feelings of insecurity in managers who feel that they are no longer in the control of their organizations' destiny (McAdam and McCormack, 2001). To reduce this feeling of insecurity will require trust between the partners.

Achrol et al. (1990) identify commitment, trust, group cohesiveness, and motivation of alliance participants as critical to inter-organization strategic alliances. Bucklin and Sengupta (1993) consider organizational compatibility as one of the key predictors of effective alliances. Owens and Richmond of Andersen Consulting identify the six obstacles to supply chain integration: lack of shared vision, culturally frozen beliefs, no shared sense of urgency, lack of champion, lack of appropriate skills for the reinvented business, and not enough visible involvement by senior management (Balsmeier and Voisin, 1996). In sum, we consider partner relationship conducive to the implementation of SCM practice as including three sub-dimensions: trust in trading partners, commitment of trading partners, and shared vision between trading partners.

The list of these sub-constructs, along with their definitions and supporting literature, are provided in Table 2.3.

Table 2.3 List of Sub-Constructs for Partner Relationship

Constructs	Definitions	Literature
Trust in Trading Partners	The willingness to rely on a trading partner in whom one has confidence.	Ganesan, 1994; Monczka et al., 1998; Wilson & Vlosky, 1998; Spekman et al., 1998a; Ballou et al., 2000; Young et al., 1999; Mariotti ,1999; Vokurka & Lummus, 2000.
Commitment of Trading Partners	The willingness of each partner to exert effort on behalf of the relationship.	Monczka et al, 1998; Spekman et al., 1998a; Mentzer et al., 2000; Wilson & Vlosky, 1998; Hicks, 1997b; Grittner, 1996.
Shared Vision between Trading Partners	The degree of similarity of the pattern of shared values and beliefs between trading partners.	Alvarez, 1994; Lee and Kim, 1999; Ballou et al., 2000; Spekman et al. 1998a; Monczka and Morgan ,1997; Farley, 1997; Sheridan, 1998.

Trust in Trading Partners is defined as the willingness to rely on a trading partner in whom one has confidence (Ganesan, 1994; Monczka et al., 1998; Wilson & Vlosky, 1998; Spekman et al., 1998a). Trust is conveyed through faith, reliance, belief, or confidence in the supply chain partner, viewed as a willingness to forego opportunistic behavior (Spekman et al., 1998a). The definition of trust, therefore, reflects two distinct components: (1) credibility, which is based on the extent to which one party believes that another party has the required expertise to perform jobs effectively and reliably, and (2) benevolence, which is based on the extent to which one party believes that another party has intentions and motives beneficial to itself when new conditions arise, conditions for which a commitment was not made (Ganesan, 1994). Trust based on a partner's expertise and reliability focuses on the objective credibility of an exchange partner, while benevolence focuses on the motives and intentions of the exchange partner.

Power and trust can be used to generate cooperation in a supply chain (Ballou et al., 2000). The exercise of power by a channel member might be used against the one worse off as a result of the cooperation. A member might be so dominant that other members may be coerced into acting to achieve the system-wide benefits. But according to Ballou et al. (2000), central to building a long-term supply chain partnership is the presence of trust, not power and its ability to condition others. Trust, as a means of engendering cooperation between trading partners, receives support in the literature. Trust has been considered by many researchers to be the binding force in most productive partner relationships (Wilson & Vlosky, 1998). Deutsch (1960), using prisoner's dilemma experiments, suggests that the initiation of cooperation requires trust. Pruitt (1981) suggests that a party will undertake high-risk, coordinated behaviors if trust exists. Mariotti (1999) and Vokurka & Lummus (2000) state that trust is the quality that allows cooperation and collaboration to take place both within the organization and among the supply chain partners. Parties who trust one another can find ways to work out difficulties such as power, conflict, and lower profitability. Trust stimulates favorable attitudes and behaviors (Schurr and Ozanne, 1985). Moreover, allowing an outside organization to view transaction-level data places a premium on trust between trading partners because of the competitive risks associated with this type of access (Young et al., 1999).

Commitment of Trading Partners refers to the willingness of buyers and suppliers to exert effort on behalf of the relationship (Monczka et al, 1998; Spekman et al., 1998a). Commitment is an enduring desire to maintain a valued relationship. It incorporates each party's intention and expectation of continuity of the relationship, and willingness to invest resources in SCM (Mentzer et al., 2000). Therefore, commitment 1)

is a critical success factor for long-term benefits; 2) shows an intention to become more deeply involved in the partnership through investments that entail risks; and 3) implies the importance of the relationship to the partners (Mentzer et al., 2000). Through commitment, partners dedicate resources to sustain and further improve the effectiveness of the supply chain. The types of resources committed may be in the form of an organization's time, money, facilities, etc. and are often referred to as "asset specific" resources, in that they are directed specifically towards the other party (Monczka et al., 1998). The influence of asset specificity on insourcing/outsourcing decisions was originally described by transaction cost theories (Williamson, 1975); only recently have theorists described how the commitment of assets can influence the nature of inter-organizational relationships.

Commitment has been identified as the variable that discriminates between relationships that continue and that break down (Wilson & Vlosky, 1998). Successful SCM execution requires the involvement and commitment of the people along the whole supply chain (Hicks, 1997b). Commitment can involve trusting the suppliers with proprietary information and other sensitive information. To a large degree, commitment "ups the ante" and makes it more difficult for partners to act in ways that might adversely affect overall supply chain performance. Grittner (1996) agrees that it's not enough to partner with a supplier in the hopes of getting the best possible price, commitment and coordination with a cost-analysis mindset is needed to maximize the supplier-customer relationship.

Shared Vision Between Trading Partners is defined as the degree of similarity of the pattern of shared values and beliefs between trading partners (Alvarez, 1994; Lee

and Kim, 1999). Shared vision is therefore the extent to which partners have beliefs in common about what behaviors, goals, and policies are important or unimportant, appropriate or inappropriate, and right or wrong (Ballou et al., 2000). Behaviors result from 1) sharing, identifying with, or internalizing the values of an organization or 2) cognitive evaluation of the instrumental worth of continued relationship with an organization.

It is obvious that supply chain members with similar organizational cultures should be more willing to trust their partners. In contrast, if the participants do not have a similar organizational culture, their divergent values make it difficult for them to trust one another and thus provide a fundamental cause to destroy business relationships (Lee and Kim, 1999). Spekman et al. (1998a) even suggest that collaboration within a supply chain can be achieved only to the extent that trading partners share a common "world view" of SCM. Organizational incompatibilities between allied organizations, in terms of reputations, job stability, strategic horizons, control systems, and goals, will lead to less strategic partnership (Mentzer et al., 2000), therefore, organizational and functional barriers must be removed from successful implementation of SCM (Sengupta and Turnbull, 1996).

Monczka and Morgan (1997) report that SCM has been poorly defined and there is a high degree of variability in people's minds about what it means, often the key people in the same organization aren't talking about the same thing when they discuss the concept of SCM. A change in the corporate culture is required for the implementation of SCM practice (Tan et al., 1998). The traditional culture that emphasizes seeking good, short-term, organization-focused performance conflicts with the SCM objective of

realizing consistently high performance and profitability in a way that benefits all contributors in the supply chain (Farley, 1997; Tan et al, 1998). To implement SCM successfully, the overall vision must be shared by all involved and both internal and external relationships must be managed for advantage (Sheridan, 1998).

2.2.4 Usage of IT Tools

Usage of IT Tools is defined as the information technology used to facilitate SCM practices. Developments in information technology have fueled the movement toward supply chain and business process integration (Chizzo, 1998). The transaction cost perspective and information processing perspective can be used to explain the impact of IT on the creation of inter-organizational coordination (Clark and Lee, 2000). Transaction costs involve costs of writing, monitoring, and enforcing contracts, as well as costs of locating potential trading partners. If these coordination costs are directly influenced by IT capabilities, actual transaction costs can be significantly lowered and economies of "outsourcing" can be more favored over that of "vertical integration". The underlying logic is that uncertainty surrounding a transaction, which increases the transaction costs, could be migrated by the superior capabilities of information technology, IT providing the capability to: 1) transact at a distance, allowing the search for transacting partners through a wide space; 2) match requirements to offering through e-markets; 3) negotiate through electronic means; 4) design contracts via software; and 5) monitor compliance with technology (Malone and Laubacher, 1998).

Information processing perspective can also be used to explore the role of IT in SCM. Information processing perspective views IT as a facilitator of new inter-

organizational relationships, and an influential element in organizational economics and strategy (Humphreys et al., 2001). Bensaou et al. (1996) examined the inter-organizational relationships via an extensive literature survey, and developed a framework to view the organization from an information processing perspective. From this perspective, information-processing needs are determined by uncertainties that exist at various levels, while the information processing capability is determined by the inter/intra-organizational coordination mechanisms. Bensaou et al.'s framework covers uncertainties at three levels: environment, partnership, and task uncertainty. To cope with these uncertainties, the information processing capabilities- structural, process, and IT mandated mechanism- are proposed.

Turner (1993) agrees that organizations cannot effectively manage cost, provide superior customer service, and be leaders in SCM without leading-edge information systems. The broad adoption of core IT tools, such as enterprise resource planning (ERP), electronic data interchange (EDI), Internet, and extranets, have helped many organizations achieve operational excellence and competitive advantage (Jones, 1998). By reviewing relevant literature (Knowles, 1996; Hicks, 1997a; Bushnell, 1998; Chizzo, 1998; Harrington, 1998; Kumar, 2001), fourteen IT tools are identified. These IT tools are further divided into three groups in terms of their primary purpose: 1) Communication Tools, 2) Resource Planning Tools, and 3) Supply Chain Management Tools. Communication Tools refer to the IT used to facilitate data transfer and communication between trading partners, which include EDI, Electronic Fund Transfer (EFT), Internet, Intranet, and Extranet; Resource Planning Tools refer to the IT used to integrate the resource planning processes in an organization, which include Material

Requirement Planning (MRP), Manufacturing Resources Planning (MRPII) and Enterprise Resource Planning (ERP). Supply Chain Management Tools are identified as the IT used to manage the various processes and relationships in the entire supply chain, which include Distribution Requirement Planning (DRP), Customer Relationship Management (CRM), Supplier Relationship Management (SRM), Vendor Managed Inventory (VMI), Data Warehouse (DW), and SCM software. The list of these three sub-dimensions for usage of IT tools, along with their definitions and supporting literature, are provided in Table 2.4. The fourteen IT tools are listed below:

Communication Tools

1) Electronic Data Interchange (EDI). The transfer of data in an agreed upon electronic format from one organization's computer program to one or more organizations' programs.
2) Electronic Fund Transfer (EFT). The transfer of a certain amount of money from one account to another through value added network (VAN) or Internet.
3) Internet. A public and global communication network that provides direct connectivity to anyone over a local area network (LAN) or Internet service provider (ISP).
4) Intranet. A corporate LAN or wide area network (WAN) that uses Internet technology and is secured behind an organization's firewalls. The intranet supports and promotes more effective internal information sharing and an organization's internal business processes.

5) Extranet. A collaborated network that uses Internet technology to link businesses with their supply chain and provides a degree of security and privacy from competitors.

Table 2.4 List of Sub-Constructs for Usage of IT Tools

Constructs	Definitions	Literature
Communication Tools	IT used to facilitate data transfer and communication between trading partners, which include EDI, EFT, Internet, Intranet, and Extranet.	O'Connell, 1999; White, 1996a; Tan, 2001; Reda, 1999; Pincince, 1998; Tattum, 1999; Schwartz 1998; Murphy and Daley 1996; Cross, 2000; Knowles, 1996; Gibson, 1998
Resource Planning Tools	IT used to integrate the resource planning processes in an organization, which include MRP, MRPII and ERP.	Chizzo, 1998; Jones, 1998; Knowles, 1996; Hicks, 1997a; Bushnell, 1998; Harrington, 1998; Kumar, 2001
Supply Chain Management Tools	IT used to manage the various processes and relationships in the entire supply chain, which include DRP, CRM, SRM, VMI, DW, and SCM software.	Chizzo, 1998; Hicks, 1997a; Bushnell, 1998; Harrington, 1998; Kumar, 2001; Cross, 2000; Tan, 2001.

Resource Planning Tools

1) Materials Requirement Planning (MRP). A scheduling technique for establishing and maintaining valid due dates and priorities for orders based on bills of material, inventory, order data, and master production schedule.
2) Manufacturing Resources Planning (MRPII). A direct outgrowth and extension of closed-loop material requirements planning (MRP or MRP II) through the integration of business plans, purchase commitment reports, sales objectives, manufacturing capabilities, and cash-flow constraints.

3) Enterprise Resource Planning (ERP). The installation of a single system that covers many information-processing needs typically handled by separate systems. ERP systems unite functions such as order management, inventory control, production planning, and financials under one integrated suite.

Supply Chain Management Tools

1) Distribution Requirement Planning (DRP). This system ties warehousing operations to transportation and reconciles forecast demand with transportation capacity and inventory.
2) Customer Relationship Management (CRM). The software is designed to integrate an organization's sales, marketing, and customer support functions in order to better serve the customer, while at the same time making the information available throughout the organization.
3) Supplier Relationship Management (SRM). The software is designed to optimize sourcing, design, and procurement processes, in collaboration with the suppliers.
4) Vendor Managed Inventory (VMI). A supply-chain initiative where the vendor monitors the buyer's inventory levels and makes periodic re-supply decisions.
5) Data Warehouse (DW). A database of databases capable of bringing all of an organization's data together into one gigantic database in support of management's decision-making process.

6) SCM Software. A suite of decision support solutions for better planning, execution, and optimization of the supply chain. SCM software may include strategic planning, demand management, supply management, fulfillment planning/execution, warehouse management, transportation management, and so on.

2.2.5 SCM Practice

The leaders in the industry are erasing the traditional corporate boundaries that separate organizations from their suppliers and customers, and they realize that the more closely they work with both suppliers and customers, the better the benefits are for all concerned. SCM practice, therefore, represents the new opportunities for differentiation and performance improvement (Zielke and Pohl, 1996).

Walton (1996) identifies five underlying dimensions of SCM partnership: planning, sharing of benefits and burdens, asset specificity, operational information exchange, and extendedness. Donlon (1996) describes the latest evolution of SCM, which includes supplier partnership, outsourcing, cycle time compression, and continuous process flow, and information technology sharing. Tan et al. (1998) use purchasing, quality, and customer relations to represent SCM practice in their empirical study. Alvarado and Kotzad (2001) suggest an organization's supply chain improvement as due to the following: avoidance of duplication effects by concentrating on core competencies; use of inter-organizational systems such as EDI; and elimination of unnecessary inventory levels by postponing customization toward the end of the supply chain. Tan (2001) suggests that a well-integrated supply chain involves coordinating the flows of

materials and information among suppliers, manufacturers and customers, and implementing product postponement and mass customization in the supply chain. In sum, six major dimensions of SCM practices are proposed and discussed below. Table 2.5 lists these six dimensions along with their definitions and supporting literature.

Strategic Suppliers Partnership is defined as the long-term relationships designed to leverage the strategic and operational capabilities of individual participating organizations to achieve significant ongoing benefits to each party (Monczka et al., 1998; Balsmeier and Voisin, 1996; Noble, 1997; Sheridan, 1998; Stuart, 1997). Strategic supplier partnership is different from operational partnership, which is an as-needed, shorter-term relationship for obtaining parity with competitors (Mentzer et al., 2000). A strategic partnership emphasizes direct, long-term association, encouraging mutual planning and problem solving efforts (Gunasekaran et al., 2001). Strategic alliances require that the following necessary and sufficient conditions be present (Yoshino & Rangan, 1995): 1) independence of the parties; 2) shared benefits among the parties; and 3) ongoing participation in one or more key strategic areas, for example, technology, products, markets, etc.

By developing strategic partnership with suppliers, it is possible to work more effectively with a few important suppliers who are willing to share responsibility for the success of the products. Suppliers participating earlier in the product design process can render more cost-effective design choices, develop alternative conceptual solutions, select the best components and technologies, and help in design assessment (Monczka et al., 1994). Strategically aligned organizations can work closely together and eliminate wasted time and effort (Balsmeier and Voisin, 1996). In addition, emphasizing internal

Table 2.5 List of Sub-Constructs for SCM Practice

Constructs	Definitions	Literature
Strategic supplier partnership	Long-term relationships designed to leverage the strategic and operational capabilities of individual participating organizations to achieve significant ongoing benefits to each party.	Monczka et al., 1998; Sheridan, 1998; Stuart, 1997; Balsmeier and Voisin, 1996; Tompkins, 1998; Lamming, 1993; Gunasekaran et al., 2001.
Customer Relationship	The practices to manage customer complaints, build long-term relationships with customers, and improve customer satisfaction.	Tan et al., 1998; Claycomb et al., 1999; Aggarwal, 1997; Bommer et al., 2001; Magretta, 1998a; 1998b; Noble, 1997; Wines, 1996.
Information Sharing	The extent to which critical and proprietary information is communicated to one's trading partners.	Monczka et al., 1998; Mentzer, 2000; Towill, 1997; Balsmeier and Voisin, 1996; Novack et al., 1995; Jones, 1998; Lalonde, 1998; Stein and Sweat, 1998; Yu et al., 2001; Vokurka & Lummus, 2000; Lancioni et al., 2000; Ballou et al. 2000.
Information Quality	The extent to which information exchanged is accurate, timely, complete, adequate, and credible.	Monczka et al., 1998; Chizzo, 1998; Holmberg, 2000; Jarrel , 1998; McAdam and McCormack, 2001; Metters, 1997; Lee et al., 1997; Mason-Jones and Towill, 1997; Berry et al., 1994; Alvarez, 1994.
Lean System	The practice of driving out the unnecessary cost, time, and other wastes from the entire supply chain.	McIvor, 2001; Taylor, 1999; Womack and Jones, 1996; Mason-Jones and Towill, 1997; Handfield and Nichols, 1999; Burgess, 1998.
Postponement	The practice of moving forward one or more operations or activities (making, sourcing and delivering) to a later point in the supply chain as far as possible.	van Hoek et al., 1999; van Hoek, 1998; 1999; Naylor et al., 1999; Beamon, 1998; Johnson & Davis, 1998; Waller et al., 2000; Beamon, 1998; Lee and Billington, 1995.

competencies requires greater reliance on external suppliers to support non-core requirement, particularly in design and engineering support.

As Tompkins (1998) points out, conventional "partnership" involving competitive bidding, multiple sources, and adversarial relationships doesn't work in integrated supply chain situations. A true supplier partnership, which emphasizes direct, long-term association, thus encouraging mutual planning and problem solving efforts (Lamming, 1993; Stuart, 1993; Gunasekaran et al., 2001), is critical in operating a leading-edge supply chain (Noble, 1997). For example, Honda of America and Chrysler, often cited for their leading practices in developing partnership relationships with suppliers, have achieved great benefits from it (Sheridan, 1998).

Customer Relationship is defined as the practices to manage customer complaints, build long-term relationships with customers, and improve customer satisfactions (Tan et al., 1998; Claycomb et al., 1999; Aggarwal, 1997). Noble (1997) and Tan et al. (1998) consider customer relationship management as one of the most important SCM practices. The growth of mass customization and personalized service is leading to an era in which relationship management with customers is becoming crucial for corporate financial survival (Wines, 1996).

A key dimension of SCM practice involves the management of upstream suppliers as well as downstream integration of customers (Tan et al., 1999). Customer relationship has long been recognized as an internal component of an organization's marketing strategy to increase sales and profits (Bommer et al., 2001). The key in customer relationship is to understand and meet customers' needs and requirements. Close customer relationship allows an organization to differentiate its product from

competitors and dramatically extend the value it provides to its customers (Magretta, 1998a) and sustain customer loyalty. An organization's customer relation practices can affect its success in managing the whole supply chain as well as its internal performance. When a customer driven corporate vision is implemented simultaneously with other SCM practices such as strategic supplier partnership, lean system, and postponement, it can produce a competitive edge in a number of different ways.

Information Sharing refers to the extent to which critical and proprietary information is communicated to one's supply chain partner (Monczka et al., 1998). Shared information can vary from strategic to tactical in nature and from information about logistics activities to general market and customer information (Mentzer, 2000). Many researchers have suggested that the key to the seamless supply chain is making available undistorted and up-to-date marketing data at every echelon within the supply chain (Towill, 1997; Turner, 1993; Balsmeier and Voisin, 1996). By taking the information available and making it visible to other parties in the supply chain, data on customers can be used as a source of competitive advantage (Novack et al., 1995; Jones, 1998).

Many researchers have emphasized the importance of information sharing in SCM practice. Lalonde (1998) considers sharing of information as one of five building blocks that characterize solid supply chain relationship. According to Stein and Sweat (1998), supply chain partners that exchange the information on a regular basis are able to work as a single entity. Together, they have a greater understanding of the end consumers and are better able to respond to change in the marketplace. Moreover, Yu et al. (2001) point out that the negative impact of the bullwhip effect on a supply chain can be reduced

or eliminated by sharing information with trading partners. Tompkins and Ang (1999) suggest that the key competitive and distinguishing factor for the 20th century is the proficient use of relevant and timely information by all functional elements within the supply chain to meet organizational objectives. For example, sharing information with suppliers gives Dell Company the benefits of faster cycle times, reduced inventory, and improved forecasts. At the same time, the customers get a higher-quality product at a lower price (Stein and Sweat, 1998).

However, there is the reluctance on the part of organizations in the supply chain to share information with each other. Information is generally viewed as providing an advantage over competitors, and organizations resist sharing with their partners (Vokurka & Lummus, 2000). This hesitancy was due to a variety of factors, including the perceived threat of giving away competitive advantage to other organizations, the sharing of sensitive information such as inventory levels and production schedules with other channel members, and the potential of losing customers to other competitors (Lancioni et al., 2000; Ballou et al. 2000; Croom et al., 2000).

Information Quality includes such aspects as the accuracy, timeliness, adequacy, and credibility of information exchanged (Monczka et al., 1998). Information sharing is without question important, but depending on what information is shared, when and how it is shared, and with whom, information sharing seems to have different functions in the supply chain (Chizzo, 1998; Holmberg, 2000). Jarrel (1998) agrees that sharing information within the entire supply chain can create the flexibility, but this requires timely, accurate information that is based on actual customer demand and extremely short-term forecast.

It is well known that information notoriously suffers from delay and distortion as it moves up the supply chain (McAdam and McCormack, 2001; Metters, 1997; Lee et al., 1997; Mason-Jones and Towill, 1997). Moreover, as a consequence of the traditional culture, organizations will deliberately distort order information to mask their intent not only to competitors, but also to their own suppliers and customers (Mason-Jones and Towill, 1997; 1999). There is a built-in reluctance within organizations to give away more than minimal information to the suppliers (Berry et al., 1994) since organizations usually perceive information disclosure as a loss of power. This will likely lead to further distortion as orders are passed along the chain. Therefore, to obtain the best SCM solution, information shared has to be as accurate as possible (Alvarez, 1994); organizations must view their information as a strategic asset and ensure that it flows with minimum delay and distortion.

Lean System is the practice of driving out the unnecessary costs, time, and other wastes from the entire supply chain (Womack and Jones; 1996; Taylor, 1999). The term "lean" embodies a system that uses less of all inputs to create outputs similar to the mass production system, but offer an increased choice to the end customer. The logic behind lean thinking in SCM is that organizations jointly identify the value stream for each product from concepts to consumptions and optimize this value stream regardless of traditional functional or corporate boundaries (McIvor, 2001). Elimination of waste is a fundamental idea within the lean system. The focus on waste was pioneered by Taichii Ohno, Toyota's Chief Engineer. Ohno identifies "Seven Wastes" in the production system: overproduction, waiting, transporting, inappropriate processing, unnecessary inventory, defects, and unnecessary motion. Although the "Seven Wastes" were

originally developed in a manufacturing context, research has shown that waste removal is equally relevant as a basis for improvement across the whole range of supply chain (Taylor, 1999).

In "Lean Thinking" wrtten by Womack and Jones (1996), five principles are identified which are fundamental to the elimination of waste. Taylor (1999) extends the above five principles into the SCM context and provides five lean principles for SCM: 1) understand what creates value from customer' s point of view; 2) identify the activities which are necessary to deliver that value across the whole supply chain- the value stream; 3) make value by eliminating waste between value-adding activities and within value-adding activities; 4) only make, or move, what is pulled by the customers and not what production units choose to make and push into the supply pipeline; 5) strive for perfection not only in terms of product quality but also in the physical process, information systems, and management which constitute supply chain activity.

Lean thinking and lean practices has become a very important dimension of implementing SCM (Mason-Jones and Towill, 1997; Handfield and Nichols, 1999). Organizations that have not reengineered their entire supply chains to drive out the unnecessary costs, time and other wastes- so that they can deliver high quality, best value products at lightning speed- will risk losing customers. Lean operating practices are the dominant driver to a highly integrated and down sized supply chain, promising both cost savings and closer, more productive working partner relationships. Reducing the time required to develop, manufacture, and distribute products not only reduces costs, but also increases productivity, allows premium prices to be charged, reduces risks, and increases flexibility (Burgess, 1998).

Postponement is defined as the practice of moving forward one or more operations or activities (making, sourcing and delivering) to a later point in the supply chain as far as possible (van Hoek et al., 1999; van Hoek, 1998; Naylor et al., 1999; Beamon, 1998; Johnson & Davis, 1998). In general, there are three types of postponement: form, time, and place postponement. Form postponement entails delaying activities that determine the form and function of products in the chain until customer orders have been received. Time postponement means delaying the forward movement of goods until customer orders have been received. Place postponement refers to the positioning of inventories upstream in centralized manufacturing or distribution operations, to postpone the forward or downward movement of goods. Time and place postponement, in combination labeled as logistics postponement, means that the forward movement of goods is delayed as long as possible. In practice, this implies that goods are stored at the central distribution points in the supply chain (van Hoek et al., 1999).

Postponement can be extended further upstream in the supply chain to suppliers of components and raw materials, and/or downstream in the delaying of transportation costs, warehousing, and storage costs (Waller et al., 2000). Therefore, such strategies include upstream postponement, downstream postponement, and distribution postponement. Upstream postponement extends up the supply chain, and manufacturers can wait to order raw materials from suppliers until they receive customer orders; downstream postponement delays some sort of physical change to the product after it leaves the primary manufacturing stage, such as further processing, adding features, mixing and sorting, or performing some other value-adding function to the product for a specific supply chain; and distribution postponement means that manufacturers wait to

ship the product until the customer order is received. In general, there are two primary considerations in developing a postponement strategy for a particular end-item: (1) determining how many steps to postpone, and (2) determining which steps to postpone (Beamon, 1998).

Postponement allows an organization to be flexible in developing different versions of the product as needed, to meet changing customer needs, and to differentiate a product or to modify a demand function (Waller et al., 2000). By keeping materials undifferentiated for as long as possible, organizations are able to increase their flexibility in responding to changes in customer demand. In addition, the cost-effectiveness of supply chains can be improved by keeping undifferentiated inventories (van Hoek et al., 1999; Lee and Billington, 1995).

2.2.6 SCM Performance

An important component in supply chain design and analysis is the establishment of appropriate performance measures. A performance measure, or a set of performance measures, is used to determine the efficiency and/or effectiveness of an existing system, or to compare competing alternative systems (Beamon, 1998).

Different researchers have attempted to assess SCM performance in different ways, but most performance measures up to now are more oriented towards economic performance than to other aspects of performance such as customer satisfaction (Harland, 1996). Garwood (1999) cautions that old yardsticks for SCM performance such as purchase price variance, direct labor efficiency, equipment utilization, and production development budget are no longer adequate, and a new set of metrics to motivate and

reward the right behavior is needed. New forms of performance measurement are crucial for successful SCM. Lack of measurement slows acceptance and implementation of major changes in the supply chain (Owens and Richmond, 1995; Alvarez, 1994). In spite of the recognition of the importance of the measures of SCM performance, organizations often lack the insight for the development of effective performance measures and metrics needed to achieve a fully integrated supply chain (Gunasekarn et al., 2001). According to Lee and Billington (1992), many organizations have no performance measures for SCM. Those that do have such metrics often do not monitor them regularly, or their metrics are not directly related to customer satisfaction. A recent study found that only five out of close to 100 organizations had measures aligned with their customers and suppliers (Monczka and Morgan, 1997).

Holmberg (2000) summarizes the problems in SCM measurement: first, strategy and measurement are not connected. Because of the missing connection, SCM measures seem to focus on internal functions instead of overall performance and customer needs; second, there is a biased focus on financial metrics. Financial performance, unfortunately, is better in showing the result of yesterdays' actions than indicating tomorrow's performance; and finally there are too many isolated and incompatible measures. The number and variety of metrics used in organizations tend to increase over time, but because metrics once introduced are too seldom removed, they soon become obsolete as strategy and underlying activities continue to change. Holmberg (2000) then suggests that the measurement of SCM must be considered from a system perspective and that SCM measurement should span the entire supply chain.

Besides Holmberg (2000), many researchers also offer suggestions for new measurement of SCM performance. Tompkins and Ang (1999) and van Hoek (1998) suggest that the new measurement must be designed to ensure that all the sub-systems and organizations in a supply chain act in the same manner to support market share, value, and profit. Bechtel and Jayaram (1997) agree that the measurement system in the supply chain must use integrated measures that are cross functional and can be applied to the entire process in order to avoid optimization at one point in the chain without considering potential consequences at other points in the supply chain. Rich (1999) points out that SCM performance measures must fit within the modern market context, unite managers, and provide metrics that are "lean" and "world-class". A customer focus is of paramount importance when developing performance measures (Kiefer & Novack, 1999). It is by focusing on the whole chain and the ultimate consumer of the supply chain's output that true supply chain excellence may be achieved (Tompkins and Ang, 1999).

In addition, Beamon (1999) presents a number of characteristics that are found in effective performance measurement systems. These characteristics include: inclusiveness (measurement of all pertinent aspects), universality (allow for comparison under various conditions), measurability (data required are measurable), and consistency (measures consistent with organizational goals). Based on the above guidelines, he suggests that an SCM measurement system must include three separate types of performance measures: resource measures (generally efficiency), output measures (generally customer satisfaction), and flexibility (how well the system reacts to uncertainty). Each type is vital to the overall performance of the supply chain.

To respond to the current requirements for SCM performance measurement, a set of new measures has been suggested and used in the literature. For example, Stevens (1990) suggests that an organization measure the performance of supply chain in terms of inventory level, service level, throughput efficiency, supplier performance, and cost. A consortium of organizations and academic institutions developed a set of agreed-upon supply chain metrics that can be used as standards. These measures fall into one of four categories: customer satisfaction/quality, time, cost, and assets (Pittiglio et al., 1994). Narasimhan and Jayaram (1998) use the customer responsiveness and manufacturing performance as the measure for SCM performance. Spekman et al. (1998a) used cost reduction and customer satisfaction as the SCM measures. Hewitt (1999) recommended customer satisfaction, return on trading assets and flexibility as the measurements for a supply chain performance. Beamon (1998) identifies several qualitative SCM performance measures: customer satisfaction, flexibility, information and material flow integration, effective risk management, and supplier performance. Gunasekaran et al. (2001) develop a framework for measuring the strategic, tactical, and operational level of supply chain performance based on an extensive literature survey. Their emphasis is on performance measurement dealing with suppliers, delivery performance, customer-service, and inventory and logistics costs in an SCM. It can be seen that each of above researchers, more or less, has addressed some dimensions of SCM performance measures, but not all. Among all measures, customer responsiveness/satisfaction received the most recognition.

Summarizing above research findings, five major dimensions of SCM performance are proposed which cover the three types of performance measurement

suggested by Beamon (1999): Supply Chain Flexibility (flexibility measure), Supply Chain Integration (resource measure), Customer Responsiveness (output measure), Supplier Performance (output measure), and Partnership Quality (output measure). Table 2.6 lists these five dimensions along with their definitions and supporting literature.

Table 2.6 List of Sub-constructs for SCM Performance

Constructs	Definitions	Literature
Supply Chain Flexibility	In general, flexibility reflects an organization's ability to effectively adapt or respond to change that directly impacts an organization's customer.	Vickery et al., 1999a; Aggarwal, 1997.
Supply Chain Integration	The extent of all activities within an organization, and the activities of its suppliers, customers, and other supply chain members are integrated together.	Stevens, 1990; Stock et al, 1998; Narasimhan and Jayaram, 1998; Frohlich & Westbrook, 2001; Magretta, 1998a; Wood, 1997.
Customer Responsiveness	The speed of an organization's responses to the customer requests.	Narasimham & Jayaram, 1998; Beamon, 1998; Lee and Billington, 1992; Stevens, 1990; Kiefer and Novack, 1999; Spekman et al., 1998a; Gunasekran et al., 2001.
Supplier Performance	Suppliers' consistency in delivering materials, components or products to your organization on time and in good condition.	Beamon, 1998; Davis, 1993; Levy, 1997; Shin et al., 2000; Tan et al., 1998; Vonderembse and Tracey, 1999; Carr and Person, 1999; Stevens, 1990; Gunasekaran et al., 2001.
Partnership Quality	How well the outcome of supply chain partnership matches the participants' expectation.	Lee and Kim, 1999; Wilson & Vlosky, 1998; Ellram, 1990; Harland, 1996; Ganesan, 1994; Walton, 1996; Ballou et al., 2000; Bucklin and Sengupta, 1993; Mentzer et al., 2000.

Supply Chain Flexibility. In general, flexibility reflects an organization's ability to effectively adapt or respond to change. Flexibility describes the organization's ability

to meet the needs of the market without excessive cost, time, organizational disruption, or loss of performance (Aggarwal, 1997). Vickery et al. (1999a) suggest that flexibility should be viewed from the perspective of the entire value-adding system and examined from an integrative, customer-oriented perspective. They define flexibility as encompassing those flexibilities that directly impact an organization's customers (i.e. flexibilities that add value in the customer's eyes) and are the shared responsibility of two or more functions along the supply chain, whether internal (e.g., marketing, manufacturing) or external (e. g. suppliers, channel members) to the organization.

Supply chain flexibility can be measured by the following five dimensions: product (customization) flexibility, volume flexibility, launch (new product introduction) flexibility, access flexibility, and responsiveness to target markets (Vickery et al, 1999a). Product flexibility refers to the ability to handle difficult, nonstandard orders, to meet special customer specifications, and to produce products characterized by numerous features, options, sizes, and colors; volume flexibility is the ability to effectively increase or decrease production in response to customer demands; launch flexibility refers to the ability to rapidly introduce many new products and product varieties; access flexibility is the ability to produce widespread or intensive distribution coverage; and the final flexibility, responsiveness to target markets, captures the overall ability of the organization to respond to the needs of its target markets.

Supply Chain Integration is defined as the extent to which all activities within an organization, and the activities of its suppliers, customers, and other supply chain members, are integrated together (Stock et al, 1998; Narasimhan and Jayaram, 1998; Wood, 1997). There are two interrelated forms of integration along the supply chain: the

first type of integration involves coordinating and integrating the forward physical flow of deliveries between suppliers, manufacturers, and customers; the other prevalent type of integration involves the backward coordination of information technologies and the flow of data from customers, to manufacturers, to suppliers (Frohlich & Westbrook, 2001).

Supply chain integration includes three stages from functional integration, to internal integration, and then to external integration. Functional integration establishes close relationships between functions such as shipping and inventory or purchasing and raw material management (Turner, 1993; Stevens, 1990; Morash & Clinton, 1997). This stage is characterized by emphasis on the internal flow of the goods rather than external customer satisfaction, and cost reduction rather than performance improvement (Narasimhan & Kim, 2001). Internal integration involves the integration of all internal functions from raw material management through production, shipping, and sales (Narasimhan and Jayaram, 1998). There is realization that there is little value in focusing on the flow of the goods into the organization unless the flow is also well managed on the way to the customers. This stage is characterized by full system-visibility from distribution to purchasing, and it requires different functions in an organization to be coordinated and integrated to achieve customer value and satisfaction (Stevens, 1990). External integration extends the scope of integration outside the organization to embrace suppliers and customers (Narasimhan and Jayaram, 1998). External integration represents more than a change of scope. It also includes a change in attitude. The former adversarial relationships between suppliers and customers change to one of mutual support and cooperation (Vokurka & Lummus, 2000). Higher level of supply chain integration will

allow organizations to meet customers' needs faster and more efficiently than non-integrated organizations (Magretta, 1998a).

A highly integrated supply chain is a real representation of superior SCM performance. Organizations that operate in isolation are placing themselves at competitive disadvantage (Wood, 1997). Not only must organizations collaborate internally across business functions, but also they must establish external strategic linkages with other organizations. One true indicator of supply chain integration is that there is no distinction, and certainly no disconnection, between a myriad of transaction processing applications within an organization, and the organization's ability to optimize and utilize decision support capabilities to improve integration of suppliers and customers and to better serve customer needs.

Customer Responsiveness is defined as the speed of an organization's response to the customer requests (Narasimham & Jayaram, 1998; Beamon, 1998). The performance of SCM must ultimately be measured by its responsiveness to customers (Lee and Billington, 1992). As mentioned by Owens and Richmond (1995), while SCM strategy varies from organization to organization, its overall objectives are clear: to become increasingly responsive to customer needs, to drive costs out of the system, and to turn savings into additional value for the customer. By measuring the performance of activities critical to ensuring satisfaction of customers, managers can target their efforts more effectively and can assess the results of their actions more objectively.

Customer responsiveness has been recognized as one of the principal aims of SCM practice (Stevens, 1990; Kiefer and Novack, 1999; Spekman et al., 1998a). Experiences of organizations like Caterpiller, General Motors, IPL, Philips, and Rank

Xerox have shown that focusing on fast, reliable delivery, and responsiveness to changing customer needs are important to achieve integration of supply chain (Narasimhan and Jayaram, 1998). To achieve effective performance measurement, supply chain metrics must be linked to customer satisfaction, especially, SCM measurement is needed to integrate the customer specification in design, to set the dimensions of quality, to control cost, and to give feedback for the control of process. It is known that, without a satisfied customer, the whole exercise of applying the supply chain strategy could be costly and futile (Gunasekran et al., 2001).

Supplier Performance is defined as suppliers' consistency in delivering materials, components, or products to an organization on time and in good condition (Beamon, 1998). In the literature, supplier performance is considered one of the determining factors for the organization's operational success (Davis, 1993; Levy, 1997; Shin et al., 2000; Tan et al., 1998; Vonderembse and Tracey, 1999; Carr and Person, 1999) and a very important dimension of SCM performance (Stevens, 1990; Beamon, 1998; Gunasekaran et al., 2001). Poor vendor quality and delivery performance results in higher levels of inventory and order backlog (Shin et al., 2000).

In practice, a significant shift has occurred from the traditional adversarial buyer-seller relationship to the use of a limited number of qualified suppliers. A reduced supplier base helps eliminate mistrust between buyers and suppliers due to lack of communication (Newman, 1988). Harley-Davidson reports that supplier involvement has helped them improve overall quality, reduce costs, and compete against Japanese manufacturers (Shin et al., 2000).

Partnership quality is defined as how well the outcome of a partnership matches the participants' expectation (Lee and Kim, 1999; Wilson & Vlosky, 1998). One big problem in SCM measurement system is that it usually consists of hard, objective measures which are in direct conflict with the shared destiny principles of partnership and long-term relationships underlying SCM (Ellram, 1990; Harland, 1996). Marketing-based and service-based views have emphasized the importance of customers' perception in measuring relationship (Christopher, 1992). These service-based issues are of far greater importance in measuring long-term relationship performance. From the standpoint of service-based view, partnership quality is considered as a soft measure for SCM performance which represents the result of a partner comparing his/her expectations with his/her perception of supply chain performance. Previous research in channel relationship has indicated that satisfaction of a channel member is instrumental in increased morale, cooperation between channel members, few terminations of relationships, and reduced litigation (Ganesan, 1994).

Partnership quality may be measured as the extent to which both organizations are committed to the partnership and find it productive and worthwhile, the extent to which each partner carries out its responsibilities and commitments, the time and effort to build and maintain the relationship, the fair benefit allocations between the partners (Walton, 1996; Ballou et al., 2000), and the satisfaction with the relationship (Bucklin and Sengupta, 1993; Mentzer et al., 2000).

2.2.7 Competitive Advantage/Capability

Competitive advantage/capability is the extent to which an organization is able to create a defensible position over its competitors (Porter, 1985; McGinnis & Vallopra, 1999). They are potential points of differentiation between an organization and its competitors and are not directly controllable by management, but are an outcome of critical management decisions (Tracey et al., 1999). Giffy et al. (1990) point out that the selection of competitive capabilities should be a reflection of the strategic business objectives and should be expressed in terms of the primary manufacturing task or order-winning attributes.

Consensus on the identification of the following important competitive capabilities exists within the empirical literature (White, 1996b; Skinner, 1985; Roth and Miller, 1990; Tracey et al., 1999): price/cost, quality, delivery, and flexibility. Expanding on the above list, Koufteros (1995) describe a research framework for competitive capabilities and define the following five dimensions: competitive pricing, premium pricing, value-to-customer quality, dependable delivery, and production innovation. These dimensions are also described by Cleveland et al. (1989), Roth and Miller (1990), Safizadeh et al. (1996), Vickery et al. (1997), Solis-Galvan (1997), Tracey et al. (1999), and Rondeau et al. (2000). Moreover, recent conceptual work suggests that time-based competition will emerge as an important competitive priority. Many researchers consider time as the next source of competitive advantage (Stalk, 1988; Vesey, 1991; Handfield and Pannesi, 1995; Kessler and Chakrobarti, 1996).

Based on the study of Koufteros (1995) and considering time effect, the following five dimensions of competitive capability are used in this study. The list of these sub-constructs, along with their definition and supporting literature, are provided in Table 2.7.

1) Price/Cost. The extent to which an organization is capable of competing against major competitors based on low price (Koufteros, 1995; Wood et al., 1990; Miller et al., 1992, Hall et al., 1993; Rondeau et al., 2000).
2) Quality. The extent to which an organization is capable of offering product quality and performance that creates higher value for customers (Gray and Harvey, 1992; Arogyaswamy and Simmons, 1993; Rondeau et al., 2000).
3) Delivery Dependability. The extent to which an organization is capable of providing on time the type and volume of product required by customer(s) (Hall, 1993, Koufteros et al., 1997; Rondeau et al., 2000).
4) Product Innovation. The extent to which an organization is capable of introducing new products and features in the market place (Koufteros, 1995; Clark and Fujimoto, 1991; Rondeau et al., 2000).
5) Time to Market. The extent to which an organization is capable of introducing new products faster than major competitors (Stalk, 1988; Vesey, 1991; Handfield and Pannesi, 1995; Kessler and Chakrobarti, 1996).

2.2.8 Organizational Performance

Organizational performance refers to how well an organization fulfilled its market and financial goals (Yamin et al., 1999). The short-term objectives of SCM are primarily to increase productivity and reduce inventory and cycle time, while a long-term objective

Table 2.7 List of Sub-constructs for Competitive Advantage

Constructs	Definitions	Literature
Price/Cost	The extent to which an organization is capable of competing against major competitors based on low price.	Koufteros, 1995; Wood et al., 1990; Miller et al., 1992, Hall et al., 1993; Rondeau et al., 2000
Quality	The extent to which an organization is capable of offering product quality and performance that creates higher value for customers.	Gray and Harvey, 1992; Arogyaswamy and Simmons, 1993; Rondeau et al., 2000.
Delivery Dependability	The extent to which an organization is capable of providing on time the type and volume of product required by customer(s).	Hall, 1993, Koufteros, 1997; Rondeau et al., 2000.
Product Innovation	The extent to which an organization is capable of introducing new products and features in the market place.	Koufteros, 1995; Clark and Fujimoto, 1991; Rondeau et al., 2000.
Time to Market	The extent to which an organization is capable of introducing new products faster than major competitors.	Stalk, 1988; Vesey, 1991; Handfield and Pannesi, 1995; Kessler and Chakrobarti, 1996.

is to increase market share and profits for all members of the supply chain (Tan et al, 1998). Financial metrics have served as a tool of comparing organizations and evaluating an organization's behavior over time (Holmberg, 2000), and the ultimate effectiveness of SCM should be measured by such performance.

Organizational performance in this study is measured by return on investment (ROI), market share, the growth of ROI, sales and market share, profit margin on sales and overall competitive position. These measures have been used widely in previous research (Stock et al., 2000; Vickery et al., 1999a). ROI is a traditional measure of profitability, while market share may be a key business goal independent of profitability. Moreover, growth of ROI, sales, and market share are all common organizational

objectives. These performance measures were assessed by respondents on a 5-point scale from "significant decrease" to "significant increase". Past research has found that managerial assessments of organizational performance are consistent with internal objective performance (Vickery et al., 1999a) and even with external secondary data (Venkatraman and Ramanujam, 1986).

In sum, this chapter discussed the theoretical foundation of SCM and various constructs in this field. In the next chapter, we will present the overall framework that depicts the relationships between these constructs and the development of research hypotheses.

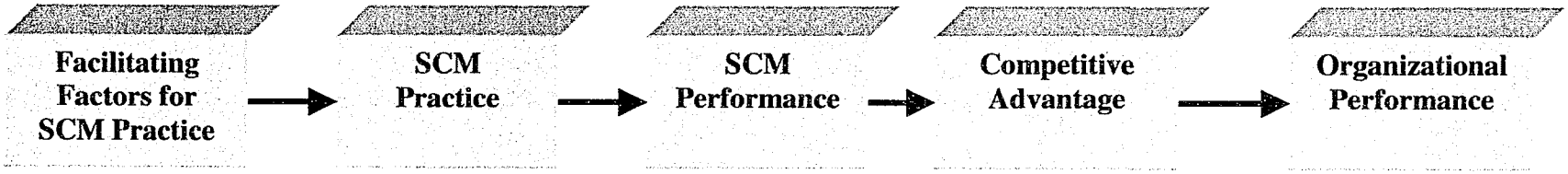
CHAPTER 3: THEORETICAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

When understanding the phenomenon of SCM, it is helpful to have a framework within which to work and from which testable hypotheses can be drawn. A theoretical framework enables predictions to be made about the likely outcome of SCM initiative. It enables observed business behavior to be evaluated and therefore provides better explanations of the motivations for the implementation of SCM and its consequences.

3.1 Theoretical Framework

To better understand the antecedents and consequences of SCM, a framework is established which describes the causal relationships between facilitating factors for SCM practice, SCM practice, SCM performance, competitive advantage, and organizational performance (Figure 3.1). The rationale underlying this research framework is straightforward. First, the implementation of SCM practice should be driven and facilitated by internal and external forces, such as environmental uncertainty, top management support, SCM strategy process, usage of IT tools, and partner relationship. Second, a higher level of SCM practice will lead to higher level of SCM performance, and a higher level of SCM performance will lead to an enhanced competitive advantage and further improved organizational performance. Previous empirical studies usually link certain aspects of SCM practice to organizational performance directly without

Figure 3.1 An SCM Research Framework (overall)

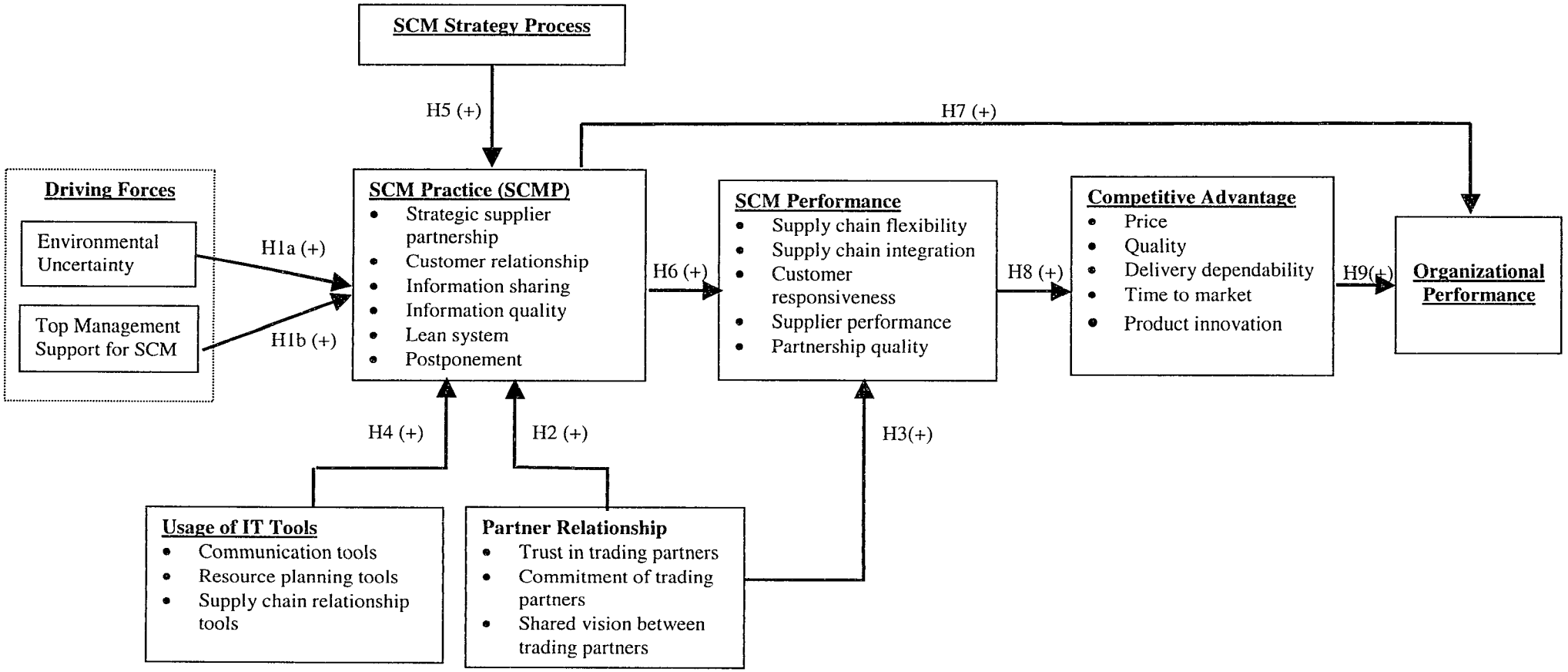


considering any intermediate performance measures, such as SCM performance and competitive advantage (Stuart, 1997; Shin et al., 2000; Frohlich and Westbrook 2001). Since organizational performance is an ultimate measure of any activity in an organization, it may not be an appropriate measure for immediate outcome of SCM practice. So, it is very possible that SCM practice impacts organizational performance indirectly through SCM performance and competitive advantage.

By considering the impact of each facilitating factor respectively and including sub-dimensions of each construct, the framework in Figure 3.1 can be expanded to the one represented in Figure 3.2, which depicts the proposed relationships between nine constructs discussed in Chapter 2. The numbers next to each arrow correspond to the ten hypotheses to be developed in this chapter.

Figure 3.2 shows that SCM practice will directly influence SCM performance and SCM performance will affect competitive advantage and further organizational performance. Moreover, it is hypothesized that SCM practice is influenced directly by environmental uncertainty, top management support for SCM, SCM strategy process, usage of IT tools, and partner relationship. The model also establishes the direct, positive relationships between partner relationship and SCM performance, and between SCM practice and organizational performance. The following section will provide theoretical support for each hypothesis.

Figure 3.2 An SCM Research Framework (detailed)



3.2 Research Hypothesis 1a (Environmental Uncertainty and SCM Practice)

Many researchers have considered environmental uncertainty an important driver for the implementation of SCM practice (Lawrence, 1997; Claycomb et al., 1999; Franks, 2000; Chandra & Kumar, 2000; Collins and Bechler, 1999). In a highly uncertain environment with changing markets, organizations internalize fewer resources and capabilities than in stable markets. Instead, organizations adopt various SCM practices such as strategic supplier partnership, lean system, and postponement, to increase organizational flexibility, manufacturing efficiency, and to reduce the risk associated with the uncertainty. Furthermore, by applying resources and capabilities of trading partners, organizations can transform perceived possibilities into new products (Sanchez, 1993) and achieve real manufacturing efficiency (Porter, 1994).

Lambe and Spekman (1997) suggest that uncertain industry structure and market environment encourage the formation of strategic supplier partnership. The same statement is supported by the earlier empirical findings of Spekman and Strauss (1986) that buyers will be more engaged in strategic partnerships with suppliers when transactions are characterized by perceived environmental uncertainty. Mentzer et al. (2000) agree that high technology uncertainty will drive organizations to form strategic partnerships with suppliers and to share information with their trading partners as technology change is largely uncontrollable by individual organizations. The threat from competitors will impel organizations to implement different customer relationship practices (such as the practices to manage customer complaints and build long-term relationships with customers) since such practices will increase customer satisfaction and loyalty. Ellram (1990) and Grover (1993) suggest that environmental uncertainty is an

important factor influencing information sharing and cooperation within supply chain partners. In an environment characterized by fast changing customer demands, the need for mass customization and flexibility is growing (Tan et al., 1998), which in turn will be facilitated by the adoption of postponement strategy (Waller et al., 2000). The above arguments lead to:

Hypothesis 1a: *The higher the level of environmental uncertainty, the higher the level of SCM practice.*

3.3 Research Hypothesis 1b (Top Management Support and SCM Practice)

Top management support has been consistently found to be important in the adoption and implementation of a strategic system such as SCM, which requires long-term business vision and top level integration among trading partners to ensure successful implementation (Premkumar and Ramamurthy, 1995). The decisions to implement various SCM practices must have the support of top management (McGrath, 1998; Mullen, 1998; Balsmeier and Voisin 1996; Thomas & Riley, 1987; Donlon, 1996; Tompkins, 1998; Mentzer et al., 2000; Day, 1995). Top management has to share an understanding of the specific benefits of collaboration to overcome the inevitable divergence of interests between participating organizations of SCM (Lee and Kim, 1999). Lack of strategic input by senior management has been considered a continuing barrier to successful implementation of SCM (O'Connell, 1999). Without top management support, the changes needed for SCM implementation in corporate structure, process reengineering, organizational culture, or attitudes are impossible (Hicks, 1997b; Burnell, 1999). Senior management is needed in getting the resources required for SCM

management. In fact, the continued investment in SCM has been considered as an act of faith on the part of executives. Burgess (1998) even suggests that the chief executive should commit 20%-50% of his/her time to the SCM project.

Without top management support, any SCM practice such as strategic supplier partnership, customer relationship, information sharing, lean system, or postponement is impossible since such practice needs long-term commitments from each organization involved. Top management must understand the importance of such SCM practices and provide vision, guidance, and support for its implementation. For example, as described in Chapter 2, information is generally viewed as providing an advantage over competitors, and organizations resist sharing with their partners. To overcome the reluctance of information sharing, top management must understand its benefits and create an organizational culture conducive to information sharing and make sure information is shared without delay and distortion. The above arguments lead to:

Hypothesis 1b: *The higher the level of top management support for SCM, the higher the level of SCM practice.*

3.4 Research Hypothesis 2 (Partner Relationship and SCM Practice)

As suggested by Sheridan (1998), information technology is only part of the solution to successful implementation of SCM practice. Without good partner relationships based on such intangibles as trust, commitment, and shared vision, today's increasingly complex SCM practice will continue to pose difficult management challenges. The problems in the supply chain, in most cases, are not technology issues, since there are lots of tools out there to help people link to the newest computer system,

but are people issues (Wright, 2001). People are not changing fast enough to a new way of doing things, mentally or procedurally. No amount of expensive software can compensate for flawed human thinking or for corporate cultures that create antagonistic relationships within a supply chain. However, practitioners appear to be falling in to the same trap as users of Business Process Engineering (BPR), in that they place excessive emphasis upon the issues of information technology, and not enough attention upon the real problems of SCM implementation: people-related barriers (Burgess, 1998).

A common cited obstacle to build true strategic supplier partnership– or develop relationships where information is shared openly- is a lack of trust (Noble, 1997; Sheridan, 1998). The empirical study of Ganesan (1994) finds that trust plays a key role in determining the long-term strategic partnerships between suppliers and vendors. Lack of trust among suppliers and manufacturers has prevented them from establishing partner relationships (Sheridan, 1997). Farley (1997) points out that the single most important prerequisite for SCM practice is a change in the corporate culture of all members in the supply chain to make it conducive to SCM. Boddy et al. (2000) explore empirically partnership between suppliers and customers through an interaction model and find that lack of shared vision (such as the cultural and other differences between the parties) causes difficulty in cooperation at first. Actions are then taken to improve cooperative behaviors that support further co-operation between the organizations. The above arguments lead to:

Hypothesis 2: *The higher the level of partner relationship, the higher the level of SCM practice.*

3.5 Research Hypothesis 3 (Partner Relationship and SCM Performance)

Good partner relationship, based on trust, commitment, and shared vision, not only facilitates SCM practice, but also directly leads to improved SCM performance. Stein and Sweat (1998) consider human links (relationships with trading partners) as the most critical factor to achieve superior SCM performance. Poirier (1997) states that mixed results of SCM performance occur because organizations have failed to develop the elements of cross-organizational trust necessary to make total supply chain improvement a reality. Hicks (1997b) suggests that the involvement and commitment of the people along the whole supply chain are required for the improvement of SCM performance. Moreover, Alvarez (1994), Lambert and Cooper (2000), and Sheridan (1998) agree that good SCM performance requires a shared understanding of the overall aims and objectives of SCM by each organization along the supply chain. Organizational incompatibilities lead to less strategic supplier partnership (Mentzer et al., 2000).

Achieving supply chain integration requires a degree of trust (Mason-Jones and Towill, 1997) and shared vision between all players (Towill, 1997). An interview of 200 executives with line responsibility reveals that lack of shared vision between potential partners leads to lack of the progress in supply chain integration (Neuman and Samuels, 1996). The commitment from suppliers usually means that an organization can get high quality products and dependable delivery from suppliers, and this will, in turn, increase the organization's responsiveness to the customers. The existence of trust, commitment, and shared vision between trading partners will increase partners' overall satisfaction about the outcome of SCM practice. The above arguments show that good partner relationship is critical for achieving superior SCM performance. It is hypothesized that:

Hypothesis 3: The higher the level of partner relationship, the higher the level of SCM performance.

Besides the direct positive impact of partnership relationship on SCM performance, partner relationship also has an indirect impact on SCM performance through SCM practice, which will be further discussed in Section 3.8.

3.6 Research Hypothesis 4 (Usage of IT Tools and SCM Practices)

Many researchers consider IT a great enabler for SCM practice (Alvarez, 1994; Spekman et al., 1998a; Chizzo, 1998; Humphreys et al., 2001; Tattum, 1999; Walton & Gupta, 1999; Benjamin and Wigand, 1995; Evans and Wurster, 1997). Modern information and communication technologies can now 'orchestrate' the revolution from push to pull supply chains (van Hoek et al., 1999). The rapid development of SCM software for client/server environments enables users to integrate suppliers' and customers' existing and future SCM systems (Tan et al., 1998). IT enables coordination across organizational boundaries to achieve new levels of efficiency and productivity (Magretta, 1998a) and opens up new possibilities for increasing value through better communication and information sharing (Burgess, 1998). IT leads to more strategic supplier partnerships and greater reliance on time-based strategies such as lean system, along with more transparent logistics structures and increased emphasis on performance measurement (Bowe-Sox and Daugherty, 1995). The use of IT has been considered a major indicator of the best SCM practices by many researchers, particularly if employed to connect customers, suppliers, and value adding activities (Lee and Billington, 1995; Kaufman et al., 2000; Power et al., 2001). In addition, IT, to a certain degree, will reduce the reluctance of information sharing between trading partners since the benefits of

working with trading partners is greater than perceived loss from information disclosure (Lancioni et al., 2000).

The adoption of different IT tools will facilitate the implementation of SCM practice. For example, the usage of EDI can support secured information sharing between trading partners (Stevens 1990; Murphy and Daley, 1996; Lim and Palvia, 2001;White, 1996a; Tan, 2001) and contribute to partnership satisfaction, success, and longevity (Walton, 1996). Internet extends the scope of SCM practice by providing a cost effective communication backbone so that information can be shared efficiently and effectively between supply chain partners (White, 1996a; Cross, 2000), while intranet can be used to support and promote more effective internal information sharing (White, 1996a). Meanwhile, information and process changes can be communicated to the business partners faster and more accurately through extranet (Reda, 1999; Pincince, 1998).

Moreover, ERP software can assist in transforming business by implementing the best SCM practices (Chizzo, 1998; Jones, 1998). Data warehousing software can provide the power and scalability to manage a large amount of data and allow responsive, simultaneous access to common data by several users across the enterprise and between trading partners (Chizzo, 1998). Without the support of IT enabler, the implementation of modern SCM practice is impossible. It is hypothesized that:

Hypothesis 4: *The higher the usage of IT tools, the higher the level of SCM practice.*

3.7 Research Hypothesis 5 (SCM Strategy Process and SCM Practice)

To practice SCM effectively, it is essential to have an effective SCM strategy process (a well-aligned and implemented SCM strategy). SCM initiatives alone cannot guarantee the successful SCM implementation. SCM practice provides a framework within which to implement a well-conceived SCM strategy, but it cannot undo the effects of a poorly conceived one (Tan et al., 1998). As discussed in Chapter 2, SCM strategy process is about the alignment of SCM with business strategy and how well it is implemented in an organization. The effectiveness of SCM strategy will influence various SCM practice. For example, a long-range SCM strategy is needed for building strategic partnership with suppliers as indicated by the long-term nature of such partnership; the need for communicating SCM strategy will create an open environment for quality information sharing; and the motivation to derive competitive advantage from SCM practice will lead to the implementation of lean system and postponement.

Vokurka and Lummus (2000) agree that the key to SCM practice is to link supply chain strategy to the overall business strategy. Carter and Narasimhan (1994) survey 300 U. S. purchasing managers and find that explicit SCM strategies and goals are required for successful SCM practice. Thomas (1999) reports that the absence of supply chain strategy leads to the failure of the implementation of information systems like ERP system and other SCM software. The survey sponsored by Ernst & Young LLP and Stevens Institute of Technology in 1998 finds that an unsuccessful SCM implementation usually is not a consequence of dated information technology but the failure to align SCM strategy and processes with business strategy (Tamas, 2000). The above arguments lead to:

Hypothesis 5: *The higher the effectiveness of SCM strategy process, the higher the level of SCM practice.*

3.8 Research Hypothesis 6 (SCM Practice and SCM Performance)

It is expected that an effective SCM practice will lead to improved SCM performance (Narasimhan and Jayaram, 1998). Most studies link SCM practice directly to organizational performance without explicitly considering any intermediate measures, such as SCM performance and competitive advantage, but a direct link from SCM practice to SCM performance is plausible.

A well-implemented SCM practice will lead to a high level of supply chain flexibility and integration (Jarrell, 1998), faster response to customer needs and market changes, better design and manufacturing processes, and increased productivity (Doyle, 1998). Strategic supplier partnership, through integration of suppliers into new product development, process improvement, and quality initiatives, can yield increased supplier performance, reduce product development time (Ragatz et al., 1997), and increase the level of customer responsiveness and satisfaction (Power et al., 2001). The empirical studies find that information sharing and information quality contributes positively to customer satisfaction (Spekman et al., 1998a), partnership quality (Walton, 1996; Lee and Kim, 1999), and dramatic improvement in performance (Towill, 1997). The adoption of postponement strategy not only increases the flexibility in the supply chain, but also balances global efficiency and customer responsiveness (van Hoek et al., 1999). The above arguments lead to:

Hypothesis 6: *The higher the level of SCM practice, the higher the level of SCM performance.*

Besides the direct impact of SCM practice on SCM performance (H3), hypothesis 2 and 6 jointly suggests an indirect relationship between partner relationship and SCM performance through SCM practice. Therefore, it can be concluded that partner relationship influences SCM performance both directly and indirectly.

3.9 Research Hypothesis 7 (SCM Practice and Organizational Performance)

Numerous studies have shown that the well-managed and well-executed SCM practice will directly lead to improved organizational performance (Shin et al, 2000; Prasad & Tata, 2000). For example, strategic supplier partnership has been reported to yield organization-specific benefits in terms of productivity, competitive advantage, and financial performance (Lamming, 1993; Stuart, 1993; Varadarajan & Cunningham, 1995; Stuart, 1997; Tan et al., 1998; Carr and Person, 1999; Stanley and Wisner, 2001). Customer relation practices lead to significant improvement in organizational performance (Tan et al., 1998). Information sharing will reduce cycle times, fulfill customer order more quickly, cut out excessive inventory cost, and improve customer service (Stein and Sweat, 1998; Balsmeier & Voisin, 1996). Monczka et al. (1998) find that information quality is significantly related to improved quality, reduced cycle time, and shorter new product development time. Moreover, Vickery et al. (1999a) find that volume flexibility is positively related to all measures of overall organizational performance. Van Hoek et al. (1999) and Beamon (1998) suggest that postponement strategy may contribute to the competitiveness and improved organizational performance by simultaneously enhancing customer service and reducing cost level.

The bottom-line impact of SCM practice has been confirmed by the real-world examples. For example, Wood (1997) reported that Procter & Gamble improved its performance through initiatives such as developing continuous supply programs with major retailers. Its cost of goods sold declined by 4.4% and other supply chain costs dropped about 25%. Wal-Mart enjoys the highest operating profit and inventory turnover of any mass merchandiser because of its successful SCM practice. A recent survey finds that organizations that are best at SCM hold a 40% to 65% advantage in their cash-to-cash cycle time over average organizations and the top organizations carry 50% to 85% less inventory than their competitors (Sheridan, 1998). It is hypothesized that:

Hypothesis 7: *The higher the level of SCM practice, the higher the level of organizational performance.*

Besides the direct influence of SCM practice on organizational performance, organizational performance is also indirectly influenced by SCM practice, which will be further discussed in Section 3.11.

3.10 Research Hypothesis 8 (SCM Performance and Competitive Advantage)

Many researchers (Stevens, 1990; Ellram, 1991; Berry et al., 1994; Thomas and Griffin, 1996; Lee and Billington, 1992; Dyer et al., 1998; Jarrell; 1998; Sheridan, 1998; Spekman et al., 1998a; Narasimhan & Jayaram, 1998; Lummus et al., 1998; Krause et al., 1998; Tan, 2001; Chandra & Kumar, 2000) agree that good SCM performance can provide an organization with competitive advantage. A supply chain with flexibility should be capable of introducing new products and features in the market place quickly; an integrated (seamless) supply chain will enable organizations to compete based on

time, cost/price, and delivery dependability; A supply chain characterized by quick responsiveness to customers and superior supplier performance will be competitive in terms of time and quality; and a high-quality partnership means that the outcome of partnership matches the expectation of participated organizations, which will be further reflected in multiple competitive measures such as price/cost, quality, time to market, and product innovation.

Frohlich and Westbrook (2001) find that the greatest degree of integration with both suppliers and customers had the strongest association with performance improvement, including cost, time, speed of product development, delivery dependability, and so on. Vonderembse and Tracey (1999) find significant correlation between supplier performance and such measures as cost, quality, delivery, and inventory. The above arguments lead to:

Hypothesis 8: *The higher the level of SCM performance, the higher the level of competitive advantage.*

3.11 Research Hypothesis 9 (Competitive Advantage and Organizational Performance)

Having a competitive advantage usually means, compared with its competitors, an organization can offer lower price, higher quality, and more customized products with higher dependability and shorter delivery time. This capability will in turn influence organizations' overall performance (Mentzer et al., 2000). Competitive advantage can lead to higher levels of economic performance, customer satisfaction and loyalty, and relationship effectiveness. Brands with higher consumer loyalty face less competitive

switching in their target segments, which can lead to increased sales and profitability (Moran, 1981).

An organization offering high quality products can charge premium price and thus increase its profit margin on sales and return on investment. While an organization having a short time-to-market and rapid product innovation can be the first in the market and thus lead to higher market share and sales volume, its overall competitive position can also be improved. Therefore, it is very plausible to propose a positive relationship between competitive advantage and organizational performance.

Hypothesis 9: *The higher the level of competitive advantage, the higher the level of organizational performance.*

Combining Hypothesis 6, 8, and 9, a causal path can be drawn from SCM practice, through SCM performance and competitive advantage, to organizational performance, which indicates the existence of an indirect impact of SCM practice on organizational performance. On the other hand, Hypothesis 7 suggests a direct, positive influence of SCM practice on organizational performance. Therefore, it can be concluded that SCM practice will impact organizational performance both directly and indirectly.

In sum, this chapter provides a theoretical framework for understanding the antecedents and consequences of SCM and develops 10 hypotheses based on the literature review. The following chapter will discuss research methodology for generating items for measurement instruments.

CHAPTER 4: INSTRUMENT DEVELOPMENT PHASE I - ITEM GENERATION AND PILOT TEST

In this chapter, the instruments for this research are developed and tested. Instruments to measure environmental uncertainty, top management support, competitive advantage, and organizational performance were adopted from previous studies with minor modifications (Lee and Kim, 1999; Bajwa et al., 1998; Tan et al., 1998; Jayaram et al., 1999; Zhang, 2001; Solis-Galvan, 1998; Vickery et al., 1999a). 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. Instead, they will be revalidated in the large-scale analysis. Usage of IT construct was identified in Chapter 2 as including fourteen IT tools facilitating SCM practice and will not be pilot-tested. The instruments to measure SCM practice, SCM performance, SCM strategy process, and partner relationship will be developed and pilot tested in this chapter.

The development of the instruments for four constructs was carried out in three stages. In the first pre-pilot stage, potential items were generated through a literature review and from construct definitions. Then the initial pool of items was pre-tested with three practitioners and six academicians. The respondents were asked to provide feedback about the clarity of the questions, instructions, and the length of the questionnaire. Based on the feedback, items were modified or discarded to strengthen the constructs and content validity. The second stage was scale development and testing through a pilot

study using Q-sort method. Items placed in a common pool were subjected to three sorting rounds by the judges to establish which items should be in the various categories. The objective was to pre-assess the convergent and discriminant validity of the scales by examining how the items were sorted into various construct categories. Analysis of inter-judge agreement about the items placement identified both bad items as well as weakness in the original definitions of the constructs. The instruments were then further refined based on pilot study results. The third stage is later described in Chapter 4, including all the validity and reliability tests using the data from a large-scale sample. Research hypotheses were then tested based on the large-scale data analysis.

4.1 Item Generation and Structured Interview

Proper generation of measurement items of a construct determines the validity and reliability of an empirical research. The very basic requirement for a good measure is content validity, which means the measurement items contained in an instrument should cover the major content of a construct (Churchill, 1979). Content validity is usually achieved through a comprehensive literature review and interviews with practitioners and academicians. A list of initial items for each construct was generated based on a comprehensive review of relevant literature. The general literature bases for items in each construct are briefly discussed below.

The items for SCM Practice (Strategic Supplier Partnership, Customer Relationship, Information Sharing, Information Quality, Lean System, and Postponement) were generated based on previous SCM literature (Stuart, 1997; Monczka et al., 1998; Tan et al., 1998; Forker et al., 1999; Shin et al., 2000; Aggarwal, 1997;

Stuart, 1997; Vonderembse and Tracey, 1999; Claycomb et al., 1999; Lee and Kim, 1999; Walton, 1996). The items for SCM Strategy Process were generated through SCM literature and manufacturing literature (Kiefer and Novack, 1999; Bates et al., 1995). The items for Partner Relationship (Trust in Trading Partners, Commitment of Trading Partners, and Shared Vision between Trading Partners) were generated through outsourcing literature, organizational behavior literature, and marketing literature (Wilson & Volsky, 1998; Ganesan, 1994; Oswald et al., 1994; Lee and Kim, 1999). The items for SCM Performance (Supply Chain Flexibility, Supply Chain Integration, Customer Responsiveness, Supplier Performance, and Partnership Quality) were generated primarily from some recent works on SCM by Vickery et al. (1999a), Beamon (1998), Beamon (1999), Walton (1996), Lee and Kim (1999), Narasimhan and Jayaram (1998), Stock et al. (1998), Tan et al. (1998), Claycomb et al. (1999), and Vonderembse and Tracey (1999).

Once item pools were created, items for the various constructs were reviewed by six academicians and re-evaluated through structured interviews with three practitioners. The focus was to check the relevance of each construct's definition and clarity of wordings of sample questionnaire items. Based on the feedback from the academicians and practitioners, redundant and ambiguous items were either modified or eliminated. New items were added whenever deemed necessary. The result was the following number of items in each pool entering Q-sort analysis (see Appendix A). There were a total of 15 pools and 103 items.

SCM Practice	
Strategic Supplier Partnership	9
Customer Relationship	9
Information Sharing	7

Information Quality	5
Lean System	12
Postponement	5
SCM Strategy Process	9
SCM Performance	
Supply Chain Flexibility	9
Supply Chain Integration	5
Customer Responsiveness	3
Supplier Performance	7
Partnership Quality	6
Partner Relationship	
Trust in Trading Partners	6
Commitment of Trading Partners	7
Shared Vision between Trading Partners	4
Total	103

4.2 Scale Development: the Q-Sort Method

Items placed in a common pool were subjected to three Q-sort rounds by two independent judges per round. The objective was to pre-assess the convergent and discriminant validity of the scales by examining how the items were sorted into various factors or dimensions.

The basic procedure was to have purchasing/production managers act as judges and sort the items into several groups, each group corresponding to a factor or dimension, based on similarities and differences among items. An indicator of construct validity was the convergence and divergence of items within the categories. If an item was consistently placed within a particular category, then it was considered to demonstrate convergent validity with the related construct, and discriminant validity with the others. Analysis of inter-judge disagreements about item placement identified both bad items, as well as weakness in the original definitions of constructs. Based on the misplacements made by the judges the items could be examined and inappropriately worded or ambiguous items could be either modified or eliminated.

4.2.1 Sorting Procedures

One 3'' by 5" card was printed for each item. The set of cards for each construct were shuffled and given to the judges. The definitions of the constructs were also given to the judges. The judges were then asked to put each card under one of the constructs to the best of their knowledge. A "Not Applicable" category was also included to ensure that the judges did not force any item into a particular category. A pair of judges included a purchasing manager and production manager to ensure the perception of the target population to be included in the analysis. Prior to sorting the cards, the judges were briefed with a standard set of instructions that were previously tested with a separate judge to ensure comprehensiveness and comprehensibility of the instructions. Judges were allowed to ask as many as questions as necessary to ensure they understood the procedure.

4.2.2 Inter-Rater Reliabilities

To assess the reliability of the sorting conducted by the judges, three different measures were used. First, for each pair of judges in each sorting step, the inter-judge raw agreement scores were calculated. This was done by counting the number of items both judges agreed to place in a certain category. An item was considered as an item with agreement, though the category in which the item was sorted together by both judges may not be the originally intended category. Second, the level of agreement between the two judges in categorizing the items was measured using Cohen's Kappa (Cohen, 1960). This index is a method of eliminating chance agreements, thus evaluating the true agreement score between two judges. A description of the Cohen's Kappa concept and methodology

is included in Appendix B. Third, item placement ratios were 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.

4.2.3 Results of First Sorting Round

In the first round, the inter-judge raw agreement scores averaged 88% (Table 4.2.3.1), the initial overall placement ratio of items within the target constructs was 88% (Table 4.2.3.2), and the Cohen's Kappa score averaged 0.87.

The calculations for Cohen's Kappa coefficient are shown below.

$$k = \frac{N_i X_{ii} - \sum_i (X_{i+} X_{+i})}{N_i^2 - \sum_i (X_{i+} X_{+i})} = \frac{(103)(91) - 728}{(103)(103) - 728} = .87$$

The calculation of the k is based on Table 4.2.3.1. N_i is the number of total items (103); X_{ii} is the total number of items on the diagonal (that is, the number of items agreed on by two judges); X_{i+} is the total number of the items on the i^{th} row of the table; and X_{+i} is the total number of items on the i^{th} column of the table (see Appendix B for the description of this methodology).

A summary of the first round inter-judge agreement indices is shown in the first column of Table 4.2.3.3. Following the guidelines of Landis and Koch (1977) for interpreting the Kappa coefficient, the value of 0.87 indicates an excellent level of agreement (beyond chance) for the judges in the first round. This value is slightly lower than the value for raw agreement which is 0.88. The level of item placement ratios averaged 0.88. For instance, the lowest item placement ratio value was 0.63 for the lean system, indicating a low degree of construct validity. On the other hand, several

Table 4.2.3.1 Inter-Judge Raw Agreement Scores: First Sorting Round

		Judge 1															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	NA
Judge 2	1	9															
	2		10														
	3			7													
	4		1		5												
	5		1			7											
	6						4										
	7							8									
	8								7		2						
	9									4							
	10										3						
	11											6					
	12												6				
	13													4			
	14													2	7		
	15															4	
	NA	1	1					1		1							2

Total Items Placement: 103	Number of Agreement: 91	Agreement Ratio: 88%

1. Strategic supplier partnership
2. Customer relationship
3. Information sharing
4. Information quality
5. Lean system
6. Postponement
7. SCM strategy process
8. Supply chain flexibility
9. Supply chain integration
10. Customer responsiveness
11. Supplier performance
12. Partnership Quality
13. Trust in trading partners
14. Commitment of trading partners
15. Shared vision between trading partners

Table 4.2.3.2 Items Placement Ratios: First Sorting Round

		Actual Categories																	
Theoretical Categories		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	NA	T	%
	1	17															1	18	94
	2		18															18	100
	3			14														14	100
	4				10													10	100
	5	2	5		1	15											1	24	63
	6						8										2	10	80
	7							17									1	18	94
	8								16		2							18	89
	9									9							1	10	90
	10										6							6	100
	11											12					2	14	86
	12												12					12	100
	13													8	4			12	67
	14													2	12			14	86
	15															8		8	100
Total Items Placement: 206								Number of Hits: 182									Overall Hit Ratio: 88%		

1. Strategic supplier partnership
2. Customer relationship
3. Information sharing
4. Information quality
5. Lean system
6. Postponement
7. SCM strategy process
8. Supply chain flexibility
9. Supply chain integration
10. Customer responsiveness
11. Supplier performance
12. Partnership quality
13. Trust in trading partners
14. Commitment of trading partners
15. Shared vision between trading partners

4.2.3.3 Inter-Judge Agreements

Agreement Measure	Round 1	Round 2	Round 3
Raw Agreement	88%	89%	89%
Cohen's Kappa	87%	88%	88%
Placement Ratio Summary			
Strategic supplier partnership	94%	90%	90%
Customer relationship	100%	94%	100%
Information sharing	100%	100%	100%
Information quality	100%	100%	100%
Lean system	63%	100%	69%
Postponement	80%	100%	90%
SCM strategy process	94%	100%	100%
Supply chain flexibility	89%	72%	89%
Supply chain integration	90%	100%	100%
Customer responsiveness	100%	100%	100%
Supplier performance	86%	79%	86%
Partnership quality	100%	100%	92%
Trust in trading partners	67%	88%	88%
Commitment of trading partners	86%	92%	100%
Shared vision between trading partners	100%	100%	100%
Average	**88%**	**93%**	**93%**

constructs (customer relationship, information sharing, information quality, customer responsiveness, partnership quality, and shared vision between trading partners) obtained a 100% item placement ratio, indicating a high degree of construct validity.

In order to improve the Cohen's Kappa measure of agreement, an examination of the off-diagonal entries in the placement matrix (Table 4.2.3.2) was conducted. This was done in two parts: one part looked at clustering and the other part at scattering. The first part of the analysis revealed one significant cluster involving two constructs (trust in trading partners and commitment of trading partners). An analysis of this cluster was conducted to identify ambiguous items (fitting in more than one category) or indeterminate items (fitting in no category), and were reworded. The second part of the analysis revealed a scattering of items of the lean system construct, raising concern for the level of its internal consistency. Items classified in a construct different from their target construct were identified and dropped or reworded. Also, feedback from both judges was obtained on each item and incorporated into the modification of the items. Overall, six items were deleted and seven items were reworded. The number of items remaining for each construct after the first round of Q-sort was as follows:

SCM Practice	
Strategic Supplier Partnership	10
Customer Relationship	9
Information Sharing	7
Information Quality	5
Lean System	8
Postponement	5
SCM Strategy Process	9
SCM Performance	
Supply Chain Flexibility	9
Supply Chain Integration	5
Customer Responsiveness	3
Supplier Performance	7
Partnership Quality	6

Partner Relationship		
	Trust in Trading Partners	4
	Commitment of Trading Partners	6
	Shared Vision between Trading Partners	4
Total		97

4.2.4 Results of Second Sorting Round

Again, two judges were involved in the second sorting round, which included the reworded items after the first sorting round. In the second round, the inter-judge raw agreement scores averaged 89% (Table 4.2.4.1), the initial overall placement ratio of items within the target constructs was 93% (Table 4.2.4.2), and the Cohen's Kappa score averaged 0.88.

A summary of the second round inter-judge agreement indices is shown in the second column of Table 4.2.3.3. The value for Kappa coefficient of .88 is higher than the value obtained in the first round (.87), indicating an excellent level of agreement for the judges in the second round. The level of item placement ratios averaged 0.93. For instance, the lowest item placement ratio value was 0.72 for supply chain flexibility, indicating a low degree of construct validity. 9 out of 15 constructs (information sharing, information quality, lean system, postponement, SCM strategy process, supply chain integration, customer responsiveness, partnership quality, and shared vision between trading partners) obtained a 100% item placement ratio, indicating a high degree of construct validity.

In order to improve the Cohen's Kappa measure of agreement, an examination of the off-diagonal entries in the placement matrix (Table 4.2.4.2) was conducted. The analysis showed there existed a slight cluster between the constructs 'trust in trading partners' and 'commitment of trading partners'. The same problem had appeared in the

Table 4.2.4.1 Inter-Judge Raw Agreement Scores: Second Sorting Round

		Judge 1															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	NA
Judge 2	1	9															
	2		8														1
	3			7													
	4				5												
	5					8											
	6						5										
	7							9									
	8								4		4						
	9									5							
	10										3						
	11											5					
	12												6				
	13													3			
	14													2	5		
	15															4	
	NA	1							1			1					1
Total Items Placement: 97					Number of Agreement: 86							Agreement Ratio: 89%					

1. Strategic supplier partnership
2. Customer relationship
3. Information sharing
4. Information quality
5. Lean system
6. Postponement
7. SCM strategy process
8. Supply chain flexibility
9. Supply chain integration
10. Customer responsiveness
11. Supplier performance
12. Partnership Quality
13. Trust in trading partners
14. Commitment of trading partners
15. Shared vision between trading partners

Table 4.2.4.2 Items Placement Ratios: Second Sorting Round

	Actual Categories																	
Theoretical Categories		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	NA	T	%
	1	18	1														1	20	90%
	2		17														1	18	94%
	3			14														14	100%
	4				10													10	100%
	5					16												16	100%
	6						10											10	100%
	7							18										18	100%
	8								13		4						1	18	72%
	9									10								10	100%
	10										6							6	100%
	11											11					3	14	79%
	12												12					12	100%
	13													7	1			8	88%
	14													1	11			12	92%
	15															8		8	100%
Total Items Placement: 194								Number of Hits: 181									Overall Hit Ratio: 93%		

1. Strategic supplier partnership
2. Customer relationship
3. Information sharing
4. Information quality
5. Lean system
6. Postponement
7. SCM strategy process
8. Supply chain flexibility
9. Supply chain integration
10. Customer responsiveness
11. Supplier performance
12. Partnership quality
13. Trust in trading partners
14. Commitment of trading partners
15. Shared vision between trading partners

first sorting round, but the situation had improved. In the first round, the two judges misplaced four items for "trust in trading partners" and two items for "commitment of trading partners"; while in second round, the two judges just misplaced one item for each of these two constructs respectively. Since these two constructs are highly correlated, the slight overlap between these two constructs can be considered acceptable.

The results of the second round showed an improvement over the type of problems found in the first round since no scattering patterns were identified. The second round results agree very well for internal consistency measurements, because the off-diagonals showed a clustering, rather than a scattering of items. Since the second round has achieved an excellent overall placement ratio of items within the target constructs (93%), we decided to keep all the items for the third sorting round. The third sorting round was used to re-validate the constructs.

4.2.5 Results of Third Sorting Round

Again, two judges were involved in the third sorting round, which included the reworded items after the second sorting round. In the third round, the inter-judge raw agreement scores averaged 89% (Table 4.2.5.1), the initial overall placement ratio of items within the target constructs was 93% (Table 4.2.5.2), and the Cohen's Kappa score averaged 0.88.

A summary of the third round inter-judge agreement indices is shown in the third column of Table 4.2.3.3. The value for the Kappa coefficient of .88 is the same as obtained in the second round (.88), representing an excellent level of agreement for the

Table 4.2.5.1 Inter-Judge Raw Agreement Scores: Third Sorting Round

		Judge 1															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	NA
Judge 2	1	8				1											
	2		9														
	3			7													
	4				5												
	5	1		1		5											
	6						4										1
	7							9									
	8								7		2						
	9									5							
	10										3						
	11											6					
	12												5				1
	13													3	1		
	14														6		
	15															4	
	NA																3
Total Items Placement: 97						Number of Agreement: 86						Agreement Ratio: 89%					

1. Strategic supplier partnership
2. Customer relationship
3. Information sharing
4. Information quality
5. Lean system
6. Postponement
7. SCM strategy process
8. Supply chain flexibility
9. Supply chain integration
10. Customer responsiveness
11. Supplier performance
12. Partnership Quality
13. Trust in trading partners
14. Commitment of trading partners
15. Shared vision between trading partners

Table 4.2.5.2: Items Placement Ratios: Third Sorting Round

Theoretical Categories	Actual Categories																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	NA	T	%
1	18				2												20	90%
2		18															18	100%
3			14														14	100%
4				10													10	100%
5			1		11											4	16	69%
6						9										1	10	90%
7							18										18	100%
8								16		2							18	89%
9									10								10	100%
10										6							6	100%
11											12					2	14	86%
12												11				1	12	92%
13													7	1			8	88%
14														12			12	100%
15															8		8	100%
Total Items Placement: 194							Number of Hits: 180								Overall Hit Ratio: 93%			

1. Strategic supplier partnership
2. Customer relationship
3. Information sharing
4. Information quality
5. Lean system
6. Postponement
7. SCM strategy process
8. Supply chain flexibility
9. Supply chain integration
10. Customer responsiveness
11. Supplier performance
12. Partnership quality
13. Trust in trading partners
14. Commitment of trading partners
15. Shared vision between trading partners

judges in the third round and also indicating the consistency of the results between the second and third sorting round. The level of item placement ratios averaged 0.93. Eight constructs (customer relations, information sharing, information quality, SCM strategy process, supply chain integration, customer responsiveness, commitment of trading partners, and shared vision between trading partners) obtained a 100% item placement ratio, indicating a high degree of construct validity.

From Table 4.2.5.2, lean system construct reveals a light scattering of items raising concern for the level of its internal consistency; two items ("our firm uses fast shipping and delivery model to our customers" and "our firm uses faster shipping and delivery modes for incoming materials, components or products") had been put into "Not Applicable" category by the two judges. These two items are dropped and four items were added to the construct based on the feedback from the judges. The other constructs have achieved a high degree of construct validity (the lowest item placement ratio is 86%). The final refinement of the scales from the pilot test was to reword one item, drop six items, and add four items. The number of items remaining for each construct after the third round of Q-sort was as follows:

SCM Practice	
Strategic Supplier Partnership	10
Customer Relations	8
Information Sharing	7
Information Quality	5
Lean System	10
Postponement	5
SCM Strategy Process	9
SCM Performance	
Supply Chain Flexibility	7
Supply Chain Integration	5
Customer Responsiveness	3
Supplier Performance	6
Partnership Quality	6

Partner Relationship		
	Trust in Trading Partners	4
	Commitment of Trading Partners	6
	Shared Vision between Trading Partners	4
Total		95

At this point, we stopped the Q-sort method at round three, for the raw agreement score of .89, Cohen's Kappa of .88, and the average placement ratio of .93 were considered an excellent level of inter-judge agreement, indicating a high level of reliability and construct validity. The resulting measurement scales for SCM practice, SCM performance, SCM strategy process, and partner relationship are reported in Appendix C and will be used in the large-scale survey (Appendix D). In the next chapter the tests for the quantitative assessment of construct validity and reliability using the large-scale sample are presented.

CHAPTER 5: INSTRUMENT DEVELOPMENT PHASE II - LARGE-SCALE ADMINISTRATION AND INSTRUMENT VALIDATION

5.1 Large-scale Data Collection Methodology

One important factor in an empirical study is the quality of respondents. In the case of the current study, the respondents are expected to have the best knowledge about the operation and management of the supply chain in his/her organization. Based on literature and recommendations from practitioners, it was decided to choose purchasing/manufacturing/materials managers as the respondents for the current study.

A mailing list was obtained from two sources: the Society of Manufacturing Engineers (SME) and the attendees at the year 2000 of the Council of Logistics Management (CLM) conference in New Orleans, Louisiana. From the SME United Sates Members database, 5,000 names were randomly selected. The list was limited to organizations with more than 100 employees since organizations with less than 100 employees are unlikely to engage in any sophisticated SCM. Six SIC codes are covered in the study: 25 "Furniture and Fixtures", 30 "Rubber and Plastics", 34 "Fabricated Metal Products", 35 "Industrial and Commercial Machinery", 36 "Electronic and Other Electric Equipment", 37 "Transportation Equipment". Respondents were purchasing/ manufacturing/materials executives and included CEOs, presidents, vice presidents, managers, and directors. This mailing list was then further refined through the following

steps: 1) some names did not have organization affiliations, and the mailing list addresses were deemed to be home addresses. These names were removed in consideration of home privacy of respondents; 2) if there were multiple names from the same organization, the person with the most relevant job title was picked and the others were removed; 3) some obvious errors in names and mailing addresses were also corrected. The refinement resulted in a list of 3003 names. From the attendees at the 2000 CLM conference, 502 names were chosen based on whether they came from Fortune 1000 manufacturing organizations. Combining two mailing lists resulted in a list of 3505 names.

Since the surveys were sent by bulk mail, the mailing address had to be filtered by a post office program to guarantee that the mailing addresses were valid according to certain standard. This resulted in the removal of 344 names from the SME list and 24 names from the attendees at the CLM conference. Therefore, the final mailing contained 3137 names.

To ensure a reasonable response rate, the survey was sent in three waves. The questionnaire with a cover letter indicating the purpose and significance of the study was mailed to the target respondents. In the cover letter, a web-address of the online version of the survey was also provided in case the respondents wished to fill it in electronically. There were a total of 258 responses from the mailings. Of these responses, 24 questionnaires were undeliverable; 15 questionnaires were returned empty with notes indicating that the target respondent is no longer an employee at the organization or retired. 10 respondents declined to participate without any reason; 10 respondents stated they were unable to participate because of time pressure or organization policy, or they

felt they were not qualified to provide the current answers. Another 3 letters indicated that the facilities for which that the target respondents worked had closed. Therefore, the final number of complete and usable responses was 196, representing a response rate of 6.30% (calculated as **196/(3137-24)**). Out of 196 respondents, the first wave produced 95 responses, and the second and third wave generated 51 and 50 responses, respectively. 44 responses were from the CLM list and 152 responses were from SME list; only 20 respondents used the on-line version of the survey.

5.2 Sample Characteristics of the Respondents, Organizations and Supply Chains

This section will discuss sample characteristics in terms of the respondents (job title, job function, and years stayed at the organization), the organizations (years of implementing SCM program, the number of product lines, the primary production system, employment size, annual sales, the percentage of electronic business transactions with customers and suppliers, and quantitative SCM measures), and the supply chains (horizontal structure, horizontal position of the organization in the supply chain, and channel structure).

5.2.1 Sample Characteristics of the Respondents (also see Table 5.2.1.1)

Job Title: more than half of the respondents (63%) are managers, while 18% state they are director and 7% are titled as CEO/president. The rest of respondents (12%) belong to the "other" category.

Job Function: about the half of the respondents (47%) choose manufacturing production as their area of expertise, while 30 % of respondents are responsible for

purchasing, 17% are responsible for distribution, 19% are responsible for transportation. Sales and corporate executives account for 9% and 3% respectively.

Years Stayed at the Organization: over half of respondents (61%) indicate they have been with the organization over 10 years, while 17% indicate having been at the organization between 6-10 years, and almost the same number of respondents (15%) state their years stayed at the organization as between 2-5. The respondents with years stayed at the organization less than 2 years account for only 8% of the sample.

In short, more than half of the respondents are managers, have been in the organization over 10 years, and/or function in the manufacturing production/purchasing area. CEO/presidents are less likely to respond to the survey. Figure 5.2.1.1 to 5.2.1.3 display the respondents by job titles, job functions, and years worked at the organization, respectively.

5.2.2 Sample Characteristics of Surveyed Organizations (also see Table 5.2.2.1 and 5.2.2.2)

The Implementation of SCM Program: about the half of organizations surveyed (49%) have embarked upon a program aimed specially at implementing SCM, and the average length of the implementation is 3.64 years.

Number of Product Lines: 27% of organizations have product lines below 5 and 29% have product lines between 5-10, while the organizations with product lines over 20 account for 28%, the rest (16%) have product lines between 11-20.

Table 5.2.1.1 Characteristics of the Respondents

1.	**Job Titles** (194)	
	CEO/President	7.22% (14)
	Director	18.04% (35)
	Manager	62.37% (121)
	Other	12.37% (24)
2.	**Job Functions** (196)	
	Corporate Executive	9.18% (18)
	Purchasing	29.59% (58)
	Manufacturing Production	46.94% (92)
	Distribution	17.35% (34)
	Transportation	18.88% (37)
	Sales	2.55% (5)
	Other	18.88% (37)
3.	**Years worked at the organization** (194)	
	Under 2 years	7.73% (15)
	2-5 years	14.95% (29)
	6-10 years	16.49% (32)
	Over 10 years	60.82% (118)

Figure 5.2.1.1 Respondents by Job Title

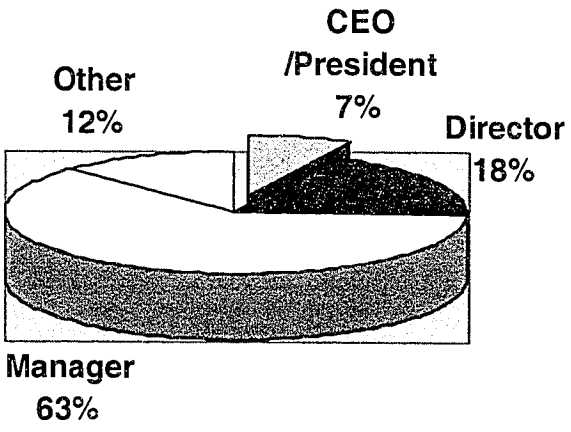


Figure 5.2.1.2 Respondents by Job Function

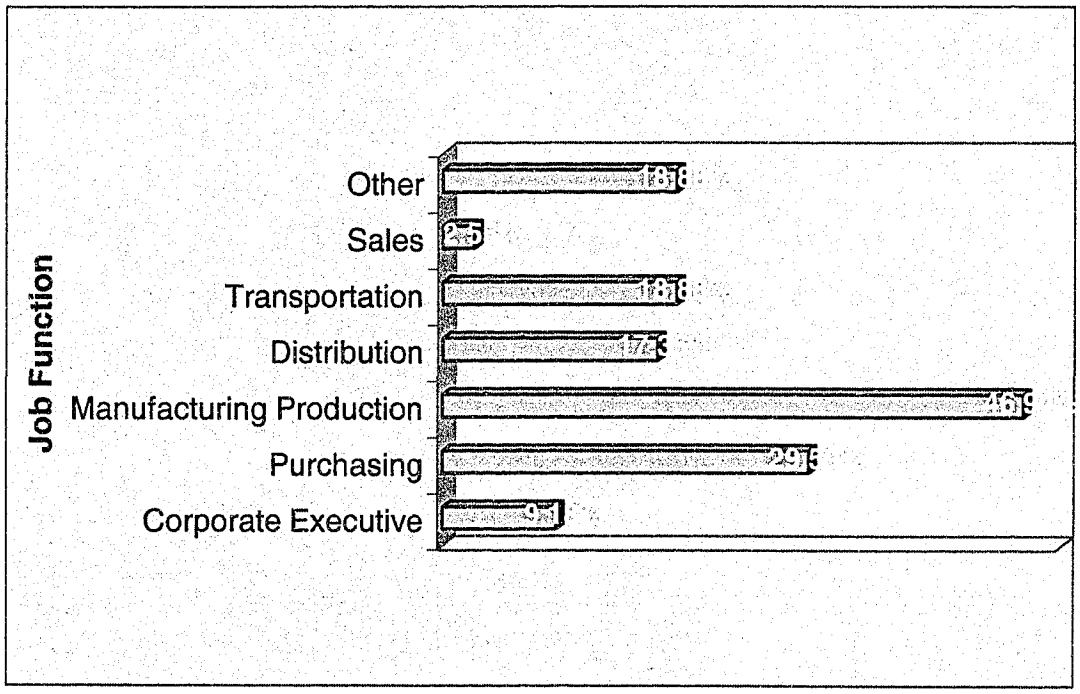
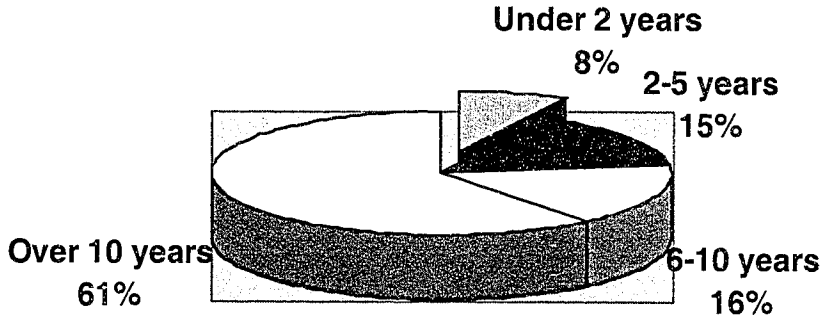


Figure 5.2.1.3 Respondents by Years Worked at the Organization



Primary Product System: almost half of the organizations (47%) use make-to-order as primary product system; while make-to-stock, engineer-to-order, and assembler-to-order account for 25%, 16%, and 12% respectively.

Number of Employees: 38% of organizations have between 100 and 250 employees, and another 38 % of organizations have over 1000 employees. Organizations with between 251-500 employees account for 14% of the sample and the rest (10%) have between 501-1000 employees.

Annual Sales: Almost half of the organizations (49%) have sales volumes exceeding 100 million and about 22% of the organizations have sales volumes below 25 million. 15% and 14% of the respondents have sales volumes between 25-50 million and between 50-100 million respectively.

In short, about half of the organizations have implemented a program aimed at specially implementing SCM, have over 10 product lines, and/or use make-to-order as primary product system. About half of the organizations are larger organizations with over 500 employees or sales volumes above 100 million. Therefore, the results of the survey must be explained with caution to smaller organizations. Figure 5.2.2.1 to Figure 5.2.2.4 display the surveyed organization according to number of product lines, primary production system, number of employees, and annual sales, respectively.

Electronic Business Transactions with Customers: About one third of the organizations (31%) state that they have done less than 10% of their business transactions electronically with customers, 23% of the organizations have done 10%-30% of their business transactions electronically with customers, and 16% of the organizations have done 30-50% of their business transactions with customers. 16% indicate 50%-80% of

their business transactions are done electronically with customers. The rest (14%) indicate that more than 80% of their business transaction with customers are done electronically.

Electronic Business Transactions with Suppliers: More than one third of the organizations (37%) state that they have done less than 10% of their business transaction electronically with suppliers, 25% of the organizations have done 10%-30% of their business transactions electronically with suppliers, and 14% of the organizations have done 30-50% of their business transactions with suppliers. 15% indicate 50%-80% of their business transactions are done electronically with suppliers. The rest (8%) indicate that more than 80% of their business transaction with suppliers are done electronically.

Comparing the electronic business transactions with suppliers and customers (see Figure 5.2.2.5), it can be seen that most of business transactions with suppliers and customers are still done off-line in a traditional way. Organizations are more likely to conduct electronic business transactions with customers than with suppliers. About 14% of the organizations have more than 80% of the transactions done electronically with customers, but only 8% of the organizations have done more than 80% of their business transactions with suppliers electronically. On the other hand, 31% of organizations conduct less than 10% of the transactions electronically with customers, but the number of the organizations that only do less than 10% of the transactions with suppliers is larger by 6%.

Quantitative SCM Measures: The respondents were asked to rank the importance of 13 supply chain performance measures (these measures are based on supply chain reference (SCOR) model of Supply-Chain Council) from 1 (high) to 13 (low). The

respondents were also asked to check whether each item is used in their organization and if used, what was the actual performance of their organization (See Table 5.2.2.2).

Table 5.2.2.2 shows that the top five supply chain performance measures according to the importance are delivery performance to commitment date (3.65), cost of goods sold (5.06), order fulfillment lead time (5.45), inventory days of supply (6.16), and perfect order fulfillment (6.44); while the bottom five are cash-to-cash cycle time (7.07), production flexibility (7.17), total supply chain management costs (7.22), value-added productivity (7.90), and warranty/return processing costs (8.77). Figure 5.2.2.6 shows the average rank of each SCM measure.

The top five most frequently used supply chain measures (in term of percentage of each measure used in the organizations) are delivery performance to commit date (59%), inventory days of supply (51%), order fulfillment lead time (39%), net asset turns (36%), and fill rate (33%). The bottom five are cash-to-cash cycle time (23%), production flexibility (22%), supply chain response time (20%), value-added productivity (17%), and total supply chain management cost (16%). Figure 5.2.2.7 shows percentage of organizations using each SCM measure.

From Figure 5.2.2.8, it can be seen that delivery performance to commit date, order fulfillment lead time, and inventory days of supply have been considered as the important supply chain performance measures and thus used by most of the organizations. But there also exist gaps between what measures organizations regard as important and what measures they actually use. For example, cost of goods sold has been considered the second most important out of 13 measures, but only rank sixth according to the actual usage in the organizations and only about one third of organizations (33%)

have used this measure. Another example is supply chain response time, which ranks sixth in term of importance, but whose rank decreases to 11^{th} in terms of usage, and this measure is only used by about 20% of surveyed organizations. On the other hand, net assets turns and warranty/returns processing costs rank eighth and thirteenth in terms of importance, respectively, but their rank increased to fourth and seventh in terms of usage.

The respondents are also asked to provide the actual performance for each measure if they know it. Measured by the mean of each item, the delivery performance to commit date is 87%, average fill rate is 93%, average perfect order fulfillment is 85%, order fulfillment lead time is 16 days, supply chain response time is 16 days, production flexibility is 8 days, cash-to cash cycle time is 66 days, inventory days of supply is 51, and new asset turns (working capital) is 7 turns per year.

5.2.3 Sample Characteristics of the Supply Chains (see Table 5.2.3.1)

Horizontal Structure: horizontal structure refers to the number of tiers across the supply chain. The supply chain may be long, with numerous tiers, or short, with few tiers. The results show that about half of supply chains (44%) have less than or equal to 3 tiers, while 16% have more that 6 tiers across the supply chains. The rest (40%) have 4 or 5 tiers within their supply chains.

Horizontal Position of an Organization in the Supply Chain: A company can be positioned at or near the initial source of supply (raw material and component supplier), be at or near the ultimate customer (distributor/wholesaler/retailer), or somewhere between these end points of the supply chain (assembler and manufacturer). Among all

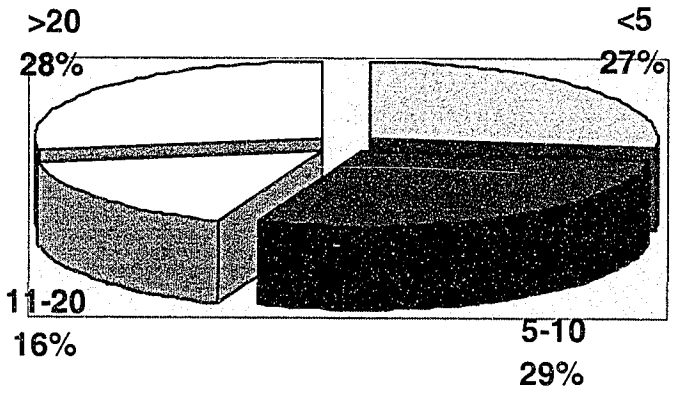
Table 5.2.2.1 Characteristics of the Surveyed Organizations

1.	Organizations that have embarked upon a program aimed specially at implementing "Supply Chain Management" (192).	
	Yes: 48.96% (94) No: 51.04% (98) Average length of implementation: 3.64	
2.	Number of product lines organization makes (152)	
	<5	26.97% (41)
	5-10	28.95% (44)
	11-20	16.45% (25)
	>20	27.63% (42)
3.	Primary production system (191)	
	Engineer to Order	16.23% (31)
	Make to Order	47.12% (90)
	Assemble to Order	12.04% (23)
	Make to Stock	24.61% (47)
4.	Number of employees (194)	
	101-250	38.14% (74)
	251-500	13.92% (27)
	501-1000	9.79% (19)
	Over 1000	38.14% (74)
5.	Annual sales in millions of $ (190)	
	5 to 10	2.63% (5)
	10 to <25	19.47% (37)
	25 to <50	14.74% (28)
	50 to <100	13.68% (26)
	>100	49.47% (94)
6.	Percentage of business transactions with your customers done electronically (190)	
	Less than 10%	31.05% (59)
	10-30%	22.63% (43)
	30-50%	15.79% (30)
	50-80%	16.32% (31)
	More than 80%	14.21% (27)
7.	Percentage of business transactions with your suppliers done electronically (189)	
	Less than 10%	37.03% (70)
	10-30%	25.40% (48)
	30-50%	13.76% (26)
	50-80%	15.34% (29)
	More than 80%	8.47% (16)

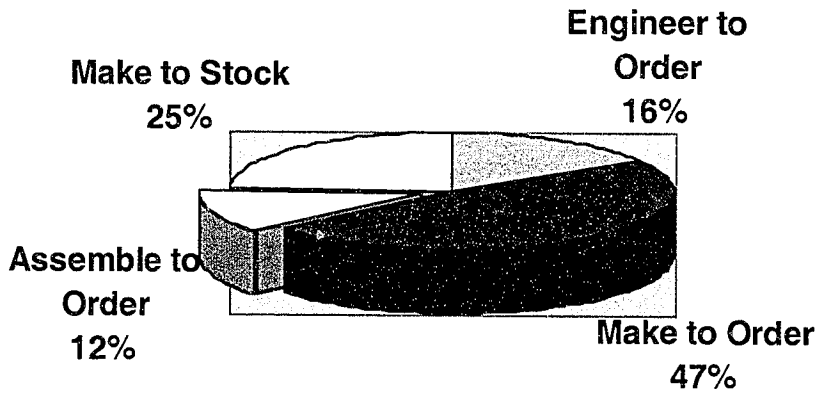
Table 5.2.2.2 SCM Measures of Surveyed Organizations

	Performance Attribute	Supply Chain Performance	Importance Average (Rank)	Used (%) (based on 196)	Actual Performance
EXTERNAL	Supply Chan Delivery Reliability	Delivery Performance to Commit Date	3.65 (1)	58.57%	87.44 (94)
		Fill Rate	6.69 (7)	32.65%	93.10% (48)
		Perfect Order Fulfillment	6.44 (5)	27.04%	85.32 (39)
	Supply Chain Responsiveness	Order Fulfillment Lead Time	5.45 (3)	39.28%	16.44 Days (60)
	Supply Chain Flexibility	Supply Chain Response Time	6.57 (6)	19.90%	16.35 Days (26)
		Production Flexibility	7.17 (10)	21.94%	7.96 Days (30)
INTERNAL	Supply Chain Asset Management Efficiency	Cash-to-Cash Cycle Time	7.07 (9)	22.96%	66.39 Days (23)
		Inventory Days of Supply	6.16 (4)	50.51%	50.94 Days (75)
		Net Asset Turns (Working Capital)	6.74 (8)	35.71%	7.3 Turns (44)
	Supply Chain Costs	Cost of Goods Sold	5.06 (2)	32.65%	
		Total Supply Chain Management Costs	7.22 (11)	16.33%	
		Value-added Productivity	7.90 (12)	17.35%	
		Warranty/Returns Processing Costs	8.77 (13)	27.55%	

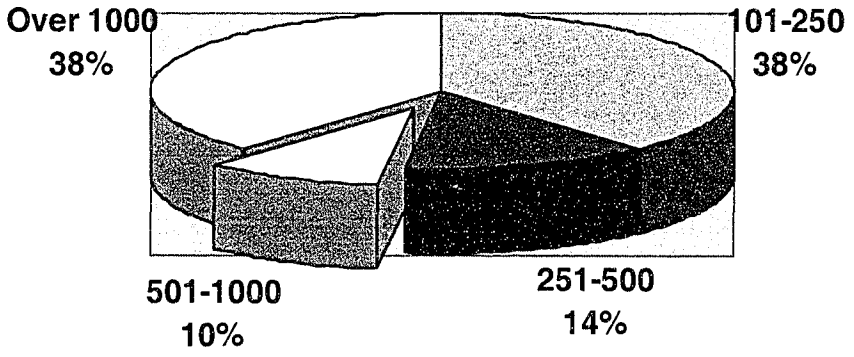
5.2.2.1 Organizations by # of Product Lines



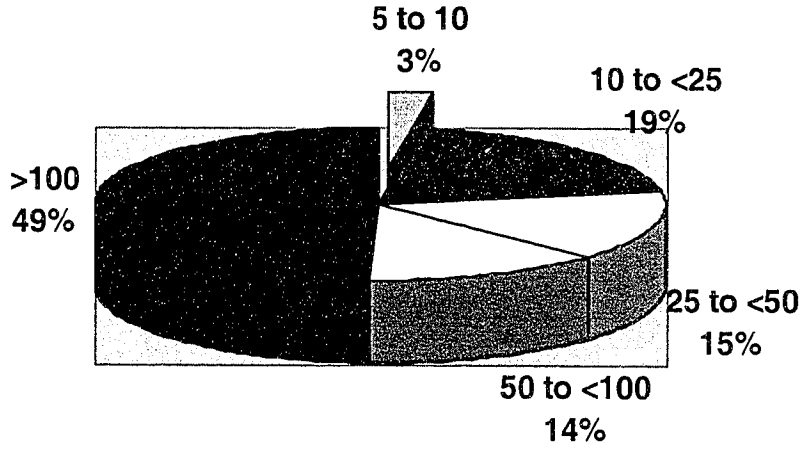
5.2.2.2 Organizations by Primary Production System

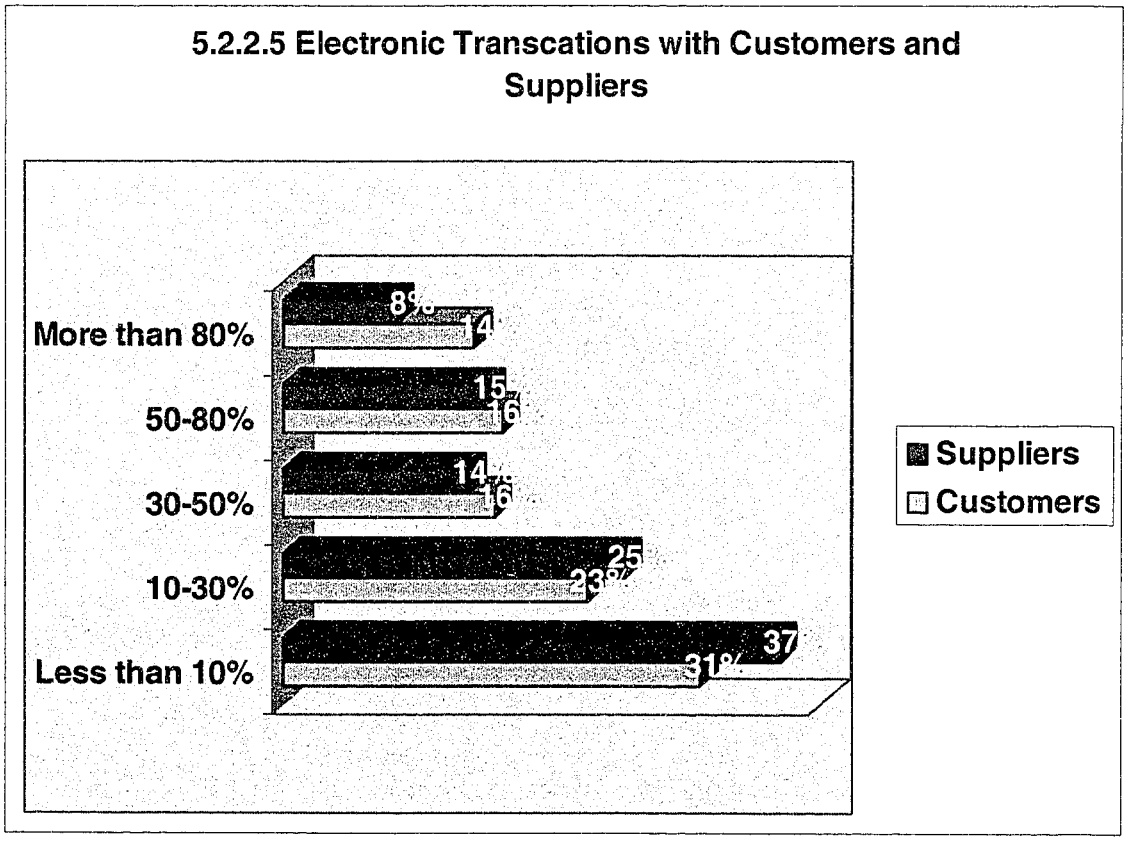


5.2.2.3 Organizations by # of Employees

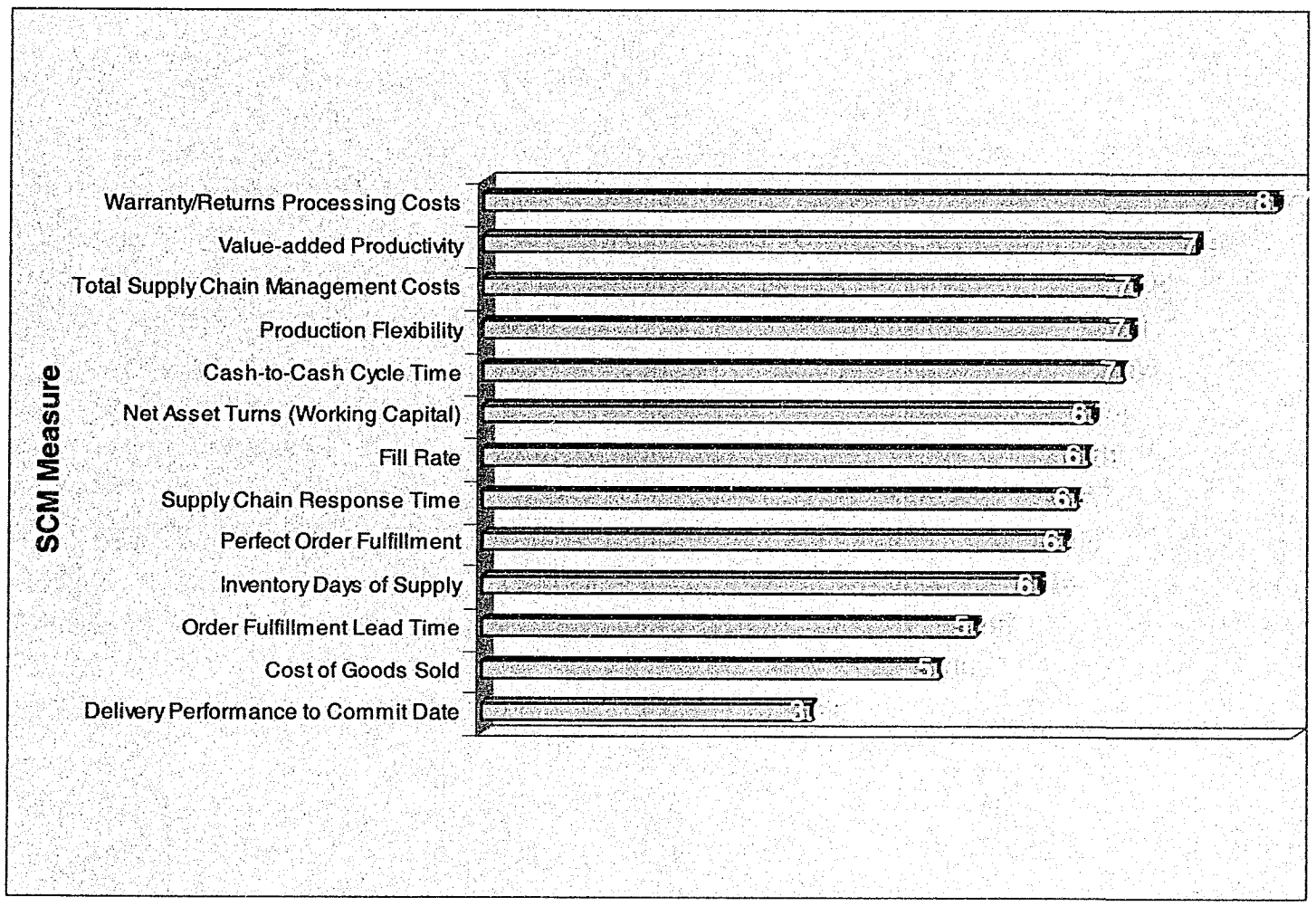


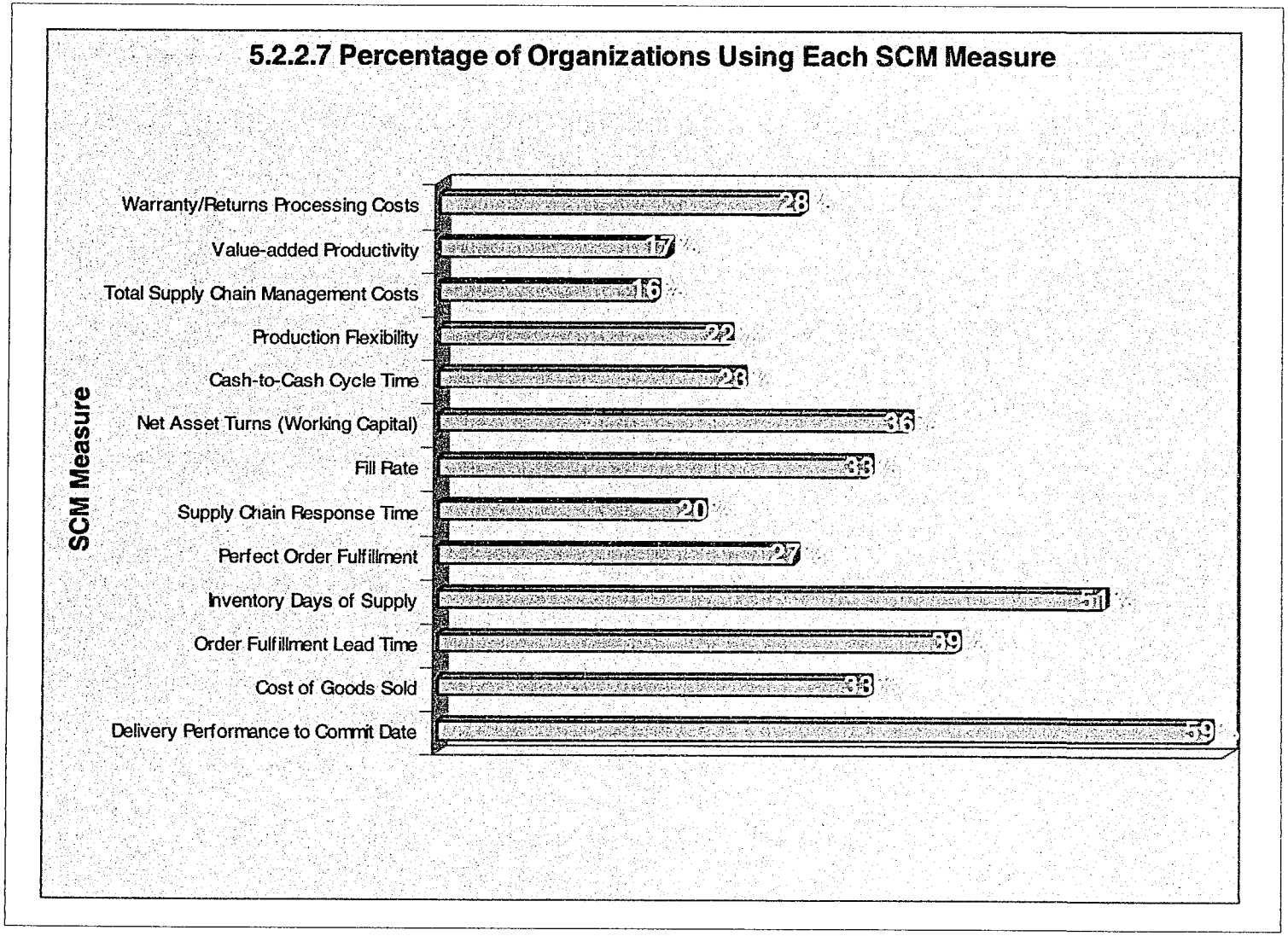
5.2.2.4 Organizations by Annual Sales (in millions of $)



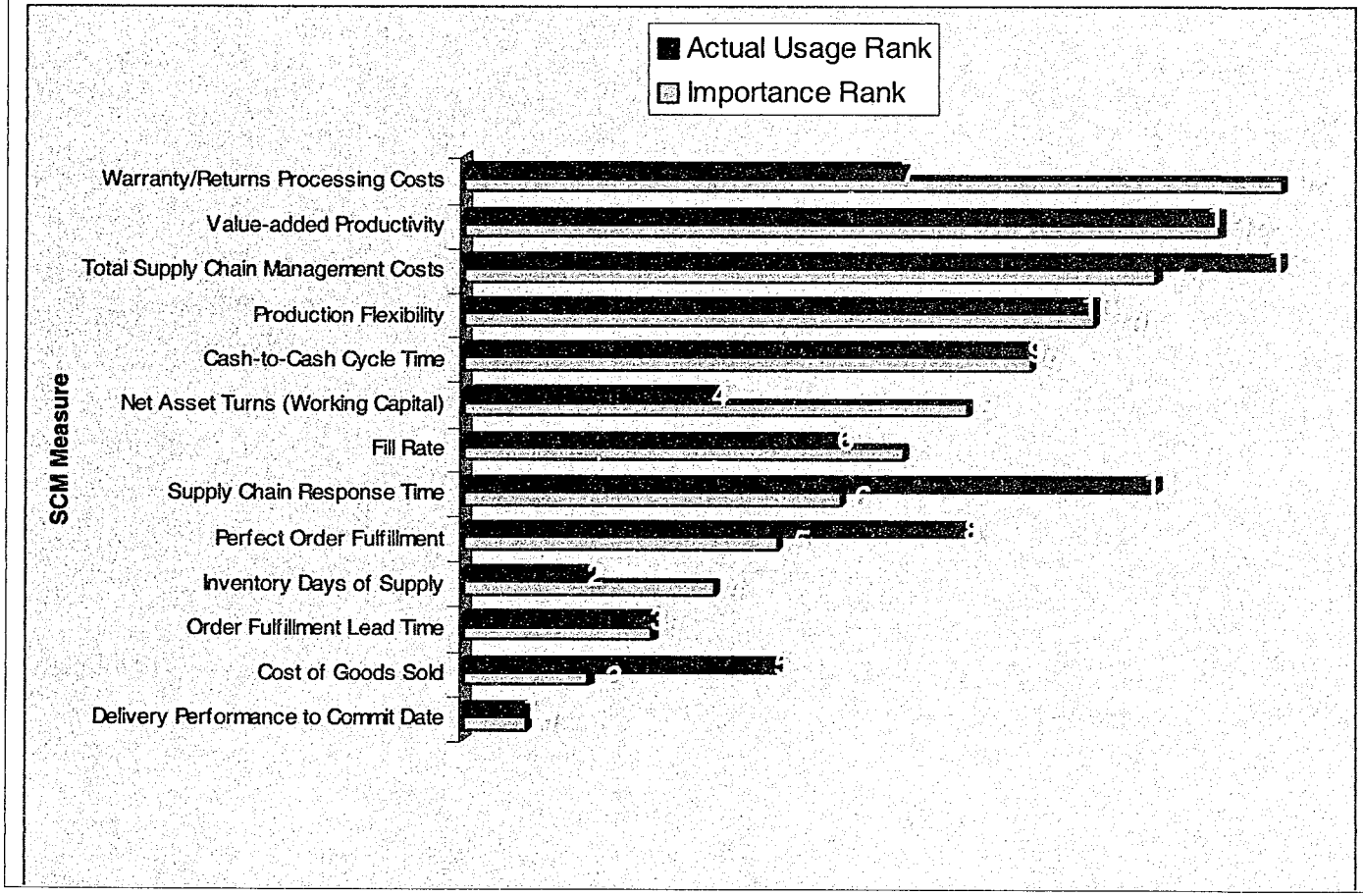

5.2.2.5 Electronic Transcations with Customers and Suppliers
More than 80%
50-80%
30-50%
10-30%
Less than 10%
15
14
25
37
Suppliers
Customers

5.2.2.6 Average Rank of the Importance of SCM Measures




5.2.2.7 Percentage of Organizations Using Each SCM Measure
SCM Measure
Warranty/Returns Processing Costs
28
Value-added Productivity
17
Total Supply Chain Management Costs
16
Production Flexibility
22
Cash-to-Cash Cycle Time
23
Net Asset Turns (Working Capital)
36
Fill Rate
33
Supply Chain Response Time
20
Perfect Order Fulfillment
27
Inventory Days of Supply
51
Order Fulfillment Lead Time
39
Cost of Goods Sold
33
Delivery Performance to Commit Date
59

5.2.2.8 Rank of Importance and Actual Usage of SCM Measures



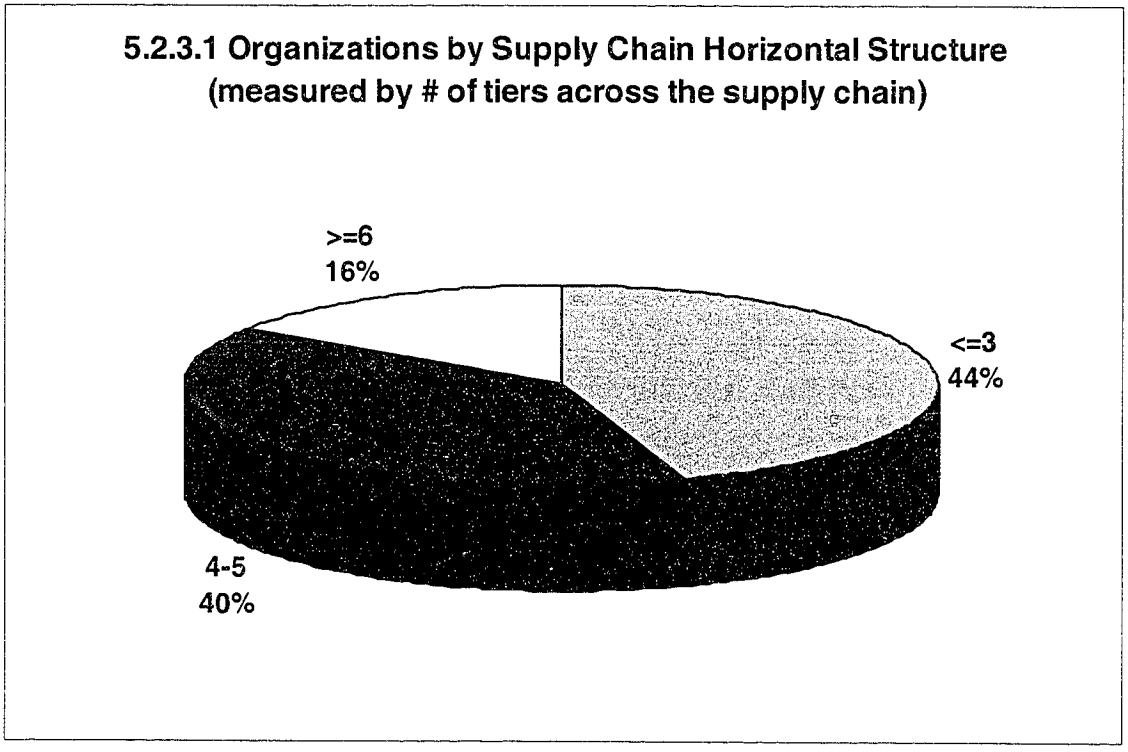
surveyed organizations, manufacturers account for 84%, assemblers and sub-assemblers accounts for 32% and 21% respectively. In addition, 12% and 33% of respondents consider themselves raw materials suppliers and component suppliers correspondingly. Furthermore, distributors, wholesalers, and retailers account for 7%, 3%, and 2% respectively (Note: one company may occupy multiple positions and may represent multiple data items, the calculation of the percentage is based on the total sample size of 196).

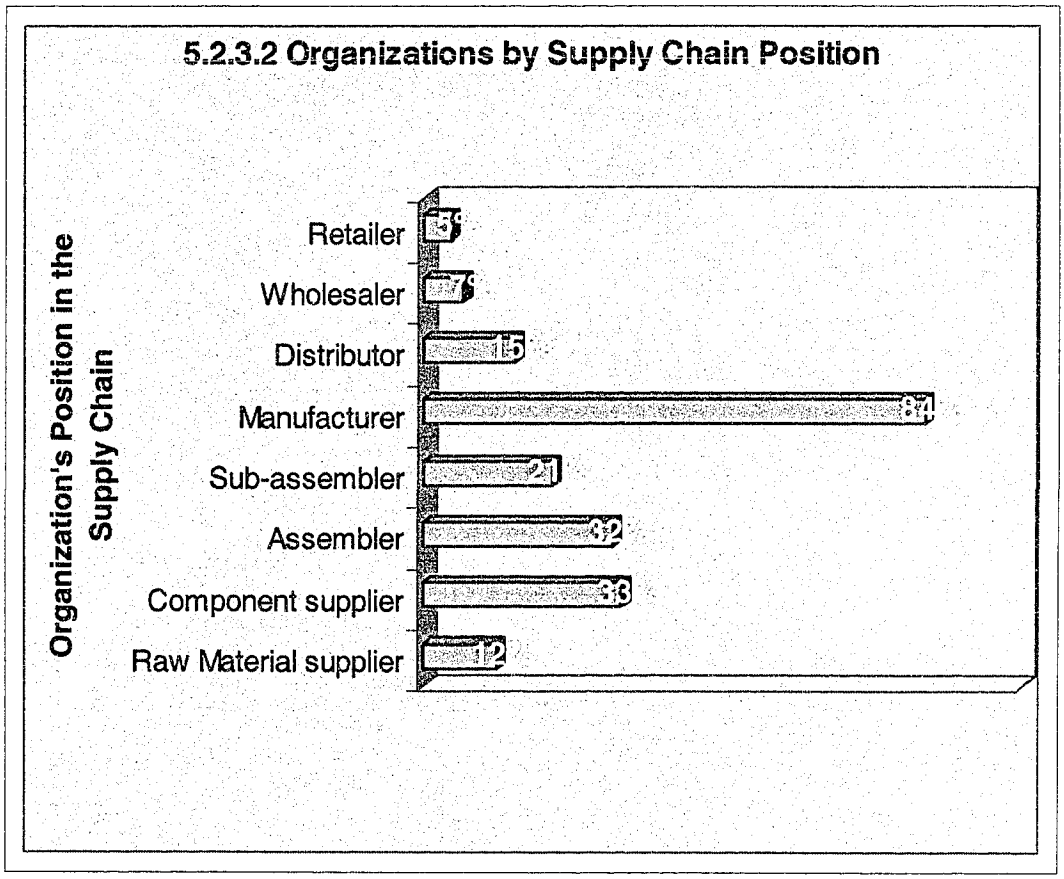
Channel Structure: supply chain channel includes indirect, direct, and virtual channel. **Indirect Channel** refers to the channel in which finished goods from the factory flow to the end customer through distribution center and wholesaler and retailer trading partners; each of these pairs is connected by a logistics service provider. **Direct Channel** refers to the channel in which a factory produces part of the product and outsources part of the product to the contract manufacturers. Then the factory connects directly with the end customer through a logistics service provider. **Virtual Channel** refers to the channel in which a factory produces part of the product and outsources part (sometime, all) of the product to the contract manufacturers. Then factory connects directly with the end customer through the Internet. Customers use the Internet to shop for products and place their orders (Alber & Walker, 1998). The results show that 62% of organizations surveyed are in direct channel, while 36% of organizations are in indirect channel. Virtual channel only accounts for 2%.

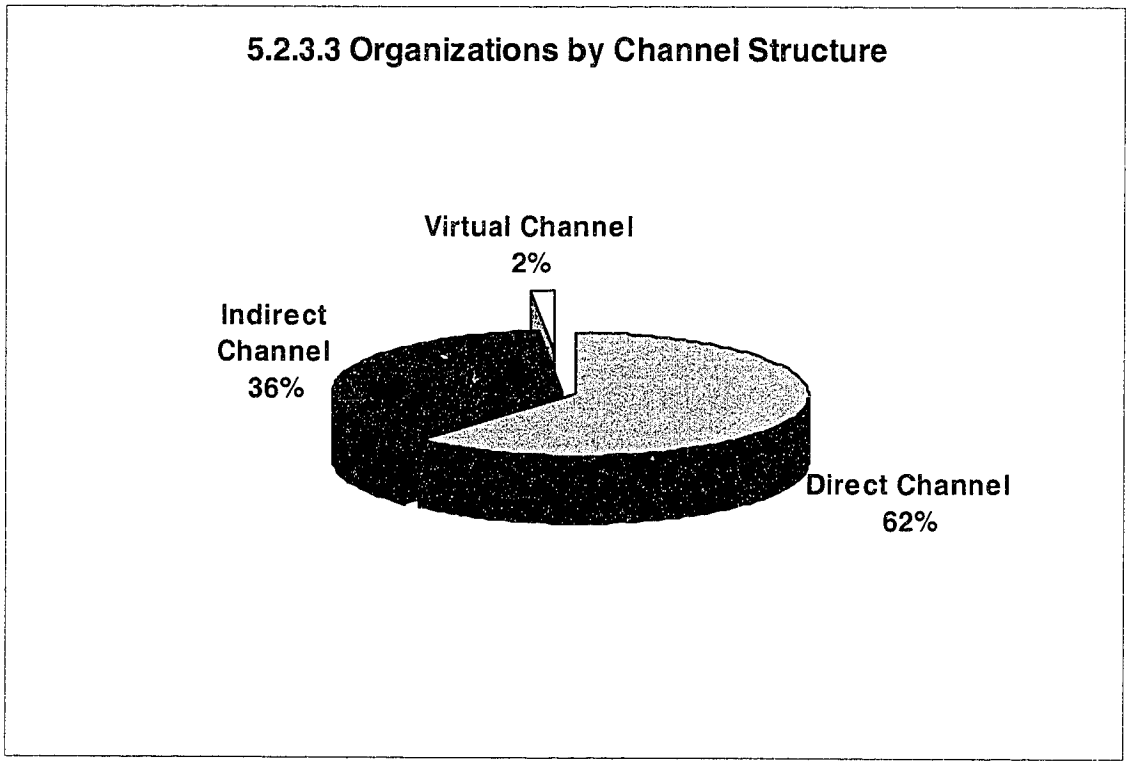
Relating to the characteristics of supply chains, most surveyed organizations are manufacturers; about half of the organizations are in direct channel with less than 4 tiers (also see Figure 5.2.3.1 to Figure 5.2.3.3).

Table 5.2.3.1 Characteristics of the Supply Chains

1.	The number of tiers across your supply chain (174).	
	<=3	44.83% (78)
	4-5	39.67% (69)
	>=6	15.52% (27)
2.	Organization's position in the supply chain (196)	
	Raw Material supplier	12.24% (24)
	Component supplier	33.16% (65)
	Assembler	31.63% (62)
	Sub-assembler	21.43% (42)
	Manufacturer	83.67% (164)
	Distributor	15.31% (30)
	Wholesaler	6.63% (13)
	Retailer	4.59% (9)
3.	Supply chain channel (181)	
	Direct Channel	61.88% (112)
	Indirect Channel	36.46% (66)
	Virtual Channel	1.66% (3)




5.2.3.2 Organizations by Supply Chain Position
Organization's Position in the Supply Chain
Retailer
Wholesaler
Distributor
Manufacturer
Sub-assembler
Assembler
Component supplier
Raw Material supplier


5.2.3.3 Organizations by Channel Structure
Virtual Channel
2%
Indirect
Channel
36%
Direct Channel
62%

5.3 Non-Response Bias

One concern of the survey is that information collected from respondents might have a non-response bias. While this research did not investigate non-response bias directly, a comparison was made between those subjects who responded after the initial mailing and those who responded to the second/third wave. Chi-square tests were used to make the comparisons. The results are shown in last column of Table 5.3.1. We can see no significant difference in employment size, sales volume, and respondent's job title between these two groups and we conclude non-response bias is not a cause for concern.

Table 5.3.1 Test of Non-Response Bias

Variables	First-wave	Second/third wave	Second/third wave	Chi-square Test
	Frequency (%)	Expected Freq. (%)	Observed Freq. (%)	
Number of Employees (194)				
100-250	36 (38.7%)	39 (38.7%)	38 (37.6%)	χ^2=2.94 df=3 p>.10
251-500	12 (12.9%)	13 (12.9%)	15 (14.6%)	
501-1000	7 (7.5%)	8 (7.5%)	12 (11.9%)	
Over 1000	38 (40.9%)	41 (40.9%)	36 (35.6%)	
Sales Volume in millions of $ (190)				
Under 10	4 (4.4%)	4 (4.4%)	1(1.0%)	χ^2=3.42 df=4 p>.10
10 to <25	18 (20.0%)	20 (20.0%)	19(19.0%)	
25 to <50	9 (10.0%)	10 (10.0%)	19(19.0%)	
50 to <100	14 (15.6%)	16 (15.6%)	12(12.0%)	
Over 100	45 (50.0%)	50 (50.0%)	49(49.0%)	
Job Title (194)				
CEO/President /Vice President	10 (10.6%)	10 (10.6%)	4 (4.0%)	χ^2=4.81 df=3 p>.10
Director	17(18.3%)	19 (18.3%)	18 (17.8%)	
Manager	54 (58.1%)	59 (58.1%)	67 (66.3%)	
Other	12 (12.9%)	13 (12.9%)	12 (11.9%)	

Note: Figures in parentheses are percentage;

The calculation formula $\chi^2 = \sum (f_e - f_o)^2 / f_e$

5.4 Large-scale Instrument Assessment Methodology

Once the data was collected, it was analyzed with the following objectives in mind: purification, factor structure (initial validity), unidimensionality, reliability, and the validation of second-order construct. The methods that were used for each analysis are corrected-item total correlation (for purification), exploratory factor analysis (for factor structure and initial validity), structural equation modeling (for unidimensionality), Cronbach's alpha (for reliability), and T coefficient (for the validation of second-order construct).

The need to purify the items (i.e., getting rid of "garbage items") before administering factor analysis is emphasized by Churchill (1979). Purification is carried out by examining the corrected-item total correlation (CITC) score of each item with respect to a specific dimension of a construct. The CITC score is a good indicator of how well each item contributes to the internal consistency of a particular construct as measured by the Cronbach's alpha coefficient (Cronbach, 1951). Items were deleted if their CITC scores were below .5, unless there are clear reasons for keeping the items in spite of low item total correlation. On the other hand, certain items with CITC scores above .50 may also be removed if their deletion can dramatically improve the overall reliability of the specific dimension. This can be determined by examining the "alpha if deleted" score.

The reliability (internal consistency) of the items comprising each dimension was examined using Cronbach's alpha. Following the guideline established by Nunnally (1978), an alpha score of higher than .70 is generally considered to be acceptable.

After purifying the items, an exploratory factor analysis (EFA) of the items in each construct was conducted. EFA is useful in discovering potential latent sources of variance and covariance in observed measurements. Items with good measurement properties should exhibit high factor loadings on the latent factor of which they are indicators, and small factor loadings on the factors that are measured by differing sets of indicators. Therefore, such results provide some evidence of initial validity of measurement items (Segars and Grover, 1993). To ensure the high quality of instrument development process, .50 was used as the cutoff score for factor loading. Items with loadings lower that .50 and items with serious cross-loadings (i.e. an item loaded very close to .50 on more than one factor) were removed. To streamline the final results, factor loadings lower than .40 were not reported. Moreover, the stability of the factors was analyzed by measuring the ratio of respondents to items, and the Tinsley and Tinsley (1987) guideline of having a minimal ratio between 5 and 10 was followed.

Even though EFA is useful at identifying underlying factor structure and thus providing initial unidimensionality (convergent validity) and discriminant validity, EFA initially assumes that the measurement errors of the items are uncorrelated. In practice, however, there is always some degree of error correlations among items and this cannot be detected by EFA (Raghunathan et al, 1999). On the other hand, according to Gerbing and Anderson (1988) and Segars and Grover (1993), EFA does not provide an explicit test of unidimensionality. Unidimensionality can be defined as the existence of one latent trait or construct underlying a set of measures (McDonald, 1981; Hattie, 1985). In fact, Gerbing and Anderson state that "factors in an exploratory analysis do not correspond directly to the constructs represented by each set of indicators because each factor from

exploratory analysis is defined as a weighted sum of all observed variables in the analysis" (p.189). More recently, the structural equation modeling (SEM) has been gaining increasing popularity due to its robustness and flexibility in establishing unidimensionality. This research will thus use SEM to test unidimensionality of each construct.

One of the most widely used SEM software is Joreskog and Sorbom's (1989) LISREL. Using LISREL, it is possible to specify, test, and modify the measurement model. Model-data fit was evaluated based on multiple fit indexes. The Chi-square is perhaps the most popular index to evaluate the goodness of fit of the model. It measures the difference between the sample covariance and the fitted covariance. However, the Chi-square index is sensitive to sample size and departures from multivariate normality. Therefore, it has been suggested that it must be interpreted with caution in most applications (Joreskog and Sorbom, 1989). Some of the other measures of overall model fit are goodness of fit index (GFI), adjusted goodness of fit index (AGFI), comparative fit index (CFI), normed-fit index (NFI), and root mean square residual (RMSR). GFI indicates the relative amount of variance and covariance jointly explained by the model. The AGFI differs from GFI in that it adjusts for the number of degree of freedom in the model. NFI is a relative comparison of proposed model to the null model. CFI avoids the underestimation of fit often noted in small samples for NFI. Many researchers interpret these index scores (GFI, AGFI, CFI, NFI) in the range of .80-.89 as representing reasonable fit; scores of .90 or higher are considered as evidence of good fit (Joreskog and Sorbom, 1989). The RMSR indicates the average discrepancy between the elements in the sample covariance matrix and the model-generated covariance matrix. RMSR

values range from 0 to 1, with smaller values indicating better model; values below .05 signify good fit (Bryne, 1989).

Beside the validation of unidimensionality, another important aspect of instrument assessment is the validation of second-order construct. For example, environmental uncertainty is measured by customer uncertainty, supplier uncertainty, and technology uncertainty and each of these sub-constructs is measured by several indicators. The question here is "do customer uncertainty, supplier uncertainty, and technology uncertainty form a high order construct (environmental uncertainty)?" Unfortunately, EFA cannot answer this question since it does not explicitly reveal second-order constructs, thus, they cannot provide statistical evidence of a second-order construct (Doll et al., 1995). T coefficient can be used to test for the existence of the single second-order construct that accounts for the variations in all its sub-constructs. T coefficient is calculated as the following: suppose that model A (see Figure 5.4.1) represents four correlated first-order factors and model B (see Figure 5.4.2) hypothesizes the same four first-order factors and a single second-order factor. T coefficient is the ratio of chi-square of model A to the chi-square of model B which indicates the percentage of variation in the four first order factors in model A explained by the second-order factor in model B (Doll et al., 1995). Even though the fit index of model B is always a little "worse" than that of model A since more constraints have been added in the model B, a T coefficient higher than .80 may indicate the existence of a second-order construct since most of the variation shared by the first-order factors is explained by the single second-order factor.

Figure 5.4.1 (Model A)

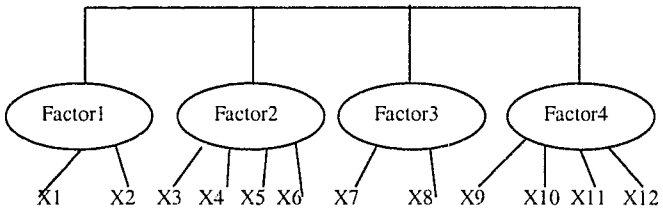
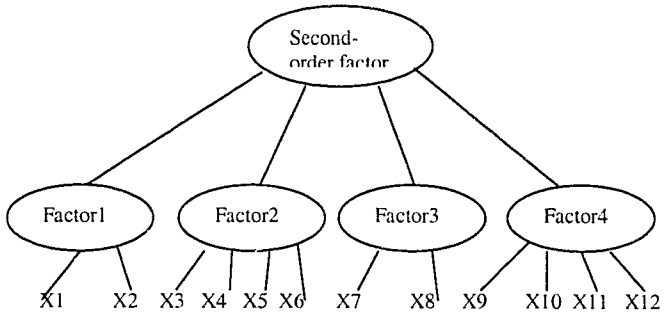


Figure 5.4.2 (Model B)



5.5 Large-scale Measurement Results

The following section will present the large-scale instrument validation results on each of the nine constructs: Environmental Uncertainty, Top Management Support, SCM Strategy Process, Partner Relationship, Usage of IT Tools, SCM Practice, SCM Performance, Competitive Advantage, and Organizational Performance. For each construct, the instrument assessment methodology described in the previous section was applied. In presenting the results of the large-scale study, the following acronyms were used to number the questionnaire items in each sub-construct. These acronyms are also listed in Appendix E.

EU	**Environmental Uncertainty**	
	EU/CU	Customer Uncertainty
	EU/SU	Supplier Uncertainty
	EU/COU	Competitor Uncertainty
	EU/TU	Technology Uncertainty
TMS	**Top Management Support**	
SCMSP	**SCM Strategy Process**	
PR	**Partner Relationship**	
	PR/TRU	Trust in Trading Partners
	PR/COM	Commitment of Trading Partners
	PR/VIS	Shared Vision between Trading Partners
IT	**The Usage of IT Tools**	
	IT/CT	Communication Tools
	IT/RPT	Resource Planning Tools
	IT/SCMT	Supply Chain Management Tools
SCMP	**Supply Chain Management Practices**	
	SCMP/SSP	Strategic Supplier Partnership
	SCMP/CRP	Customer Relationship Practice
	SCMP/IS	Information Sharing
	SCMP/IQ	Information Quality
	SCMP/LS	Lean System
	SCMP/POS	Postponement
SCMPER	**Supply Chain Management Performance**	
	PER/SCF	Supply Chain Flexibility
	PER/SCI	Supply Chain Integration
	PER/CR	Customer Responsiveness
	PER/SP	Supplier Performance
	PER/PQ	Partnership Quality
CA	**Competitive Advantage**	
	CA/PC	Price/Cost
	CA/PI	Production Innovation
	CA/DD	Delivery Dependability
	CA/QL	Quality
	CA/TM	Time to Market
OP	**Organizational Performance**	

5.5.1 Driving Forces

5.5.1.1 Environmental Uncertainty

The Environmental Uncertainty (EU) construct was initially represented by four dimensions and 18 items, including Customer Uncertainty (EU/CU) (4 items), Supplier Uncertainty (EU/SU)(5 items), Competitor Uncertainty (EU/COU) (5 items), and Technology Uncertainty (EU/TU) (4 items). The analysis began with purification using CITC analysis. The CITC for each item and its corresponding code name are shown in Table 5.5.1.1.1.

The CITC scores for all items in EU/SU and EU/TU are all well above .50. For the EU/CU dimension, three items (out of four) have CITC scores below .50. Careful examination of items revealed that EU/CU1 ("customers' needs are unpredictable") is too general and EU/CU2 ("customers' requirements regarding product features are difficult to forecast") can be constructed as part of EU/CU4 ("customers' product preferences change over the year"). It was decided to drop EU/CU1 and EU/CU2, and keep EU/CU3 and EU/CU4 for further analysis. The resulting reliability for this dimension is .79 and CITCs for the two remaining items are both .65.

In assessing CITC of EU, the most troublesome sub-construct is EU/COU since the CITCs of all items under this dimension are much below .50, and the reliability of this sub-construct is only .49. Careful examinations of the items reveal two possible reasons for this result. First, the competitor uncertainty may be caused by the combined effects of customer, supplier, and technology uncertainty and hence has been implicitly measured in the other sub-constructs. Second, competitor uncertainty may not be a relevant measure of external environment of SCM. Since SCM focuses on building long-term

relationships with suppliers and customers, the risk of losing good suppliers and customers will be reduced and hence the threat from the competitors will be lessened, or even eliminated. Therefore, it was decided to drop "competitor uncertainty" sub-construct for later analysis. The final Cronbach's alpha scores are .79 for EU/CU, .83 for EU/SU, and .84 for EU/TU. Table 5.5.1.1.1 presents the reliability analysis results.

An exploratory factor analysis was then conducted using principal components as means of extraction and varimax as method of rotation. The ratio of respondents to items is 18 and thus, meets the general guideline. The factor results are shown in Table 5.5.1.1.2. The cumulative variance explained by the three factors is 66.83%. For simplicity, only loadings above .40 were displayed. All items loaded on their respective factors and there were no items with cross-loadings greater than .40.

Next, unidimensionality for each sub-construct (EU/CU, EU/SU and EU/TU) was tested using LISREL. Following Sethi and King (1994), iterative modifications were made for each of the sub-constructs by observing modification indices and coefficients to improve key model fit statistics. Further, as recommended by Joreskog and Sorbom (1989), only one item was altered at a time to avoid over-modification of the model. This iterative process continued until all model parameters and key fit indices met recommended criteria. If the constructs have less than 4 items, model fit statistics could not be obtained. To address this problem two-factor model will be tested by adding the items of another construct. The items of another construct are added only to provide a common basis for comparison and to keep items in sufficient number so that model fit statistics could be obtained. Section A of Appendix F presents the details of this modification process and the items.

The next step will use T coefficient to test if these three sub-constructs (EU/CU, EU/SU, and EU/TU) underlie a single higher-order construct (EU). But in the case of three correlated first-order factors, a second-order model has the same degree of freedom and chi-square as that of the first-order model, thus T coefficient equals 1.0, which has no meaning (Doll et al., 1995). In this situation, an indirect way is to look at the standardized coefficient for each sub-construct. If all of them are statistically significant, a second-order can be considered. From Table 5.5.1.1.3, it can be seen NFI (.95), GFI (.97) and AGFI (.94) for first/second model are all well above .90 and indicate a very good model-data fit. The standardized coefficients are .53 for EU/CU, .51 for EU/SU, and .43 for EU/TU and all are statistically significant, hence, the higher-order construct (EU) can be considered. The final set of measurement items for the Environmental Uncertainty and the resulting reliabilities are listed in Table 5.5.1.1.4.

5.5.1.2 Top Management Support for SCM

Top Management Support for the SCM (TMS) construct contained one dimension comprising 5 items. The analysis began with purification using CITC analysis. Since this is a single-factor construct, its item coding, CITCs, Cronbach's alpha, and factor loadings are all shown in Table 5.5.1.2.1. The Cronbach's alpha for TMS is .91. The variance explained by this factor is 74.16%.

LISREL was then used to test for unidimensionality. The same procedure was followed as that of previous construct (EU). Section B of Appendix F presents the details of this modification process and the items. The final set of measurement items for TMS and the resulting reliability are listed in Table 5.5.1.2.2.

Table 5.5.1.1.1 Purification for Environmental Uncertainty

Coding	Items	CITC-1	CITC-2	α
	Customer Uncertainty (EU/CU)			
EU/CU1	Customers' needs are unpredictable.	.44		
EU/CU2	Customers' requirements regarding product features are difficult to forecast.	.47		
EU/CU3	Customers order different product combinations over the year.	.48	.65	α= .79
EU/CU4	Customers' product preferences change over the year.	.57	.65	
	Supplier Uncertainty (EU/SU)			
EU/SU1	The properties of materials from suppliers can vary greatly within the same batch.	.56		α= .83
EU/SU2	Suppliers' engineering level is unpredictable.	.61		
EU/SU3	Suppliers' product quality is unpredictable.	.65		
EU/SU4	Suppliers' delivery time can easily go wrong.	.65		
EU/SU5	Suppliers' delivery quantity can easily go wrong.	.61		
	Competitor Uncertainty (EU/COU)			
EU/COU1	Competitors' actions are unpredictable.	.26		
EU/COU2	Competition is intensified in our industry.	.22		
EU/COU3	Competitors are from different industries.	.33		
EU/COU4	Competitors are from different countries.	.20		
EU/COU5	Competitors often introduce new product unexpectedly.	.32		
	Technology Uncertainty (EU/TU)			
EU/TU1	Technology is changing significantly in our industry.	.64		α= .84
EU/TU2	Technological changes provide opportunities for enhancing competitive advantage in our industry.	.66		
EU/TU3	Technological breakthrough results in many new product ideas in our industry.	.76		
EU/TU4	Improving technology generates new products frequently in our industry.	.66		

Table 5.5.1.1.2 Exploratory Factor Analysis for Retained Environmental Uncertainty

Item	F1-Supplier Uncertainty	F2-Technology Uncertainty	F3-Customer Uncertainty	α
EU/SU1	.71			.83
EU/SU2	.75			
EU/SU3	.80			
EU/SU4	.80			
EU/SU5	.76			
EU/TU1		.77		.84
EU/TU2		.82		
EU/TU3		.87		
EU/TU4		.81		
EU/CU3			.90	.79
EU/CU4			.88	
Eigenvalue	2.96	2.73	1.67	
% of Variance	26.85	24.80	15.18	
Cumulative % of variance	26.85	51.66	66.83	

Table 5.5.1.1.3 Goodness of Fit Indexes for First and Second Order Model

Construct	Model	Chi-Square (df)	Chi-Square/df	NFI	GFI	AGFI	RMSR	T coefficient
EU	**First /Second**	31.24 (24)	1.30	0.95	0.97	0.94	.04	--
PR	**First /Second**	39.32 (32)	1.23	.96	.96	.93	.02	--
IT	**First /Second**	128.17 (62)	2.07	.86	.91	.87	.10	--
SCMP	**First-Order**	326.47(260)	1.26	.85	.88	.85	.05	96.61%
	Second-Order	337.90(269)	1.26	.84	.88	.85	.05	
SCMPER	**First-Order**	246.26(155)	1.59	.86	.89	.85	.05	90.18%
	Second-Order	273.09(164)	1.67	.85	.88	.84	.06	
CA	**First-Order**	119.38 (55)	2.17	.90	.91	.86	.04	81.27%
	Second-Order	146.90 (60)	2.45	.87	.90	.84	.06	

Table 5.5.1.1.4 Environmental Uncertainty- Final Construct Measurement Items

Coding	Items	α
	Customer Uncertainty (EU/CU)	
EU/CU3	Customers order different product combinations over the year.	**α= .79**
EU/CU4	Customers' product preferences change over the year.	
	Supplier Uncertainty (EU/SU)	
EU/SU1	The properties of materials from suppliers can vary greatly within the same batch.	**α= .81**
EU/SU2	Suppliers' engineering level is unpredictable.	
EU/SU3	Suppliers' product quality is unpredictable.	
EU/SU4	Suppliers' delivery time can easily go wrong.	
	Technology Uncertainty (EU/TU)	
EU/TU2	Technological changes provide opportunities for enhancing competitive advantage in our industry.	**α= .82**
EU/TU3	Technological breakthrough results in many new product ideas in our industry.	
EU/TU4	Improving technology generates new products frequently in our industry.	

Table 5.5.1.2.1 Purification and Factor Loading for Top Management Support for SCM

Coding	Items	CITC-1	CITC-2	α	Factor Loadings
	Top Management Support (TMS)				
TMS1	Top management is interested in our relationship with our trading partners.	.74		α= .91	.84
TMS2	Top management considers the relationship between us and our trading partners to be important.	.80			.89
TMS3	Top management supports SCM with the resources we need.	.78			.86
TMS4	Top management regards SCM as a high priority item.	.76			.84
TMS5	Top management participates in SCM and its optimization.	.81			.88
	Eigenvalue				3.7
	% of variance				74.16

Table 5.5.1.2.2 Top Management Support for SCM- Final Construct Measurement Items

Coding	Items	α
	Top Management Support for SCM (TMS)	
TMS2	Top management considers the relationship between us and our trading partners to be important.	α= . 90
TMS3	Top management supports SCM with the resources we need.	
TMS4	Top management regards SCM as a high priority item.	
TMS5	Top management participates in SCM and its optimization.	

5.5.2 SCM Strategy Process

The SCM Strategy Process (SCMSP) construct contained one dimension comprising 9 items. The analysis began with purification using CITC analysis. Its item coding, CITC, Cronbach's alpha, and factor loadings are all shown in Table 5.5.2.1. The Cronbach's alpha for SCMSP is .95. The variance explained by this factor is 70.64%.

LISREL was used to further purify this construct and test for unidimensionality. Section C of Appendix F presents the details of this modification process and the items. The final set of measurement items for SCMSP and the resulting reliability are listed in Table 5.5.2.2.

5.5.3 Partner Relationship

The Partner Relationship (PR) construct was initially represented by three dimensions and 14 items, including Trust in Trading Partners (PR/TRU) (4 items), Commitment of Trading Partners (PR/COM)(6 items), and Shared Vision between Trading Partners (PR/VIS) (4 items). The analysis began with purification using CITC analysis. The CITC for each item and its corresponding code name are shown in Table 5.5.3.1. All the items have CITCs above .50 and all three sub-constructs (PR/TRU, PR/COM and PR/VIS) have reliabilities above .80.

An exploratory factor analysis was then conducted using principal components as means of extraction and varimax as method of rotation. The ratio of respondents to items is 14 and thus, meets the general guideline. The factor results are shown in Table 5.5.3.2. For simplicity, only loadings above .40 are displayed. All items load on their respective

Table 5.5.2.1 Purification and Factor Loading for SCM Strategy Process

Coding	Items	CITC-1	CITC-2	α	Factor Loadings
	SCM Strategy Process (SCMSP)				
SCMSP1	We actively pursue SCM strategy.	.75		α= .95	.80
SCMSP2	We systematically address long-term SCM trends.	.82			.86
SCMSP3	We translate business strategy into SCM terms.	.84			.88
SCMSP4	We make an effort to anticipate the potential of new SCM practices and technologies.	.76			.81
SCMSP5	We have a well-developed SCM Strategy.	.86			.89
SCMSP6	We have a regular system for monitoring SCM performance.	.72			.78
SCMSP7	We derive competitive strength for our business through SCM.	.81			.85
SCMSP8	We have a formal process for the implementation of SCM.	.82			.86
SCMSP9	We communicate our objectives and strategies of SCM to all concerned employee.	.77			.82
	Eigenvalue				6.36
	% of variance				70.64

Table 5.5.2.2 SCM Strategy Process- Final Construct Measurement Items

Coding	Items	α
	SCM Strategy Process (SCMSP)	
SCMSP1	We actively pursue SCM strategy.	α= .93
SCMSP2	We systematically address long-term SCM trends.	
SCMSP3	We translate business strategy into SCM terms.	
SCMSP4	We make an effort to anticipate the potential of new SCM practices and technologies.	
SCMSP7	We derive competitive strength for our business through SCM.	
SCMSP8	We have a formal process for the implementation of SCM.	
SCMSP9	We communicate our objectives and strategies of SCM to all concerned employee.	

factors and there are no items with cross-loadings greater than .40. Corbach's alpha's for the three sub-constructs are .83, .85, and .84 respectively. The cumulative variance explained by the three factors is 63.30%.

Then, unidimensionality for each sub-construct (PR/TRU, PR/COM, and PR/VIS) was then tested using LISREL. This iterative process continued until all model parameters and key fit indices met recommended criteria. Section D of Appendix F presents the details of this modification process and the items.

A second–order model is used to test whether these three sub-constructs (PR/TRU, PR/COM and PR/VIS) underlie a single higher-order construct (PR). The fit indexes for this model are listed in Table 5.5.1.1.3. It is shown that NFI (.96), GFI (.96) and AGFI (.93) are all well above .90 and indicate a very good model-data fit. The standardized coefficients are .79 for PR/TRU, .82 for PR/COM, and .78 for PR/VIS and all statistically significant, hence, the higher-order construct (PR) can be considered.

The final set of measurement items for the Partner Relationship and the resulting reliabilities are listed in Table 5.5.3.3.

5.5.4 Usage of IT Tools

The usage of IT tools construct was initially represented by three dimensions and 14 items, including Communication Tools (IT/CT) (4 items), Resource Planning Tools (IT/RPT)(3 items), and Supply Chain Management Tools (IT/SCMT) (6 items).

First, purification was conducted by using CITC analysis. The CITC for each item and its corresponding code name are shown in Table 5.5.4.1. For the IT/CT dimension, items IT/CT2 ("the extent of the usage of EFT in your firm to facilitate supply chain

Table 5.5.3.1 Purification for Partner Relationship

Coding	Items	CITC-1	CITC-2	α
	Trust in Trading Partner (PR/TRU)			
PR/TRU1	Our trading partners have been open and honest in dealing with us.	.70		
PR/TRU2	Our trading partners are reliable.	.68		
PR/TRU3	Our trading partners respect the confidentiality of the information they receive from us.	.70		**α= .84**
PR/TRU4	Our transactions with trading partners do not have to be closely supervised.	.64		
	Commitment of Trading Partner (PR/COM)			
PR/COM1	Our trading partners have made sacrifices for us in the past.	.57		
PR/COM2	Our trading partners are willing to provide assistance to us without exception.	.61		
PR/COM3	We expect to increase business with our trading partners in the future.	.50		
PR/COM4	We have invested a lot of effort in our relationship with trading partners.	.51		**α= .83**
PR/COM5	Our trading partners abide by agreements very well.	.74		
PR/COM6	We and our trading partners always try to keep each others' promises.	.67		
	Shared Vision Between Trading Partner (PR/VIS)			
PR/VIS1	We and our trading partners understand each others' business policies and rules very well.	.61		
PR/VIS2	We and our trading partners have a similar understanding about the aims and objectives of the supply chain.	.74		**α= .85**
PR/VIS3	We and our trading partners have a similar understanding about the importance of collaboration across the supply chain.	.78		
PR/VIS4	We and our trading partners have a similar understanding about the importance of improvements that benefit the supply chain as a whole.	.66		

Table 5.5.3.2 Exploratory Factor Analysis for Retained Partner Relationship Construct

Item	**F1-Commitment of Trading Partner**	**F2-Shared Vision between Trading Partner**	**F3-Trust in Trading Partner**	α
PR/COM1	.62			
PR/COM2	.68			
PR/COM3	.71			
PR/COM4	.68			**α=.83**
PR/COM5	.69			
PR/COM6	.62			
PR/VIS1		.71		
PR/VIS2		.81		**α=.85**
PR/VIS3		.82		
PR/VIS4		.76		
PR/TRU1			.75	
PR/TRU2			.73	
PR/TRU3			.76	**α=.84**
PR/TRU4			.79	
Eigenvalue	3.08	2.96	2.83	
% of Variance	22.01	21.12	20.18	
Cumulative % of variance	22.01	43.12	63.30	

Table 5.5.3.3 Partner Relationship- Final Construct Measurement Items

Coding	Items	α
	Trust in Trading Partners (PR/TRU)	
PR/TRU1	Our trading partners have been open and honest in dealing with us.	α= .80
PR/TRU3	Our trading partners respect the confidentiality of the information they receive from us.	
PR/TRU4	Our transactions with trading partners do not have to be closely supervised	
	Commitment of Trading Partners (PR/COM)	
PR/COM1	Our trading partners have made sacrifices for us in the past.	α= .78
PR/COM4	We have invested a lot of effort in our relationship with trading partners.	
PR/COM5	Our trading partners abide by agreements very well.	
PR/COM6	We and our trading partners always try to keep each others' promises.	
	Shared Vision Between Trading Partners (PR/VIS)	
PR/VIS2	We and our trading partners have a similar understanding about the aims and objectives of the supply chain.	α= .85
PR/VIS3	We and our trading partners have a similar understanding about the importance of collaboration across the supply chain.	
PR/VIS4	We and our trading partners have a similar understanding about the importance of improvements that benefit the supply chain as a whole	

management") and IT/CT3 ("the extent of the usage of Internet in your firm to facilitate supply chain management") had respective scores of .47 and .43. After careful examinations of these two items, it was decided to keep item IT/CT2, which is just a little bit below .50, considering its importance to this dimension. On the other hand, it was decided to remove IT/CT3. Since Internet exists in almost every organization, it may not be a good measure for the usage of IT tools facilitating SCM. For the IT/RPT dimension, item IT/RPT2 ("the extent of the usage of MRPII in your firm to facilitate supply chain management") had a CITC score of .46, slightly below .50. Considering its importance to this dimension, IT/RPT2 was kept at this stage. For the CT/SCMT, the CITC scores for all items were above .54. The final Cronbach's alpha scores were .74 for IT/CT, .70 for IT/RPT, and .83 for IT/SCMT.

An exploratory factor analysis was then conducted using principle components as means of extraction and varimax as method of rotation. The ratio of respondents to items is 14 and thus, meets the general guidelines. The factor results are shown in Table 5.5.4.2. For simplicity, only loadings above .40 are displayed. All items except IT/CT4 ("the extent of the usage of Intranet in your firm to facilitate supply chain management") and IT/CT5 ("the extent of the usage of Extranet in your firm to facilitate supply chain management") load on their respective factors. IT/CT4 has a factor loading of .72 on its respective factor and a cross loading of .41 with the factor of IT/RPT, while IT/CT5 has a factor loading of .67 on its respective factor and a cross-loading of .41 with the factor of IT/SCMT. Since these two items dominantly loaded on their respective factors, considering the importance of these two items, it was decided to keep these two items at this stage. The cumulative variance explained by the three factors is 59.13%.

Unidimensionality for each sub-construct (IT/CT, IT/RPT and IT/SCMT) was then tested using LISREL. Section E of Appendix F presents the details of this modification process and the items.

To test for the existence of a single higher-order construct (IT), a second-order model was constructed. The fit indexes for this model are listed in Table 5.5.1.1.3. It is shown that NFI (.86), GFI (.91), and AGFI (.87) are all above .80 and indicate a moderate model-data fit. The standardized coefficients are .87 for IT/CT, .79 for IT/PR, and .81 for IT/SCMT and all are statistically significant, hence, the higher-order construct (IT) can be considered. The final set of measurement items for the usage of IT tools and the resulting reliabilities are listed in Table 5.5.4.3.

5.5.5 SCM Practice

The SCM Practice (SCMP) construct was initially represented by 6 dimensions and 45 items, including Strategic Supplier Partnership (SCMP/SSP) (10 items), Customer Relationship (SCMP/CRP) (8 items), Information Sharing (SCMP/IS) (7 items), Information Quality (SCMP/IQ) (5 items), Lean System (SCMP/LS) (10 items), and Postponement (SCMP/POS) (5 items).

The analysis began with purification using CITC analysis. The CITC for each item and its corresponding code name are shown in Table 5.5.5.1. The CITC scores for all items in SCMP/IS and SCMP/IQ were all above .50. For the SCMP/SSP dimension, items SCMP/SSP1 ("we rely on a few dependable suppliers"), SCMP/SSP2 ("we rely on a few quality suppliers") and SCMP/SSP10 ("we certify our suppliers for quality") have low CITC scores of .36, .47, and .36 respectively. Careful examinations of these three

Table 5.5.4.1 Purification for Usage of IT Tools

Coding	Items	CITC-1	CITC-2	α
	Communication Tools (IT/CT)			
IT/CT1	The extent of usage of EDI in your firm to facilitate supply chain management.	.53	.54	
IT/CT2	The extent of usage of EFT in your firm to facilitate supply chain management.	.47	.49	
IT/CT3	The extent of usage of Internet in your firm to facilitate supply chain management.	.43		α= .74
IT/CT4	The extent of usage of Intranet in your firm to facilitate supply chain management.	.65	.58	
IT/CT5	The extent of usage of Extranet in your firm to facilitate supply chain management.	.54	.52	
	Resource Planning Tools (IT/RPT)			
IT/RPT1	The extent of usage of MRP in your firm to facilitate supply chain management.	.66		α= .70
IT/RPT2	The extent of usage of MRPII in your firm to facilitate supply chain management.	.46		
IT/RPT3	The extent of usage of ERP in your firm to facilitate supply chain management.	.52		
	Supply Chain Management Tools (IT/SCMT)			
IT/SCMT1	The extent of usage of DRP in your firm to facilitate supply chain management.	.60		
IT/SCMT2	The extent of usage of CRM in your firm to facilitate supply chain management.	.67		α= .83
IT/SCMT3	The extent of usage of SRM in your firm to facilitate supply chain management.	.71		
IT/SCMT4	The extent of usage of VMI in your firm to facilitate supply chain management.	.57		
IT/SCMT5	The extent of usage of DW in your firm to facilitate supply chain management.	.54		
IT/SCMT6	The extent of usage of SCM software in your firm.	.60		

Table 5.5.4.2 Exploratory Factor Analysis for Retained Usage of IT Tools Construct

Item	**F1-Supply Chain Management Tools**	**F2-Communication Tools**	**F3- Resource Planning Tools**	α
IT/SCMT1	.66			
IT/SCMT2	.74			
IT/SCMT3	.82			
IT/SCMT4	.67			**α=.83**
IT/SCMT5	.52			
IT/SCMT6	.73			
IT/CT1		.75		
IT/CT2		.56		**α=.74**
IT/CT4		.72	.41	
IT/CT5	.41	.67		
IT/RPT1			.83	
IT/RPT2			.65	**α=.70**
IT/RPT3			.69	
Eigenvalue	3.34	2.23	2.11	
% of Variance	25.68	17.15	16.30	
Cumulative % of variance	25.68	42.83	59.13	

Table 5.5.4.3 Usage of IT Tools- Final Construct Measurement Items

Coding	Items	α
	Communication Tools (IT/CT)	
IT/CT1	The extent of usage of EDI in your firm to facilitate supply chain management.	α= .74
IT/CT2	The extent of usage of EFT in your firm to facilitate supply chain management.	
IT/CT4	The extent of usage of Intranet in your firm to facilitate supply chain management.	
IT/CT5	The extent of usage of Extranet in your firm to facilitate supply chain management.	
	Resource Planning Tools (IT/RPT)	
IT/RPT1	The extent of usage of MRP in your firm to facilitate supply chain management.	α= .70
IT/RPT2	The extent of usage of MRPII in your firm to facilitate supply chain management.	
IT/RPT3	The extent of usage of ERP in your firm to facilitate supply chain management.	
	Supply Chain Management Tools (IT/SCM)	
IT/SCMT1	The extent of usage of DRP in your firm to facilitate supply chain management.	α= .83
IT/SCMT2	The extent of usage of CRM in your firm to facilitate supply chain management.	
IT/SCMT3	The extent of usage of SRM in your firm to facilitate supply chain management.	
IT/SCMT4	The extent of usage of VMI in your firm to facilitate supply chain management.	
IT/SCMT5	The extent of usage of DW in your firm to facilitate supply chain management.	
IT/SCMT6	The extent of usage of SCM software in your firm.	

items find that SCMP/SSP1 and SCMP/SSP2 have been included in SCMP/SSP3 ("we consider quality as our number one criterion in selecting suppliers"). On the other hand, SCMP/SSP10 appears not a critical indicator of partnership, since certification of supplier may be a requirement for all the suppliers, it does not necessarily means that the organization has built partnership with the suppliers. Therefore, it was decided to remove these three items at this stage. For the SCMP/CRP dimension, item SCMP/CRP7 ("we share a sense of fair play with our customers") had a CITC score of .45. It can be seen that this item is too general and thus was removed.

For SCMP/LS dimension, CITC scores for half of the items were below .50. A careful examination of the descriptions of the items found that the last five items, including SCMP/LS6 ("suppliers' warehouses/factories are located nearby"), SCMP/LS7 ("we order in small lot sizes from our suppliers"), SCMP/LS8 ("inspection of incoming materials/components/products has been reduced"), SCMP/LS9 ("inspection of outbound materials has been reduced"), and SCMP/LS10 ("we involve our customers in process/product design"), can be considered the outcomes of lean system, thus are not true measures of the practice of lean system itself. Therefore, it was decided to remove these items. The CITC scores for the remaining 5 items were all above .50, except SCMP/LS4. SCMP/LS4 ("our firm pushes suppliers for shorter lead-times") had a CITC score of .49, slightly below .50. Considering the importance of this item, SCMP/LS4 was kept at this stage.

For the SCMP/POS dimensions, item SCMP/POS5 ("our goods are stored at appropriate distribution points close to the customers in the supply chain") had a very low CITC score of .13. The examination of the description of this item finds that it has been

included in SCMP/POS4 ("we delay final product assembly activities until the last possible position (or nearest to customers) in the supply chain") and thus was deleted at this stage. The CITC scores for the remaining items are all above .50 except SCMP/POS2. SCMP/POS2 ("our production process modules can be re-arranged so that customization can be carried out later at distribution centers") had a CITC score of .48, slightly below .50. Considering the importance of this item, SCMP/LS4 was kept at this stage. The final Cronbach's alpha scores were .87 for SCMP/SSP, .88 for SCMP/CRP, .86 for SCMP/IS, .86 for SCMP/IQ, .78 for SCMP/LS, and .75 for SCMP/POS.

Thus, the factor analysis was conducted on the remaining 35 items. The ratio of respondents to items is 6 and thus, meets the general guideline. The factor results are shown in Table 5.5.5.2. For simplicity, only loadings above .40 are displayed. Six factors emerged from the factor analysis. Item SCMP/SSP9 ("we actively involve suppliers in new product development processes") had a low factor loading of .44 on its respective factor. The examination of this item finds that it is too specific and has already been included in other items and thus was removed. Item SCMP/IS4 ("our trading partners keep us fully informed about issues that affect our business"), SCMP/IS6 ("we and our trading partners exchange information that helps establishment of business planning"), and SCMP/IS7 ("we and our trading partners keep each other informed about events or changes that may affect the other partners") had cross loadings of .48, .45, and .50 respectively with SCMP/IQ. These cross-loadings are possible since Information Sharing and Information Quality are highly correlated, this may cause confusion to the respondents. On the other hand, after comparing the descriptions of these three items with the others in the same construct, it appeared that these three items were too specific and

already included in the other indicators and thus were deleted. After removing these four items, a factor analysis was performed with the remaining 31 items and the results were shown in Table 5.5.5.3. All items, except SCMP/POS2, loaded on their respective factors. SCMP/POS2 has a factor loading of .62 on its respective factor and a cross loading of .41 with the factor of SCMP/IS and thus was removed. Another factor analysis was performed with remaining 30 items and the results were shown in Table 5.5.5.4. The cumulative variance explained by the six factors is 62.83%.

Then, LISREL was used to further purify the items and test the unidimensionality of each sub-construct. Section F of Appendix F presents the details of this modification process and the items.

The next step is to use T coefficient to test whether these six sub-constructs (SCMP/SSP, SCMP/CRP, SCMP/IS, SCMP/IQ, SCMP/LS and SCMP/POS) underlie a single higher-order construct (SCMP). The fit indices of both first-order and second-order models for SCMP and its T coefficient are listed in Table 5.5.1.1.3. It can be seen that the first and second models have identical GFI, AGFI, RMSR, which are .88, .85, and .05 respectively, indicating satisfactory model fits. The T coefficient is 96.61%, which provides good evidence of a higher order SCMP construct, since about ninety-seven percent of the variation in the six first-order factors is explained by the SCMP construct.

The final set of measurement items for the SCMP and the resulting reliabilities are listed in Table 5.5.5.5.

Table 5.5.5.1 Purification for SCM Practice

Coding	Items	CITC -1	CITC -2	α
	Strategic Supplier Partnership (SCMP/SSP)			
SCMP/SSP1	We rely on a few dependable suppliers.	.36		
SCMP/SSP2	We rely on a few high quality suppliers.	.47		
SCMP/SSP3	We consider quality as our number one criterion in selecting suppliers.	.53	.54	
SCMP/SSP4	We strive to establish long-term relationship with our suppliers.	.65	.68	α=
SCMP/SSP5	We regularly solve problems jointly with our suppliers.	.59	.68	**.87**
SCMP/SSP6	We have helped our suppliers to improve their product quality.	.66	.70	
SCMP/SSP7	We have continuous improvement programs that include our key suppliers.	.67	.71	
SCMP/SSP8	We include our key suppliers in our planning and goal-setting activities.	.70	.71	
SCMP/SSP9	We actively involve our key suppliers in new product development processes.	.55	.57	
SCMP/SSP10	We certify our suppliers for quality.	.35		
	Customer Relationship Practices (SCMP/CRP)			
SCMP/CRP1	We frequently evaluate the formal and informal complaints of our customers.	.57	.56	
SCMP/CRP2	We frequently interact with customers to set reliability, responsiveness, and other standards for us.	.61	.62	
SCMP/CRP3	We have frequent follow-up with our customers for quality/service feedback.	.73	.76	
SCMP/CRP4	We frequently measure and evaluate customer satisfaction.	.69	.71	α= **.88**
SCMP/CRP5	We frequently determine future customer expectations.	.70	.71	
SCMP/CRP6	We facilitate customers' ability to seek assistance from us.	.70	.68	
SCMP/CRP7	We share a sense of fair play with our customers.	.45		
SCMP/CRP8	We periodically evaluate the importance of our relationship with our customers.	.64	.60	
	Information Sharing (SCMP/IS)			
SCMP/IS1	We share our business units' proprietary information with trading partners.	.53		
SCMP/IS2	We inform trading partners in advance of changing needs.	.61		
SCMP/IS3	Our trading partners share proprietary information with us.	.63		
SCMP/IS4	Our trading partners keep us fully informed about issues that affect our business.	.63		α= **.86**
SCMP/IS5	Our trading partners share business knowledge of core business processes with us.	.72		
SCMP/IS6	We and our trading partners exchange information that helps establishment of business planning.	.66		
SCMP/IS7	We and our trading partners keep each other informed about events or changes that may affect the other partners.	.72		

Table 5.5.5.1 Purification for SCM Practice (continued from last page)

Coding	Items	CITC -1	CITC -2	α
	Information Quality (SCMP/IQ)			
SCMP/IQ1	Information exchange between our trading partners and us is timely.	.67		α= .86
SCMP/IQ2	Information exchange between our trading partners and us is accurate.	.77		
SCMP/IQ3	Information exchange between our trading partners and us is complete.	.67		
SCMP/IQ4	Information exchange between our trading partners and us is adequate.	.57		
SCMP/IQ5	Information exchange between our trading partners and us is reliable.	.76		
	Lean System (SCMP/LS)			
SCMP/LS1	Our firm reduces set-up time.	.55	.65	α= .78
SCMP/LS2	Our firm has continuous quality improvement program.	.46	.52	
SCMP/LS3	Our firm uses a "Pull" production system.	.49	.55	
SCMP/LS4	Our firm pushes suppliers for shorter lead-times.	.46	.49	
SCMP/LS5	Our firm streamlines ordering, receiving and other paperwork from suppliers.	.60	.56	
SCMP/LS6	Suppliers' warehouses/factories are located nearby.	.35		
SCMP/LS7	We order in small lot sizes from our suppliers.	.35		
SCMP/LS8	Inspection of incoming materials/components/products has been reduced.	.51		
SCMP/LS9	Inspection of outbound materials has been reduced.	.39		
SCMP/LS10	We involve our customers in process/product design.	.31		
	Postponement (SCMP/POS)			
SCMP/POS1	Our products are designed for modular assembly.	.51	.53	α= .75
SCMP/POS2	Our production process modules can be re-arranged so that customization can be carried out later at distribution centers.	.53	.48	
SCMP/POS3	We delay final product assembly activities until customer orders have actually been received.	.48	.58	
SCMP/POS4	We delay final product assembly activities until the last possible position (or nearest to customers) in the supply chain.	.56	.61	
SCMP/POS5	Our goods are stored at appropriate distribution points close to the customers in the supply chain	.13		

Table 5.5.5.2 Initial Factor Analysis for SCM Practice Construct

Item	F1-CRP	F2-SSP	F3-IQ	F4-IS	F5-LS	F6-POS	α
SCMP/CRP1	.68						
SCMP/CRP2	.72						
SCMP/CRP3	.84						α=.88
SCMP/CRP4	.76						
SCMP/CRP5	.74						
SCMP/CRP6	.69						
SCMP/CRP8	.61						
SCMP/SSP3		.61					
SCMP/SSP4		.79					
SCMP/SSP5		.74					
SCMP/SSP6		.77					
SCMP/SSP7		.69					α=.87
SCMP/SSP8		.66					
SCMP/SSP9		*.44*					
SCMP/IQ1			.73				
SCMP/IQ2			.81				
SCMP/IQ3			.77				α=.86
SCMP/IQ4			.73				
SCMP/IQ5			.82				
SCMP/IS1				.70			
SCMP/IS2				.56			
SCMP/IS3				.72			α=.86
SCMP/IS4			*.48*	*.55*			
SCMP/IS5				.68			
SCMP/IS6			*.45*	*.59*			
SCMP/IS7			*.50*	*.64*			
SCMP/LS1					.78		
SCMP/LS2					.59		
SCMP/LS3					.62		α=.78
SCMP/LS4					.60		
SCMP/LS5					.61		
SCMP/POS1						.71	
SCMP/POS2						.64	α=.75
SCMP/POS3						.79	
SCMP/POS4						.80	
Eigenvalue	4.27	4.10	4.05	3.74	2.78	2.44	
% of Variance	12.20	11.71	11.57	10.70	7.94	6.97	
Cumulative % of variance	12.20	23.91	35.48	46.18	54.12	61.09	

Table 5.5.5.3 Second-Round Factor Analysis for SCM Practice Construct

Item	F1-CRP	F2-SSP	F3-IQ	F4-LS	F5-IS	F6-POS	α
SCMP/CRP1	.69						
SCMP/CRP2	.73						
SCMP/CRP3	.85						α=.88
SCMP/CRP4	.76						
SCMP/CRP5	.73						
SCMP/CRP6	.69						
SCMP/CRP8	.60						
SCMP/SSP3		.62					
SCMP/SSP4		.78					
SCMP/SSP5		.74					α=.86
SCMP/SSP6		.78					
SCMP/SSP7		.69					
SCMP/SSP8		.68					
SCMP/IQ1			.68				
SCMP/IQ2			.83				
SCMP/IQ3			.76				α=.86
SCMP/IQ4			.73				
SCMP/IQ5			.82				
SCMP/LS1				.79			
SCMP/LS2				.61			
SCMP/LS3				.64			α=.78
SCMP/LS4				.58			
SCMP/LS5				.60			
SCMP/IS1					.78		
SCMP/IS2					.57		α=.78
SCMP/IS3					.75		
SCMP/IS5					.58		
SCMP/POS1						.71	
SCMP/POS2					.41	.62	α=.75
SCMP/POS3						.80	
SCMP/POS4						.80	
Eigenvalue	4.16	3.89	3.51	2.67	2.64	2.42	
% of Variance	13.40	12.56	11.32	8.67	8.53	7.81	
Cumulative % of variance	13.40	25.96	37.28	45.95	54.48	62.29	

Table 5.5.5.4 Final Factor Analysis for SCM Practice Construct

Item	F1-CRP	F2-SSP	F3-IQ	F4-LS	F5-IS	F6-POS	α
SCMP/CRP1	.69						
SCMP/CRP2	.74						
SCMP/CRP3	.84						α=.88
SCMP/CRP4	.76						
SCMP/CRP5	.73						
SCMP/CRP6	.68						
SCMP/CRP8	.60						
SCMP/SSP3		.62					
SCMP/SSP4		.78					
SCMP/SSP5		.74					α=.86
SCMP/SSP6		.79					
SCMP/SSP7		.70					
SCMP/SSP8		.68					
SCMP/IQ1			.68				
SCMP/IQ2			.83				
SCMP/IQ3			.76				α=.86
SCMP/IQ4			.73				
SCMP/IQ5			.83				
SCMP/LS1				.79			
SCMP/LS2				.61			
SCMP/LS3				.65			α=.78
SCMP/LS4				.58			
SCMP/LS5				.61			
SCMP/IS1					.80		
SCMP/IS2					.58		α=.78
SCMP/IS3					.76		
SCMP/IS5					.59		
SCMP/POS1						.68	
SCMP/POS3						.85	α=.73
SCMP/POS4						.83	
Eigenvalue	4.12	3.91	3.50	2.69	2.54	2.10	
% of Variance	13.74	13.03	11.65	8.95	8.45	7.01	
Cumulative % of variance	13.74	26.77	38.42	47.37	55.82	62.83	

Table 5.5.5.5 SCM Practice- Final Construct Measurement Items

Coding	Items	α
	Strategic Supplier Partnership (SCMP/SSP)	
SCMP/SSP3	We consider quality as our number one criterion in selecting suppliers.	α= .84
SCMP/SSP5	We regularly solve problems jointly with our suppliers.	
SCMP/SSP6	We have helped our suppliers to improve their product quality.	
SCMP/SSP7	We have continuous improvement programs that include our key suppliers.	
SCMP/SSP8	We include our key suppliers in our planning and goal-setting activities.	
	Customer Relationship Practices (SCMP/CRP)	
SCMP/CRP2	We frequently interact with customers to set reliability, responsiveness, and other standards for us.	α= .84
SCMP/CRP4	We frequently measure and evaluate customer satisfaction.	
SCMP/CRP5	We frequently determine future customer expectations.	
SCMP/CRP6	We facilitate customers' ability to seek assistance from us.	
SCMP/CRP8	We periodically evaluate the importance of our relationship with our customers.	
	Information Sharing (SCM/IS)	
SCMP/IS2	We inform trading partners in advance of changing needs.	α= .72
SCMP/IS3	Our trading partners share proprietary information with us.	
SCMP/IS5	Our trading partners share business knowledge of core business processes with us.	
	Information Quality (SCMP/IQ)	
SCMP/IQ1	Information exchange between our trading partners and us is timely.	α= .86
SCMP/IQ2	Information exchange between our trading partners and us is accurate.	
SCMP/IQ3	Information exchange between our trading partners and us is complete.	
SCMP/IQ4	Information exchange between our trading partners and us is adequate.	
SCMP/IQ5	Information exchange between our trading partners and us is reliable.	
	Lean System (SCMP/LS)	
SCMP/LS1	Our firm reduces set-up time.	α= .78
SCMP/LS2	Our firm has continuous quality improvement program.	
SCMP/LS3	Our firm uses a "Pull" production system.	
SCMP/LS4	Our firm pushes suppliers for shorter lead-times.	
SCMP/LS5	Our firm streamlines ordering, receiving and other paperwork from suppliers.	
	Postponement (SCMP/POS)	
SCMP/POS1	Our products are designed for modular assembly.	α= .73
SCMP/POS3	We delay final product assembly activities until customer orders have actually been received.	
SCMP/POS4	We delay final product assembly activities until the last possible position (or nearest to customers) in the supply chain.	

5.5.6 SCM Performance

The SCM Performance (PER) construct was initially represented by 5 dimensions and 27 items, including Supply Chain Flexibility (PER/SCF) (7 items), Supply Chain Integration (PER/SCI) (5 items), Responsiveness to Customers (PER/RC) (3 items), Supplier Performance (PER/SP) (6 items), and Partnership Quality (PER/PQ) (6 items).

The CITC for each item and its corresponding code name are shown in Table 5.5.6.1. The CITC scores for all items in PER/SCF and PER/CR were all above .50. For the PER/SCI dimension, item PER/SCI5 ("our supply chain is characterized by full system visibility from suppliers' suppliers to customers' customers") has a low CITC score of .43. The examination of the description of the item found that it was too general and thus was eliminated. For the PER/SP dimension, item PER/SP5 ("our suppliers provide materials/components/ products to us at low cost") and PER/SP6 ("our supply base has reduced over the past three years") have low CITC scores of .43 and .31 respectively. After careful examinations of the items, it seemed PER/SP5 is subsumed by PER/SP4 (" our suppliers provide high quality materials/component/product to us") and item PER/SP6 appeared not a direct measure of Supplier Performance, so it was decided to remove these two items at this stage. For the PER/PQ dimension, item PER/PQ1 ("we do not wish to terminate current partnership with trading partners and establish new ones") had a very low CITC score of .28. Careful examination of the description of this item reveals that it may not be a good indicator of partnership quality since an organization's inclination in keeping up the relationship may be because they have no other choice or are forced to do so by the dominant party in the supply chain. It was thus

decided to remove this item. The final Cronbach's alpha scores were .84 for PER/SCF, .77 for PER/SCI, .80 for PER/CR, .88 for PER/SP, and .83 for PER/PQ.

Factor analysis is conducted on the remaining 23 items. The ratio of respondents to items is 9. The factor results are shown in Table 5.5.6.2. Except for PER/SCF dimension, all items loaded on their respective factors, with most of loadings greater than .70. PER/SCF revealed two distinctive factors, with the first three items (PER/SCF1, PER/SCF2, and PER/SCF3) loaded on one factor and another three items (PER/SCF4, PER/SCF5, and PER/SCF6) loaded on another one. Item PER/SCF7 almost equally cross-loaded on these two factors. A close look at the these seven items shows that PER/SCF1, PER/SCF2, and PER/SCF3 measure customization flexibility of the supply chain, while PER/SCF4, PER/SCF5, and PER/SCF6 represent the volume and product flexibility of the supply chain. It was thus determined that PER/SCF be split into two dimensions in the later analysis: customization flexibility (codes as PER/CF) and volume and product flexibility (coded as PER/VPF). Item PER/SCF7 appeared to represent the outcome of the above two kinds of flexibilities, and it was decided to remove at this stage.

After removing item PER/SCF7, a factor analysis was performed with the remaining 22 items and the results were shown in Table 5.5.6.3. All items loaded on their respective factors. The final Cronbach's alpha scores were .80 for PER/CF, .83 for PER/VPF, .77 for PER/SCI, .80 for PER/CR, .88 for PER/SP, and .83 for PER/PQ. The cumulative variance explained by the six factors is 70.23%.

Then, LISREL was used to further purify the items and test the unidimensionality of each sub-construct. Section G of Appendix F presents the details of this modification process and the items.

T coefficient is then used to test whether these six sub-constructs (PER/CF, PER/VPF, PER/SCI, PER/CR, PER/SP, and PER/PQ) underlie a single higher-order construct (SCMPER). The fit indices of both first-order and second-order models for SCMPER and its T coefficient are listed in Table 5.5.1.1.3. It is shown that all indicators of goodness-of-fit for the second-order model are not significantly different from the first-order model. Both models have NFI, GFI, and AGFI greater than .80, and RMSR close to .05., indicating a satisfactory model fit. The T coefficient is 90.18%, which provides good evidence of a higher order SCMPER construct, since about ninety percent of the variation in the six first-order factors is explained by the SCMPER construct.

The final set of measurement items for the SCMPER and the resulting reliabilities are listed in Table 5.5.6.4.

5.5.7 Competitive Advantage

The Competitive Advantage (CA) construct was initially represented by 5 dimensions and 16 items, including Price/Cost (CA/PC) (2 items), Quality (CA/QU) (4 items), Delivery Dependability (CA/DD) (3 items), Production Innovation (CA/PI) (3 items), and Time to Market (CC/TM) (4 items).

The CITC for each item and its corresponding code name are shown in Table 5.5.7.1. The CITC scores for all items in CA/PC, CA/QL, and CA/PI are all above .50. For the CA/DD dimension, item CA/DD1 ("we deliver the kind of products needed") has

Table 5.5.6.1 Purification for SCM Performance

Coding	Items	CITC -1	CITC -2	α
	Supply Chain Flexibility (PER/SCF)			
PER/SCF1	Our supply chain is able to handle difficult nonstandard orders.	.56		α=.84
PER/SCF2	Our supply chain is able to meet special customer specification.	.61		
PER/SCF3	Our supply chain is able to produce products characterized by numerous features options, sizes and colors.	.54		
PER/SCF4	Our supply chain is able to rapidly adjust capacity so as to accelerate or decelerate production in response to changes in customer demand.	.65		
PER/SCF5	Our supply chain is able to rapidly introduce large numbers of product improvements/variation.	.67		
PER/SCF6	Our supply chain is able to handle rapid introduction of new products.	.56		
PER/SCF7	Our supply chain is able to respond to the needs and wants of the firm's target market(s).	.56		
	Supply Chain Integration (PER/SCI)			
PER/SCI1	There is a high level of communication and coordination between all functions in our firm.	.63	.61	α=.77
PER/SCI2	Cross-functional teams are frequently used for process design and improvement in our firm.	.54	.58	
PER/SCI3	There is a high level of integration of information systems in our firm.	.57	.57	
PER/SCI4	There is a great amount of cross-over of the activities of our firm and our trading partners.	.55	.51	
PER/SCI5	Our supply chain is characterized by full system visibility from suppliers' suppliers to customers' customers.	.43		
	Responsiveness to Customers (PER/CR)			
PER/CR1	Our firm fills customer orders on time.	.60		α=.80
PER/CR2	Our firm has short order-to-delivery cycle time.	.60		
PER/CR3	Our firm has fast customer response time.	.68		
	Supplier Performance (PER/SP)			
PER/SP1	Our suppliers deliver materials/components/products to us on time.	.69	.73	α=.88
PER/SP2	Our suppliers provide dependable delivery to us.	.71	.77	
PER/SP3	Our suppliers provide materials/components/products that are highly reliable.	.73	.76	
PER/SP4	Our suppliers provide high quality materials/component/products to us.	.69	.73	
PER/SP5	Our suppliers provide materials/component/products to us at low cost.	.43		
PER/SP6	Our supplier base has reduced over the past three years.	.31		
	Partnership Quality (PER/PQ)			
PER/PQ1	We do not wish to terminate current partnerships with trading partners and establish new ones.	.28		α=.83
PER/PQ2	We believe our relationship with our trading partners is profitable.	.60	.50	
PER/PQ3	We and our trading partners share any risk that can occur in the supply chain.	.54	.62	
PER/PQ4	We and our trading partners share benefits obtained from SCM.	.59	.65	
PER/PQ5	Our relationship with trading partners is marked by a high degree of harmony.	.67	.69	
PER/PQ6	Our overall relationship with trading partners is satisfactory.	.66	.68	

Table 5.5.6.2 Initial Factor Analysis for SCM Performance Construct

Item	F1-SP	F2-PQ	F3-SCF2	F4-SCF1	F5-SCI	F6-CR	α
PER/SP1	.81						α=.88
PER/SP2	.84						
PER/SP3	.83						
PER/SP4	.80						
PER/PQ2		.70					α=.83
PER/PQ3		.70					
PER/PQ4		.72					
PER/PQ5		.74					
PER/PQ6		.74					
PER/SCF4			.74				α=.83
PER/SCF5			.82				
PER/SCF6			.77				
PER/SCF1				.83			α=.80
PER/SCF2				.84			
PER/SCF3				.70			
PER/SCF7			.42	.44			
PER/SCI1					.71		α=.77
PER/SCI2					.82		
PER/SCI3					.71		
PER/SCI4					.64		
PER/CR1						.77	α=.80
PER/CR2						.86	
PER/CR3						.81	
Eigenvalue	3.02	2.97	2.67	2.48	2.42	2.31	
% of Variance	13.11	12.92	11.62	10.76	10.54	10.02	
Cumulative % of variance	13.11	26.03	37.65	48.41	58.95	68.97	

Table 5.5.6.3 Final Factor Analysis for SCM Performance Construct

Item	F1-SP	F2-PQ	F3-VPF	F4-SCI	F5-CR	F6-CF	α
PER/SP1	.81						α=.80
PER/SP2	.84						
PER/SP3	.83						
PER/SP4	.80						
PER/PQ2		.70					α=.83
PER/PQ3		.70					
PER/PQ4		.72					
PER/PQ5		.74					
PER/PQ6		.75					
PER/SCF4			.74				α=.83
PER/SCF5			.83				
PER/SCF6			.76				
PER/SCI1				.71			α=.77
PER/SCI2				.82			
PER/SCI3				.70			
PER/SCI4				.64			
PER/CR1					.77		α=.80
PER/CR2					.86		
PER/CR3					.81		
PER/SCF1						.83	α=.80
PER/SCF2						.84	
PER/SCF3						.71	
Eigenvalue	2.99	2.96	2.51	2.42	2.30	2.28	
% of Variance	13.59	13.46	11.39	10.99	10.43	10.37	
Cumulative % of variance	13.59	27.05	38.44	49.43	59.86	70.23	

Table 5.5.6.4 SCM Performance- Final Construct Measurement Items

Coding	Items	α
	Customization Flexibility (PER/CF)	
PER/SCF1	Our supply chain is able to handle difficult nonstandard orders.	α= .77
PER/SCF2	Our supply chain is able to meet special customer specification.	
PER/SCF3	Our supply chain is able to produce products characterized by numerous features options, sizes and colors.	
	Volume and Product Flexibility (PER/VFP)	
PER/SCF4	Our supply chain is able to rapidly adjust capacity so as to accelerate or decelerate production in response to changes in customer demand.	α= .83
PER/SCF5	Our supply chain is able to rapidly introduce large numbers of product improvements/variation.	
PER/SCF6	Our supply chain is able to handle rapid introduction of new products.	
	Supply Chain Integration (PER/SCI)	
PER/SCI1	There is a high level of communication and coordination between all functions in our firm.	α= .77
PER/SCI2	Cross-functional teams are frequently used for process design and improvement in our firm.	
PER/SCI3	There is a high level of integration of information systems in our firm.	
PER/SCI4	There is a great amount of cross-over of the activities of our firm and our trading partners.	
	Responsiveness to Customers (PER/CR)	
PER/CR1	Our firm fills customer orders on time.	α= .80
PER/CR2	Our firm has short order-to-delivery cycle time.	
PER/CR3	Our firm has fast customer response time.	
	Supplier Performance (PER/SP)	
PER/SP1	Our suppliers deliver materials/components/products to us on time.	α=.84
PER/SP2	Our suppliers provide dependable delivery to us.	
PER/SP4	Our suppliers provide high quality materials/component/products to us.	
	Partnership Quality (PER/PQ)	
PER/PQ2	We believe our relationship with our trading partners is profitable.	α= .79
PER/PQ3	We and our trading partners share any risk that can occur in the supply chain.	
PER/PQ5	Our relationship with trading partners is marked by a high degree of harmony.	
PER/PQ6	Our overall relationship with trading partners is satisfactory.	

a very low CITC score of .17. The examination of the items found that CA/DD3 ("we provide dependable delivery") subsumes CA/DD1. Therefore, it was decided to eliminate CA/DD1 at this stage. For the CC/TM dimension, item CC/TM1 ("we deliver products to market quickly") had a CITC score of .48 and was removed, since it has been included in CA/TM4 ("we have fast product development"). The final Cronbach's alpha scores were .73 for CA/PC, .88 for CA/QL, .93 for CA/DD, .80 for CA/PI, and .75 for CA/TM.

The factor analysis was then conducted on the remaining 14 items. The ratio of respondents to items is 14. The factor results are shown in Table 5.5.7.2. It can be seen that all items loaded on their respective factors, with most of loadings greater than .80. The cumulative variance explained by the five factors is 77.61%.

LISREL was used to further purify the items and test the unidimensionality of each sub-construct. Section H of Appendix F presents the details of this modification process and the items.

T coefficient was used to validate the high-order construct (CA). The fit indices of both first-order and second-order models for CA and the resulting T coefficient are listed in Table 5.5.1.1.3. It is shown that all indexes of goodness-of-fit for the second-order model are a little worse than those of the first order model. But the difference is not significant, GFI, AGFI, NFI and RMSR is .91, .86, .90, and .04 for the first-order model, and .90, .84, .87 and .06 for the second-order model respectively. The T coefficient is 81.27%, which indicates the existence of a higher order CA construct, since about eighty-one percent of the variation in the five first-order factors is explained by the CA construct.

The final set of measurement items for the CA construct and the resulting reliabilities are listed in Table 5.5.7.3.

5.5.8 Organizational Performance

The Organizational Performance (OP) construct contained 7 items. The analysis began with purification using CITC analysis. Its item coding, CITC, Cronbach's alpha, and factor loadings are all shown in Table 5.5.8.1. The Cronbach's alpha for OP is .92. The variance explained by this factor is 69.14%.

Next, LISREL was used to further purify this construct. Section I of Appendix F presents the details of this modification process and the items. After the modification through LISREL, OP has been split into two dimensions: market performance (coded as OP/MP) and financial performance (coded as OP/FP). The Cronbach's alpha scores were .90 for MP, and .89 for FP. The final set of measurement items for OP and the resulting reliabilities are listed in Table 5.5.8.2.

5.5.9 Summary of Large-scale Analysis Results

Table 5.5.9.1 contains the summary of measurement analysis. For each construct dimension, the numbers of final construct measurement items and Cronbach's alpha scores are displayed. It can be seen from the table that the final alpha scores for all construct dimensions are greater than the minimum required value of .70, and most of the alpha scores are over .80. Overall, the final measurement instrument for all nine constructs in the current study were found to be valid and reliable and thus can be used in future research. The revised questionnaire is reported in Appendix G.

Table 5.5.7.1 Purification for Competitive Advantage

Coding	Items	CITC-1	CITC-2	α
	Price/Cost (CA/PC)			
CA/PC1	We offer competitive price.	.59		α=.73
CA/PC2	We are able to offer price as low as or lower than our competitors.	.59		
	Quality (CA/QL)			
CA/QL1	We are able to compete based on quality.	.72		α=.88
CA/QL2	We offer products that are highly reliable.	.78		
CA/QL3	We offer products that are highly durable.	.70		
CA/QL4	We offer high quality products to our customers.	.82		
	Delivery Dependability (CA/DD)			
CA/DD1	We deliver the kind of products needed.	.17		α=.93
CA/DD2	We deliver customer orders on time.	.75	.86	
CA/DD3	We provide dependable delivery.	.71	.86	
	Production Innovation (CA/PI)			
CA/PI1	We provide customized products.	.60		α=.80
CA/PI2	We alter our product offerings to meet client needs.	.70		
CA/PI3	We respond well to customer demand for "new" features.	.65		
	Time to Market (CA/TM)			
CA/TM1	We deliver product to market quickly.	.48		α=.75
CA/TM2	We are first in the market in introducing new products.	.55	.56	
CA/TM3	We have our time-to-market lower than industry average.	.65	.59	
CA/TM4	We have fast product development.	.57	.57	

Table 5.5.7.2 Factor Analysis Result for Competitive Advantage

Item	F1-QL	F2-PI	F3-TM	F4-DD	F5-PC	α
CA/QL1	.80					α=.88
CA/QL2	.86					
CA/QL3	.81					
CA/QL4	.86					
CA/PI1		.87				α=.80
CA/PI2		.82				
CA/PI3		.74				
CA/TM2			.76			α=.75
CA/TM3			.79			
CA/TM4			.81			
CA/DD2				.94		α=.93
CA/DD3				.92		
CA/PC1					.87	α=.73
CA/PC2					.87	
Eigenvalue	3.13	2.14	2.06	1.92	1.62	
% of Variance	22.38	15.27	14.70	13.69	11.57	
Cumulative % of variance	22.38	37.65	52.35	66.04	77.61	

Table 5.5.7.3 Competitive Advantage- Final Construct Measurement Items

Coding	Items	α
	Price/Cost (CA/PC)	
CA/PC1	We offer competitive price.	α= .73
CA/PC2	We are able to offer price as low or lower than our competitors.	
	Quality (CA/QU)	
CA/QL2	We offer products that are highly reliable.	α= .87
CA/QL3	We offer products that are highly durable.	
CA/QL4	We offer high quality products to our customers.	
	Delivery Dependability (CA/DD)	
CA/DD2	We deliver customer orders on time.	α= .93
CA/DD3	We provide dependable delivery.	
	Product Innovation (CA/PI)	
CA/PI1	We provide customized products.	α= .80
CA/PI2	We alter our product offerings to meet client needs.	
CA/PI3	We respond well to customer demand for "new" features.	
	Time to Market (CA/TM)	
CA/TM2	We are first in the market in introducing new products.	α= .75
CA/TM3	We have our time-to-market lower than industry average.	
CA/TM4	We have fast product development.	

Table 5.5.8.1 Purification and Factor Loading for Organizational Performance

Coding	Items	CITC-1	CITC-2	α	Factor Loadings
	Organizational Performance (OP)				
OP1	Market share.	.77		α= .92	.84
OP2	Return on investment.	.80			.86
OP3	The growth of market share.	.78			.85
OP4	The growth of sales.	.74			.82
OP5	Growth in return on investment.	.79			.85
OP6	Profit margin on sales.	.67			.76
OP7	Overall competitive position.	.81			.86
	Eigenvalue				6.86
	% of variance				69.41

Table 5.5.8.2 Organizational Performance- Final Construct Measurement Items

Coding	Items	α
	Market Performance (OP/MP)	
OP1	Market Share.	α= .90
OP3	The growth of market share.	
OP4	The growth of sales.	
	Financial Performance (OP/FP)	
OP2	Return on investment.	α= .90
OP5	Growth in return on investment.	
OP6	Profit margin on sales.	

Table 5.5.9.1 Summary of Measurement Analysis

Constructs	Sub-constructs	# of items	Alpha
Environmental Uncertainty (EU)	Customer Uncertainty (EU/CU)	2	.79
	Supplier Uncertainty (EU/SU)	4	.81
	Technology Uncertainty (EU/TU)	3	.82
Top Management Support for SCM (TMS)	Top Management Support for SCM (TMS)	4	.90
SCM Strategy Process (SCMSP)	SCM Strategy Process (SCMSP)	7	.93
Partner Relationship (PR)	Trust in Trading Partners (PR/TRU)	3	.80
	Commitment of Trading Partners (PR/COM)	4	.78
	Shared Vision between Trading Partners (PR/VIS)	3	.85
Usage of IT Tools (IT)	Communication Tools (IT/CT)	4	.74
	Resource Planning Tools (IT/RPT)	3	.70
	Supply Chain Management Tools (IT/SCMT)	6	.83
SCM Practices (SCMP)	Strategic Supplier Partnership (SCMP/SSP)	5	.84
	Customer Relationship Practice (SCMP/CRP)	5	.84
	Information Sharing (SCMP/IS)	3	.72
	Information Quality (SCMP/IQ)	5	.86
	Lean System (SCMP/LS)	5	.78
	Postponement (SCMP/POS)	3	.73
SCM Performance (SCMPER)	Customization Flexibility (SCMP/CF)	3	.77
	Volume and Product Flexibility (PER/VPF)	3	.83
	Supply Chain Integration (PER/SCI)	4	.77
	Responsiveness to the Customers (PER/CR)	3	.80
	Supplier Performance (PER/SP)	3	.84
	Partnership Quality (PER/PQ)	4	.79
Competitive Advantage (CA)	Price/Cost (CA/PC)	2	.73
	Quality (CA/QU)	3	.87
	Delivery Dependability (CA/DD)	2	.93
	Product Innovation (CA/PI)	3	.80
	Time to Market (CA/TT)	3	.75
Organizational Performance (OP)	Market Performance (OP/MP)	3	.90
	Financial Performance (OP/FP)	3	.90

5.6 Construct-Level Correlation Analysis

The Pearson correlation (i.e., no causal relationships are specified) was used to check for the preliminary statistical validity of the 10 hypotheses presented in Chapter 3. Each construct was represented by a composite score, computed by taking the average scores of all items in a specific construct. The results are presented in Table 5.6.1. All correlations are statistically significant at the .01 level, except the correlation between environmental uncertainty and SCM practice (H1b) is not significant. The correlation coefficients in descending order larger than .50 are: .62 (SCM Practice to SCM Performance), .61 (SCM Strategy Process to SCM Practice), .60 (Partner Relationship to SCM Practice), .59 (SCM Performance to Competitive Advantage), .57 (Partner Relationship to SCM Performance), and .53 (Top Management Support to SCM Practice). It can be concluded that there are high correlations between the constructs for most hypothesized relationships; the test for causal relationships between the constructs using structural equation modeling will be discussed in the next chapter.

Table 5.6.1 Construct-Level Correlation Analysis Results

Hypothesis	Independent Variable	Dependent Variable	Pearson Correlation
H1a	Top Management Support for SCM (TMS)	SCM Practice (SCMP)	.530**
H1b	Environmental Uncertainty (EU)	SCM Practice (SCMP)	-.084
H2	Partner Relationship (PR)	SCM Practice (SCMP)	.603**
H3	Partner Relationship (PR)	SCM Performance (SCMPER)	.574**
H4	Usage of IT Tools (IT)	SCM Practice (SCMP)	.222**
H5	SCM Strategy Process (SCMSP)	SCM Practice (SCMP)	.611**
H6	SCM Practice (SCMP)	SCM Performance (SCMPER)	.621**
H7	SCM Practice (SCMP)	Organizational Performance (OP)	.422**
H8	SCM Performance (SCMPER)	Competitive Advantage (CA)	.589**
H9	Competitive Advantage (CA)	Organizational Performance (OP)	.379**
** Correlation is significant at .01 level			

CHAPTER 6: CAUSAL MODEL AND HYPOTHESES TESTING

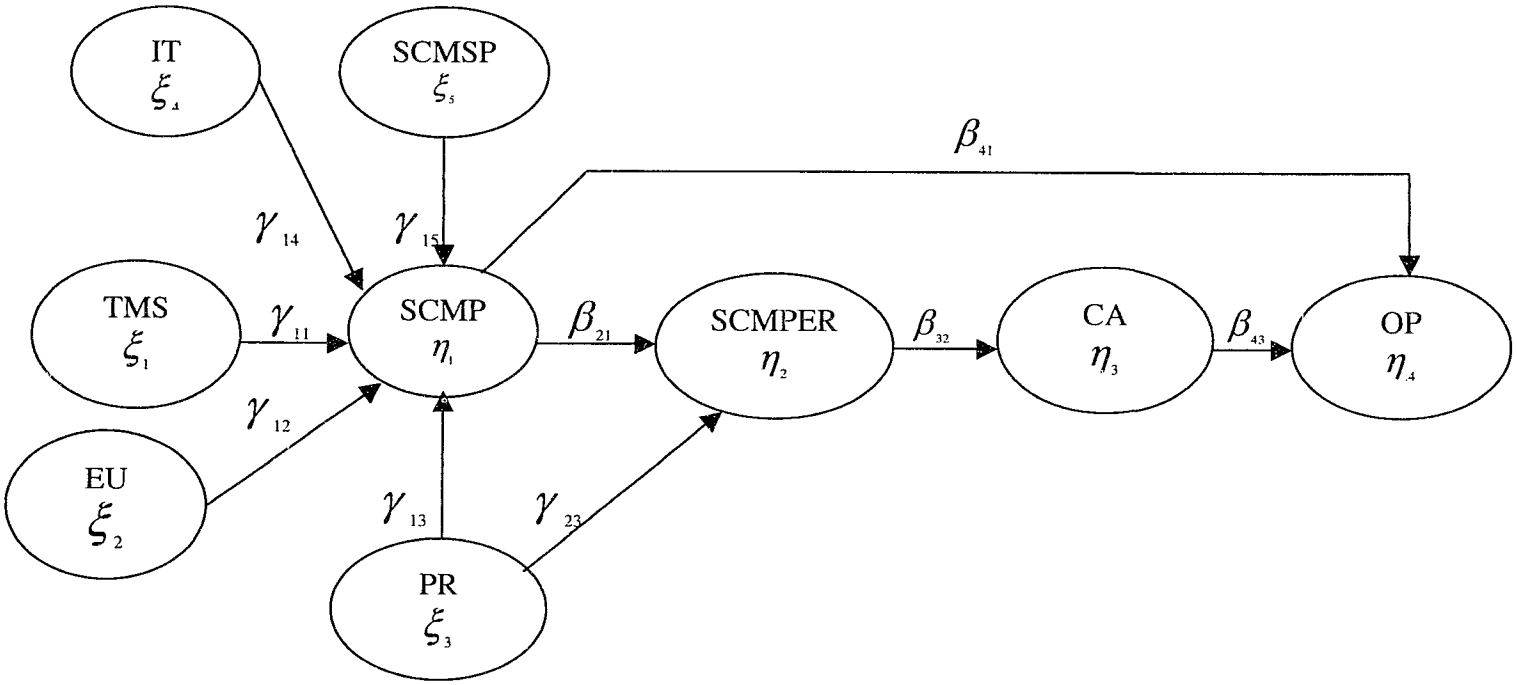
Although the bivariate correlations are statistically significant for most pairs of the constructs considered for the hypotheses (9 out of 10), we still need to explore the significance of these hypothesized relationships when all the relationships are put together in a multivariate complex model due to the interactions among variables. A rigorous hypotheses testing can be done by structural equation modeling (SEM) framework (Joreskog and Sorbom, 1989).

The standard SEM is composed of two parts- the *measurement* model (a sub-model in SEM that specifies the indicators of each construct and assesses the reliability of each construct for later use in estimating the causal relationships) and the *structural* model (the set of dependent relationships linking the model constructs). Since the measurement properties of each construct in the current study have already been evaluated through rigorous validity and reliability analysis, the SEM model described in this chapter will focus on path analysis using the LISREL software. The significance of each path in the proposed structural model will be tested and the overall goodness-of-fit of the entire structural equation model will be assessed as well.

6. 1 The Proposed Structural Model

The proposed structural model depicted in Figure 6.1 is a replication of the framework presented in Figure 3.2 using the mathematical notation in the structural

Figure 6.1.1 Proposed Structural Equation Model



TMS: Top Management Support for SCM
EU: Environmental Uncertainty
PR: Partner Relationship
IT: Usage of IT Tools
SCMSP: SCM Strategy Process
SCMP: SCM Practice
SCMPER: SCMP Performance
CA: Competitive Advantage
OP: Organizational Performance

equation model. There are nine variables in the model: Top Management Support for SCM (TMS) -ξ_1, Environmental Uncertainty (EU)-ξ_2, Partner Relationship (PR)- ξ_3, Usage of IT Tools (IT)- ξ_4, SCM Strategy Process (SCMSP)- ξ_5, SCM Practice (SCMP)- η_1, SCM Performance (SCMPER)- η_2, Competitive Advantage (CA)- η_3, and Organizational Performance (OP)- η_4. TMS, EU, PR, IT, and SCMSP are regarded as independent (exogenous) variables, and all others are dependent (endogenous) variables.

The general structural equation model relating the above latent exogenous and endogenous variables is

$$\eta = \beta\,\eta + \tau\,\xi + \varsigma$$

where η is a (4×1) vector of latent endogenous variables; ξ is a (5×1) vector of the latent exogenous variable; τ (gamma) is a (4×5) vector of coefficients relating the 5 exogenous variables to 4 endogenous variables; β is a (4×4) matrix of coefficients of relating the 4 endogenous variables to one another. ς is a (4×1) vector of errors in the structural equations.

The 10 hypotheses proposed in Chapter 3 are represented by the 10 causal relationships in the model. Hypothesis 1a is represented in Figure 6.1 by the relationship γ_{11}(TMS→ SCMP); Hypothesis 1b is represented by the relationship γ_{12} (EU→ SCMP), Hypothesis 2 is represented by the relationship γ_{13} (PR→ SCMP); Hypothesis 3 is represented by the relationship γ_{23} (PR→ OP); Hypothesis 4 is represented by the

relationship γ_{14} (IT→ SCMP); Hypothesis 5 is represented by the relationship γ_{15} (SCMSP→SCMP); Hypothesis 6 is represented by the relationship β_{21} (SCMP→SCMPER); Hypothesis 7 is represented by the relationship β_{41} (SCMP→OP), Hypothesis 8 is represented by the relationship β_{32} (SCMPER→CA); and Hypothesis 9 is represented by the relationship β_{43} (CA→OP).

The research model presented in Chapter 3 postulated: SCM practice is related to top management support, environmental uncertainty, partner relationship, usage of IT tools, and SCM strategy process (causal path represented in the structural equation 1 below); SCM performance is related to partner relationship and SCM practice (causal path represented in the structural equation 2 below); competitive advantage is related to SCM performance (causal path represented in the structural equation 3 below); and organizational performance is related to SCM practice and competitive advantage (causal path represented in the structural equation 4 below).

$$\eta_1 = \gamma_{11}\xi_1 + \gamma_{12}\xi_2 + \gamma_{13}\xi_3 + \gamma_{14}\xi_4 + \gamma_{15}\xi_5 + \zeta_1 \quad (1)$$

$$\eta_2 = \gamma_{23}\xi_3 + \beta_{21}\eta_1 + \zeta_2 \quad (2)$$

$$\eta_3 = \beta_{32}\eta_2 + \zeta_3 \quad (3)$$

$$\eta_4 = \beta_{41}\eta_1 + \beta_{43}\eta_3 + \zeta_4 \quad (4)$$

To assess the fit of the hypothesized model to the data, various fit indices can be used, which include Chi-square, GFI, AGFI, CFI, NFI, and RMSR. As described in the previous chapter, the first four indices (GFI, AGFI, CFI, and NFI) in the range of .80-.89 represent reasonable fit; scores of .90 or higher are considered as evidence of good fit.

RMSR values range from 0 to 1, with smaller values indicating a better model; values below .05 signify good fit.

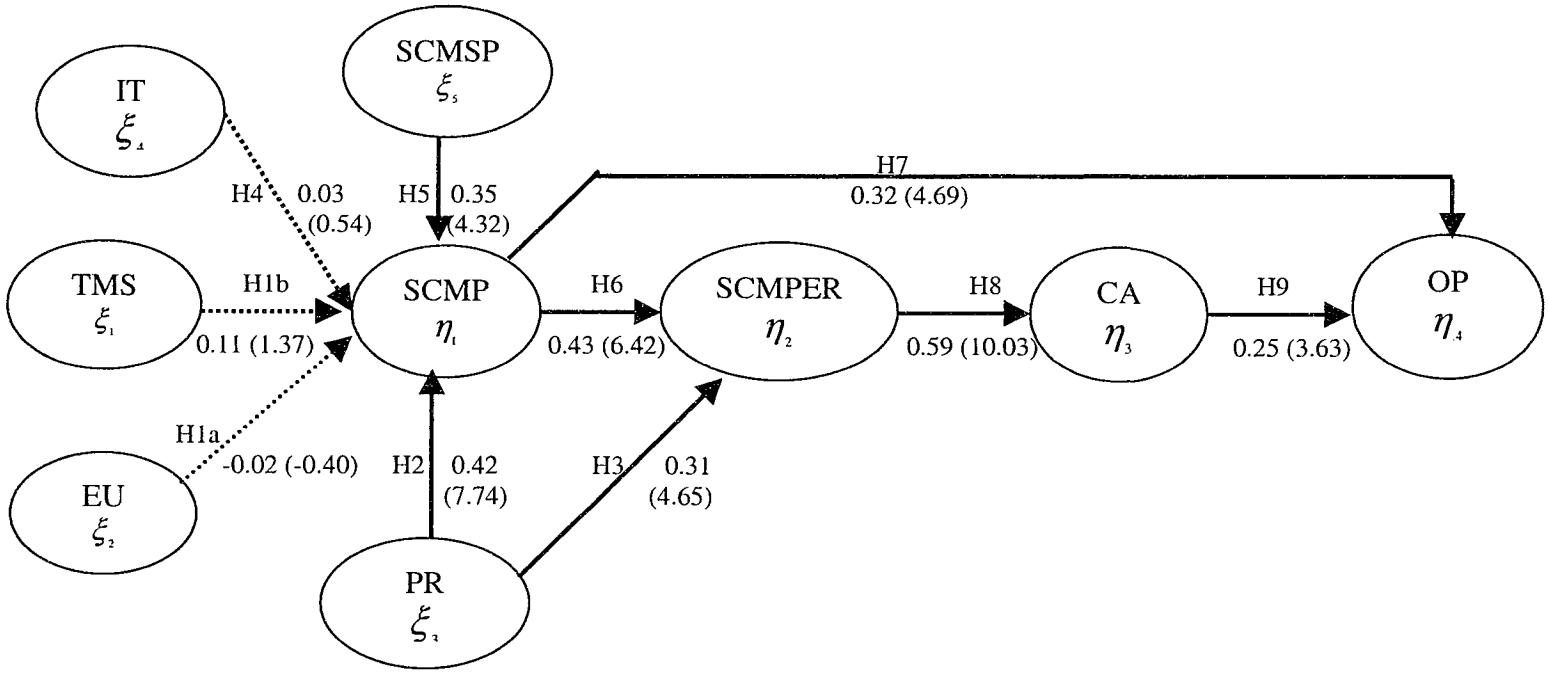
If the model fits the data adequately, the magnitudes and t-values of the gamma (γ) and beta (β) coefficients will be evaluated to test the hypotheses. Using one-tailed test, a t-value greater than 2.33 is significant at the level of 0.01; and a t-value greater than 1.65 is significant at 0.05; and a t-value of 1.28 is significant at the level of 0.10.

6.2 Structural Equation Model Results Using LISREL

Figure 6.2.1 displays the path diagram resulting from the structural modeling analysis using LISREL. The model fit measures are: GFI= .96, AGFI= .88, NFI= .94, and RMSR=.027. GFI and NFI are above the recommended value of .90; RMSR is below the suggested maximum value of .05; only the AGFI is slightly below the recommended .90 level. These results indicate good fit of the proposed model to the data.

The findings for the structural equation model are presented in Table 6.2.1. Out of the 10 hypothesized relationships, 7 were found to be significant at the 0.01 level. These hypotheses include H2 (direct impact of partner relationship on SCM practice), H3 (direct impact of partner relationship on SCM performance), H5 (direct impact of SCM strategy process on SCM practice), H6 (direct impact of SCM practice on SCM performance), H7 (direct impact of SCM practice on organizational performance), H8 (direct impact of SCM performance on competitive advantage), and H9 (direct impact of competitive advantage on organizational performance). The t-values for H1a, H1b, and H4 are –0.40, 1.37 and 0.54, respectively, which is not significant even at the .10 level.

Figure 6.2.1 Results- Structural Equation Model



Note: Bold lines are for significant paths; dashed lines indicate insignificant paths; t-values are in parentheses.

TMS: Top Management Support for SCM
EU: Environmental Uncertainty
PR: Partner Relationship
IT: Usage of IT Tools
SCMSP: SCM Strategy Process
SCMP: SCM Practice
SCMPER: SCMP Performance
CA: Competitive Advantage
OP: Organizational Performance

Model Fit Indices:

GFI=.96
AGFI=.88
NFI=. 94
RMSR=.027

Table 6.2.1 Results for Proposed Structural Equation Model

Hypothesis	Relationship	Total Effects	Direct Effects	Indirect Effects	Hypothesis
H1a	EU→ SCMP	-0.02 (-0.40)	-0.02 (-0.40)		*Not Supported*
H1b	TMS→ SCMP	0.11(1.37)	0.11(1.37)		*Not Supported*
H2	PR→ SCMP	.42 **(7.74)	.42 **(7.74)		**Supported**
H3	PR→ SCMPER	0.51** (8.49)	.31** (4.65)	0.19** (5.12)	**Supported**
H4	IT→SCMP	0.03 (0.54)	0.03 (0.54)		*Not Supported*
H5	SCMSP→ SCMP	0.35** (4.32)	0.35** (4.32)		**Supported**
H6	SCMP→SCMPER	0.43** (6.42)	0.43** (6.42)		**Supported**
H7	SCMP→ OP	0.38** (5.82)	0.32** (4.69)	0.06** (3.05)	**Supported**
H8	SCMPER→ CA	0.59** (10.03)	0.59** (10.03)		**Supported**
H9	CA→OP	0.25** (3.63)	0.25** (3.63)		**Supported**
GFI=.96 AGFI=.88 NFI=.94 RMSR= 0.027					

Note: * significant at α <0.05, ** significant at α <0.01 (one-tailed test). t-values are in parentheses.

The results indicate that there are no significant, direct relationships between environmental uncertainty and SCM practice, top management support and SCM practice, or between the usage of IT tools and SCM practice.

Among the seven significant relationships, the top three standardized coefficients are .59 (SCM performance to competitive advantage), .43 (SCM practice to SCM performance), and .42 (partner relationship to SCM practice). Therefore, the path (partner relationship→SCM practice→ SCM performance→ competitive advantage) represents strongest link in the proposed model. It can be concluded that effective partner the relationship will greatly lead to improved SCM practice, which will in turn lead to improved SCM performance. Improved SCM performance will indeed enhance an organization's competitive advantage.

On the other hand, the bottom three standardized coefficients are .25 (competitive advantage to organizational performance), .31 (partner relationship to SCM performance), and .32 (SCM performance to organizational performance). This indicates even though the impact of SCM performance and competitive advantage on organizational performance are statistically significant, the strengths of these impacts are relatively weak. This could be true since organizational performance is usually influenced by many factors and it is hard to see whether any one factor will dominantly determine the overall performance of an organization.

6.2.1 Hypotheses with Direct and Indirect Effects

The hypotheses with direct effects are already discussed. A closer look at the hypotheses with both direct and indirect effects is needed. It can be seen from Table 6.2.1

that partner relationship has an indirect, significant influence on SCM performance through SCM practice. The coefficients of the indirect effect and total effect are 0.19 (t-value=5.12) and 0.51 (8.49) respectively. Both effects are significant at 0.01 level. This indicates that partner relationship has a direct, positive influence on SCM performance and also an indirect one through SCM practice.

Table 6.2.1 also shows that SCM practice has an indirect significant influence on organizational performance through SCM performance and competitive advantage. The coefficients of the indirect effect and total effect are 0.06 (t-value=3.05) and 0.38 (5.82) respectively. Both effects are significant at 0.01 level. Comparing the direct effect (β=0.32) with the indirect effect (β=0.06), it can be seen that the direct effect plays a larger role in this relationship. In other words, the SCM practice can directly impact organizational performance.

6.3 Discussion of Structural Equation Model and Hypotheses Testing Results

The previous section reported the LISREL structural modeling and hypotheses testing results on the proposed model. To summarize, 7 out of 10 of the hypothesized relationships were significant at the 0.01 level and the final LISREL structural model displayed very good fit to the data.

However, statistical significance and model fit are not ultimate objectives of academic research. They are just the means to achieve the end, which is better understanding of the subject under investigation and discovery of new relationships. The results from this research can be used not only by academicians in further exploring and testing causal linkages in SCM, but also by practitioners for guiding the implementation

of SCM practice and the evaluation of SCM performance. This section will discuss the theoretical and practical implications of the test of each hypothesis.

Hypothesis 1a: *The higher the level of environmental uncertainty, the higher the level of SCM practices.*

This relationship was found to be non significant (γ=-0.02, t= -0.40), which indicates that there is no direct, positive relationship between environmental uncertainty and SCM practice. This non-significant relationship may be explained by the following: First, as today's competition is no longer between organizations but among supply chains, SCM practice has become a common practice for organizations regardless of their environmental conditions (Spekman et al., 1998a; O'Connell, 1999), thus, the effect of environmental uncertainty on SCM practice may not be significant. Second, organizations may have implemented SCM voluntarily, not out of the pressure from the external environment, but by the motivation for improving organizational performance and gaining competitive advantage. For example, the study of Premkumar and Ramamurthy (1995) find that an organization based on certain internal and external motivations proactively initiates the action for adopting an inter-organizational system (to share information) with its trading partners. Hall (1999) agrees that a fundamental reason for organizations to enter into strategic supplier partnership is to create new distinctive capabilities from current capabilities. Therefore, an organization in a stable environment may have a high level of SCM practice. It is also possible that the environmental uncertainty measures may not be adequate for SCM research. Future research may need to consider environmental uncertainty at the supply chain level, not just at the individual organization level.

Hypothesis 1b: *The higher the level of top management support for SCM, the higher the level of SCM practice.*

This relationship is found to be non-significant (γ=0.11, t=1.37). This indicates that top management support has no direct positive influence on SCM practices. This may be explained by the role of top management. Top management is usually involved in strategic issues of SCM and thus may not have a direct impact on actual implementation of SCM. On the other hand, this result shows that top management support is not enough for reaching a higher level of SCM practice and should be accompanied by other facilitating factors.

Hypothesis 2: *The higher the level of partner relationship, the higher the level of SCM practice.*

This relationship is found to be significant (γ=0.42, t=7.74). This result confirms the critical role of partner relationship in effective SCM implementation. As already pointed out in the literature, the biggest challenge for SCM implementation is people issues, not technology issues since no amount of expensive software can compensate for flawed human thinking. Effective implementation of different SCM practices will need the existence of trust, commitment, and shared vision between trading partners. Partner relationship built on these attributes will be conducive for an organization to implement different SCM practices such as strategic supplier partnership, customer relation building, information sharing, information quality, lean system, and postponement.

Hypothesis 3: *The higher the level of partner relationship, the higher the level of SCM performance.*

This relationship is found to be significant (γ=0.31, t=4.65). It demonstrates that partner relationship affects not only SCM practice but also SCM performance directly. This hypothesis has been proposed in previous literature (Poirier, 1997; Lambert and Cooper, 2000; Mason-Jones and Towill, 1997; Sheridan, 1998) but has not been empirically tested. The significance of Hypothesis 3 empirically confirmed that good partner relationship could indeed improve the performance of SCM. On the other hand, the results also show that partner relationship also indirectly influences SCM performance through SCM practice.

The significance of Hypotheses 2 and 3, together with indirect influence discussed above, jointly explains the critical role of partner relationship in implementing SCM practice and improving SCM performance. However, when implementing SCM, practitioners tend to place excessive emphasis upon the issues of information technology, but not enough attention upon people-related barriers (Burgess, 1998). The empirical results of this study demonstrate to the managers, that obtaining favorable results from SCM is based on building the effective relationship with trading partners.

Hypothesis 4: *The higher the usage of IT tools, the higher the level of SCM practice.*

This relationship is found to be non significant (γ=0.03, t=0.54), which indicates that the usage of IT tools has no direct positive influence on SCM practice. This sounds surprising at first since the role of IT in SCM practice has been widely recognized in the

literature. The following reasons may provide the rationale for this finding. First, the higher level of IT usage may not necessarily result in a higher level of SCM practice, since it is not the level of IT usage, but how IT is used (furthermore, how IT is aligned with business strategy) that will finally affect the implementation of SCM practices. Second, as suggested by many researchers (Sheridan, 1998; Wright, 2001; Burgess, 1998) and the significances of Hypotheses 2 and 3, IT is only part of the solution to effective SCM implementation. To achieve a high level of SCM practice, the usage of IT must be accompanied by other factors, such as good partner relationship and effective SCM strategy process.

Hypothesis 5: *The more effective the SCM strategy process, the higher the level of SCM practice.*

The relationship is found to be significant (γ=0.35, t=4.32). This finding is important since the SCM strategy has received the least attention by the practitioners (Tamas, 2000). The focus on SCM issues is rarely strategic but rather primarily operational (Stevens, 1990). This finding reveals the critical role of effective SCM strategy process in the implementation of SCM practice. As mentioned in Chapter 3, SCM practice provides a framework within which to implement a well-conceived SCM strategy, but cannot undo the effects of a poorly conceived one. Moreover, the influence of top management support and usage of IT tools on SCM practice can be only achieved through SCM strategy process. Therefore, if organizations want to implement SCM effectively, it will be necessary for them to be aware of the importance of setting up an effective SCM strategy process, such as aligning SCM strategy with business strategy,

having a regular system for monitoring SCM performance, communicating the objectives and strategies of SCM to all employees, and so on.

Hypothesis 6: *The higher the level of SCM practice, the higher the level of SCM performance.*

The relationship is found to be significant (β=0.43, t=6.42). It empirically confirms the theoretical notion that a well-managed and well-executed supply chain directly leads to improved SCM performance. The previous literature usually link SCM practice directly to organizational performance (Shin et al., 2000; Narasimhan and Jayaram, 1998; Tan et al., 1998) without explicitly considering any intermediate variable such as SCM performance and competitive advantage. The results show that there exists an immediate impact of SCM practice on the performance of SCM.

Hypothesis 7: *The higher the level of SCM practice, the higher the level of organizational performance.*

The relationship is found to be significant (β=0.32, t=4.69). This finding is important because there exists doubt among the researchers and practitioners about the economic justification of SCM practice. The statistical significance of Hypothesis 7 confirms that SCM practice, indeed, has a bottom-line influence on the organizational performance. The implementation of SCM will directly improve an organization's financial and marketing performances in the long run. The results also show that SCM practice has a significant, indirect influence on organizational performance through SCM performance and competitive advantage.

Combining the results of Hypothesis 6 and 7 shows that SCM practice influences directly not only SCM performance but also organizational performance. However, the strengths of these two impacts are different as indicated by the standardized coefficients. SCM practice has a stronger direct, influence on SCM performance (β=0.43) than on organizational performance (β=0.32).

Hypothesis 8: *The higher the level of SCM performance, the higher the level of competitive advantage.*

The relationship is found to be significant (β=0.59, t=10.03). This finding empirically confirms the assertion in the literature that good SCM performance could provide an organization with competitive advantage. The successful SCM implementation will improve the organization's performance on cost, quality, dependability, flexibility, and time-to-market, and give the organization a defensible position over its competitors through coordination of inter-organizational activities along the supply chain.

Hypothesis 9: *The higher the level of competitive advantage, the higher the level of organizational performance.*

The relationship is found to be statistically significant (β=0.25, t=3.63) and it establishes the direct relationship between competitive advantage and organizational performance. This finding is also supported by Zhang's study (2001), which shows a strong causal relationship between competitive advantage and customer satisfaction and financial performance. Therefore, it can be concluded that competitive advantage will

affect an organization's overall performance, such as market share, sales growth, profit margin, and so on.

6.4 Modified Structural Equation Model Results

In search for an alternative model, a two-step approach recommended by Anderson and Gerbing (1998) was followed. The first step used confirmatory factor analysis (CFA) to develop an acceptable structural or measurement model. Estimation of the initial structural model showed that although the model fit indices were generally good in the initial model, no significant direct links from environmental uncertainty to SCM practice, from top management support to SCM practice, or from the usage of IT tools to SCM practice are found. This may be caused by the measurement problems or the wrong specification of the relationships.

Careful examination of the constructs finds that environmental uncertainty may not be a relevant construct in this model. As pointed out previously, SCM has become a common practice to survive global competition and to obtain competitive advantage; the organizations have adopted SCM practice regardless of their environmental condition. On the other hand, the uncertainty from customers and suppliers can be reduced or even eliminated by implementing various SCM practices, such as strategic supplier partnership and long-term customer relations. Thus, a higher level of SCM practice will be associated with a lower level of environmental uncertainty, if measured by customer and supplier uncertainty. Therefore, the direct impact of environmental uncertainty on SCM practice may not be statistically significant. Moreover, we faced some measurement problems of the environmental uncertainty. As pointed out earlier in Chapter 5, environmental

uncertainty originally consisted of 4 sub-constructs (customer uncertainty, supplier uncertainty, competitor uncertainty, and technology uncertainty). In the process of item purification, CITCs of all items under competitor uncertainty are much below .50, and the reliability of this sub-construct is only .49, therefore, this sub-construct was dropped at that stage. Moreover, 2 items (out of 4) for customer uncertainty were also dropped at the purification stage, which left 2 items for later analysis. Although single-item, or two- tem scales, are not uncommon to measure constructs accurately or completely, it is usually recommended to use at least 3 items for a construct. As such it is felt that the proposed scales for the measurements of environmental uncertainty need further clarification and development. Therefore, it was decided to drop the environmental uncertainty construct from model re-specification.

After dropping the environmental uncertainty construct from the original model, the model was rerun and the modification indices provided by the LISREL were checked. Moreover, the underlying theoretical concepts were examined to determine the reasonableness of the modifications. Two interesting new paths not proposed in the original model were found. The new paths were: **Path 1**: the direct positive impact of top management support (TMS) on SCM strategy process (SCMSP), and **Path 2:** the direct positive impact of usage of IT Tools (IT) on SCM strategy process (SCMSP). In other words, although the direct effects of TMS and IT on SCM practice (SCMP) (H1b, H4) are not significant, they indirectly affect SCMP through SCMSP.

After adding these two new paths, the structural model was assessed again using LISREL. The final results are presented in Figure 6.4.1 and Table 6.4.1. All relationships had a t-value of greater than 2.0 and were significant at the .05 level. The model fit

indices had also improved. AGFI had improved from .88 to .89. GFI, AGFI, and NFI were all above 0.90. RMSR (0.035) was far below the maximum .05 level. These results indicate good fit of the modified model to the data.

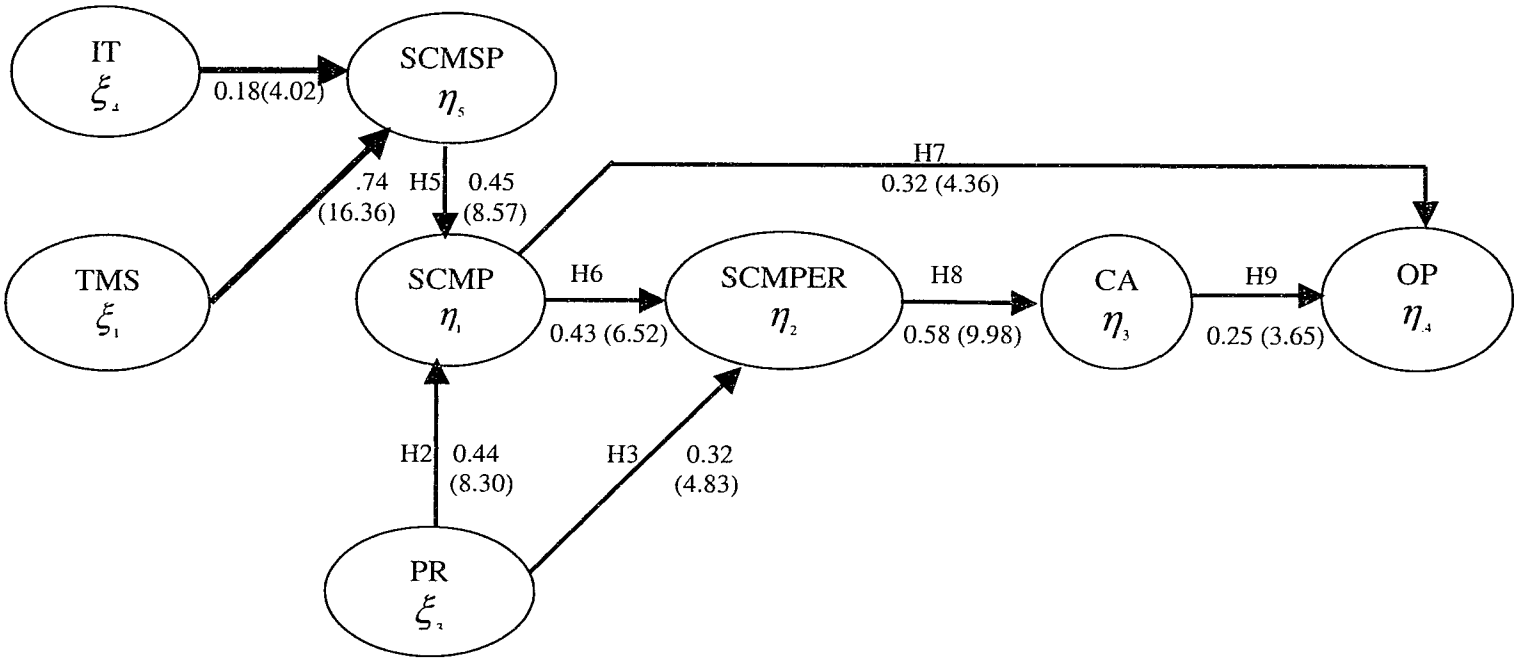
It can be seen that the relationship from top management support to SCM strategy process has a standardized coefficient of .74, representing the highest one in the modified model. This signifies the critical role of top management in supporting the SCM strategy process. While the relationship between usage of IT tools and SCM strategy process has the lowest standardized coefficient of .18, indicating that the strengths of this relationship is not as strong as that of the other links. The implications and theoretical justification of these two new relationships will be provided below.

6.4.1 Discussion of the New Paths

Path 1: *The indirect influence of top management support on SCM practice through SCM strategy process.*

The results did not support the original hypothesis that top management support directly impact SCM practices. Using a two-tailed test, we could also infer that there was no significant association of top management support and SCM practice. However, an indirect path between these two constructs through SCM strategy process is found. That is, top management support affects SCM practice indirectly through SCM strategy process. This finding again supports our previous assertion that the role of top management in the implementation of SCM is strategic but not operational. Instead of involving day-to-day execution of SCM, the main responsibilities of top management will be focused on forming SCM strategy, setting up measures for SCM, making sure

Figure 6.4.1 Results- Revised Structural Equation Model



Note: Bold lines are for paths; t-values are in parentheses.

TMS: Top Management Support for SCM
EU: Environmental Uncertainty
PR: Partner Relationship
IT: Usage of IT Tools
SCMSP: SCM Strategy Process
SCMP: SCM Practice
SCMPER: SCMP Performance
CA: Competitive Advantage
OP: Organizational Performance

Model Fit Indices:

GFI=.95
AGFI=.89
NFI=. 94
RMSR=.035

Table 6.4.1 Results for Revised Structural Equation Model

Hypothesis	Relationship	Total Effects	Direct Effects	Indirect Effects	Hypothesis
New path 1	TMS→ SCMSP	0.74** (16.36)	0.74** (16.36)		**Supported**
H2	PR→ SCMP	0.44** (8.30)	0.44** (8.30)		**Supported**
H3	PR→ SCMPER	0.51** (8.51)	0.32** (4.83)	0.19** (5.13)	**Supported**
New path 2	IT→SCMSP	0.18** (4.02)	0.18** (4.02)		**Supported**
H5	SCMSP→ SCMP	0.45** (8.57)	0.45** (8.57)		**Supported**
H6	SCMP→SCMPER	0.43** (6.52)	0.43** (6.52)		**Supported**
H7	SCMP→ OP	0.38** (5.80)	0.32** (4.63)	0.06** (3.03)	**Supported**
H8	SCMPER→ CA	0.58** (9.98)	0.58** (9.98)		**Supported**
H9	CA→OP	0.25** (3.65)	0.25** (3.65)		**Supported**
GFI=.95 AGFI=.89 NFI=.94 RMSR= 0.035					

Note: * significant at α <0.05, ** significant at α <0.01 (one-tailed test). t-values are in parentheses.

SCM strategy align with business strategy, and providing necessary resources for SCM implementation. Through overall vision and guidance of top management, SCM practice could be adopted and implemented effectively in an organization.

Path 2: *The indirect influence of usage of IT tools on SCM practice through SCM strategy process.*

The findings did not support the original hypothesis that usage of IT tools has a positive influence on SCM practice. Using a two-tailed test, we could also infer that there was no significant association of the usage of IT tools and SCM practice. On the other hand, an indirect path between usage of IT tools and SCM practice was found through SCM strategy process. That is, the usage of IT tools influences SCM practice indirectly through SCM strategy process. The direct relationship between usage of IT tools and SCM strategy process indicates that IT can affect directly how SCM strategy is aligned and implemented in an organization. As pointed out earlier in this research, the use of IT has been considered a major indicator of SCM best practices and will, therefore, enhance the effectiveness of SCM strategy process and competitive advantage derived from SCM. In addition, IT can be used to monitor SCM practice and performance and communicate objectives and strategies of SCM to all concerned employees, thus leading to a more effective process of implementing SCM strategy.

6.5 Summary of Results

Overall, the results indicates that higher levels of SCM practice will lead to improved SCM performance, and improved SCM performance will enhance competitive advantage and finally organizational performance. The results also show that

organizational performance is not only influenced directly by SCM practice, but also indirectly through SCM performance and competitive advantage. Moreover, the findings reveal that effective SCM strategy process will facilitate SCM practice, and good partner relationship not only is critical to the implementation of SCM, but also influence the performance of SCM as well. However, the findings did not support the direct impact of environmental uncertainty, top management support, and usage of IT tools on SCM practice. The impact of top management support and usage of IT tools on SCM practice seems to be indirect rather than direct.

The next chapter will conclude with the summary of research findings and major contributions, implications for managers, limitations of the research, and recommendations for future research.

CHAPTER 7. SUMMARY AND RECOMMENDATIONS FOR FUTURE RESEARCH

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

7.1 Summary

The current research represents one of the first large-scale empirical efforts to systemically investigate the complex causal relationships in the supply chain management. It aims to answer the following important questions: 1) what are the key dimensions of SCM practice, 2) how to measure and further compare the SCM performance, and 3) what factors influence the SCM practice. As we have mentioned in the introduction, there is no clear definition of constructs and conceptual frameworks on SCM in the current literature and most of empirical research mainly focuses on the upstream or the downstream side of SCM independently, with a heavy emphasis on the upstream side. Few studies have empirically considered both upstream and downstream sides of the supply chain simultaneously. The integrated model developed here considers the whole (internal and external) supply chain, explores the antecedents and consequences of SCM, and represents an attempt to build a theoretical framework in the area of SCM research. Based on the data collected from 196 purchasing/manufacturing/materials managers, the model is tested using structural

equation modeling methodology. The study contributes to our knowledge of SCM in a number of ways.

First, this research provided a theoretical framework that identified the salient dimensions of SCM, including environmental uncertainty, top management support, partner relationship, usage of IT tools, SCM strategy process, SCM practice, SCM performance, competitive advantage, and organizational performance. This framework provides a foundation for future research. In the future, more constructs may be added to complement the nomological network of constructs.

Second, the study provides valid and reliable measurements for the following four constructs: 1) SCM practice, 2) SCM performance, 3) SCM strategy process, and 4) partner relationship. All the scales have been tested through rigorous statistical methodology including purification, factorial validity, unidimensionality, reliability, and the validation of second-order construct. All the scales are shown to meet the requirements for reliability and validity and thus, can be used in future research. Such valid and reliable scales have been otherwise lacking in the literature of empirical SCM research. The development of these measurements will greatly stimulate and facilitate the theory development in this field.

Third, this study provides supporting evidence to the conceptual and prescriptive literature about previously untested statements regarding the impacts of SCM practice. The results demonstrate that a higher level of SCM practice will lead to a higher level of SCM performance, further enhanced competitive advantage and better organizational performance. As discussed in Chapter 2, the theories of industrial organization and transaction cost analysis, political economy, and competitive strategy all provide the

rationale for the implementation of SCM. The results of this study further provide the empirical support for above justifications. It can be concluded that SCM is a very effective form of organizing in today's competing environmental and will provide sustainable competitive advantage for the organizations.

Fourth, the results highlight the critical role of partner relationship in facilitating SCM practices and improving SCM performance. Effective partner relationship will directly lead to a higher level of SCM practice. Moreover, partner relationship will influence SCM performance directly and indirectly through SCM practice. This is a very valuable finding since partner relationship has received the least attention in the organization.

Fifth, the research reveals the nature of the influence of top management support and usage of IT tools on SCM practice. The research did not support the original hypotheses, that is, there is the direct impact of top management support and usage of IT tools on SCM practice. However, an interesting finding was that top management support and usage of IT tools indirectly influence SCM practice through SCM strategy process. The nature of these relationships appears to be indirect rather than direct. The empirical findings on these relationships added significantly to the current body of knowledge in SCM field. It shows that the role of top management in the implementation of SCM is strategic, but not operational. Top management will be mainly responsible for SCM strategy process, that is, how SCM strategy is aligned and implemented. Through the support for SCM strategy process, top management will have influence indirectly on the implementation of SCM. Moreover, the indirect influence of usage of IT tools on SCM practice demonstrates that the higher level of usage of IT alone will not necessarily result

in the higher level of SCM practice, if not accompanied by other factors, such as good partner relationship and effective SCM strategy process.

Overall, the findings verify the strategic role of SCM for an organization's survival in today's competing business environments. The implementation of various SCM practices will lead to improved SCM performance, enhanced competitive advantage, and further increased organizational performance. The findings also indicate the significant role of partner relationship and SCM strategy process for the implementation of SCM practice. Among the five hypothesized independent variables (environmental uncertainty, top management support, usage of IT tools, partner relationship, and SCM strategy process), only two variables appear to have a strong direct relationship with SCM practice. The impact of top management support and usage of IT tools on SCM practice turned out to be indirect through SCM strategy process.

This seems to indicate that merely having top management support and usage of IT tools appears to be insufficient for organizations to implement various SCM practices. Until an organization has established good partner relationship built on trust, commitment, and shared vision and has had an effective SCM strategy process fully aligned with business strategy, organizations would be less inclined to adopt different SCM practices, such as strategic supplier partnership, customer relationship practice, lean system, and postponement. Also, organizations already having good partner relationship and effective SCM strategy process would more readily implement various SCM practices, although the degree of top management support and the usage of IT tools in their organizations may vary.

7.2 Implication for practitioners

The results of this study have several important implications for practitioners. First, as today's competition is moving from among organizations to between supply chains, more and more organizations are increasingly adopting SCM practice, in the hope for reducing SCM cost and securing competitive advantage. But there exist doubts about the potential benefits from SCM. The findings of this research assure the practitioners that SCM is an effective way of competing, and the implementation of SCM practice does have strong impact on competitive advantage and organizational performance.

Second, the research identifies the key dimensions of SCM practices that an organization can adopt. Just as pointed out by Monczka and Morgan (1997), SCM has been poorly defined and there is a high degree of variability in people's mind about its meaning. Many organizations still tend to consider SCM as being the same as integrated logistics management (van Hoek, 1998; Alvarado and Kotzab, 2001) or as a synonym of supplier management (Lamming, 1996; Banfield, 1999). Even though organizations have realized the importance of implementing SCM, they often do not know exactly what to implement, or just focus on part of SCM practice issues. The findings demonstrate to the practitioners that SCM practice should focus on building strategic supplier partnership, improving customer relationship, sharing high-quality information with trading partners, and implementing lean system and postponement strategy.

Third, the study provides a set of valid and reliable measurements for evaluating an organization's level of SCM performance, and further benchmarking and comparing SCM performance across different organizations. Although there are numerous studies discussing the measurement of SCM, they either are oriented towards economic metrics,

internal function, or just focuses on certain dimensions of SCM performance. The measurements developed in this research capture the different aspects (including tangible and intangible factors) of SCM performance, and, thus, can be considered a better measure for SCM performance. These measures can be used by practitioners not only to evaluate the immediate outcome of their SCM practice, but also to understand the impacts of SCM performance on competitive advantage and organizational performance.

Fourth, the findings identify the facilitating factors (top management support, usage of IT tools, partner relationship, and SCM strategy process) for the implementation of SCM. The findings also highlight the importance of building partner relationship in facilitating SCM practice and improving SCM performance. Although organizations have tended to focus on the applications of IT on SCM, they have not given enough attention to the development of partner relationship. This phenomenon may reflect the nature of IT and partner relationship. Compared with partner relationship, IT can be more easily implemented, and its benefits are more tangible and measurable. While the establishment of good partner relationship (such as trust, commitment, and shared vision) is much more difficult and time-consuming than the installation of SCM software, its impact on overall performance is mostly invisible. The results of this study demonstrate to the practitioners that to achieve higher levels of SCM practice and performance, good partner relationship is a must. Therefore, it would be worthwhile for organizations that are contemplating the adoption of SCM practices to spend time and effort to build good relationships with their supply chain partners.

7.3 Limitations of the Research

While the current research made significant contributions from both a theoretical and practical point of view, it also has some limitations, which are described below.

First, environmental uncertainty construct in this research suffered from measurement issues. Because of this limitation, we were not able to verify the impact of environmental uncertainty on SCM practice. There is a need to revise this construct from the measurement angle and then explore the relationship between this construct and SCM practice.

Second, because of the limited number of observations (196), the revalidation of constructs was not carried out in this research. Lack of systematic confirmatory research, impedes general agreement on the use of instrument. This needs to be addressed in future research.

Third, in this research, single respondent (purchasing, manufacturing, or materials managers) in an organization was asked to respond to complex SCM issues dealing with all the participants along the supply chain, including upstream suppliers and downstream customers. But no person in an organization is in charge of the entire supply chain: for example, purchasing managers are mainly responsible for purchasing and supply side, and may be not in an appropriate position to answer the customer-related questions; and the main area of manufacturing managers is production and they may not have enough knowledge of their suppliers and customers. Therefore, the use of single respondent may generate some measurement inaccuracy.

Fourth, because of time limitation and to keep the model at a manageable size, this research did not consider the factors inhibiting the implementation of SCM. The

impact of interdependence of the partners (Ganesan, 1994; Mentzer et al., 2000), channel conflict (Monczka et al., 1998; Mentzer et al., 2000), power (Gaski, 1984) and organizational/national culture on partnership and inter-organizational relationships may inhibit implementation of SCM (Lee and Kim, 1999; Clark and Lee, 2000). There are important issues to be addressed.

7.4 Recommendations for Future Research

The limitations discussed above and careful considerations of the research potentials lead to some interesting directions for future research. These can be largely categorized into measurement issues and structural issues.

7.4.1 Measurement Issues

First, better construct definition and measurement items should be developed for environmental uncertainty construct. As pointed out previously, environmental uncertainty suffered from measurement issues in this study and may not be appropriate for SCM research. Future research should attempt to verify this understanding by developing better definition and sub-dimensions for this construct. A possible solution may be to measure environmental uncertainty from the supply chain level, not just from the level of individual organization.

Second, since the usefulness of a measurement scale comes from its generalizability, future research should revalidate measurement scales developed through this research by the similar reference populations.

Third, future research should conduct factorial invariance tests. Generalizability of measurement scales can further be supported by factorial invariance tests. Using the instruments developed in this research, one may test for factorial invariance across industries, across different organization size, and across organizations with different supply chain structure (such as supply chain length, organization's position in the supply chain, channel structure, and so on).

Fourth, future research should apply multiple methods of obtaining data. The use of single respondent to represent what are supposed to be intra/inter-organization wide variables may generate some inaccuracy, more than the usual amount of random error (Koufteros, 1995). Future research should seek to utilize multiple respondents from each participating organization as an effort to enhance reliability of research findings. Once a construct is measured with multiple methods, random error and method variance may be assessed using a multitrait-multimethod approach.

7.4.2 Structural Issues

First, future research can hypothesize and test the direct impact of top management support and usage of IT tools on the SCM strategy process. These two relationships are not hypothesized originally, but are identified during the process of the model re-specification. The test of such hypotheses will further reveal the nature and role of top management support and usage of IT tools on the implementation of SCM.

Second, future research should examine the hypothesized structural relationships across industries. Assuming an adequate sample size in each industry, structural analysis may be done by industry. This would reveal either industry-specific structural

relationships or invariance of structural relationships across industries. The same hypothesized structural relationships across countries can also be tested in the future research. This will allow the comparison of SCM in different countries, the identification of country-specific SCM issues, and the generalization of common SCM facilitating factors and SCM practice across countries.

Third, future research should incorporate the factors inhibiting the implementation of SCM. As pointed out earlier, the inhibiting factors of SCM practice, such as interdependence of the partners, channel conflict, power, and organizational/national culture, has received attention in the literature. The studies of the impacts of such inhibiting factors and solutions to reduce or even eliminate such negative influence on SCM practice are critical for further understanding SCM issues and improving overall performance of SCM. Future research should explore the impact of such inhibiting factors on SCM practice and SCM performance.

Fourth, future research should test hypothesized structural relationships at a specific performance level. Dividing the sample group into high and low SCM performers and testing for relationships within these two groups, respectively, may provide important insights into determinants of high and low performers of SCM. The analysis can also uncover the relationship between levels of performance and levels of congruence among the SCM facilitating factors (such as top management support, partner relationship, usage of IT tools, and so on).

Fifth, future studies can also examine the proposed relationships by bringing some contextual variables into the model, such as organizational size and supply chain structure. For example, it will be intriguing to investigate how SCM practices differ

across organization size. It will also be very interesting to examine the impact of supply chain structure (supply chain length, organization's position in the supply chain, channel structure, and so on) on SCM practice and performance.

Sixth, this study indicates that partner relationship plays an important role in implementing SCM practice and improving SCM performance. There are several issues regarding the establishment of good partner relationship (such as trust, commitment, and shared vision). For example, how does one get trading partners to trust each other? What tools and procedures can be used to establish a shared vision between trading partners? What skills are necessary to develop commitment and credibility in the relationship of trading partners? How should an organization identify channel partners who participate in trust-creating behaviors? What is the role of channel conflict in partner relationship? There are to be addressed in future research.

Seventh, in this study, composite measures are used to represent each construct, and only the structural model is tested using LISREL. However, the strength and nature of relationships among sub-constructs across variables may vary. For example, it is certain that SCM practices play critical roles in affecting SCM performance at the organizational level. More detailed questions can be raised, such as which SCM practice (i.e. strategic supplier partnership, customer relationship, lean system, etc.) has more impact on SCM performance, or which dimension of SCM performance (i.e. supply chain flexibility, supply chain integration, etc.) influences competitive advantage more. By assessing these relationships at the sub-construct level, one may explore numerous alternative models of structural relationships and make the findings more meaningful for decision makers.

Eighth, future research can create an integrative, quantitative metric, similar to total productive maintenance (Nakajima, 1988), for measuring and benchmarking SCM performance of an organization. Such metric is of increasing importance to organizations and academicians seeking to model, analyze, and optimize supply chain systems. Due to the complex nature of the supply chain, at present it is still very difficult to analyze the overall performance of a supply chain quantitatively. The current study identifies the major dimensions of SCM performance; a set of quantitative measurements for each dimension of SCM performance can, thus, be identified. For example, supply chain flexibility can be measured by supply chain response time, production flexibility, volume flexibility, and delivery flexibility; customer responsiveness can be measured by customer fill rate, order fulfillment lead-time, perfect order fulfillment, and so on. A metric can then be developed to measure the performance of SCM formulated as a function of a number of the above quantitative measures of SCM. Such a metric will greatly facilitate quantitative SCM research, investigating supply chain modeling and optimization. This will be undertaken in future research.

Ninth, future research can study SCM issues at the supply chain level. Taking a complete supply chain as an example, it is of interest to investigate the characteristics, policy, and mechanism governing this supply chain, the interactions among all the participants within the supply chain (first-tier suppliers, second-tier suppliers, manufacturers, carriers, customers, etc), and how the SCM practices and SCM performances differ across each participating organization. Moreover, comparisons can be made between supply chains. For example, by comparing the characteristics and performance of different supply chains (the supply chains of Ford, GM, Chrysler and so

on), it is possible to identify the strength and weakness of each supply chain and also the best common SCM practice across the supply chain; the recommendations can, thus, be made to improve the overall efficiency and effectiveness of the whole supply chain.

Finally, future research can expand the current theoretical framework by integrating new constructs from other fields. For example, it is of interest to study the integration of electronic commerce (EC) and SCM by incorporating new constructs representing EC into this model.

REFERENCES

Achrol, R. S. and Stern, L. W. (1988), "Environmental Determinants of Decision-Making Uncertainty in Marketing Channels", Journal of Market Research, 25(1), pp.36-50.

Achrol, R. S., Scheer, L. K., and Stern, L. W. (1990), "Designing Successful Trans-organizational Marketing Alliances", Report No. 90-118, Cambridge, MA: Marketing Science Institute.

Alber, K. L. and Walker, W. T. (1998), "Supply Chain Management: Principles and Techniques for the Practitioners", APICS Educational and Research Foundation, Inc..

Aldrich, H. E. (1979), Organizations and Environments, Prentice-Hall, Inc., Englewood Cliffs, NJ.

Aggarwal, S. (1997), "Flexibility Management: the Ultimate Strategy", Industrial Management, 39(1), pp.26-31.

Alvarado, U. Y. and Kotzab, H. (2001), "Supply Chain Management: the Integration of Logistics in Marketing", Industrial Marketing Management, 30, pp.183-198.

Alvarez, D. (1994), "Solving the Puzzle of Industry's Rubic Cube-effective Supply Chain Management", Logistics Focus, 2(4), pp. 2-4.

Anderson, J. G., and Gerbing, G. W. (1998), "Structural Equation Modeling in Practice: a Review and Recommended Two-step Approach", Psychological Bulletin, 103, pp.411-423.

Andraski, J. C. (1994), "Foundations for a Successful Continuous Replenishment Program", International Journal of Logistics Management, 5, pp.1-8.

Arogyaswamy, B., and Simmons, R. P. (1993), Value-Directed Management: Organizations, Customers, and Quality. Quorum Books, Westport, Conn.

Ayers, J. (1999), "Supply Chain Strategies", Information Systems Management, Spring, pp.72-79.

Bajwa, D. S., Rai, A. and Brennan, I. (1998), "Key Antecedents of Executive Information System Success: a Path Analytic Approach", Decision Support Systems, 22(1), pp.31-43.

Ballou, R. H., Gillbert, S. M. and Mukherjee, A. (2000), "New Managerial Challenge from Supply Chain Opportunities", Industrial Marketing Management, 29, pp.7-18.

Balsmeier, P. W. and Voisin, W. (1996), "Supply Chain Management: a Time-Based Strategy", Industrial Management, 38(5), pp. 24-27.

Banfield, E. (1999), "Harnessing Value in the Supply Chain", John Wiley and Sons, New York, NY.

Bates, K. A., Amundson, S. D., Schroeder, R. G. and Morris, W. T. (1995), "The Crucial Interrelationship between Manufacturing Strategy and Organization Culture", Management Science, 41(10), pp.1565-1580.

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.

Bechtel, C. and Jayaram, J. (1997), "Supply Chain Management: A Strategic Perspective", International Journal of Logistics Management, 8(1), pp.15-34.

Benjamin, R. I. and Wigand, R. (1995), "Electronic Markets and Virtual Value Chains on the Information Superhighway", Sloan Management Review, 36(2), pp.62-72.

Bensaou, M., and Venkatraman, N. (1996), "Inter-organizational Relationship and Information Technology: a Conceptual Synthesis and a Research Framework", European Journal of Information Systems, 5, pp.194-106.

Berry, D., Towill, D. R., and Wadsley, N. (1994), "Supply Chain Management in the Electronics Products Industry", International Journal of Physical Distribution and Logistics Management, 24(10), pp.20-32.

Boddy, D., Magbeth, D. K., Charles, M, and Fraser-Kraus, H. (1998), "Success and Failure in Implementing Partnering", European Journal of Purchasing and Supply Management, 4, pp.143-151.

Boddy, D., MacBeth, D. and Wagner, B. (2000), "Implementing Collaboration Between Organizations: an Empirical Study of Supply Chain Partnering", Journal of Management Studies, 37(7), pp.1003-1017.

Bommer, M., O'Neil, B. and Treat, S. (2001), "Strategic Assessment of the Supply Chain Interface: a Beverage Industry Case Study", International Journal of Physical Distribution and Logistics Management, 31(1), pp.11-25.

Bowersox, D. J. and Daugherty, P .J. (1995), "Logistics Paradigms: the Impact of Information Technology", Journal of Business Logistics, 16(1), pp.65-80.

Bryne, B. M. (1989), A Primer of LISREL: Basic Applications and Programming for Confirmatory Factor Analytic Model, New York: Springer-Verlag.

Bucklin, L. P. and Sengupta, S. (1993), "Organizing Successful Co-marketing Alliances", Journal of Marketing, 57 (April), pp.32-46.

Burgess, R. (1998), "Avoiding Supply Chain Management Failure: Lessons From Business Process Re-engineering", International Journal of Logistics Management, 9(1), pp.15-23.

Burnell, J. (1999), "Change Management the Key to Supply Chain Management Success", Automatic I.D. News, 15(4), pp.40-41.

Bushnell, R. (1998), "E-commence in the Supply Chain: What it Can do", Automatic I. D. News, 14(12), pp.56.

Carr, A. S., and Person, J. N. (1999), "Strategically Managed Buyers-Seller Relationships and Performance Outcomes", Journal of Operations Management, 17(5), pp.497-519.

Carter, J. R. and Narasimhan, R. (1994), "The Role of Purchasing and Materials Management in Total Quality Management and Customer Satisfaction," International Journal of Purchasing and Materials Management, 30(3), pp.3-13.

Chandra, C. and Kumar, S. (2000), "Supply Chain Management in Theory and Practice: a Passing Fad or a Fundamental Change", Industrial Management and Data Systems, 100(3), pp.100-113.

Chizzo, S. A. (1998), "Supply Chain Strategies: Solutions for the Customer-Driven Enterprise", Software Magazine. Supply Chain Management Directions Supplement, pp 4-9.

Choi, T. Y. and Hartley, J. L. (1996), "An Exploration of Supplier Selection Practices Across the Supply Chain", Journal of Operations Management, 14, pp.333-343.

Christopher, M. G. (1992), Logistics and Supply Chain Management, Pitman Publishing, London, UK.

Christopher, M. and Juttner, U. (2000), "Developing Strategic Partnership in the Supply Chain: a Practitioner Perspective", European Journal of Purchasing and Supply Management, 6(2), pp.117-127.

Churchill, G. A. (1979), "A Paradigm for Developing Better Measures of Marketing Constructs", Journal of Marketing Studies, Vol.16, pp.12-27.

Clark, K. B., and Fujimoto, T. (1991), Product Development Performance: Strategy, Organization, and Management in the World Auto Industry. Harvard Business School Press, Boston, MA.

Clark, T. H. and Lee, H. G. (2000), "Performance, Interdependence and Coordination in Business-to-Business Electronic Commerce and Supply Chain Management", Information Technology and Management, 1, pp.85-105.

Claycomb, C., Droge, C. and 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.

Cleveland, G., Schroeder, R. G., and Anderson, J. C. (1989), "A Theory of Production Competence", Decision Science 20(4), pp.655-668.

Cohen, J. (1960), "A Coefficient of Agreement for Nominal Scales", Educational and Psychological Measurement, Spring, pp.37-46.

Collins, R. and Bechler, K. (1999), "Outsourcing in the Chemical and Automotive Industries: Choice or Competitive Imperative?", The Journal of Supply Chain Management, Fall, 35(4), pp.4-11.

Colombo, M. G. (1998), The Challenging Boundaries of the Firm, New York: Routledge.

Cooper, M. C., Lambert, D. M. and Pagh, J. D. (1997), "Supply Chain Management: More Than a New Name for Logistics", The International Journal of Logistics Management, 8(1), pp.1-13.

Council of Logistics Management (CLM) (1998), What It's All About, 4(6), Oak Brook, IL.

Cox, A.(1996), "Relational Competence and Strategic Procurement Management", European Journal of Purchasing and Supply Management, 2(1), pp.57-70.

Cox, A. (1999), "Power, Value and Supply Chain Management", Supply Chain Management: an International Journal, 4(4), pp.167-175.

Cronbach, L. J. (1951), "Coefficient Alpha and Internal Structure of Tests", Psychometrika, 16, pp.297-334.

Croom, S., Romano, P., and Giannakis, M (2000), "Supply Chain Management: an Analytical Framework for Critical Literature Review", European Journal of Purchasing and Supply Management, 6, pp. 67-83.

Cross, G. J. (2000), "How E-Business is Transforming Supply Chain Management", Journal of Business Strategy, March/April, pp.36-39.

Dale, D. (1999), Managing Quality, Blackwell Press, London.

Davis, T. (1993), "Effective Supply Chain Management", Sloan Management Review, 34(4), pp.35-46.

Day, G. S. (1995), "Advantage Alliances", Journal of the Academy of Marketing Science, 23(4), pp.297-300.

Deutsch, M. (1960), "The Effect of Motivational Orientation on Trust and Suspicion", Human Relations, 13, pp.123-139.

Doll, W. J., Raghunathan, T., Lim, S. J. and Gupta, Y. P (1995), "A Confirmatory Factor Analysis of the User Information Satisfaction Instrument", Information Systems Research, 6(2), pp.177-188.

Donlon, J. P. (1996), "Maximizing Value in the Supply Chain", Chief Executive, 117, pp.54-63.

Doyle, M. (1998), "Overcoming Communication Barriers", Transportation and Distribution, 39 (10), pp.91.

Dyer, J. H., Cho, D. S., and Chu, W. (1998), "Strategic Supplier Segmentation: the Next "Best Practice" in Supply Chain Management", California Management Review, 40(2), pp.57-77.

Ellram, L. M. (1990), "The Supplier Selection Decision in Strategic Partnerships", Journal of Purchasing and Materials and Management, Fall, pp.8-14.

Ellram, L. M. (1991), "Supply Chain Management: the Industrial Organization Perspective", International Journal of Physical Distribution and Logical Management, 21(1), pp.13-22.

Ettlie, J. E. and Reza, E. M. (1992), "Organizational Integration and Process Innovation", Academy of Management Journal, 35(4), pp.795-827.

Evans, P. B. and Wurster, T. S. (1997), "Strategies and the New Economics of Information", Harvard Business Review, 75(5), pp.71-82.

Evans, G. N., Naim, M. M., and Towill, D. R. (1993), "Dynamic Supply Chain Performance: Assessing the Impact of Information Systems", Logistics Information Management, 6(4), pp.15-25.

Farley, G. A., (1997), "Discovering Supply Chain Management: a Roundtable Discussion", APCIS- the Performance Advantage, 7(1), pp.38-39.

Fliedner, G. and Vokurka, R. J. (1997), "Agility: Competitive Weapon of the 1990's and Beyond", Production and Inventory Management Journal, 38(3), pp.19-24.

Ford, D. (1998), Managing Business Relationships, Chichester: Wiley.

Forker, L. B., Ruch, W. A. and Hershauer, J. C. (1999), "Examining Supplier Improvement Efforts from Both Sides", Journal of Supply Chain Management, 35(3), pp.40-50.

Frohlich, M. T. and Westbrook, R. (2001), "Arcs of Integration: an International Study of Supply Chain Strategies", Journal of Operations Management", 19, pp.185-200.

Franks, J. (2000), "Supply Chain Innovation", Work Study, 49(4), pp.152-155.

Ganesan, S. (1994), "Determinants of Long-Term Orientation in Buyer-Seller Relationships", Journal of Marketing, 58, pp.1-19.

Garwood, D. (1999), "Supply Chain Management: New Paradigms for Customers and Suppliers", Hospital Materials Management Quarterly, 20(3), pp. 1-3.

Gaski, J. F. (1984), "The Theory of Power and Conflict in Channels of Distribution", Journal of Marketing, 48, pp.9-29.

Gerbing, D. W. and J. C. Anderson, (1988), "Evaluating Structural Equation Methods, Number of Indicators per Factor, and Improper Solutions on Structural Equation Modeling Fit Indices", Structural Equation Modeling, 2(2), pp.119-144.

Gibson, P. (1998), "The Missing Link", Electronic Business, 24(8), pp. 57-60.

Giffy, C. A., Roth, A. and Seal, G. M. (1990), "Surveys Shows Priorities are Quality, Workers, and Mature Technologies", CIM Review, 7(1), pp.5-16.

Gray, J. L., and Harvey, T. W. (1992). Quality Value Banking: Effective Management Systems that Increase Earnings, Lower Costs, and Provide Competitive Customer Service, Wiley, New York, NY.

Grittner, P. (1996), "Four Elements of Successful Sourcing Strategies", Management Review, 85(10), pp. 41-45.

Grover, V. (1993), "An Empirically Derived Model for the Adoption of Customer-Based Inter-organizational Systems", Decision Sciences, 24(3), pp.603-639.

Gunasekaran, A, Patel, C, and 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, A. K. and Wilemon, D. L. (1990), "Accelerating the Development of Technology-based New Products", California Management Review, 32(2), pp.24-44.

Hall, R. W. (1993), "A framework for Linking Intangible Resources and Capabilities to Sustainable Competitive Advantage", Strategy Management Journal, 14, 607-618.

Hall, G., Rosenthal, J., and Wade, J. (1993). "How to Make Reengineering Really Work." Harvard Business Review, November-December, pp.119-131.

Hall, R. (1999), "Rearranging Risks and Rewards in a Supply Chain", Journal of General Management, 24(3), pp.22-33.

Hamel, G. D. and Prahalad, C. K. (1989), "Collaborate with Your Competitors- and Win", Harvard Business Review, January-February.

Handfield, R. B., and Pannesi, R. T. (1992), "An Empirical Study of Delivery Speed and Reliability", International Journal of Operations and Production Management, 12(2), pp.58-72.

Handfield, R. B., and Pannesi, R. T. (1995), "Antecedents of Lead-time Competitiveness in Make-to-Order Manufacturing Firms ", International Journal of Production Research, 33(2), pp.511-537.

Handfield, R. B and Nichols, E. L., Jr (1999), Introduction to Supply Chain Management, Prentice Hall, Upper Saddler River, New Jersey.

Harland, C. M. (1996), "Supply Chain Management: Relationships, Chains and Networks", British Journal of Management, 7 (special issues), pp. s63-s80.

Harrigan, K. R. (1985), Strategic Flexibility: A Management Guide to Changing Times, D. C., Health and Company, Lexington, MA.

Harrington, L. H. (1998), "Software Tools to Revamp Your Supply Chain", Transportation and Distribution, 39(11), pp.59-70.

Hattie, J. (1985), "Methodology Review: Assessing Unidimensionality of Tests and Items", Applied Psychological Measurement, 9, pp.139-164.

Hewitt, F. (1999), "Information Technology Mediated Business Process Management-Lessons from the Supply Chain", International Journal of Technology Management, 17(1,2), pp.37-53.

Hicks, D. A. (1997a), "The Manager's Guide to Supply Chain and Logistics Problem-Solving Tools and Techniques: Part II: Tools, Companies, and Industries", IIE Solutions, 29(10), pp.24-29.

Hicks, D. A. (1997b), "The Manager's Guide to Supply Chain and Logistics Problem-Solving Tools and Techniques: Part III: End User Experiences", IIE Solutions, 29(11), pp.34-38.

Hitt, M. A., Ireland, D. R., and Hoskisson, R. E. (1999), Strategic Management, Cincinnati, OH: Southwestern College Publishing.

Holmberg, S. (2000), "A Systems Perspective on Supply Chain Measurements", International Journal of Physical Distribution and Logistics Management, 30(10), pp.847-868.

Houlihan, J. B. (1988), "International Supply Chains: a New Approach", Management Decision, 26(3), pp.13-19.

Humphreys, P. K., Lai, M. K., and Sculli, D. (2001), "An Inter-organizational Information System for Supply Chain Management", International Journal of Production Economics, 70, pp.245-255.

Jarrell, J. L. (1998), "Supply Chain Economics", World Trade, 11(11), pp.58-61.

Jayaram, J., Droge, C. and Vickery, S. (1999), "The Impact of Human Resource Management Practices on Manufacturing Performance", Journal of Operations Management, 18(1), pp.1-20.

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

Johnson, J. L. (1999), "Strategic Integration in Industrial Distribution Channels: Managing the Inter-firm Relationship as a Strategic Asset", Journal of the Academy of Marketing Science, 27(1), pp.4-18.

Johnson, M. E. and Davis, T. (1998), "Improving Supply Chain Performance by Using Order Fulfillment Metrics", National Productivity Review, 17(3), pp.3-16.

Jones, T. C. and Riley, D. W. (1985), "Using Inventory for Competitive Advantage through Supply Chain Management", International Journal of Physical Distribution and Materials Management, 15(5), pp.16-26.

Jones, C. (1998), "Moving beyond ERP: Making the Missing Link", Logistics Focus, 6(7), pp.2-7.

Joreskog, K. G. and Sorbom D. (1989), LISREL 7 Users' Reference Guide, Scientific Software Inc., Chicago, IL.

Kaufman, A., Wood, C. H. and Theyel, G. (2000), "Collaboration and Technology Linkages: a Strategic Supplier Typology", Strategic Management Journal, 21(6), pp.649-663.

Kay, J. (1993), Foundations of Corporate Success, Oxford: Oxford University Press.

Kessler, E. and Chakrabarti, A. (1996). "Innovation Speed: A Conceptual Mode of Context, Antecedents, and Outcomes", The Academy of Management Review, 21(4), pp.1143-1191.

Kiefer, A.W. and 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.

Knowles, A. (1996), "Supply Chain Forges New Link", Software Magazine, 16(10), pp. 99-104.

Koufteros, X. A. (1995), Time-Based Manufacturing: Developing a Nomological Network of Constructs and Instrument Development. Doctoral Dissertation, University of Toledo, Toledo, OH.

Koufteros, X. A., Vonderembse, M. A., and Doll, W. J., (1997), "Competitive Capabilities: Measurement and Relationships", Proceedings Decision Science Institute 3, pp.1067-1068.

Krause, D. R., Handfield R. B., Scannel, T. V. (1998), " An Empirical Investigation of Supplier Development: Reactive and Strategic Processes", Journal of Operations Management, 17(1), pp.39-58.

Kumar, K. (2001), "Technology for Supporting Supply Chain Management", Association for Computing Machinery. Communications of the ACM, 44(6), pp.58-61.

Landis, J. R. & Koch, G. G. (1977) "The Measurement of Observer Agreement for Categorical Data," Biometrics, 33, 159-174.

Lalonde, B. J. (1998), "Building a Supply Chain Relationship", Supply Chain Management Review, 2(2), pp.7-8.

Lambe, C. J., and Spekman, R .E. (1997), "Alliances, External Technology Acquisition and Discontinuous Technological Change", Journal of Product Innovation Management, 14(2), pp.102-116.

Lambert, D. M. and Cooper, M .C. (2000), "Issues in Supply Chain Management", Industrial Marketing Management, 29, pp.65-83.

Lamming, R. (1993), Beyond Partnership: Strategies for Innovation and Lean Supply, Prentice-Hall, New York.

Lamming, R. C. (1996), "Squaring Lean Supply with Supply Chain Management", International Journal of Operations and Production Management, 16(2), pp.183-196.

Lancioni, R. A., Smith, M. F. and Oliva, T. A., (2000), "The Role of the Internet in Supply Chain Management", Industrial Marketing Management, 29, pp.45-56.

Landis, J. R. and Koch, C. G. (1977), "The Measurement of Observer Agreement for Categorical Data", Biometrics, 33, March, pp.159-174.

Lawrence, A. (1997), "Customer Power Forces Supply Chain Integration", Works Management, 50(4), pp.43-47.

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

Lee, H. L. and Billington, C. (1995), "The Evolution of Supply Chain Management Models and Practices at Hewlett Packard", Interface, 25 (5), pp. 42-63.

Lee, H. L., Padmanabhan, V., Whang, S. (1997), "Information Distortion in a Supply Chain: The Bullwhip Effect", Management Science, 43(4), pp.546-558.

Lee, J. and Kim, Y. (1999), "Effect of Partnership Quality on IS Outsourcing: Conceptual Framework and Empirical Validation", Journal of Management Information Systems, 15(4), pp.26-61.

Lenz, R. T. (1980), "Environment, Strategy, Organization Structure and Performance: Patterns in One Industry", Strategic Management Journal, 1(3), pp.209-226.

Levy, D.L. (1997), "Lean Production in an International Supply Chain", Sloan Management Review, 38(2), pp.94-102.

Lim, D. and Palvia, P. C. (2001), "EDI in Strategic Supply Chain: Impact on Customer Service", International Journal of Information Management, 21, pp.193-211.

Lummus, R. R., Vokurka, R. J., Alber, K. L. (1998), "Strategic Supply Chain Planning", Production and Inventory Management Journal, 39 (3), pp.49-58.

Lummus, R. R. and Vokurka, R. J. (1999), "Defining Supply Chain Management: a Historical Perspective and Practical Guidelines", Industrial Management and Data Systems, 99(1), pp.11-17.

Lummus, R. R., Krumwiede, D. W. and Vokurka, R. J. (2001), "The Relationship of Logistics to Supply Chain Management: Developing a Common Industry Definition", Industrial Management and Data Systems, 101(8), pp.426-431.

Magretta, J. (1998a), "The Power of Virtual Integration: An Interview with Dell Computers' Michael Dell", Harvard Business Review, 76(2), pp.72-84.

Magretta, J. (1998b), "Fast, Global, and Entrepreneurial: Supply Chain Management, Hong Kong Style: an Interview with Victor Fung", Harvard Business Review, 76(5), pp.102-114.

Malone, T. and Laubacher, R. (1998), "The Dawn of the E-lance Economy", Harvard Business Review, (September-October), pp.145-152.

Mariotti, J. L. (1999), "The Trust Factor in Supply Chain Management", Supply Chain Management Review, 3(1, Spring), pp.70-77.

Mason-Jones R. and Towill. D. R. (1997), "Information Enrichment: Designing the Supply Chain for Competitive Advantage", Supply Chain Management, 2(4), pp.137-148.

Mason-Jones R. and Towill. D. R. (1999), "Total Cycle Time Compression and the Agile Supply Chain", International Journal of Production Economics, 62, pp.31-73.

McAdam, R, and McCormack, D. (2001), "Integrating Business Processes for Global Alignment and Supply Chain Management", Business Process Management Journal, 7(2), pp.113-130.

McDonald, R. P. (1981), "The Dimensionality of Tests and Items", British Journal of Mathematical and Statistical Psychology, 34, pp.100-117.

McGinnis, M. A, Vallopra, R. M. (1999), "Purchasing and Supplier Involvement in Process Improvement: A Source of Competitive Advantage", Journal of Supply Chain Management, 35(4), pp.42-50.

McGrath, M. E. (1998), "Know Your Supply Chain Costs", Electronic Business, 24(11), pp.18, 80.

McIvor, R. (2001), "Lean Supply: the Design and Cost Reduction Dimensions", European Journal of Purchasing and Supply Chain Management, 7, pp.227-242.

Mentzer, J. T. (1999), "Supplier Partnering," pp.457-477 in Handbook of Relationship Marketing. Jagdish N. Sheth and Atul Parvatiyar (Eds.) Thousand Oaks, CA: Sage Publication, Inc.

Mentzer, J. T., Min, S. and Zacharia, Z. G. (2000), "The Nature of Interfirm Partnering in Supply Chain Management", Journal of Retailing, 76(4), pp.549-568.

Metters, R. (1997), "Quantifying the Bullwhip Effect in Supply Chains", Journal of Operations Management, 15, pp.89-100.

Miller, D. and Droge, C. (1986), "Psychological and Traditional Determinants of Structure", Administrative Science Quarterly, 31(4), pp.539-560.

Miller, J. G., DeMeyer, A., and Nakane, J. (1992). Benchmarking Global Manufacturing, Business One Irwin, Homewood, IL.

Milliken, F. J. (1987), "Three Types of Perceived Uncertainty about the Environment: State, Effect, and Response Uncertainty", Academy of Management Review, 12, pp.133-143.

Monczka, R. M., Trent, R. J. and Callahan, T. J. (1994), "Supply Base Strategies to Maximize Supplier Performance", International Journal of Physical Distribution and Logistics, 24(1), pp.42-54.

Monczka, R. M. and Morgan, J. (1997), "What's Wrong with Supply Chain Management?", Purchasing, 122(1), pp.69-72.

Monczka, R. M and Morgan, J. (1998), "Questions You Need to Ask about Your Supply Chain", Purchasing, 124(8), pp. 42-47.

Monczka, R. M., Petersen, K. J., Handfield, R. B., and Ragatz, G. L. (1998), "Success Factors in Strategic Supplier Alliances: the Buying Company Perspective", Decision Science, 29(3), pp.5553-577.

Moore, G. and 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.

Moran, W. T. (1981), "Research on Discrete Consumption Markets Can Guide Resource Shifts, Help Increase Profitability", Marketing News, 14(23), pp. 4.

Morash, E. A. and Clinton, S. R. (1997), "The Role of Transportation Capabilities in International Supply Chain Management", Transportation Journal, 36(3), pp.5-17.

Mullen, J. (1998), "Board Position is Key to Supply Chain Management", Supply Management, 3(12), pp.51.

Murphy, P. and Daley, J. (1996), "International freight forwarder perspectives on EDI and information management issues", Journal of Business Logistics, 17(1), pp. 63-84.

Nahm, A. Y. (2000), Exploring the Relationship Between External Environment, Internal Environment, and Manufacturing Practices: An Industrial/Post-Industrial Perspective, Doctoral Dissertation, University of Toledo, Toledo, OH.

Nakajima, S. (1988), Introduction to TPM: Total Productive Maintenance, Cambridge, MA: Productivity Press.

Narasimhan, R. and Jayaram, J. (1998), "Causal Linkage in Supply Chain Management: an Exploratory Study of North American Manufacturing Firms", Decision Science, 29(3), pp. 579-605.

Narasimhan R. and Kim, S. W. (2001), " Information System Utilization Strategy for Supply Chain Integration", Journal of Business Logistics, 22(2), pp.51-76.

Naylor, J.B., Naim, M. M., and Berry, D. (1999), "Leagility: Integrating the Lean and Agile Manufacturing Paradigms in the Total Supply Chain", International Journal of Production Economics, 62(1,2), pp. 107-118.

Neuman, J. and Samuels, C. (1996), "Supply Chain Integration: Vision or Reality", Supply Chain Management, 1(2), pp.7-10.

New, S. J. and Payne, P. (1995), "Research Framework in Logistics: Three Models, Seven Dinners and a Survey", International Journal of Physical Distribution and Logistics Management, 25(10), pp.60-77.

Newman, R. G. (1988), " The Buyer-Supplier Relationship Under Just-in-time", Production and Inventory Management Journal, 29(3), pp.45-50.

Noble, D. (1997), "Purchasing and Supplier Management as a Future Competitive Edge", Logistics Focus, 5(5), pp.23-27.

Novack, R. A., Langley, C. J. Jr, and Rinehart, L. M. (1995), "Creating Logistics Value: Themes for the Future", Oak Brook, IL: Council of Logistics Management.

Nunnally, J. C. (1978), Psychometric Theory, McCraw-Hill, New York, NY.

O' Connell, J. (1999), "Streamlining Supply Chain Management Processes", Document World, 41(1), pp. 40-42.

Oliver, R. K. and Webber, M. D. (1982), "Supply Chain Management: Logistics Catches Up With Strategy". In: M. Christopher (1992), Logistics: The Strategic Issues, pp.63-75. Chapman and Hall, London, UK.

Oswald, S. L., Mossholder, K. W., and Harris, S. G. (1994), "Vision Salience and Strategic Involvement: Implications for Psychological Attachment to Organization and Job", Strategic Management Journal, 15, pp.477-489.

Oswald, S. L., Mossholder, K. W., and Harris, S. G. (1997), "Relations Between Strategic Involvement and Manager's Perceptions of Environment and Competitive Advantage Strengths", Group and Organization Management, 22(3), pp.343-365.

Owens, G. and 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.

Paswan, A. K., Dant, R. P. and Lumpkin, J. R. (1998), " An Empirical Investigation of the Linkage among Relationalism, Environmental Uncertainty, and Bureaucratization", Journal of Business Research, 43(3), pp.125-140.

Patterson, J. (1995), "Adding Value by Managing Supply Chain Activities", Marketing News, 29(15), pp.6.

Pfeffer, J. (1982), Organizations and Organization Theory. Boston, MA: Pitman.

Pincince, T. (1998), "Extranet: Future Trends and Scenarios", Telecommunications, 32(1), p.61.

Pittiglio, Rabin, Todd, and McGrath (1994), Integrated Supply Chain Performance Measurement: A Multi-Industry Consortium Recommendation, Westin Ma.

Poirier, C. C. (1997), "Evolving to the Ultimate Level of Performance Through Supply Chain Management", National Productivity Review, 17(1), pp.11-23.

Porter, M. (1980), Competitive Strategy: Techniques for Analyzing Industries and Competitors, New York: The Free Press.

Porter, M. E. (1985), Competitive Advantage: Creating and Sustaining Superior Performance, New York: The Free Press.

Porter, A. M. (1994), "Beyond Cost Avoidance", Purchasing, 117(8), pp.11-12.

Power, D. J., Sohal, A., and Rahman, S. U. (2001), "Critical Success Factors in Agile Supply Chain Management: An Empirical Study", International Journal of Physical Distribution and Logistics Management, 31(4), pp.247-265.

Prasad, S. and Tata, J. (2000), "Information Investment in Supply Chain Management", Logistics Information Management, 13 (1), pp.33-38.

Prater, E., Biehl, M. and Smith, M. A. (2001), "International Supply Chain Agility: Tradeoffs Between Flexibility and Uncertainty", International Journal of Operations and Production Management, 21(5/6), pp.823-839.

Premkumar, G and Ramamurthy, K. (1995), "The Role of Interorganizational and Organizational Factors on the Decision Mode for Adoption of Interorganizational Systems", Decision Sciences, 26(3), pp.303-336.

Pruitt, D. G., (1981), Negotiation Behavior, Academic Press, Inc., New York.

Ragatz, G. L., Handfield, R. B. and Scannell, T. V. (1997), "Success Factors for Integrating Suppliers into New Product Development", Journal of Product Innovation Management, 14(3), pp.190-202.

Raghunathan, B., Raghunathan, T. S., Tu, Q. (1999), "Dimensionality of the Strategic Grid Framework: the Construct and Its Measurement", Information System Research, 10(4), pp343-355.

Reda, S. (1999), "Internet-EDI Initiatives Show Potential to Reinvent Supply Chain Management", Stores, 81(1), pp 26-27.

Reve, T. (1990), "The Firm as a Nexus of Internal and External Contracts" in Aoki, M., B. Gustafson and O. E. Williamson (eds), the Firm as Nexus of Treaties, Sage Publications, Thousand Oaks, CA. pp.136-138.

Rich, N. (1999), "Supply Chain Management: the Measurement 'Wall'", Logistics Focus, 7(4), pp.26-31.

Romano, P., and Vinelli, A. (2001), "Quality Management in a Supply Chain Perspective: Strategic and Operative Choices in a Textile-Apparel Network", International Journal of Operations and Production Management, 21(4), pp.446-460.

Rondeau, P. J., Vonderembse, M. A. and Ragu-Nathan, T. S., (2000), "Exploring Work System Practices for Time-Based Manufacturers: Their Impact on Competitive Advantage", Journal of Operations Management, 18, 509-529.

Roth, A., and Miller, J. (1990), Manufacturing Strategy, Manufacturing Strength, Managerial Success, and Economic Outcomes. In: Ettlie J., Burstein, M., Fiegehaum. A. (Eds.) Manufacturing Strategy. Kluwer Academic Published, Norwell, MA, pp.97-108.

Safizadeh, H. M., Ritzman, L. P., Sharma, D., and Wood, C. (1996), "An Empirical Analysis of the Product-Process Mix", Management Science, 42(11), 1576-1591.

Sanchez, R. (1993), "Strategic Flexibility, Firm Organizational, and Managerial Work in Dynamic Markets: a Strategic-Options Perspective", Advances in Strategic Management, 9, pp.251-291.

Saunders, M. (1994), Strategic Purchasing and Supply Chain Management, Pitman, London, UK.

Schurr, P. H. and Ozanne, J. L. (1985), "Influences on Exchange Processes: Buyers' Preconceptions of a Seller's Trustworthiness and Bargaining Toughness", Journal of Consumer Research, 11(4), pp. 939-953.

Schwartz, M. (1998), "Extending the Supply Chain", Software Magazine, 18(15), pp.44-48.

Scott, C. and Westbrook, R. (1991), "New Strategic Tools for Supply Chain Management", International Journal of Physical Distribution and Logical Management, 21(1), pp.23-33.

Segars, A. H. and Grover, V. (1993), "Re-examining Perceived Ease of Use and Usefulness: a Confirmatory Factor Analysis", MIS Quarterly, 17(4), 517-525.

Sengupta, S. and Turnbull, J. (1996), "Seamless Optimization of the Entire Supply Chain", IIE Solutions, 28(10), pp. 28-33.

Sethi, V and King, W. R. (1994), "Development of Measures to Assess the Extent to Which an Information Technology Application Provides Competitive Advantage", Management Science, 40(12), 1601-1627.

Sheridan, J. (1997), "Bonds of Trust", Industry Week, 246(6), pp.52-62.

Sheridan, J. H. (1998), " The Supply-Chain Paradox", Industry Week, 247(3), pp. 20-29.

Shin, H, Collier, D. A., and Wilson, D. D. (2000), "Supply Management Orientation and Supplier/Buyer Performance", Journal of Operations Management, 18(3), pp.317-333.

Skinner, W. (1985), The Taming of the Lions: How Manufacturing Leadership Involved, 1780-1984. In: Clark, K. B., Hayes, R., Lorenz, C. (Eds), the Uneasy Alliance: Managing the Productivity-Technology Dilemma. The Harvard Business School Press, Boston, MA, pp.63-110.

Simchi-Levi, D., Kaminsky, P., and Simchi-Levi, E. (2000), Designing and Managing the Supply Chain, New York: Irwin/McGraw-Hill.

Slack, N., Harland, C. M., Chamber, S., Harrison, A. and Johnston, R. (1998), Operations Management, Pitman Publishing, London.

Solis-Galvan, L. E. (1998), An Exploratory Study of the Relationship between Quality Management and Manufacturing Competitive Capabilities, Doctoral Dissertation, the University of Toledo, Toledo, OH.

Spekman, R. E., and Strauss, D. (1986), "An Exploratory Investigation of a Buyer's Concern for Factors Affecting more Co-operative Buyer-Seller Relationships", Industrial Marketing and Purchasing, (1,3), pp.26-43.

Spekman, R., Salmond, D. and Kamauff, J., (1994), "At Last Procurement Becomes Strategic", Long-Range Planning, 27(2), pp.76-84.

Spekman, R. E., Kamauff, J. W. Jr and Myhr, N. (1998a), "An Empirical Investigation into Supply Chain Management: a Perspective on Partnerships", Supply Chain Management, 3(2), pp.53-67.

Spekman, R. E., Forbes, T. M., Isabella, L. A. and Macavoy, T. C. (1998b), "Alliance Management: a View from the Past and a Look to the Future", Journal of Management Studies, 35(6), pp.747-772.

Stalk, G. (1988), "Time- the Next Source of Competitive Advantage", Harvard Business Review, 66(4), pp.41-51.

Stanley, L. L . and Wisner, J. D. (2001), "Service Quality along the Supply Chain: Implications for Purchasing", Journal of Operations Management, 19, pp.287-306.

Stein, T. and Sweat, J. (1998), "Killer Supply Chains", Informationweek, 708 (9), pp.36-46.

Stern, L. and Reve, T. (1980), "Distribution Channels as Political Economies: A Framework for Competitive Analysis", Journal of Marketing, 44, pp.52-64.

Stern, L .W. and El-Ansary, A. I. (1982), Marketing Channels. Englewood Cliffs, NJ: Prentice Hall.

Stevens, G. C. (1989), "Integrating the Supply Chain", International Journal of Physical Distribution and Materials Management, 19(8), pp.3-8.

Stevens, G. C., (1990) "Successful Supply-Chain Management", Management Decision, 28(8), pp. 25-30.

Stock, G. N., Greis, N. P. and Kasarda, J. D. (1998), "Logistics, Strategy and Structure", International Journal of Operations & Production Management, 18 (1), pp.37-52.

Stock, G. N., Greis, N. P. and Kasarda, J. D. (2000), "Enterprise Logistics and Supply Chain Structure: the Role of Fit", Journal of Operations Management, 18, pp.531-547.

Stuart, F. I. (1993), "Supplier Partnerships: Influencing Factors and Strategic Benefits", International Journal of Purchasing and Materials Management, 29(4), pp.22-28.

Stuart, F. I. (1997), "Supply-Chain Strategy: Organizational Influence Through Supplier Alliances", British Academy of Management, 8, pp.223-236.

Supply Chain Council, http://www.supply-chain.org.

Tamas, M. (2000), "Mismatch Strategies: the Weak Link in the Supply Chain", Supply Chain Management: An International Journal, 5(4), pp.171-175.

Tan, K. C. (2001), "A Framework of Supply Chain Management Literature", European Journal of Purchasing and Supply Management, 7(1), pp.39-48.

Tan, K. C., Kannan, V. R. and 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. C., Kannan, V. R., Handfield, R. B., and Ghosh, S. (1999), "Supply Chain Management: an Empirical Study of Its Impact on Performance", International Journal of Purchasing and Material Management, 19(10), pp.1034-1052.

Tattum, L., (1999), "Staying at the Cutting Edge of Supply Chain Practice", Chemical Week, 161(11), pp. s10-s12.

Taylor, D. H. (1999), "Supply Chain Improvement: the Lean Approach", Logistics Focus, Jan/Feb, pp.14-20.

Thomas, C. J. and Riley, D. W. (1987), "Using Inventory for Competitive Advantage through Supply Chain Management", International Journal of Physical Distribution and Logistics Management, 17(2), pp.94-104.

Thomas, D. and Griffin, P. M. (1996), "Coordinated Supply Chain Management", European Journal of operational Research, 94(1), pp.1-15.

Thomas, J. (1999), "Why Your Supply Chain Doesn't Work", Logistics Management and Distribution Report, 38(6), pp.42-44.

Tinsley, H. E. A. and Tinsley, D. J. (1987), "Use of Factor Analysis in Counseling Psychology Research", Journal of Counseling Psychology, 34, pp.414-424.

Tompkins, J. (1998), "Time to Rise above Supply Chain Management", Transportation and Distribution, 39(10), pp. SCF16-SCF 18.

Tompkins, J. and Ang, D. (1999), "What are Your Greatest Challenges Related to Supply Chain Performance Measurement?", IIE Solutions, 31(6), pp. 66.

Towill, D. R. (1997), "The Seamless Chain- the Predator's Strategic Advantage", International Journal of Technology Management, 13(1), pp 37-56.

Tracey, M., Vonderembse, M. A., and Lim, J. S. (1999), "Manufacturing Technology and Strategy Formulation: Keys to Enhancing Competitiveness and Improving Performance", Journal of Operations Management, 17 (4), pp.411-428.

Tracey M. and Smith-Doerflein K. A. (2001), "Supply Chain Management: What Training Professionals Need to Know", Industrial and Commercial Training, 33(3), pp.99-103.

Turner, J. R., (1993) "Integrated Supply Chain Management: What's Wrong with This Picture", Industrial Engineering, 25(12), pp. 52-55.

Van Hoek, R. I. (1998), "Measuring the Unmeasurable"- Measuring and Improving Performance in the Supply Chain", Supply Chain Management, 3(4), pp.187-192.

Van Hoek, R. I., (1999), "Postponement and the Reconfiguration Challenge for Food Supply Chains", Supply Chain Management, 4(1), pp.18-34.

Van Hoek, R. I, Voss, R. I, and Commandeur, H. R. (1999), "Restructuring European Supply Chain by Implementing Postponement Strategies", Long Range Planning, 32(5), pp.505-518.

Varadarajan, P. R. and Cunningham, M. H. (1995), "Strategic Alliances: A Synthesis of Conceptual Foundation", Journal of the Academy of Marketing Science, 23(4), pp.282-296.

Venkatraman, N. and Rananujam, V. (1986), "Measurement of Business Performance in the Absence of Objective Measures", Strategic Management Review, 11(4), pp.801-814.

Vesey, J. T. (1991), "The New Competitors: They Think in Terms of Speed-to-Market", Academy of Management Executive, 5(2), pp.23-33.

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., Droge, C., and Markland, R. E. (1997), "Dimensions of Manufacturing Strength in the Furniture Industry", Journal of Operations Management 15, pp.317-330.

Vickery, S., Calantone, R. and Droge, C., (1999a), "Supply Chain Flexibility: an Empirical Study", The Journal of Supply Chain Management, 35(3), pp. 16-24.

Vickery, S., Droge, C. and Germain, R. (1999b), "The Relationship between Product Customization and Organizational Structure", International Journal of Operations Management, 17(4), pp.377-391.

Vokurka, R. J. and Lummus, R. R. (2000), "The Role of Just-in-Time in Supply Chain Management", International Journal of Logistics Management, 11(1), pp.89-98.

Vonderembse, M. A. and Tracey, M. (1999), "The Impact of Supplier Selection Criteria and Supplier Involvement on Manufacturing Performance", Journal of Supply Chain Management, 35(3), pp.33-39.

Waller, M. A., Dabholkar, P. A., and Gentry, J. J. (2000), "Postponement, Product Customization, and Market-oriented Supply Chain Management", Journal of Business Logistics, 21(2), pp.133-159.

Walton, L. W., (1996), "Partnership Satisfaction: Using the Underlying Dimensions of Supply Chain Partnership to Measure Current and Expected Levels of Satisfaction", Journal of Business Logistics", 17(2), pp.57-75.

Walton, S. V. and Gupta, J. N. D. (1999), "Electronic Data Interchange for Process Change in an Integrated Supply Chain", International Journal of Operations and Production Management, 19(4), pp.372-388.

White, A. G. (1996a), "Supply Chain Link Up Manufacturing Systems", 14 (10), pp.94-98.

White, G. P. (1996b), "A Meta-analysis Model of Manufacturing Capabilities", Journal of Operations Management, 14 (4), pp.315-331.

Williamson, O. (1975), Markets and Hierarchies: Analysis and Antitrust Implications, New York: The Free Press.

Williamson, O. (1985), The Economic Institutions of Capitalism, New York: Free Press.

Williamson, O. E. (1986), Economic Organization, Wheatsheaf Books, Brighton, Sussex.

Wilson, D.T. and Vlosky, R. P. (1998), "Inter-organizational Information System Technology and Buyer-Seller Relationships", Journal of Business and Industrial Marketing, 13(3), pp.215-234.

Wines, L. (1996), "High Order Strategy for Manufacturing", The Journal of Business Strategy, 17(4), pp. 32-33.

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

Wood, A. (1997), "Extending the Supply Chain: Strengthening Links with IT", Chemical Week, 159(25), pp.25-26.

Wood, C. H, Ritzman, L. P., and Sharma, D. (1990), Intended and Achieved Competitive Advantage: Measures, Frequencies, and Financial Impact. In J. E. Ettlie, M. C. Burstein and A. Fiegenbaum (Eds), Manufacturing Strategy: The Research Agenda for the Next Decade. Kluwer, Boston, MA.

Wright, C. (2001), "Supply Chain Management in the E-World", Asiamoney, 12(1), pp.78-83.

Yamin, S., Gunasekruan, A., and Mavondo, F. T. (1999), "Relationship Between Generic Strategy, Competitive Advantage and Firm Performance: an Empirical Analysis", Technovation, 19(8), pp.507-518.

Yoshino, M., Rangan, S. (1995), Strategic Alliances: An Entrepreneurial Approach to Globalization, Boston, MA: Harvard Business School Press.

Young, D., Carr, H. H. and Rainer, R. K., Jr (1999), "Strategic Implications of Electronic Linkages", Information Systems Management, Winter, pp.32-39.

Yu, Z.X., Yan, H. and Cheng, T. C. E. (2001), "Benefits of Information Sharing with Supply Chain Partnerships", Industrial Management and Data Systems, 101(3), pp.114-119.

Zhang, Q. Y. (2001), Technology Infusion Enabled Value Chain Flexibility: a Learning and Capability-Based Perspective, Doctoral Dissertation, University of Toledo, Toledo, OH.

Zielke, A. and Pohl, M. (1996), " Virtual Vertical Integration: the Key to Success", The Mckinsey Quarterly, 3, pp. 160-163.

APPENDIX A: MEASUREMENT ITEMS ENTERING Q-SORT

SCM PRACTICE

Strategic Supplier Partnership

We rely on a few dependable suppliers.
We rely on a few high quality suppliers.
We consider quality as our number one criterion in selecting suppliers.
We strive to establish long-term relationship with our suppliers.
We regularly solve problems jointly with our suppliers.
We have helped our suppliers to improve their product quality.
We have continuous improvement programs that include our key suppliers.
We include our key suppliers in our planning and goal-setting activities.
We actively involve our key suppliers in new product development processes.

Customer Relations

We frequently evaluate the formal and informal complaints of our customers.
We frequently interact with customers to set reliability, responsiveness, and other standards for us.
We have frequent follow-up with our customers for quality/service feedback.
We frequently measure and evaluate customer satisfaction.
We frequently determine future customer expectations.
We facilitate customers' ability to seek assistance from us.
We share a sense of fair play with our customers.
We periodically evaluate the importance of our relationship with our customers.
We involve our customers in product design.

Information Sharing

We share our business units' proprietary information with trading partners.
We inform trading partners in advance of changing needs.
Our trading partners share proprietary information with us.
Our trading partners keep us fully informed about issues that affect our business.
Our trading partners share business knowledge of core business processes with us.
We and our trading partners exchange information that helps establishment of business planning
We and our trading partners keep each other informed about events or changes that may affect the other partners.

Information Quality

Information exchange between our trading partners and us is timely.
Information exchange between our trading partners and us is accurate.
Information exchange between our trading partners and us is complete.
Information exchange between our trading partners and us is adequate.
Information exchange between our trading partners and us is reliable.

Lean System

Our firm pushes suppliers for shorter lead-times.
Our firm uses faster shipping and delivery modes for incoming materials, components or products.
Our firm streamlines ordering, receiving and other paperwork from suppliers.
Suppliers' warehouses/factories are located nearby.
We order in small lot sizes.
Inspection of incoming materials/components/products has been reduced.
Our firm uses fast shipping and delivery modes to our customers.
Our firm simplifies and standardizes communications with customers.
Small lot size orders are placed by customers.

Inspection of outbound materials has been reduced.
We certify our suppliers for quality.
Customers certify us concerning product quality.

Postponement

Our product uses modular design.
Our production process modules can be re-arranged so that customization can be carried out later at distribution centers.
We delay final product assembly activities until customer orders have actually been received.
We delay final product assembly activities until the last possible position (or nearest to customers) in the supply chain.
Our goods are stored at appropriate distribution points close to the customers in the supply chain.

SCM STRATEGY PROCESS

We actively pursue SCM strategy.
We systematically address long-term SCM trends.
We translate business strategy into SCM terms.
We make an effort to anticipate the potential of new SCM practices and technologies.
We have a well-developed SCM strategy.
We have a regular system for monitoring SCM performance.
We derive competitive strength for our business through SCM.
We have a formal process for the implementation of SCM.
We communicate our objectives and strategies of SCM to every employee.

SCM PERFORMANCE

Supply Chain Flexibility

Our supply chain is able to handle difficult nonstandard orders.
Our supply chain is able to meet special customer specification.
Our supply chain is able to produce products characterized by numerous features options, sizes and colors.
Our supply chain is able to rapidly adjust capacity so as to accelerate or decelerate production in response to changes in customer demand.
Our supply chain is able to rapidly introduce large numbers of product improvements/variation.
Our supply chain is able to handle rapid introduction of new products.
Our supply chain is able to effectively provide widespread distribution coverage.
Our supply chain is able to effectively provide intensive distribution coverage.
Our supply chain is able to respond to the needs and wants of the firm's target market(s).

Supply Chain Integration

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 high level of integration of information systems in our firm.
There is a great amount of cross-over of the activities of our firm and our trading partners.
Our supply chain is characterized by full system visibility from suppliers' suppliers to customers' customers.

Responsiveness to Customers

Our firm fills customer orders on time.
Our firm has short lead-time.
Our firm has fast customer response time.

Supplier Performance

Our suppliers deliver materials/components/products to us on time.
Our suppliers provide dependable delivery to us.
Our suppliers provide materials/components/products that are highly reliable.
Our suppliers provide high quality materials/component/products to us.
Our suppliers provide materials/component/products to us at low cost.
Percentage of single sourced items has increased over the past three years in our firm.
Percentage of certified suppliers has increased over the past three years in our firm.

Partnership Quality

We do not wish to terminate current partnerships with trading partners and establish new ones.
We believe our relationship with our trading partners is profitable.
We and our trading partners share any risk that can occur in the supply chain.
We and our trading partners share benefits obtained from SCM.
Our relationship with trading partners is marked by a high degree of harmony.
Our overall relationship with trading partners is satisfactory.

PARTNER RELATIONSHIP

Trust in Trading Partners

Our trading partners have been open and honest in dealing with us.
Our trading partners are reliable.
Our trading partners respect the confidentiality of the information they receive from us.
Our transactions with trading partners do not have to be closely supervised.
Our trading partners have made sacrifices for us in the past.
Our trading partners are willing to provide assistance to us without exception.

Commitment of Trading Partners

We expect our relationship with our trading partners to continue for a long time.
We expect our relationship with our trading partners to strengthen over time.
We are willing to put in considerable investment into building our business with our trading partners.
We expect to increase business with our trading partners in the future.
We have invested a lot of effort in our relationship with trading partners.
Our trading partners abide by agreements very well.
We and our trading partners always try to keep each others' promises.

Shared Vision between Trading Partners

We and our trading partners understand each others' business policies and rules very well.
We and our trading partners have a similar understanding about the aims and objectives of the supply chain.
We and our trading partners have a similar understanding about the importance of collaboration across the supply chain.
We and our trading partners have a similar understanding about the importance of improvements that benefit the supply chain as a whole.

APPENDIX B: COHEN'S KAPPA AND MORRE 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 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		
		Acceptable	Rejectable	Totals
Judge 2	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., $\Sigma_i P_{ii} = P_{11} + P_{22}$. However, Cohen suggested comparing the actual agreement, $\Sigma_i P_{ii}$, with the chance of agreement that would occur if the row and columns are independent, i.e., $\Sigma_i P_{i+}P_{+i}$. The difference between the actual and chance agreements, $\Sigma_i P_{ii} - \Sigma_i P_{i+}P_{+i}$, 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., $100\% - \Sigma_i P_i + P_{+I} = 1 - \Sigma_i P_i + P_{+i}$. 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 judgement 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:

p_o= the proportion of units in which the judges agreed
p_c= 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 $\Sigma P_{ii} = 0$, 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 Ration") 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, but be hesitant about accepting any scale based on row B. In an examination of off-diagonal entries indicate 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 AFTER Q-SORT

SCM PRACTICE

Strategic Supplier Partnership

We rely on a few dependable suppliers.
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We certify our suppliers for quality.

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Information exchange between our trading partners and us is reliable.

Lean System

Our firm pushes suppliers for shorter lead-times.
Our firm has continuous quality improvement program.
Our firm uses a "Pull" production system
Our firm pushes suppliers for shorter lead-times.
Our firm streamlines ordering, receiving and other paperwork from suppliers.
Suppliers' warehouses/factories are located nearby.
We order in small lot sizes.
Inspection of incoming materials/components/products has been reduced.
Inspection of outbound materials has been reduced.

We involve our customers in process/product design

Postponement

Our product uses modular design.
Our production process modules can be re-arranged so that customization can be carried out later at distribution centers.
We delay final product assembly activities until customer orders have actually been received.
We delay final product assembly activities until the last possible position (or nearest to customers) in the supply chain.
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We have a regular system for monitoring SCM performance.
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We have a formal process for the implementation of SCM.
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Our firm has short lead-time.
Our firm has fast customer response time.

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Our suppliers provide dependable delivery to us.
Our suppliers provide materials/components/products that are highly reliable.

Our suppliers provide high quality materials/component/products to us.
Our suppliers provide materials/component/products to us at low cost.
Our supplier base has reduced over the past three years.

Partnership Quality

We do not wish to terminate current partnerships with trading partners and establish new ones.
We believe our relationship with our trading partners is profitable.
We and our trading partners share any risk that can occur in the supply chain.
We and our trading partners share benefits obtained from SCM.
Our relationship with trading partners is marked by a high degree of harmony.
Our overall relationship with trading partners is satisfactory.

PARTNER RELATIONSHIP

Trust in Trading Partners

Our trading partners have been open and honest in dealing with us.
Our trading partners are reliable.
Our trading partners respect the confidentiality of the information they receive from us.
Our transactions with trading partners do not have to be closely supervised.

Commitment of Trading Partners

Our trading partners have made sacrifices for us in the past.
Our trading partners are willing to provide assistance to us without exception.
We expect to increase business with our trading partners in the future.
We have invested a lot of effort in our relationship with trading partners.
Our trading partners abide by agreements very well.
We and our trading partners always try to keep each others' promises.

Shared Vision between Trading Partners

We and our trading partners understand each others' business policies and rules very well.
We and our trading partners have a similar understanding about the aims and objectives of the supply chain.
We and our trading partners have a similar understanding about the importance of collaboration across the supply chain.
We and our trading partners have a similar understanding about the importance of improvements that benefit the supply chain as a whole.

APPENDIX D: LARGE-SCALE MAIL SURVEY QUESTIONNAIRE

A STUDY OF SUPPLY CHAIN MANAGEMENT PRACTICES, PERFORMANCE AND COMPETITIVE ADVANTAGE

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All RESPONSES WILL BE KEPT CONFIDENTIAL. DATA WILL BE USED FOR STATISTICAL ANALYSIS ONLY.

A SURVEY OF SUPPLY CHAIN MANAGEMENT PRACTICE AND PERFORMANCE

Supply Chain Management (SCM) is the systemic, strategic coordination of the traditional business functions and tactics across these business functions within a particular company, and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole.

Trading partner (same as strategic partner) refers to any external organization that plays an integral and critical role in the enterprise and whose business fortune depends all or in part on the success of the enterprise. This includes customers, suppliers, contract manufacturers, subassembly plants, distribution centers, wholesalers, retailers, carriers, freight forwarder service and so on.

Unless otherwise specifically requested, please use the following scale to answer each item:

1	2	3*	4	5	6
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Applicable

In this scale, 3 represents the following: neutral, neither agree or disagree, moderate or average level as the case may be.

About the Environment of Your Firm

With regard to the perceived environmental uncertainty of your firm, please circle the appropriate number that accurately reflects your firm's PRESENT conditions.

Customers' needs are unpredictable	1	2	3	4	5	6
Customers' requirements regarding product features are difficult to forecast	1	2	3	4	5	6
Customers order different product combinations over the year	1	2	3	4	5	6
Customers' product preferences change over the year	1	2	3	4	5	6
The properties of materials from suppliers can vary greatly within the same batch	1	2	3	4	5	6
Suppliers' engineering level is unpredictable	1	2	3	4	5	6
Suppliers' product quality is unpredictable	1	2	3	4	5	6
Suppliers' delivery time can easily go wrong	1	2	3	4	5	6
Suppliers' delivery quantity can easily go wrong	1	2	3	4	5	6
Competitors' actions are unpredictable	1	2	3	4	5	6
Competition is intensified in our industry	1	2	3	4	5	6
Competitors are from different industries	1	2	3	4	5	6
Competitors are from different countries	1	2	3	4	5	6
Competitors often introduce new product unexpectedly	1	2	3	4	5	6
Technology is changing significantly in our industry	1	2	3	4	5	6
Technological changes provide opportunities for enhancing competitive advantage in our industry	1	2	3	4	5	6
Technological breakthrough results in many new product ideas in our industry	1	2	3	4	5	6
Improving technology generates new products frequently in our industry	1	2	3	4	5	6

About Top Management Support for SCM in Your Firm

With regard to top management support for SCM, please circle the appropriate number that accurately reflects your firm's PRESENT conditions.

Top management is interested in our relationship with our trading partners	1	2	3	4	5	6
Top management considers the relationship between us and our trading partners to be important	1	2	3	4	5	6
Top management supports SCM with the resources we need	1	2	3	4	5	6
Top management regards SCM as a high priority item	1	2	3	4	5	6
Top management participates in SCM and its optimization	1	2	3	4	5	6

About the SCM Strategy Process in Your Firm

SCM strategy refers to the design and blueprint that frames the acquisition and development of supply chain capability into the future. This study focuses on the process of the SCM strategy, that is, how well SCM strategy is aligned and implemented in your firm.

With regard to SCM strategy process in your firm, please circle the number that accurately reflects your firm's PRESENT conditions.

We actively pursue SCM strategy	1	2	3	4	5	6
We systematically address long-term SCM trends	1	2	3	4	5	6

Unless otherwise specifically requested, please use the following scale to answer each item:

1	2	3	4	5	6
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Applicable

We translate business strategy into SCM terms	1	2	3	4	5	6
We make an effort to anticipate the potential of new SCM practices and technologies	1	2	3	4	5	6
We have a well-developed SCM strategy	1	2	3	4	5	6
We have a regular system for monitoring SCM performance	1	2	3	4	5	6
We derive competitive strength for our business through SCM	1	2	3	4	5	6
We have a formal process for the implementation of SCM	1	2	3	4	5	6
We communicate our objectives and strategies of SCM to all concerned employee	1	2	3	4	5	6

About SCM Practices in Your Firm

With regard to SCM practices, please circle the number that accurately reflects your firm's PRESENT conditions.

STRATEGIC SUPPLIER PARTNERSHIP

We rely on a few dependable suppliers	1	2	3	4	5	6
We rely on a few high quality suppliers	1	2	3	4	5	6
We consider quality as our number one criterion in selecting suppliers	1	2	3	4	5	6
We strive to establish long-term relationship with our suppliers	1	2	3	4	5	6
We regularly solve problems jointly with our suppliers	1	2	3	4	5	6
We have helped our suppliers to improve their product quality	1	2	3	4	5	6
We have continuous improvement programs that include our key suppliers	1	2	3	4	5	6
We include our key suppliers in our planning and goal-setting activities	1	2	3	4	5	6
We actively involve our key suppliers in new product development processes	1	2	3	4	5	6
We certify our suppliers for quality	1	2	3	4	5	6

CUSTOMER RELATIONS PRACTICES

We frequently evaluate the formal and informal complaints of our customers	1	2	3	4	5	6
We frequently interact with customers to set reliability, responsiveness, and other standards for us	1	2	3	4	5	6
We have frequent follow-up with our customers for quality/service feedback	1	2	3	4	5	6
We frequently measure and evaluate customer satisfaction	1	2	3	4	5	6
We frequently determine future customer expectations	1	2	3	4	5	6
We facilitate customers' ability to seek assistance from us	1	2	3	4	5	6
We share a sense of fair play with our customers	1	2	3	4	5	6
We periodically evaluate the importance of our relationship with our customers	1	2	3	4	5	6

INFORMATION SHARING

We share our business units' proprietary information with trading partners	1	2	3	4	5	6
We inform trading partners in advance of changing needs	1	2	3	4	5	6
Our trading partners share proprietary information with us	1	2	3	4	5	6
Our trading partners keep us fully informed about issues that affect our business	1	2	3	4	5	6
Our trading partners share business knowledge of core business processes with us	1	2	3	4	5	6
We and our trading partners exchange information that helps establishment of business planning	1	2	3	4	5	6
We and our trading partners keep each other informed about events or changes that may affect the other partners	1	2	3	4	5	6

INFORMATION QUALITY

Information exchange between our trading partners and us is timely	1	2	3	4	5	6

Unless otherwise specifically requested, please use the following scale to answer each item:

1	2	3	4	5	6
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Applicable

Information exchange between our trading partners and us is accurate	1	2	3	4	5	6
Information exchange between our trading partners and us is complete	1	2	3	4	5	6
Information exchange between our trading partners and us is adequate	1	2	3	4	5	6
Information exchange between our trading partners and us is reliable	1	2	3	4	5	6
LEAN SYSTEM						
Our firm reduces set-up time	1	2	3	4	5	6
Our firm has continuous quality improvement program	1	2	3	4	5	6
Our firm uses a "Pull" production system	1	2	3	4	5	6
Our firm pushes suppliers for shorter lead-times	1	2	3	4	5	6
Our firm streamlines ordering, receiving and other paperwork from suppliers	1	2	3	4	5	6
Suppliers' warehouses/factories are located nearby	1	2	3	4	5	6
We order in small lot sizes from our suppliers	1	2	3	4	5	6
Inspection of incoming materials/ components/products has been reduced	1	2	3	4	5	6
Inspection of outbound materials has been reduced	1	2	3	4	5	6
We involve our customers in process/ product design	1	2	3	4	5	6
POSTPONEMENT						
Our products are designed for modular assembly	1	2	3	4	5	6
Our production process modules can be re-arranged so that customization can be carried out later at distribution centers	1	2	3	4	5	6
We delay final product assembly activities until customer orders have actually been received	1	2	3	4	5	6
We delay final product assembly activities until the last possible position (or nearest to customers) in the supply chain	1	2	3	4	5	6
Our goods are stored at appropriate distribution points close to the customers in the supply chain	1	2	3	4	5	6

About Partner Relationship Facilitating SCM

With regard to your partner relationship facilitating SCM, please circle the number that accurately reflects your firm's PRESENT conditions.

TRUST IN TRADING PARTNERS						
Our trading partners have been open and honest in dealing with us	1	2	3	4	5	6
Our trading partners are reliable	1	2	3	4	5	6
Our trading partners respect the confidentiality of the information they receive from us	1	2	3	4	5	6
Our transactions with trading partners do not have to be closely supervised	1	2	3	4	5	6
COMMITMENT OF TRADING PARTNERS						
Our trading partners have made sacrifices for us in the past	1	2	3	4	5	6
Our trading partners are willing to provide assistance to us without exception	1	2	3	4	5	6
We expect to increase business with our trading partners in the future	1	2	3	4	5	6
We have invested a lot of effort in our relationship with trading partners	1	2	3	4	5	6
Our trading partners abide by agreements very well	1	2	3	4	5	6
We and our trading partners always try to keep each others' promises	1	2	3	4	5	6
SHARED VISION BETWEEN TRADING PARTNERS						
We and our trading partners understand each others' business policies and rules very well	1	2	3	4	5	6
We and our trading partners have a similar understanding about the aims and objectives of the supply chain	1	2	3	4	5	6
We and our trading partners have a similar understanding about the importance of collaboration across the supply chain	1	2	3	4	5	6
We and our trading partners have a similar						

Unless otherwise specifically requested, please use the following scale to answer each item:

1	2	3	4	5	6
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Applicable

understanding about the importance of improvements that benefit the supply chain as a whole	1	2	3	4	5	6

About the Performance of Your SCM

With regard to the ACTUAL level of the performance of your SCM, please circle the appropriate number to indicate the extent to which you agree or disagree with each statement

SUPPLY CHAIN FLEXIBILITY

Our supply chain is able to handle difficult nonstandard orders	1	2	3	4	5	6
Our supply chain is able to meet special customer specification	1	2	3	4	5	6
Our supply chain is able to produce products characterized by numerous features options, sizes and colors	1	2	3	4	5	6
Our supply chain is able to rapidly adjust capacity so as to accelerate or decelerate production in response to changes in customer demand	1	2	3	4	5	6
Our supply chain is able to rapidly introduce large numbers of product improvements/variation	1	2	3	4	5	6
Our supply chain is able to handle rapid introduction of new products	1	2	3	4	5	6
Our supply chain is able to respond to the needs and wants of the firm's target market(s)	1	2	3	4	5	6

SUPPLY CHAIN INTEGRATION

There is a high level of communication and coordination between all functions in our firm	1	2	3	4	5	6
Cross-functional teams are frequently used for process design and improvement in our firm	1	2	3	4	5	6
There is a high level of integration of information systems in our firm	1	2	3	4	5	6
There is a great amount of cross-over of the activities of our firm and our trading partners	1	2	3	4	5	6
Our supply chain is characterized by full system visibility from suppliers' suppliers to customers' customers	1	2	3	4	5	6

RESPONSIVENESS TO CUSTOMERS

Our firm fills customer orders on time	1	2	3	4	5	6
Our firm has short order-to-delivery cycle time	1	2	3	4	5	6
Our firm has fast customer response time	1	2	3	4	5	6

SUPPLIER PERFORMANCE

Our suppliers deliver materials/ components/products to us on time	1	2	3	4	5	6
Our suppliers provide dependable delivery to us	1	2	3	4	5	6
Our suppliers provide materials/ components/products that are highly reliable	1	2	3	4	5	6
Our suppliers provide high quality materials/component/products to us	1	2	3	4	5	6
Our suppliers provide materials/ component/products to us at low cost	1	2	3	4	5	6
Our supplier base has reduced over the past three years	1	2	3	4	5	6

PARTNERSHIP QUALITY

We do not wish to terminate current partnerships with trading partners and establish new ones	1	2	3	4	5	6
We believe our relationship with our trading partners is profitable	1	2	3	4	5	6
We and our trading partners share any risk that can occur in the supply chain	1	2	3	4	5	6
We and our trading partners share benefits obtained from SCM	1	2	3	4	5	6
Our relationship with trading partners is marked by a high degree of harmony	1	2	3	4	5	6
Our overall relationship with trading partners is satisfactory	1	2	3	4	5	6

Unless otherwise specifically requested, please use the following scale to answer each item:

1	2	3	4	5	6
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Applicable

About the Global Performance of the supply chain

With regard to global performance of the supply chain your firm is in compared with INDUSTRY AVERAGE, please circle the appropriate number which best indicates your perception of each item.

1	2	3	4	5	6
Much Below	Below	Same	Above	Much Above	Not Applicable

Sum of days of inventory at all nodes of the supply chain	1	2	3	4	5	6
Sum of total costs at all nodes of the supply chain	1	2	3	4	5	6

About the Competitive Advantage of Your Firm

With regard to competitive advantage of your firm, please circle the appropriate number to indicate the extent to which you agree or disagree with each statement.

We offer competitive price	1	2	3	4	5	6
We are able to offer price as low or lower than our competitors	1	2	3	4	5	6
We provide customized products	1	2	3	4	5	6
We alter our product offerings to meet client needs	1	2	3	4	5	6
We respond well to customer demand for "new" features	1	2	3	4	5	6
We deliver the kind of products needed	1	2	3	4	5	6
We deliver customer orders on time	1	2	3	4	5	6
We provide dependable delivery	1	2	3	4	5	6
We are able to compete based on quality	1	2	3	4	5	6
We offer products that are highly reliable	1	2	3	4	5	6
We offer products that are highly durable	1	2	3	4	5	6
We offer high quality products to our customers	1	2	3	4	5	6
We deliver product to market quickly	1	2	3	4	5	6
We are first in the market in introducing new products	1	2	3	4	5	6
We have our time-to-market lower than industry average	1	2	3	4	5	6
We have fast product development	1	2	3	4	5	6

About Performance of Your Firm

As a result of SCM practices in your firm, please circle appropriate number which best indicates your firm's overall performance.

1	2	3	4	5	6
Significant Decrease	Decrease	Same as Before	Increase	Significant Increase	Not Applicable

Market share	1	2	3	4	5	6
Return on investment	1	2	3	4	5	6
The growth of market share	1	2	3	4	5	6
The growth of sales	1	2	3	4	5	6
Growth in return on investment	1	2	3	4	5	6
Profit margin on sales	1	2	3	4	5	6
Overall competitive position	1	2	3	4	5	6

About the Information Technology (IT) Enablers Used in Your Supply Chain

Please indicate the extent of usage of the following IT tools in your firm to facilitate supply chain management (please see page 8 for the definition of each IT tool).

1	2	3	4	5
Not at all	To a small extent	To a moderate extent	To a considerable extent	To a great extent

EDI_____ EFT____ Internet _____ Intranet _____
Extranet _____ MRP____ MRPII_____ DRP_____
ERP _____ CRM____ SRM_____ VMI _____
DW_____ SCM Software _____

Please indicate the extent of usage of the following IT tools by ALL your trading partners (Note: All your trading partners may not use the same IT tools. Here we try to find common tools used by all your trading partners):

EDI_____ EFT____ Internet _____ Intranet _____
Extranet _____ MRP____ MRPII_____ DRP_____
ERP _____ CRM____ SRM_____ VMI _____
DW_____ SCM Software _____

General Information about Your Firm
For the following question, please check the appropriate response.

1) Has your organization embarked upon a program aimed specially at implementing "Supply Chain Management"?
_____ Yes _____ No.
If your answer is Yes, how long ? _____ years.

2) Please indicate your 4-digit SIC code _____

3) The number of product lines your firm makes_____

4) Your primary production system (choose most appropriate one)
____Engineer to Order _____Make to Order
____Assemble to Order _____Make to Stock

5) Number of employees in your company:
___ 1 -50 ___ 51-100 ___ 101-250
___251-500 ___ 501 -1000 ___ Over 1000

6) Average annual sales of your company in millions of $:
___ Under 5 ___5 to <10 ____10 to <25
___25 to <50 ___ 50 to <100 ____ >100

7) Your present job title:
____CEO/president _____Director
____Manager _____Other (please indicate_____)

8) Your present job function (mark all that apply):
_____ Corporate Executive _____ Purchasing
_____ Manufacturing Production _____ Distribution
_____ Transportation _____ Sales
_____ Other (please indicate _____)

9) The years you have stayed at this organization:
_____ under 2 years _____2-5 years
_____ 6-10 years _____over 10 years

10) Please rank the importance of the following factors (from 1-most important to 5-least important) in selecting your suppliers (use each number only once)
_____ Cost _____Quality _____Lead time
_____ On time delivery _____ Delivery reliability

11) What percentage of your business transactions with your customers is done electronically?
_____ Less than 10% _____10-30% _____30-50%
_____50-80% _____More than 80%

12) What percentage of your business transactions with your suppliers is done electronically?
_____ Less than 10% _____10-30% _____30-50%
_____50-80% _____ More than 80%

13) Please indicate the number of tiers across your supply chain.
____<= 3 _____4-5 _____ 6-7 _____ 8-10 ____ >10

14) Please mark the position of your company in the supply chain (mark all that apply).
_____ Raw material supplier _____Component supplier
_____ Assembler ____ Sub-assembler
_____ Manufacturer _____ Distributor
_____Wholesaler _____ Retailer

15) Supply chain channel includes direct, indirect and virtual channel. Please mark one that best describes the main supply chain channel your firm is in. (please see the explanation of each supply chain channel on page 8).

_____Direct Channel _____Indirect Channel
_____Virtual Channel

16) Some supply chains have a Channel Master (Hub Company). Channel Master is a company that determines the structure and operation of the whole supply chain, and coordinates the activities across it. Does the supply chain your firm is in have a Channel Master? ____ Yes ____ No.
If your answer is Yes, is your firm the Channel Master in the supply chain? _____Yes _____ No

17) The following items are used to measure SCM performance. Based on your opinion, please rank the importance of 13 items from 1 (high) to 13 (low) on the ***Imprt.*** column. Also check whether each item is used in your firm in ***Used*** column and if used, please fill in the ACTUAL SCM performance if you know in the last column.

Supply Chain Performance	*Imprt.*	*Used*	*Actual Performance*
Delivery Performance to Commit Date	☐	☐	_____%
Fill Rate	☐	☐	_____%
Perfect Order Fulfillment	☐	☐	_____%
Order Fulfillment Lead time	☐	☐	_____Days
Supply Chain Response Time	☐	☐	_____Days
Production Flexibility	☐	☐	_____Days
Cash-to-Cash Cycle Time	☐	☐	_____Days
Inventory Days of Supply	☐	☐	_____Days
Net Asset Turns (Working Capital)	☐	☐	_____Turns
Cost of Goods Sold	☐	☐	
Total Supply Chain Management Costs	☐	☐	
Value-added Productivity	☐	☐	
Warranty/Returns Processing Costs	☐	☐	

THANK YOU FOR YOUR ASSISTANCE IN THIS PROJECT!

Definitions of Channels

Indirect Channel: finished goods from the factory flow to the end customer through distribution center and wholesaler and retailer trading partners; each of these pairs is connected by a logistics service provider.

Direct Channel: the factory produces part of the product and outsources part of the product to the contract manufacturers. Then factory connects directly with the end customer through a logistics service provider.

Virtual Channel: the factory produces part of the product and outsources part (sometime, all) of the product to the contract manufacturers. Then factory connects directly with the end customer through the Internet. Customers use the Internet to shop for products and place their orders.

Definitions of IT Tools

Electronic Data Interchange (EDI): The transfer of data in an agreed electronic format from one organization's computer program to one or more organizations, companies or programs.

Electronic Fund Transfer (EFT): The transfer of a certain amount of money from one account to another through VAN or Internet.

Internet: A public and global communication network that provides direct connectivity to anyone over a local area network (LAN) or Internet service provider (ISP).

Intranet: A corporate LAN or wide area network (WAN) that uses Internet technology and is secured behind company's firewalls. The intranet supports and promotes more effective internal information sharing and a company's internal business processes.

Extranet: A collaborated network that uses Internet technology to link businesses with their supply chain and provides a degree of security and privacy from competitors.

Materials Requirement Planning (MRP): A scheduling technique for establishing and maintaining valid due dates and priorities for orders based on bills of material, inventory, order data, and the master production schedule.

Manufacturing Resources Planning (MRPII): A direct outgrowth and extension of closed-loop material requirements planning (MRP or MRP I) through the integration of business plans, purchase commitment reports, sales objectives, manufacturing capabilities, and cash-flow constraints.

Distribution Requirement Planning (DRP): This system ties warehousing operations to transportation and reconciles forecast demand with transportation capacity and inventory.

Enterprise Resource Planning (ERP): the installation of a single system that covers many information-processing needs typically handled by separate systems. ERP systems unite functions such as order management, inventory control, production planning, and financials under one integrated suite.

Customer Relationship Management (CRM): The software is designed to integrate a company's sales, marketing, and customer support functions in order to better serve the customer, while at the same time making the information available throughout the organization.

Supplier Relationship Management (SRM): The software is designed to optimize sourcing, design and procurement processes in collaboration with the suppliers.

Vendor Managed Inventory (VMI): A supply-chain initiative where the vendor monitors the buyer's inventory levels and makes periodic re-supply decisions.

Data Warehouse (DW): a database of databases capable of bringing all of a firm's data together into one gigantic database.

SCM Software: a suite of decision support solutions for better planning, execution and optimization of the supply chain. SCM software may include strategic planning, demand management, supply management, fulfillment planning/execution, warehouse management, transportation management, and so on. The major vendors of SCM software include I2 Technologies, Manugistics, and Peoplesoft.

If you would like to receive the summary of results of this research, please complete the following details or attach your business card:

Your Name: _____

Business Name: _____

_____

Address: _____

_____

City: _____ State: _____

Zip Code: _____

Tel: _____ Fax: _____

E-mail: _____

APPENDIX E: ACRONYMS USED FOR CODING OF ITEMS IN EACH SUB-CONSTRUCT

EU	**Environmental Uncertainty**	
	EU/CU	Customer Uncertainty
	EU/SU	Supplier Uncertainty
	EU/COU	Competitor Uncertainty
	EU/TU	Technology Uncertainty
TMS	**Top Management Support**	
SCMSP	**SCM Strategy Process**	
PR	**Partner Relationship**	
	PR/TRU	Trust in Trading Partners
	PR/COM	Commitment of Trading Partners
	PR/VIS	Shared Vision between Trading Partners
IT	**Usage of IT Tools**	
	IT/CT	Communication Tools
	IT/RPT	Resource Planning Tools
	IT/SCMT	Supply Chain Management Tools
SCMP	**Supply Chain Management Practices**	
	SCMP/SSP	Strategic Supplier Partnership
	SCMP/CRP	Customer Relationship Practice
	SCMP/IS	Information Sharing
	SCMP/IQ	Information Quality
	SCMP/LS	Lean System
	SCMP/POS	Postponement
SCMPER	**Supply Chain Management Performance**	
	PER/SCF	Supply Chain Flexibility
	PER/SCI	Supply Chain Integration
	PER/CR	Customer Responsiveness
	PER/SP	Supplier Performance
	PER/PQ	Partnership Quality
CA	**Competitive Advantage**	
	CA/PC	Price/Cost
	CA/PI	Production Innovation
	CA/DD	Delivery Dependability
	CA/QL	Quality
	CA/TM	Time to Market
OP	**Organizational Performance**	

APPENDIX F: DESCRIPTION OF MODIFICATION PROCESS AND ASSESSMENT OF UNIDIMENSIONALITY AND CONVERGENT VALIDITY OF SCM CONSTRUCTS

Items	Fit Indices

Section A: 1. Environmental Uncertainty - Supplier Uncertainty

Initial Model (SU1, SU2, SU3, SU4, SU5) χ^2 = 28.16 P=.00 GFI=.95 AGFI=.84 NFI=.92

Although all λ coefficient were good, the AGFI (.84) was a little low indicating possibility of error correlation. The modification index indicated moderate error correlation between SU4 and SU5 (25.38). It was decided to drop item SU5 since, on an examination of the description of the two items, it appeared that item SU4 subsumes SU5.

Iteration 1 (SU1, SU2, SU3, SU4) χ^2 = .61 P=.74 GFI=1.00 AGFI=.99 NFI=1.00

The final 4-item model had both satisfactory λ coefficient and excellent model fit. Therefore no further modifications were done. The items are listed below.

Supplier Uncertainty

SU1: The properties of materials from suppliers can vary greatly within the same batch.
SU2: Suppliers' engineering level is unpredictable.
SU3: Suppliers' product quality is unpredictable.
SU4: Suppliers' delivery time can easily go wrong.
SU5:* Suppliers' delivery quantity can easily go wrong.

Section A: 2. Environmental Uncertainty - Customer Uncertainty

Initial Model (CU3, CU4)

Iteration 1 (CU3, CU4) (SU1, SU2, SU3, SU4) χ^2 = 6.66 P=.57 GFI=.99 AGFI=.97 NFI=.98

Since this factor had only two items model fit statistics could not be obtained. To address this problem two-factor model was tested by adding the items of Supplier Uncertainty. (Note: the items of Supplier Uncertainty were added only to provide a common basis for comparison and to keep items in sufficient numbers so that model fit statistics could be obtained.) The final model had both satisfactory λ coefficient and excellent model fit. Therefore no further modifications were done. The items are listed below.

Customer Uncertainty

CU3: Customers order different product combinations over the year.
CU4: Customers' product preferences change over the year.

Section A: 3. Environmental Uncertainty - Technology Uncertainty

Initial Model (TU1, TU2, TU3, TU4) χ^2 = 9.79 P=.00 GFI=.98 AGFI=.88 NFI=.97

Although all λ coefficient were good, the AGFI (.88) was a little blow .90 indicating possibility of error correlation. A model run with either one of these four items removed would not have yielded model fit statistics since only three times remained resulting in the degrees of freedom being zero. Two two-factor models were tested by adding the items of Supplier Uncertainty.

Iteration 1 (TU1, TU2, TU3, TU4)
(SU1, SU2, SU3, SU4) χ^2 = 38.74 P=.00 GFI=.95 AGFI=.91 NFI=.93

Iteration 2 (TU2, TU3, TU4)
(SU1, SU2, SU3, SU4) χ^2 = 25.00 P=.02 GFI=.96 AGFI=.92 NFI=.95

The model tested in iteration 1 includes the items from Supplier Uncertainty and the items from the initial model of Technology Uncertainty. The model in iteration 2 also has all the items from Supplier Uncertainty and all except item TU1 from Technology Uncertainty. Given the indicated high error correction between items TU1 and TU2 it was decided to drop item TU1, it appeared that TU1 is too general and is already included in other items. The model resulting from iteration 2 showed significant improvement. No further modifications were done. The items are listed below.

Technology Uncertainty

TU1:* Technology is changing significantly in our industry.
TU2: Technological changes provide opportunities for enhancing competitive advantage in our industry.
TU3: Technological breakthrough results in many new product ideas in our industry.
TU4: Improving technology generates new products frequently in our industry.

Section B: Top Management Support for SCM

Initial Model (TMS1, TMS2, TMS3, TMS4, TMS5) χ^2 = 117.55 P=.00 GFI=.81 AGFI=.42 NFI=.86

Although all λ coefficient were good (above .78), the AGFI (.42) was low indicating possibility of error correlation. The modification index indicated high error correlation between TMS1 and TMS2 (114.53). It was decided to drop item TMS1 since, on an examination of the description of the two items, it appeared that item TMS2 subsumes TMS1.

Iteration 1 (TMS2, TMS3, TMS4, TMS5) χ^2 = 2.46 P=.29 GFI=.99 AGFI=.97 NFI=1.00

The final 4-item model had both satisfactory λ coefficient and excellent model fit. Therefore no further modifications were done. The items are listed below.

Top Management Support for SCM

TMS1:* Top management is interested in our relationship with our trading partners.
TMS2: Top management considers the relationship between us and our trading partners to be important.
TMS3: Top management supports SCM with the resources we need.
TMS4: Top management regards SCM as a high priority item.
TMS5: Top management participates in SCM and its optimization.

Section C: SCM Strategy Process

Initial Model (SCMSP1, SCMSP2, SCMSP3, SCMSP4, SCMSP5, SCMSP6, SCMSP7, SCMSP8, SCMSP9) χ^2 = 95.19 P=.00 GFI=.90 AGFI=.84 NFI=.94

Although all λ coefficient were good (above .75), the AGFI (.84) was a little low indicating possibility of error correlation. The modification index indicated some moderately error correlation between item SCMSP5 and SCMSP8 (17.05), and item SCMSP1 and SCMSP2 (10.98). Given the higher error correlation between item SCMSP5 and SCMSP8, it was decided to first drop item SCMSP5 since, on an examination of the description of the two items, SCMSP5 seemed too general and was already measured by the other items.

Iteration 1 (SCMSP1, SCMSP2, SCMSP3, SCMSP4, SCMSP6, SCMSP7, SCMSP8, SCMSP9) χ^2 = 62.71 P=.00 GFI=.93 AGFI=.87 NFI=.95

The model resulting from iteration 1 showed the improvements in all fit indices. However, the modification index still indicated some moderately error correlation between SCMSP6 and SCMSP7 (13.05), and SCMSP3 and SCMSP6 (10.46). It was decided to drop SCMSP6, since this item has error correlation with the other two.

Iteration 2 (SCMSP1, SCMSP2, SCMSP3, SCMSP4, SCMSP7, SCMSP8, SCMSP9) χ^2 = 28.44 P=.00 GFI=.96 AGFI=.92 NFI=.97

The model resulting from iteration 2 showed significant improvement in all fit indices. No Further modifications were done.

SCM Strategy Process

SCMSP1:	We actively pursue SCM strategy.
SCMSP2:	We systematically address long-term SCM trends.
SCMSP3:	We translate business strategy into SCM terms.
SCMSP4:	We make an effort to anticipate the potential of new SCM practices and technologies.
SCMSP5:*	We have a well-developed SCM Strategy.
SCMSP6:*	We have a regular system for monitoring SCM performance.
SCMSP7:	We derive competitive strength for our business through SCM.
SCMSP8:	We have a formal process for the implementation of SCM.
SCMSP9:	We communicate our objectives and strategies of SCM to all concerned employee.

Section D: 1. Partner Relationship-Commitment of Trading Partners

Initial Model (COM1, COM2, COM3, COM4, COM5, COM6) χ^2 = 68.37 P=.00 GFI=.90 AGFI=.76 NFI=.84

λ coefficient of item COM3 and COM4 in the above model were very low (.32 and .37 respectively). On an examination of the two items, it appears that the meaning of item COM3 appears a little vague since "we expect to..." does not necessarily mean actual

commitment. COM3 was thus dropped for the next iteration.

Iteration 1 (COM1, COM2, COM4, COM5, COM6) χ^2 = 30.54 P=.00 GFI=.94 AGFI=.82 NFI=.92

The model resulting from iteration 1 showed the improvements in all fit indices. However, the modification index still indicated some moderately error correlation between COM1 and COM2 (28.26), It was decided to drop COM2, based on the examination of the description of the two items, it appeared that COM2 ("Our trading partners are willing to ...") might not be a good measure of commitment compared with COM1 ("Our trading partners have made....").

Iteration 2 (COM1, COM4, COM5, COM6) χ^2 = 1.94 P=.37 GFI=1.00 AGFI=.98 NFI=.99

The final 4-item model had both satisfactory λ coefficient and excellent model fit. Therefore no further modifications were done. The items are listed below.

Commitment of Trading Partners

COM1: Our trading partners have made sacrifices for us in the past.
COM2:* Our trading partners are willing to provide assistance to us without exception.
COM3:* We expect to increase business with our trading partners in the future.
COM4: We have invested a lot of effort in our relationship with trading partners.
COM5: Our trading partners abide by agreements very well.
COM6: We and our trading partners always try to keep each others' promises.

Section D: 2. Partner Relationship- Trust in Trading Partners

Initial Model (TRU1, TRU2, TRU3, TRU4) χ^2 = 26.17 P=.00 GFI=.94 AGFI=.69 NFI=.93

Although all λ coefficient were good, the AGFI (.69) was very low indicating possibility of error correlation. A model run with either one of these four items removed would not have yielded model fit statistics since only three items remained resulting in the degrees of freedom being zero. Two two-factor models were tested by adding the items of Commitment of Trading Partners.

Iteration 1 (TRU1, TRU2, TRU3, TRU4)
(COM1, COM4, COM5, COM6) χ^2 = 43.52 P=.00 GFI=.95 AGFI=.90 NFI=.94

Iteration 2 (TRU1, TRU3, TRU4)
(COM1, COM4, COM5, COM6) χ^2 = 13.27 P=.43 GFI=.98 AGFI=.96 NFI=.98

The model tested in iteration 1 included the items from Commitment of Trading Partners and the items from the initial model of Trust in Trading Partners. The model in iteration 2 also has all the items from Commitment of Trading Partners and all except item TRU2 from Trust construct. Given the indicated high error correction between items TRU1 and TRU2 it was decided to drop item TU1, it appeared that TRU1 subsumed TRU2. The model resulting from iteration 2 showed significant improvement. No further modifications were done. The items are listed below.

Trust in Trading Partners

TRU1: Our trading partners have been open and honest in dealing with us.
TRU2:* Our trading partners are reliable.
TRU3: Our trading partners respect the confidentiality of the information they receive from us.
TRU4: Our transactions with trading partners do not have to be closely supervised.

Section D: 3. Partner Relationship- Shared Vision Between Trading Partners

Initial Model (VIS1, VIS2, VIS3, VIS4) χ^2 = 18.62 P=.00 GFI=.95 AGFI=.77 NFI=.95

Although all λ coefficient were good, the AGFI (.77) was very low indicating possibility of error correlation. A model run with either one of these four items removed would not have yielded model fit statistics since only three items remained resulting in the degrees of freedom being zero. Two two-factor models were tested by adding the items of Commitment of Trading Partners.

Iteration 1 (VIS1, VIS2, VIS3, VIS4)
(COM1, COM4, COM5, COM6) χ^2 = 41.66 P=.00 GFI=.95 AGFI=.90 NFI=.94

Iteration 2 (VIS2, VIS3, VIS4)
(COM1, COM4, COM5, COM6) χ^2 = 13.27 P=.43 GFI=.98 AGFI=.96 NFI=.98

The model tested in iteration 1 included the items from Commitment of Trading Partners and the items from the initial model of shared vision on Trading Partners. The model in iteration 2 also has all the items from Commitment of Trading Partners and all except item VIS1 from Shared Vision construct. Given the high error correction between items TRU1 and TRU2 (15.84) it was decided to drop item TRU1, on an examination of the description of the two items, it appeared that item VIS2 is a better measure in this study. VIS1just measured general understanding between trading partners but VIS2 aimed at identify shared vision for SCM between trading partners. The model resulting from iteration 2 showed significant improvement. No further modifications were done. The items are listed below.

Trust in Trading Partners

VIS1:* We and our trading partners understand each others' business policies and rules very well.
VIS2: We and our trading partners have a similar understanding about the aims and objectives of the supply chain.
VIS3: We and our trading partners have a similar understanding about the importance of collaboration across the supply chain.
VIS4: We and our trading partners have a similar understanding about the importance of improvements that benefit the supply chain as a whole.

Section E: 1. Usage of IT Tools-Communication Tools for SCM

Initial Model (CT1, CT2, CT4, CT5) χ^2 = .44 P=.80 GFI=1.00 AGFI=.99 NFI=1.00

The initial model had both satisfactory λ coefficients and excellent model fit. Therefore no modifications were done. The items are listed below.

Communication Tools for SCM

CT1: The extent of the usage of EDI in your firm to facilitate supply chain management.
CT2: The extent of the usage of EFT in your firm to facilitate supply chain management.
CT4: The extent of the usage of intranet in your firm to facilitate supply chain management.
CT5: The extent of the usage of extranet in your firm to facilitate supply chain management.

Section E: 2. Usage of IT Tools-Supply Chain Management Tools

Initial Model (SCMT1, SCMT2, SCMT3, SCMT4, SCMT5, SCMT6) χ^2 = 17.91 P=.04 GFI=.97 AGFI=.93 NFI=.96

The initial model had both satisfactory λ coefficients and excellent model fit. Therefore no modifications were done. The items are listed below.

Supply Chain Management Tools

SCMT1: The extent of the usage of DRP in your firm to facilitate supply chain management.
SCMT2: The extent of the usage of CRM in your firm to facilitate supply chain management.
SCMT3: The extent of the usage of SRM in your firm to facilitate supply chain management.
SCMT4: The extent of the usage of VMI in your firm to facilitate supply chain management.
SCMT5: The extent of the usage of DW in your firm to facilitate supply chain management.
SCMT6: The extent of the usage of SCM Software in your firm.

Section E: 3. Usage of IT Tools-Resource Planning Tools

Initial Model (RPT1, RPT2, RPT3)

Iteration 1 (RPT1, RPT2, RPT3) (SCMT1, SCMT2, SCMT3, SCMT4, SCMT5, SCMT6) χ^2 = 51.39 P=.00 GFI=.94 AGFI=.90 NFI=.91

Since a model run with three items would not have yielded model fit statistics. A two-factor model was tested by adding the items of Supply Chain Management Tools. The fit indices indicated satisfactory model fit. No further modifications were done. The items are listed below.

Resource Planning Tools

RPT1: The extent of the usage of MRP in your firm to facilitate supply chain management.
RPT2: The extent of the usage of MRPII in your firm to facilitate supply chain management.
RPT3: The extent of the usage of ERP in your firm to facilitate supply chain management.

Section F: 1. SCM Practice-Strategic Supplier Partnership

Initial Model (SSP3, SSP4, SSP5, SSP6, SSP7, SSP8) χ^2 = 40.49 P=.00 GFI=.94 AGFI=.85 NFI=.93

Although all λ coefficient were good, the AGFI (.85) was a little low indicating possibility of error correlation. The modification index indicated high error correlation between SSP4 and SSP5 (22.26). It was decided to drop item SSP4 since, on an

examination of the description of the two items, it appeared that item SSP4 was too general.

Iteration 1 (SSP3, SSP5, SSP6, SSP7, SSP8) χ^2 = 9.38 P=.09 GFI=.98 AGFI=.94 NFI=.98

The final model had both satisfactory λ coefficient and excellent model fit. Therefore no further modifications were done. The items are listed below.

Strategic Supplier Partnership

SSP3: We consider quality as our number one criterion in selecting suppliers.
SSP4:* We strive to establish long-term relationship with our suppliers.
SSP5: We regularly solve problems jointly with our suppliers.
SSP6: We have helped our suppliers to improve their product quality.
SSP7: We have continuous improvement programs that include our key suppliers.
SSP8: We include our key suppliers in our planning and goal-setting activities.

Section F: 2. SCM Practice-Customer Relationship Practices

Initial Model (CRP1, CRP2, CRP3, CRP4, CRP5, CRP6, CRP8) χ^2 = 91.33 P=.00 GFI=.88 AGFI=.76 NFI=.88

Although all λ coefficient were good, the AGFI (.76) was low indicating possibility of error correlation. The modification index indicated high error correlation between CRP2 and CRP3 (30.15). It was decided to drop item CRP3 since, on an examination of the description of the two items, it appeared that item CRP3 could be constructed as part of CRP2.

Iteration 1 (CRP1, CRP2, CRP4, CRP5, CRP6, CRP8) χ^2 = 33.45 P=.00 GFI=.95 AGFI=.87 NFI=.93

The model resulting from iteration 1 showed the improvements in all fit indices. However, the modification index still indicated some moderately error correlation between CRP1 and CRP2 (18.16). It was decided to drop CRP1, based on the examination of the description of the two items, it appeared that CRP2 subsumed CRP1.

Iteration 2 (CRP2, CRP4, CRP5, CRP6, CRP8) χ^2 = 9.71 P=.08 GFI=.98 AGFI=.94 NFI=.97

The final model had both satisfactory λ coefficient and excellent model fit. Therefore no further modifications were done. The items are listed below.

Customer Relation Practices

CRP1:* We frequently evaluate the formal and informal complaints of our customers.
CRP2: We frequently interact with customers to set reliability, responsiveness, and other standards for us.
CRP3:* We have frequent follow-up with our customers for quality/service feedback.
CRP4: We frequently measure and evaluate customer satisfaction.
CRP5: We frequently determine future customer expectations.
CRP6: We facilitate customers' ability to seek assistance from us.
CRP8: We periodically evaluate the importance of our relationship with our customers.

Section F: 3. SCM Practice-Information Quality

Initial Model (IQ1, IQ2, IQ3, IQ4, IQ5) χ^2 =9.46 P=.09 GFI=.98 AGFI=.94 NFI=.98

The initial model had both satisfactory λ coefficients and excellent model fit. Therefore no modifications were done. The items are listed below.

Information Quality

IQ1: Information exchange between our trading partners and us is timely.
IQ2: Information exchange between our trading partners and us is accurate.
IQ3: Information exchange between our trading partners and us is complete.
IQ4: Information exchange between our trading partners and us is adequate.
IQ5: Information exchange between our trading partners and us is reliable.

Section F: 4. SCM Practice-Information Sharing

Initial Model (IS1, IS2, IS3, IS5) χ^2 = 16.95 P=.00 GFI=.96 AGFI=.79 NFI=.92

Although all λ coefficient were good, the AGFI (.79) was very low indicating possibility of error correlation. A model run with either one of these four items removed would not have yielded model fit statistics since only three items remained resulting in the degrees of freedom being zero. Two two-factor models were tested by adding the items of Information Quality.

Iteration 1 (IS1, IS2, IS3, IS5)
(IQ1, IQ2, IQ3, IQ4, IQ5) χ^2 = 80.82 P=.00 GFI=.92 AGFI=.85 NFI=.90

Iteration 2 (IS2, IS3, IS5)
(IQ1, IQ2, IQ3, IQ4, IQ5) χ^2 = 34.86 P=.01 GFI=.96 AGFI=.92 NFI=.95

The model tested in iteration 1 included the items from Information Quality and the items from the initial model of Information Sharing. The model in iteration 2 also had all the items from Information Quality and all except item IS1 from Information Sharing. Given the indicated high error correction between items IS1 and IS3 (25.70) and IS1 and IS5 (11.29), it was decided to drop item IS1 since this item has error correlation with the other two. The model resulting from iteration 2 showed significant improvement. No further modifications were done. The items are listed below.

Information Sharing

IS1:* We share our business units' proprietary information with trading partners.
IS2: We inform trading partners in advance of changing needs.
IS3: Our trading partners share proprietary information with us.
IS5: Our trading partners share business knowledge of core business processes with us.

Section F: 5. SCM Practice-Lean System

Initial Model (LS1, LS2, LS3, LS4, LS5) χ^2 = 13.38 P=.02 GFI=.97 AGFI=.92 NFI=.95

The initial model had both satisfactory λ coefficients and excellent model fit. Therefore no modifications were done. The items are listed below.

Lean System

LS1: Our firm reduces set-up time.
LS2: Our firm has continuous quality improvement program.
LS3: Our firm uses a "Pull" production system.
LS4: Our firm pushes suppliers for shorter lead-times.
LS5: Our firm streamlines ordering, receiving and other paperwork from suppliers.

Section F: 4. SCM Practice-Postponement

Initial Model (POS1, POS3, POS4)

Iteration 1 (POS1, POS3, POS4)
(LS1, LS3, LS4, LS5) χ^2 = 27.95 P=.00 GFI=.96 AGFI=.92 NFI=.92

Since a model run with three items would not have yielded model fit statistics. A two-factor model was tested by adding the items of Lean System. The fit indices indicated satisfactory model fit. No further modifications were done. The items are listed below.

Postponement

POS1: Our products are designed for modular assembly.
POS3: We delay final product assembly activities until customer orders have actually been received.
POS4: We delay final product assembly activities until the last possible position (or nearest to customers) in the supply chain.

Section G: 1. SCM Performance-Customization Flexibility and Volume and Product Flexibility

Initial Model (SCF1, SCF2, SCF3)
(SCF4, SCF5, SCF6) χ^2 = 20.26 P=.01 GFI=.97 AGFI=.91 NFI=.96

Since Customization Flexibility, and Volume and Product Flexibility had only three items separately, a model run with either one of these factors would not have yielded model fit statistics. To address this problem the two factors were tested as a two-factor initial model. The initial 2 factors, 3-item model had both satisfactory λ coefficient and excellent model fit. Therefore no modifications were done. The items are listed below.

Customization Flexibility

SCF1: Our supply chain is able to handle difficult nonstandard orders.

SCF2: Our supply chain is able to meet special customer specification.
SCF3: Our supply chain is able to produce products characterized by numerous features options, sizes and colors.

Volume and Product Flexibility

SCF4: Our supply chain is able to rapidly adjust capacity so as to accelerate or decelerate production in response to changes in customer demand.
SCF5: Our supply chain is able to rapidly introduce large numbers of product improvements/variation.
SCF6: Our supply chain is able to handle rapid introduction of new products.

Section G: 2. SCM Performance-Supply Chain Integration

Initial Model (SCI1, SCI2, SCI3, SCI4) χ^2 = 6.12 P=.05 GFI=.98 AGFI=.92 NFI=.97

The initial model had both satisfactory λ coefficients and excellent model fit. Therefore no modifications were done. The items are listed below.

Supply Chain Integration

SCI1: There is a high level of communication and coordination between all functions in our firm.
SCI2: Cross-functional teams are frequently used for process design and improvement in our firm.
SCI4: There is a high level of integration of information systems in our firm.
SCI5: There is a great amount of cross-over of the activities of our firm and our trading partners.

Section G: 3. SCM Performance-Responsiveness to Customers

Initial Model (CR1, CR2, CR3)

Iteration 1 (CR1, CR2, CR3)
(SCI1, SCI2, SCI3, SCI4) χ^2 = 24.62 P=.03 GFI=.97 AGFI=.93 NFI=.94

Since a model run with three items would not have yielded model fit statistics. A two-factor model was tested by adding the items of Supply Chain Integration. The fit indices indicated satisfactory model fit. No further modifications were done. The items are listed below.

Responsiveness to Customers

CR1: Our firm fills customer orders on time.
CR2: Our firm has short order-to-delivery cycle time.
CR3: Our firm has fast customer response time.

Section G: 4. SCM Performance-Supplier Performance

Initial Model (SP1, SP2, SP3, SP4) χ^2 = 150.67 P=.00 GFI=.72 AGFI=-.39 NFI=.70

Although all λ coefficient were good, the AGFI(-.39) was very low indicating possibility of error correlation. A model run with either one of these four items removed would not have yielded model fit statistics since only three items remained resulting in

the degrees of freedom being zero. Two two-factor models were tested by adding the items of Responsiveness to Customers.

Iteration 1 (SP1, SP2, SP3, SP4)
(CR1, CR2, CR3) χ^2 = 155.94 P=.00 GFI=.81 AGFI=.60 NFI=.77

Iteration 2 (SP1, SP2, SP4)
(CR1, CR2, CR3) χ^2 = 9.61 P=.29 GFI=.98 AGFI=.96 NFI=.98

The model tested in iteration 1 included the items from Responsiveness to Customers and the items from the initial model of Supplier Performance. The model in iteration 2 also had all the items from Responsiveness to Customers and all except item SP3 from Supplier Performance. Given the indicated high error correction between items SP3 and SP4 (147.09) and IS1 and IS5 (11.29), it was decided to drop item SP3 since item SP4 subsumed item SP3. The model resulting from iteration 2 showed significant improvement. No further modifications were done. The items are listed below.

Supplier Performance

SP1: Our suppliers deliver materials/components/products to us on time.
SP2: Our suppliers provide dependable delivery to us.
SP3:* Our suppliers provide materials/components/products that are highly reliable.
SP4: Our suppliers provide high quality materials/component/products to us

Section G: 5. SCM Performance- Partnership Quality

Initial Model (PQ2, PQ3, PQ4, PQ5, PQ6) χ^2 = 43.29 P=.00 GFI=.92 AGFI=.76 NFI=.89

Although the initial model had satisfactory λ coefficient, the AGFI(.76) was low indicating possibility of error correlation. The modification index indicated high error correlation between PQ3 and PQ4 (33.32). It was decided to drop item PQ4 since, on an examination of the description of the two items, it appeared that item PQ3 is a more important measure of partnership quality than item PQ4.

Iteration 1 (PQ2, PQ3, PQ5, PQ6) χ^2 = 5.79 P=.06 GFI=.99 AGFI=.93 NFI=.98

The final model had both good λ coefficient and excellent model fit. Therefore no further modifications were done. The items are listed below.

Partnership Quality

PQ2: We believe our relationship with our trading partners is profitable.
PQ3: We and our trading partners share any risk that can occur in the supply chain.
PQ4:* We and our trading partners share benefits obtained from SCM.
PQ5: Our relationship with trading partners is marked by a high degree of harmony.
PQ6: Our overall relationship with trading partners is satisfactory.

Section H: Competitive Advantage (Price/Cost, Quality, Delivery Dependability, Production Innovation and Time-to-Market)

Initial Model (PC1, PC2) (QU1, QU2, QU3, QU4)
(DD2, DD3) (PI1,PI2, PI3)
(TM2, TM3,TM4) χ^2 = 164.48 P=.00 GFI=.89 AGFI=.83 NFI=.88

Except Quality, all the other four factors had only two or three items separately; a model run with either one of these factors would not have yielded model fit statistics. To address this problem the five factors were tested simultaneously as a five-factor model. Although the initial model had satisfactory λ coefficient, the AGFI (.83) was a little low indicating possibility of error correlation. The modification index indicated some error correlation between QU1 and QU3 (13.43). It was decided to drop item QU1 since, on an examination of the description of the two items, it appeared that item QU1 is too general and has been measured in the other three items of this dimension.

Iteration 1 (PC1, PC2) (QU2, QU3, QU4)
(DD2, DD3) (PI1,PI2, PI3)
(TM2, TM3,TM4) χ^2 = 119.38 P=.00 GFI=.91 AGFI=.86 NFI=.90

The model resulting from iteration 1 had satisfactory λ coefficient and good model fit. Even though AGFI (.86) is still a little below .90, no modification could be done. The items are listed below.

Price/Cost

PC1: We offer competitive price.
PC2: We are able to offer price as low or lower than our competitors.

Quality

QU1:* We are able to compete based on quality.
QU2: We offer products that are highly reliable.
QU3: We offer products that are highly durable.
QU4: We offer high quality products to our customers.

Delivery Dependability

DD2: We deliver customer orders on time.
DD3: We provide dependable delivery.

Product Innovation

PI1: We provide customized products.
PI2: We alter our product offerings to meet client needs.
PI3: We respond well to customer demand for "new" features.

Time to Market

TM2: We are first in the market in introducing new products.
TM3: We have our time-to-market lower than industry average.
TM4: We have fast product development.

Section I: Organizational Performance

Initial Model (OP1,OP2, OP3, OP4, OP5, OP6, OP7) χ^2 = 228.51 P=.00 GFI=.75 AGFI=.50 NFI=.83

Although the initial model had satisfactory λ coefficient, the AGFI(.50) was very low indicating possibility of error correlation. The modification index indicated high error correlation between OP1 and OP3 (66.14), OP2 and OP5 (53.39) and OP3 and OP6 (33.51). It was felt that these items are very important measures of organizational performance and should not be removed. The high error correlation may be caused by the wrong model specification. After an examination of the descriptions of the items, it seemed that items OP1, OP3, OP4 and OP7 represent firm's market performance, while OP2, OP5 and OP6 reflect firm' financial performance. It was decided to split this dimension into two factors: one is market performance and another is financial performance. A two-factor model was then tested.

Iteration 1 (OP1, OP3, OP4, OP7) (OP2, OP5, OP6) χ^2 = 51.35 P=.00 GFI=.93 AGFI=.85 NFI=.95

The model resulting from iteration 1 had satisfactory λ coefficient, the AGFI (.85) was a little low indicating possibility of error correlation. The modification index indicated moderate error correlation between OP6 and OP7 (16.15). It was decided to drop item OP7 since, on an examination of the description of the two items, it appeared that item OP is too general.

Iteration 2 (OP1, OP3, OP4) (OP2, OP5, OP6) χ^2 = 13.42 P=.10 GFI=.98 AGFI=.94 NFI=.99

The final two-factor, 3 items model had both satisfactory λ coefficient and excellent model fit. Therefore no further modifications were done. The items are listed below.

Market Performance

OP1: Market share.
OP3: The growth of market share.
OP4: The growth of sales.
OP7:* Overall competitive advantage.

Financial Performance

OP2: Return on investment.
OP5: Growth in return on investment.
OP6: Profit margin on sales.

Note: the asterisked items (*) were eliminated upon scale validation and should not be used.

APPENDIX G: THE QUESTIONNAIRE RECOMMENDED FOR FUTURE RESEARCH

A SURVEY OF SUPPLY CHAIN MANAGEMENT PRACTICE AND PERFORMANCE

Supply Chain Management (SCM) is the systemic, strategic coordination of the traditional business functions and tactics across these business functions within a particular company, and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole.

Trading partner (same as strategic partner) refers to any external organization that plays an integral and critical role in the enterprise and whose business fortune depends all or in part on the success of the enterprise. This includes customers, suppliers, contract manufacturers, subassembly plants, distribution centers, wholesalers, retailers, carriers, freight forwarder service and so on.

Unless otherwise specifically requested, please use the following scale to answer each item:

1	2	3*	4	5	6
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Applicable

In this scale, 3 represents the following: neutral, neither agree or disagree, moderate or average level as the case may be.

About Top Management Support for SCM in Your Firm

With regard to top management support for SCM, please circle the appropriate number that accurately reflects your firm's PRESENT conditions.

Top management considers the relationship between us and our trading partners to be important	1	2	3	4	5	6
Top management supports SCM with the resources we need	1	2	3	4	5	6
Top management regards SCM as a high priority item	1	2	3	4	5	6
Top management participates in SCM and its optimization	1	2	3	4	5	6

About the SCM Strategy Process in Your Firm

SCM strategy refers to the design and blueprint that frames the acquisition and development of supply chain capability into the future. This study focuses on the process of the SCM strategy, that is, how well SCM strategy is aligned and implemented in your firm.

With regard to SCM strategy process in your firm, please circle the number that accurately reflects your firm's PRESENT conditions.

We actively pursue SCM strategy	1	2	3	4	5	6
We systematically address long-term SCM trends	1	2	3	4	5	6
We translate business strategy into SCM terms	1	2	3	4	5	6
We make an effort to anticipate the potential of new SCM practices and technologies	1	2	3	4	5	6
We derive competitive strength for our business through SCM	1	2	3	4	5	6
We have a formal process for the implementation of SCM	1	2	3	4	5	6
We communicate our objectives and strategies of SCM to all concerned employee	1	2	3	4	5	6

About SCM Practices in Your Firm

With regard to SCM practices, please circle the number that accurately reflects your firm's PRESENT conditions.

STRATEGIC SUPPLIER PARTNERSHIP

We consider quality as our number one criterion in selecting suppliers	1	2	3	4	5	6
We regularly solve problems jointly with our suppliers	1	2	3	4	5	6
We have helped our suppliers to improve their product quality	1	2	3	4	5	6
We have continuous improvement programs that include our key suppliers	1	2	3	4	5	6
We include our key suppliers in our planning and goal-setting activities	1	2	3	4	5	6

CUSTOMER RELATIONS PRACTICES

We frequently interact with customers to set reliability, responsiveness, and other standards for us	1	2	3	4	5	6
We frequently measure and evaluate customer satisfaction	1	2	3	4	5	6
We frequently determine future customer expectations	1	2	3	4	5	6
We facilitate customers' ability to seek assistance from us	1	2	3	4	5	6

Unless otherwise specifically requested, please use the following scale to answer each item:

1 Strongly Disagree | 2 Disagree | 3 Neutral | 4 Agree | 5 Strongly Agree | 6 Not Applicable

We periodically evaluate the importance of our relationship with our customers 1 2 3 4 5 6

INFORMATION SHARING

We inform trading partners in advance of changing needs 1 2 3 4 5 6

Our trading partners share proprietary information with us 1 2 3 4 5 6

Our trading partners share business knowledge of core business processes with us 1 2 3 4 5 6

INFORMATION QUALITY

Information exchange between our trading partners and us is timely 1 2 3 4 5 6

Information exchange between our trading partners and us is accurate 1 2 3 4 5 6

Information exchange between our trading partners and us is complete 1 2 3 4 5 6

Information exchange between our trading partners and us is adequate 1 2 3 4 5 6

Information exchange between our trading partners and us is reliable 1 2 3 4 5 6

LEAN SYSTEM

Our firm reduces set-up time 1 2 3 4 5 6

Our firm has continuous quality improvement program 1 2 3 4 5 6

Our firm uses a "Pull" production system 1 2 3 4 5 6

Our firm pushes suppliers for shorter lead-times 1 2 3 4 5 6

Our firm streamlines ordering, receiving and other paperwork from suppliers 1 2 3 4 5 6

POSTPONEMENT

Our products are designed for modular assembly 1 2 3 4 5 6

We delay final product assembly activities until customer orders have actually been received 1 2 3 4 5 6

We delay final product assembly activities until the last possible position (or nearest to customers) in the supply chain 1 2 3 4 5 6

About Partner Relationship Facilitating SCM

With regard to your partner relationship facilitating SCM, please circle the number that accurately reflects your firm's PRESENT conditions.

TRUST IN TRADING PARTNERS

Our trading partners have been open and honest in dealing with us 1 2 3 4 5 6

Our trading partners respect the confidentiality of the information they receive from us 1 2 3 4 5 6

Our transactions with trading partners do not have to be closely supervised 1 2 3 4 5 6

COMMITMENT OF TRADING PARTNERS

Our trading partners have made sacrifices for us in the past 1 2 3 4 5 6

We have invested a lot of effort in our relationship with trading partners 1 2 3 4 5 6

Our trading partners abide by agreements very well 1 2 3 4 5 6

We and our trading partners always try to keep each others' promises 1 2 3 4 5 6

SHARED VISION BETWEEN TRADING PARTNERS

We and our trading partners have a similar understanding about the aims and objectives of the supply chain 1 2 3 4 5 6

We and our trading partners have a similar understanding about the importance of collaboration across the supply chain 1 2 3 4 5 6

We and our trading partners have a similar understanding about the importance of improvements that benefit the supply chain as a whole 1 2 3 4 5 6

About the Performance of Your SCM

With regard to the ACTUAL level of the performance of your SCM, please circle the appropriate number to indicate the extent to which you agree or disagree with each statement

SUPPLY CHAIN FLEXIBILITY

Our supply chain is able to handle difficult nonstandard orders 1 2 3 4 5 6

Unless otherwise specifically requested, please use the following scale to answer each item:

1	2	3	4	5	6
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Applicable

Our supply chain is able to meet special customer specification	1	2	3	4	5	6
Our supply chain is able to produce products characterized by numerous features options, sizes and colors	1	2	3	4	5	6
Our supply chain is able to rapidly adjust capacity so as to accelerate or decelerate production in response to changes in customer demand	1	2	3	4	5	6
Our supply chain is able to rapidly introduce large numbers of product improvements/variation	1	2	3	4	5	6
Our supply chain is able to handle rapid introduction of new products	1	2	3	4	5	6

SUPPLY CHAIN INTEGRATION

There is a high level of communication and coordination between all functions in our firm	1	2	3	4	5	6
Cross-functional teams are frequently used for process design and improvement in our firm	1	2	3	4	5	6
There is a high level of integration of information systems in our firm	1	2	3	4	5	6
There is a great amount of cross-over of the activities of our firm and our trading partners	1	2	3	4	5	6

RESPONSIVENESS TO CUSTOMERS

Our firm fills customer orders on time	1	2	3	4	5	6
Our firm has short order-to-delivery cycle time	1	2	3	4	5	6
Our firm has fast customer response time	1	2	3	4	5	6

SUPPLIER PERFORMANCE

Our suppliers deliver materials/ components/products to us on time	1	2	3	4	5	6
Our suppliers provide dependable delivery to us	1	2	3	4	5	6
Our suppliers provide high quality materials/component/products to us	1	2	3	4	5	6

PARTNERSHIP QUALITY

We believe our relationship with our trading partners is profitable	1	2	3	4	5	6
We and our trading partners share any risk that can occur in the supply chain	1	2	3	4	5	6
Our relationship with trading partners is marked by a high degree of harmony	1	2	3	4	5	6
Our overall relationship with trading *partners is satisfactory*	1	2	3	4	5	6

About the Global Performance of the supply chain

With regard to global performance of the supply chain your firm is in compared with INDUSTRY AVERAGE, please circle the appropriate number which best indicates your perception of each item.

1	2	3	4	5	6
Much Below	Below	Same	Above	Much Above	Not Applicable

Sum of days of inventory at all nodes of the supply chain	1	2	3	4	5	6
Sum of total costs at all nodes of the supply chain	1	2	3	4	5	6

About the Competitive Advantage of Your Firm

With regard to competitive advantage of your firm, please circle the appropriate number to indicate the extent to which you agree or disagree with each statement.

We offer competitive price	1	2	3	4	5	6
We are able to offer price as low or lower than our competitors	1	2	3	4	5	6
We provide customized products	1	2	3	4	5	6
We alter our product offerings to meet client needs	1	2	3	4	5	6
We respond well to customer demand for "new" features	1	2	3	4	5	6
We deliver customer orders on time	1	2	3	4	5	6
We provide dependable delivery	1	2	3	4	5	6
We offer products that are highly reliable	1	2	3	4	5	6
We offer products that are highly durable	1	2	3	4	5	6

Unless otherwise specifically requested, please use the following scale to answer each item:

1	2	3	4	5	6
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Not Applicable

We offer high quality products to our customers	1	2	3	4	5	6
We are first in the market in introducing new products	1	2	3	4	5	6
We have our time-to-market lower than industry average	1	2	3	4	5	6
We have fast product development	1	2	3	4	5	6

About Performance of Your Firm

As a result of SCM practices in your firm, please circle appropriate number which best indicates your firm's overall performance.

1	2	3	4	5	6
Significant Decrease	Decrease	Same as Before	Increase	Significant Increase	Not Applicable

Market share	1	2	3	4	5	6
Return on investment	1	2	3	4	5	6
The growth of market share	1	2	3	4	5	6
The growth of sales	1	2	3	4	5	6
Growth in return on investment	1	2	3	4	5	6
Profit margin on sales	1	2	3	4	5	6

About the Information Technology (IT) Enablers Used in Your Supply Chain

Please indicate the extent of usage of the following IT tools in your firm to facilitate supply chain management (please see page 8 for the definition of each IT tool).

1	2	3	4	5
Not at all	To a small extent	To a moderate extent	To a considerable extent	To a great extent

EDI_____ EFT____ Intranet _____ Extranet _____
MRP____ MRPII_____ ERP _____ DRP_____
CRM____ SRM_____ VMI _____ DW____
SCM Software _____

Please indicate the extent of usage of the following IT tools by ALL your trading partners (Note: All your trading partners may not use the same IT tools. Here we try to find common tools used by all your trading partners):

EDI_____ EFT____ Intranet _____ Extranet _____
MRP____ MRPII_____ ERP _____ DRP_____
CRM____ SRM_____ VMI _____ DW____
SCM Software _____

General Information about Your Firm
For the following question, please check the appropriate response.

1) Has your organization embarked upon a program aimed specially at implementing "Supply Chain Management"?
_____ Yes _____ No.
If your answer is Yes, how long ? _____ years.

2) Please indicate your 4-digit SIC code _____

3) The number of product lines your firm makes_____

4) Your primary production system (choose most appropriate one)
____Engineer to Order _____Make to Order
____Assemble to Order _____Make to Stock

5) Number of employees in your company:
___ 1 -50 ___ 51-100 ___ 101-250
___251-500 ___ 501 -1000 ___ Over 1000

6) Average annual sales of your company in millions of $:
___ Under 5 ___5 to <10 ____10 to <25
___25 to <50 ___ 50 to <100 ____ >100

7) Your present job title:
____CEO/president _____Director
____Manager _____Other (please indicate_____)

8) Your present job function (mark all that apply):
_____ Corporate Executive _____ Purchasing
_____ Manufacturing Production _____ Distribution
_____ Transportation _____ Sales
_____ Other (please indicate _____)

9) The years you have stayed at this organization:
_____ under 2 years _____2-5 years
_____ 6-10 years _____over 10 years

10) Please rank the importance of the following factors (from 1-most important to 5-least important) in selecting your suppliers (use each number only once)
_____ Cost _____Quality _____Lead time
_____ On time delivery _____ Delivery reliability

11) What percentage of your business transactions with your customers is done electronically?
_____ Less than 10% _____10-30% _____30-50%
_____50-80% _____More than 80%

12) What percentage of your business transactions with your suppliers is done electronically?
_____ Less than 10% _____10-30% _____30-50%
_____50-80% _____ More than 80%

13) Please indicate the number of tiers across your supply chain.
____<= 3 _____4-5 _____ 6-7 _____ 8-10 ____ >10

14) Please mark the position of your company in the supply chain (mark all that apply).
_____ Raw material supplier _____Component supplier
_____ Assembler ____ Sub-assembler
_____ Manufacturer _____ Distributor
_____Wholesaler _____ Retailer

15) Supply chain channel includes direct, indirect and virtual channel. Please mark one that best describes the main supply chain channel your firm is in. (please see the explanation of each supply chain channel on page 8).

_____Direct Channel _____Indirect Channel
_____Virtual Channel

16) Some supply chains have a Channel Master (Hub Company). Channel Master is a company that determines the structure and operation of the whole supply chain, and coordinates the activities across it. Does the supply chain your firm is in have a Channel Master? ____ Yes ____ No.
If your answer is Yes, is your firm the Channel Master in the supply chain? _____Yes _____ No

17) The following items are used to measure SCM performance. Based on your opinion, please rank the importance of 13 items from 1 (high) to 13 (low) on the ***Imprt.*** column. Also check whether each item is used in your firm in ***Used*** column and if used, please fill in the ACTUAL SCM performance if you know in the last column.

Supply Chain Performance	*Imprt.*	*Used*	*Actual Performance*
Delivery Performance to Commit Date	☐	☐	_____%
Fill Rate	☐	☐	_____%
Perfect Order Fulfillment	☐	☐	_____%
Order Fulfillment Lead time	☐	☐	_____Days
Supply Chain Response Time	☐	☐	_____Days
Production Flexibility	☐	☐	_____Days
Cash-to-Cash Cycle Time	☐	☐	_____Days
Inventory Days of Supply	☐	☐	_____Days
Net Asset Turns (Working Capital)	☐	☐	_____Turns
Cost of Goods Sold	☐	☐	
Total Supply Chain Management Costs	☐	☐	
Value-added Productivity	☐	☐	
Warranty/Returns Processing Costs	☐	☐	

THANK YOU FOR YOUR ASSISTANCE IN THIS PROJECT!

Definitions of Channels

Indirect Channel: finished goods from the factory flow to the end customer through distribution center and wholesaler and retailer trading partners; each of these pairs is connected by a logistics service provider.

Direct Channel: the factory produces part of the product and outsources part of the product to the contract manufacturers. Then factory connects directly with the end customer through a logistics service provider.

Virtual Channel: the factory produces part of the product and outsources part (sometime, all) of the product to the contract manufacturers. Then factory connects directly with the end customer through the Internet. Customers use the Internet to shop for products and place their orders.

Definitions of IT Tools

Electronic Data Interchange (EDI): The transfer of data in an agreed electronic format from one organization's computer program to one or more organizations, companies or programs.

Electronic Fund Transfer (EFT): The transfer of a certain amount of money from one account to another through VAN or Internet.

Internet: A public and global communication network that provides direct connectivity to anyone over a local area network (LAN) or Internet service provider (ISP).

Intranet: A corporate LAN or wide area network (WAN) that uses Internet technology and is secured behind company's firewalls. The intranet supports and promotes more effective internal information sharing and a company's internal business processes.

Extranet: A collaborated network that uses Internet technology to link businesses with their supply chain and provides a degree of security and privacy from competitors.

Materials Requirement Planning (MRP): A scheduling technique for establishing and maintaining valid due dates and priorities for orders based on bills of material, inventory, order data, and the master production schedule.

Manufacturing Resources Planning (MRPII): A direct outgrowth and extension of closed-loop material requirements planning (MRP or MRP I) through the integration of business plans, purchase commitment reports, sales objectives, manufacturing capabilities, and cash-flow constraints.

Distribution Requirement Planning (DRP): This system ties warehousing operations to transportation and reconciles forecast demand with transportation capacity and inventory.

Enterprise Resource Planning (ERP): the installation of a single system that covers many information-processing needs typically handled by separate systems. ERP systems unite functions such as order management, inventory control, production planning, and financials under one integrated suite.

Customer Relationship Management (CRM): The software is designed to integrate a company's sales, marketing, and customer support functions in order to better serve the customer, while at the same time making the information available throughout the organization.

Supplier Relationship Management (SRM): The software is designed to optimize sourcing, design and procurement processes in collaboration with the suppliers.

Vendor Managed Inventory (VMI): A supply-chain initiative where the vendor monitors the buyer's inventory levels and makes periodic re-supply decisions.

Data Warehouse (DW): a database of databases capable of bringing all of a firm's data together into one gigantic database.

SCM Software: a suite of decision support solutions for better planning, execution and optimization of the supply chain. SCM software may include strategic planning, demand management, supply management, fulfillment planning/execution, warehouse management, transportation management, and so on. The major vendors of SCM software include I2 Technologies, Manugistics, and Peoplesoft.

If you would like to receive the summary of results of this research, please complete the following details or attach your business card:

Your Name: _____

Business Name: _____

_____

Address: _____

_____

City: _____ State: _____

Zip Code: _____

Tel: _____ Fax: _____

E-mail: _____