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A Research Model for Collaborative Knowledge Management Practice, Supply Chain Integration and Performance

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An Abstract of

A Research Model for Collaborative Knowledge Management Practice, Supply Chain Integration and Performance

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With the trend of globalization, increased customer demand and advancement in technology development, firms are experiencing ever intense pressure to collaborate with their trading partners to compete with other supply chains. The often discussed inter-firm information sharing practices are not sufficient to provide enough insights and understanding to each trading partner for optimizing its products/services (Droschl and Koronakis, 2003). Firms are seeking to collaborate with their partners at greater extent in the areas such as knowledge management to exploit the potentials of an efficient and effective supply chain.

Collaborative Knowledge Management Practice (CKMP) is the discipline of enabling individuals in a series of organizations to collectively create, share, access, and apply knowledge across company boundaries to achieve the business objectives of the entire supply chain. It allows firms to better understand each other and to learn from each other's expertise, thus improve the overall efficiency of the supply chain.

This study follows the Technology Adoption framework of Iacovou, Benbasat, and Dexter (1995) and proposes a research model to analyze the antecedents of collaborative knowledge management, CKMP, and its organizational impact. The researcher developed measures for organizational infrastructure, perceived CKMP benefits, knowledge complementarity, CKMP, and knowledge quality. These instruments were validated through pre-test and a large scale survey to supply chain professionals in firms that have adopted CKMP with a response rate of 12%.

The theoretical implications of the research include providing understanding to the factors that facilitate knowledge collaboration in supply chain. Results from structural equation modeling indicated that technology infrastructure, organizational infrastructure, environmental characteristics, and knowledge complementarity had direct and positive relationship to CKMP. The hypotheses about perceived benefits and partner relationships were not supported by the data. The effects of CKMP on supply chain knowledge quality, supply chain integration and supply chain performance was also confirmed with large effect sizes.

Practitioners can benefit from the result of the study. It can help practitioner to understand the current CKMP adoption rate and the characteristics of those that have adopted in the US manufacturing industry. The research identified major components of CKMP, important antecedents, potential outcomes, and provided valid measurement instrument to these practices, so that practitioners can take it as a roadmap to guide them through the implementation process.

Suggested directions for future research include the revision of a few CKMP sub-dimension measurement items; the comparison of knowledge collaboration activities between efficient and responsive supply chains; as well as the extension of research scope to include international partners into the CKMP networks.

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CHAPTER 1: INTRODUCTION

Supply chain is a complex network of organizations extending both on the upstream side into tiers of suppliers and on the downstream side into a network of customer companies, retailers and final consumers (Desouza, Chattaraj and Kraft, 2003). Supply chain management has been a common practice in today's business world. As pointed out by numerous researchers, current competition is no longer between organizations, but between supply chains. Organizations must integrate their operations with trading partners, rather than work against them in order to maintain competitive advantages for the entire supply chain (Such as Spekman et al., 1994, Monczka and Morgan, 1998; Cox, 1999; Lambert and Cooper, 2000). In today's business environments, it is no longer an option, but a must to better manage and integrate the supply chain (Spekman et al., 1998; O'Connell, 1999).

A fundamental incentive for organization's enthusiasm to strategic supply chain integration comes from the belief that the partnering companies will be able to create a new capability which they would otherwise not be able to create separately (Hall and Andriani, 1998). Such capability involves risk sharing, enhanced market responsiveness, corresponsive logistic support etc. All of them can be translated to competitive advantages for all the firms on the value chain. Thus, companies are pursuing to establish and maintain intensive and interactive relationships with their partners in order to collaborate in such activities as new product development, business processes integration and strategic knowledge exchange (Lin et al, 2002). Siemieniuch and Sinclair (2004) reported that the European manufacturers are increasingly pushing their key partners to take responsibility in designing, developing and supplying components and systems. In 1989, 5 ± 15% of all the work of making an automobile was conducted by suppliers; by 1997, the figure had risen to 10 ± 80%. Thus, supply chain integration has received increasing attention from academicians, consultants, and business managers alike (Van Hoek, 1998; Tan et al., 1998; Croom et al., 2000).

However, supply chain integration is a cross-functional, complex, and dynamic process, and very difficult to manage (Crawford, 1996; Song et al., 1997). Despite considerable progress that has been made to explore the ways to enhance supply chain integration, there are still many issues remain unexplored. It is particularly evident in relation to across supply chain knowledge management issues. Although supply chain's primary role is as a material-processing and product movement system, information processing is critical to supply chain success (Bowersox, et al., 1999). Daft and Weick (1984) argued that gathering, processing, and acting on data from the environment is a firm's main task. Cormican and O'Sullivan, (2003) also believed that knowledge is key resource that must be managed for all the organizations in the supply chain to remain competitive in global markets.

Some supply chains, such as those of automakers, can have thousands of suppliers in different tiers and millions of distributors, retailers etc (Bowersox, et al., 1995). Across supply chain knowledge collaboration can be a daunting task, particularly when each firm of the supply chain maintains disparate enterprise resources planning (ERP) systems, customer relationship management (CRM) and other knowledge applications. With the prevailing needs and the difficulty in knowledge sharing across supply chain, comes an increased demand for strong knowledge management practices. Hult et al (2004) argued that the lack of effective inter-organizational knowledge management practices will result in unsynchronized supply chain, where constituents would be hurt by inaccurate forecasts, excessive planning and recovery times, poor on-time performance, frequent product shortages and backorders, bloated cost structure, poor supplier performance, poor inventory turn-over rates etc. Zimmerman (2002) expresses similar concern that if knowledge can not make its way smoothly through the supply chain in a timely manner, firms will experience delays in product design, planning, manufacturing, and shipping etc. The impact to organizational performances would be declined market share, profits margins, return on assets, revenues and customer attrition. Thus, studies on how to establish and maintain dynamic multidirectional knowledge flow has become a major avenue of research in supply chain management.

Collaborative knowledge management practice (CKMP) is the discipline of enabling individuals in a series of organizations to collectively create, share, access, and apply knowledge across company boundaries to achieve the business objectives of the entire supply chain. CKMP is different from traditional inter-organizational systems (e.g. EDI), which only allows limited amount of transaction data to be shared. While the CKMP intends to exchange rich knowledge among supply chain partners by establishing a knowledge network that allows the participants to create, share, and apply knowledge to strategically improve operational efficiency and effectiveness and enables the analysis and management of all supply chain activities. CKMP can fundamentally change the nature of inter-organizational relationships in sharing resources and competences.

Through CKMP, firms achieve integration by tightly coupling processes at the interfaces between stages of the value chain (Lin et al, 2002). Sakkas et al. (1999) believe that the introduction of CKMP triggers the formation of new organizational entities to resume the role of the information broker and in effect re-shape the traditional supply chain. The partner firms can take advantage of lowering search cost for information and expertise, combined capability for generating and access to larger amount of and higher quality knowledge. Thus, CKMP is believed to enhance the competitive advantage of the supply chain as a whole. Holland (1995) also argued that the implementation of inter-organizational knowledge management system by suppliers can improve organizational coordination and product quality.

The last decade has witnessed business world's significant interest in exploring the operation and impact of knowledge management on the supply chain dynamic performance. However, our literature review reveals that the research on managing knowledge across organizational boundaries can best be described as sparse (e.g. Holtshouse, 1998). The small numbers of existing papers are limited in scope. The key question is more than whether to manage knowledge collaboratively, but how to manage it. The studies of Apostolou et al (1999), Zaneldin et al (2001), and Lin et al (2002) only examined the technological aspects of knowledge coordination. Desouza et al (2003) explored the internal information flow mechanism of collaborative knowledge management system, but they didn't investigate how companies can leverage knowledge for the improved performance. While other articles only studied limited operational consequences of CKMP, without exploring the strategic implication to the supply chain, for example, Hult et al (2004) studied the system's effects on total cycle time, and

Cormican and O'Sullivan (2003) illustrated the influence to NPD innovativeness. Very little work has been done to formulate an investigative model validated by empirical evidence for the management of knowledge at supply chain context. The conceptual confusion and the lack of theoretical framework in supply chain wide knowledge management research hinders the development of new knowledge in academia as well as supply chain collaboration practices in real corporate world. There are many problems still exist in the coordinating knowledge management efforts for supply chain participants. Lee and Choi (2003) presented some cases of firms with mixed results when trying to implement CKMP. They reported that there are some barriers (e.g. expensive technology investment, personnel trainings, lack of managerial support, lack of mutual trust) which hinder organizations to involve in collaborative knowledge management practice. Many organizations still treat knowledge management as an in-house function that is stand alone from their integration endeavourer with supply chain partners. Further research efforts are needed to view knowledge management efforts from the supply chain perspective and study the related enabling environment and organization impact of CKMP.

This current study represents an attempt to introduce the concept and framework of collaborative knowledge management practice; explore how to maximize knowledge coordination among supply chain constituents by analyzing the organizational and technological infrastructures and the contextual factors that drives such practices; and empirically test the effects of collaborative knowledge management practices to facilitate supply chain integration and enhance entire supply chain performance.

The remainder of the paper will be presented in seven chapters. The following chapter is the literature review section that surveys the previous research on knowledge, organizational knowledge, supply chain knowledge and collaborative knowledge management practices. Chapter three presents the theoretical model of the current study and thoroughly discusses the constructs in the model. The hypotheses of the causal relationships of technological, organizational, and contextual enablers to CKMP as well as the performance consequences will also be presented and theoretically examined. Chapter Four illustrates the measurement item generation and pre-test processes. Chapter Five discusses testing methods, sampling issues and the measuring model. Chapter Six covers the structural model and the results of hypothesis testing by structural equation modeling. Chapter Seven is the dimension level analyses to explore the relationship among the sub-dimensions of the constructs in the model. The last chapter (Eight) covers the discussion of the theoretical and practical implications as well as the authors' thoughts about research limitations and future study directions.

Chapter 2: LITERATURE REVIEW ON KM and CKMP

Knowledge is an elusive concept. How should it be defined is still subject to debate in the academic world. On the one hand, knowledge can be viewed as representation of the world; on the other hand it can be conceptualized as a product of the interaction between individual cognition and reality (Lin et al 2002). To clearly define knowledge, we should look at the data-information-knowledge hierarchy, which has been extensively discussed in literature. Some authors use these terms interchangeably (such as Huber 1991). However, the confusion and misunderstanding of the three terms can lead to problems in knowledge management system design (Davenport and Prusak, 1998) or strategic decisions for organizations in the knowledge era (Alavi and Tiwana, 2002). Thus the discussions about the data–information–knowledge hierarchy have important implications for CKMP.

2.1 Data-Information-Knowledge Hierarchy

Many researchers have defined data as taken-for-granted, simple and isolated raw facts. It is a set of symbols that have not being interpreted, its meanings depend upon the representation system (i.e. symbols, language, etc.) used. Davenport and Prusak (1998) argued that data is the discrete and objective fact that describes only a part of what happened. Data says nothing about its own importance or relevance because it provides no judgment or interpretation and no sustainable basis of action. Many authors saw data as the raw material of higher order constructs (such as Webster 1961, Davis and Olson, 1985). Only after endowed with relevance, purpose and meaning, and processed into comprehensible forms to the recipients, and is of real or perceived value in current or prospective actions or decisions, data becomes information (Davis and Olson, 1985).

Information

Information is often defined as meaningful, useful data that is organized to describe a particular situation or condition (Davenport and Prusak 1998, Tuomi, 2000). It is generated by manipulating, presenting and interpreting the collected data. However, the information yielded from the same data (individual interpretations) may be different. The receiver's existing knowledge in part determines the perspective of observation and the meanings that data carries to the receiver. Thus, what type of information can be generated from the data and how such information is processed are influenced by each individual's existed knowledge base. Transferability is another important feature of information. It is relatively easy to be communicated between people. Machlup (1983) argued that information is the basis for knowledge creation and transfer, because information might add to, restructure or change our existing knowledge.

Knowledge

Webster (1961) defined knowledge as a clear and certain perception of something; the act, fact, or state of understanding. It can be seen as people's cognitive outcome of information. Dretske (1981) argued that knowledge is information produced (or sustained) belief. Knowledge is created when information is given meaning by being interpreted, analyzed, synthesized, validated and codified. Polanyi (1966) considered knowledge as "justified true belief". His perspective emphasized knowledge as a dynamic human process of justifying personal beliefs under an aspiration for the "truth". Similarly, Nonaka and Takeuchi (1996) argued that knowledge is the mental structure that consists of beliefs, perspectives, concepts, judgments and expectations, methodologies and know-how with a goal to predict future consequences, or to make inferences. These works recognize knowledge involves two aspects, the concrete knowing about and more abstract knowing how (Grant, 1996).

Knowledge was defined by Davenport and Prusak (1998) as “a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms”.

Polanyi (1966) wrote "we know more than we can tell”. Knowledge that can be expressed clearly and objective represents only the tip of iceberg of the entire body of one’s knowledge. To make sense of new information, one implicitly relies on culturally shared and accumulated stocks of knowledge. According to Polanyi (1966), “knowing emerges in dynamic interaction between focal and subsidiary components of meaning. Subsidiary knowledge is subliminal and contextual cues, which we may not be aware of as such. These subliminal and marginal cues provide the context against which focal knowledge gets its shape”.

In short, the generally accepted views regard data as simple facts that would become information when combined into meaningful structures. Information subsequently becomes knowledge as human perspective is added and the information being put into a context. Tuomi (2000) cited reading book as an example to illustrate the relationship of the data-information-knowledge hierarchy. The book contains data in its letters and words. Reading and understanding a book is a processes of collecting information; the reader's previous knowledge affects what information he or she is getting from the reading. While breaking down and integrating the collected information with other related information creates knowledge, which is ready to use for solving the reader's practical problems in life.

2.2 Organizational knowledge

Choo and Bontis (2002) view organizations as bundles of knowledge assets. The organizational capability to learn, create and maintain knowledge, as well as the conditions under which such capabilities are developed, has been deemed critical to the operational and strategic health of organizations. This is simply because from the resources based view, knowledge is a strategic resource that is hard to imitate and provides its possessor a unique and inherently protected advantage. Thus, any techniques and approaches that facilitate knowledge growth and application are considered as critical to today's business success. However, it is until relatively recent that the importance of organizational knowledge is emphasized (Stewart, 1997). Mansell and Wehn (1998) identified several trends in today's business world: the increasing digitization of social and economic life, the wide spread use of information and communication technologies, a more literate workforce, the increasing dependence of advanced economies on service and the expansion of a professional and technical class et al. All of these emerging factors have made organizational activities and transactions more and more depend on specialized or theoretical knowledge. Thus the studies unpacking organizational knowledge to learn how organizations 'remember' what they know and learn from their own as well as others' experiences turn out to be theoretically and practically important (Eisenhardt and Santos, 2002).

Organizational knowledge is commonly understood as intellectual capital encompassing both knowledge of individuals employed by the organization and group knowledge that is embedded in the organizational policies, procedures and protocols. Both the individual and group knowledge have two basic forms: those that can be easily codified and transmitted in formal, systematic language and shared asynchronously are called explicit knowledge. While the other type of knowledge that is more personal and subjective in quality and experiential and intuitive in nature thus difficult to transmit and share is referred to as tacit knowledge. Vasconcelos et al (2000) presented an ontological diagram illustrated the classification of knowledge as well as the relationships of various kinds of knowledge within an organizational domain.

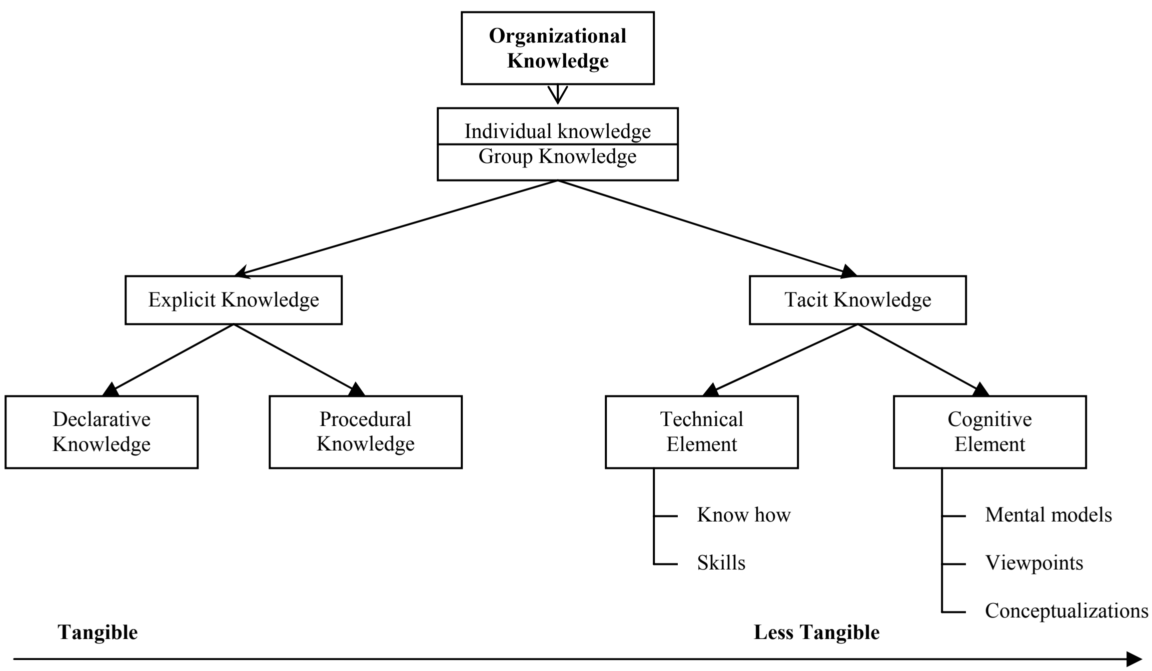


Figure 2.1. Ontological Diagram of organizational knowledge, adopted from Vasconcelos et al

Explicit Knowledge

Explicit knowledge , sometimes called codified knowledge, includes information and skills that can be easily described, documented, collected, stored, distributed to others in a tangible format (such as paper or electronic documents). Nonaka (1994) emphasized explicit knowledge's key feature of being context free in explaining his famous knowledge creation model. Thus the capture and transfer of explicit knowledge is relatively easy. Anderson's ACT model (1983) further divided explicit knowledge into two dimensions: declarative knowledge is often expressed in the form of propositions, definitions, or descriptions; while procedural knowledge are those about methodological and procedural guidelines that is used in such activities as remembering how to drive a car or play a piano.

Tacit Knowledge

Tacit knowledge is the subjective and experience-based knowledge that is hard to be expressed in words, sentences and other systematic manners. It is context specific and deeply rooted in action and commitment. It often includes cognitive skills such as beliefs, perspectives, intuition and mental models as well as technical skills such as craft and know-how (Nonaka and Takeuchi, 1996). Thus to formalize, capture, store and transfer tacit knowledge to others can be difficult. Nonaka (1994) also identified two sub-dimensions of tacit knowledge: the technical element covers concrete know-how, crafts and skills that apply to specific contexts. By contrast, the cognitive element captures an individual's images of reality and visions for the future. It centers on what Johnson-Laird (1983) called "mental models", which include schemata, paradigms, beliefs, and viewpoints that provide "perspectives" that help individuals to perceive and define their world. People combine their possessed knowledge with obtained information to create and manipulate analogies in their minds to form various working models about the world.

2.3 Organizational Knowledge Management Practice

The emergent trend of recognizing the growing importance of organizational knowledge surely brings about increasing concerns over how to create, store, access, transfer and make full use of such super abundance of organizational knowledge. A knowledge management system is often introduced to facilitate the organizational functions of identifying and mapping intellectual assets, generating new knowledge, and systemizing knowledge storage, retrieval and sharing.

However, despite the research community's strong interest in knowledge management, researchers and practitioners have not reached an agreement upon a precise definition to knowledge management practice. There are many different interpretations regarding what exactly knowledge management is and how to best address the emerging issue of how to put effective use to knowledge management practice's potential power (e.g. Wiig, 1995; Nonaka & Takeuchi, 1995; Edvinsson & Malone, 1997; Davenport & Prusak, 1998). Organizational knowledge management is a broad and multi-faceted topic involving social-cultural, organizational, behavioral, and technical dimensions (Alavi and Tiwana, 2003). King (2001) defined knowledge management as a mechanism involves the acquisition, explicating and communicating of mission specific professional expertise in a manner that is focused and relevant to an organizational participants who receive the communications. Lee and Young (2000) also defined knowledge management as the deliberately designed organizational processes that govern the creation, dissemination, growth, and leveraging of knowledge to fulfill organizational objectives. Marshall (1997) considered that KM refers to the harnessing of intellectual capital within an organization. Despite the different perspectives researchers take in defining knowledge management, it is universally agreed that knowledge management practice will create competitive advantages by improving the efficiency for organizations to access and utilize existing knowledge as well as generating new knowledge. In most firms, knowledge management practice tends to be kept as an in-house, stand-along function that is not adequately shared with others. Users of the closed knowledge management systems can only access and utilize a fraction of knowledge circulating in supply chain. They would not be able to take a holistic view to the operations of entire supply chain, hesitate to share expertise with others and be unwilling to collaborate for new knowledge creation. In consequence, organizations could not take a full advantage of all the knowledge supply chain partners possess.

Globalization, advancement in technology and the increasingly intense competition in post-industrial business world have made cross-functional and inter-organization collaboration a very popular practice (e.g. integrated product development). Knowledge management practice should follow the rationale and be connected and coordinated across supply chain partner firms for maximum efficiency. The apparent advantages of collaborative knowledge management practice are demonstrated by the system's powerful multidisciplinary problem-solving ability because of the larger amount of knowledge created and leveraged at the intersection of disciplines and functions (Boland and Tenkasi, 1995; Iansiti, 1995; Leonard-Barton, 1995). Roper and Crone (2003) also argued that the development of boundary spanning or inter-firm knowledge transfer and coordination could help partners in supply chain to internalize sources of internally generated uncertainty and to respond more effectively to externally generated uncertainty.

2.4 Supply Chain Knowledge

In a global economy, employees, partners, suppliers and customers are increasingly sharing knowledge to gain efficiencies in their supply chains. It has been an emergent trend that firms are exploring new ways to put enterprise knowledge in the hands of customers, suppliers and partners to share with them their intellectual capital (Apostolou, 1999). Some authors attempted to address the reasons about firm's increasing enthusiasm to share knowledge with their supply chain partners.

Davis and Meyer (1998) suggest that knowledge and related intangibles not only make business operate but are part of all of "product package" current firms are offering. It is becoming increasingly hard for any firm to be able to sell anything doesn't include combination of tangible products and intangible service, which include solutions etc that can be classified as knowledge. What these firms offer to their customers are product-service hybrids. The supply chain knowledge take the format of technical know how, product design, marketing presentation, understanding the customer, personal creativity and innovation etc that add value to the supply chain partners.

Christensen et al (2005) echoed similar arguments and believed that driven by global competition and continuing expansion of knowledge, firms are pushed to operate with Just-In-Time (JIT) and Mass Scale Build-To-Order (MSBTO) principles with their supply chain partners to address the market requirement for high levels of product customization and fast delivery. Knowledge from customers about such issues as future purchasing requirements, and anticipated product quality levels and suppliers' knowledge about managing and improving product quality, product design, production scheduling, inventory management and control can be critical to supply chain operations, especially between long term and stable trading partners where the number and variety of product demand is large. In this scenario, supply chain have to share supply chain knowledge such as technical know how, product design, marketing presentation, understanding the customer, personal creativity and innovation in order to be operate with JIT and MSBTO. Thus we would like to observe organizational knowledge from the supply chain perspective and define supply chain knowledge as the conglomeration of all the information resources and knowledge assets available for supply chain partners which would help the achievement of supply chain objectives. Supply chain knowledge can not be purchased in a market, is difficult to transfer and to imitate, because of its experiential nature and inter-firm linkages. The next section continues the discussions about our attempts to use inter-firm knowledge collaboration to management the elusive supply chain knowledge.

2.5 Collaborative Knowledge Management Practice (CKMP)

Collaborative Knowledge Management Practice (CKMP) refers to organizational undertaken of collectively create, store, access, disseminate and apply knowledge across company boundaries to achieve business objectives of the entire supply chain. The purpose of CKMP is simply to facilitate intra and inter organizational knowledge management and to create and leverage knowledge resources and intellectual assets collaboratively (Cormican and O'Sullivan, 2003).

Many studies take knowledge process perspective to examined organizational KM practices (i.e. Bassi, 1998 and Blake, 1998). Lee and Yang (2000) conclude five knowledge processes, namely: knowledge acquisition, knowledge innovation (organizational amplifies the knowledge created by individuals and crystallizes it as a part of the knowledge network of the organization), knowledge protection, knowledge integration, and knowledge dissemination. Alvai and Leidner (2001) simplifies the knowledge process model by combining knowledge acquisition, knowledge innovation, and knowledge integration into a single knowledge creation process and propose a new knowledge application process to emphasize the objective of the KM practice. Their model is composed of four major knowledge functions: knowledge creation, knowledge storage and retrieval, knowledge transfer, and knowledge application. Similarly, Cormican and O'Sullivan (2003) argue that activities in Alvai and Leidner's second process (knowledge storage and retrieval) have different nature, thus break it into three separate dimensions. Their framework has five generic activities: knowledge generation, knowledge representation, knowledge storage, knowledge access, and knowledge transfer. Based on the above studies, collaborative KM practices can be understood as supply chain wide systematic attempts to generate, store and use knowledge collaboratively in order to improve overall performance. We summarize these above mentioned knowledge processes of regular stand alone KM practice of each organization and propose the following five knowledge processes for collaborative knowledge management practices:

Collaborative Knowledge Generation relates to the chain-wide joint efforts for knowledge addition and the correction of existing out-of-date knowledge. Example activities include the creation of new ideas, the recognition of new patterns, the synthesis of different disciplines and the development of new processes, capture knowledge etc.

(Davenport and Prusak, 1998). Organizations should enhance knowledge environment which is conducive to effective knowledge creation.

Collaborative Knowledge Storage is the process of coordinating data format, location of knowledge storage, knowledge ownership and governing mechanism. Probst etc. (24) described knowledge storage as a function that preserves and stores perceptions and experiences beyond the moment when they occur, so that they can be retrieved at a later time (Smith, 2001). Olivera (2000) contended that organizational capability for knowledge storage has important consequences for organizational performance. Argote et al (1990) stated that stored knowledge can effectively safeguard the organization from the distracting effects of turnover and assist in framing and solving problems. Thus, collaborative knowledge storage is the inter-firm efforts to unit and leverage multiple knowledge repositories or retention bins for efficient knowledge acquisition and preservation (Walsh, and Ungson, 1991; Levitt, and March, 1988; Starbuck, 1992). The ultimate objective of collaborative knowledge storage is to set up a knowledge server with common interface and to provide an extensible architecture unifying and organizing access to disparate knowledge repositories in different member organizations and Internet data resources for smooth knowledge integration across the supply chain.

Barrier-Free Knowledge Access refers to the process of retrieving information and knowledge from the system for reuse by knowledge users within and outside the organization where the knowledge in question resides and the associated mechanisms about how stored knowledge to be accessed, leveraged or transferred et al. Stored knowledge has limited value if it is not transferred. Jasimuddin (2005) argued that it was simply wasting organizational resources to store knowledge that is not put into use in the future. Davenport and Prusak (1998) pointed out stored knowledge became a valuable corporate asset only it is accessible, its value increased with the level of accessibility. Typically there will be a variety of databases, document repositories and corporate applications residing in different servers, systems and organizations and presented in different format. They often need to be integrated to given users a holistic view for decision making purposes. The collaborative knowledge management architecture should be able to make those contents from distributed sources accessible, and more or less as if they all came from a single data store. Bob Newhouse, senior knowledge management advisor for the Houston based American productivity and Quality Center (APQC) explains that some supply chains continue to build information repositories, best – practice-fathering databases, and web portals only to realize that supply managers and suppliers are not accessing these tools (Yuva, 2002). Thus to provide easy access to knowledge by people with various expectations and requirements can be a big challenge for knowledge managers.

Collaborative Knowledge Dissemination is the process related to making knowledge available to knowledge users within and across organizational boundaries and facilitating knowledge transfer among individuals in order to promote learning and produce new knowledge or understanding. The value of knowledge is realized only when stored knowledge is disseminated to occasions where it can make an impact. Making knowledge accessible to all potential users is not enough. The mechanism to organize and index knowledge is critical, potential users must know their needed knowledge does exist and have clear idea to locate it then he/she can retrieve it.

Collaborative Knowledge Application is the process of utilizing stored knowledge for decision-making and problem solving by individuals or groups. Knowledge itself does not produce any organizational value, its application for taking effective action does. CKMP emphasizes interactions between individuals and organizations. It will support and facilitate knowledge transactions across the supply chain.

The above-discussed five knowledge processes supplement with each other and jointly form a spirally incurring cycle. At a regular structural business environment, all supply chain function runs smoothly. The supply chain operation is a process of the application of existing knowledge that has been created and fine-tuned over years. It is a static mode where factors such as weekly forecasting, build-to-order and customer services are well managed based on past knowledge. However, at unstructured times when big changes come to the supply chain operation environment, for example, a major new competitor coming into market, or one particular trading partner has made substantial operation changes, organizations in the entire supply chain must make changes to their existing operations to adapt those external or internal changes to remain competitive. At this time, new knowledge has been created and must be harvested, stored, and disseminated for possible future applications. The entire cycle of knowledge process focus on supply chain system optimization and efficiencies by squeezing and integrating competitive advantage from existing business processes before they are marginalized by changing competitive pressures and customer trends.

CKMP is not simply limited to inter-firm information sharing, and more importantly, it enhances knowledge coordination, such as sharing digested understanding and aggregating analysis based on each member's source information and unique expertise. For example, Bayer benefits more if Wal-Mart shares the knowledge about its expert forecast for the recent market trends of Aspirin than getting the simple POS data. As suggested in the CPFR framework (collaborative Planning, Forecasting and Replenishment), upstream suppliers can better adjust their operation functions and strategic directions when downstream customers are being involved in creating knowledge about sales forecasts, event planning, and replenishment schemes, etc.

It is important for the supply chain to be able to bring together knowledge from disparate sources and present it to knowledge users in a comprehensive fashion. CKMP emphasizes interactions between trading partners for collaboration. Because any external and internal changes may result in chain reactions in supply chain, local sub-optimization in these series of changes will negatively affect the performance of many partners in the supply chain. Trading partners have to collaborate with each other to get a sense of changes quickly and to integrate their knowledge with that of other partners for best possible business solutions. However, in practice, there are still many firms that do not collaborate with their trading partners for knowledge management practice. What distinguish them from those which do? Understanding the drivers and barriers of CKMP adoption and implementation becomes increasingly important. The better insight from this study would help firms improve their strategies and cope with the impact of CKMP. Therefore, the following chapter presents a theoretical model about CKMP implementations.

CHARPTER 3: THEORETICAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

To better understand the antecedents and consequences of CKMP, a framework is established to describe the causal relationships between facilitating factors, CKMP, and its impact. This study has 2 objectives: 1) to identify the most important factors that drive organizations to implement CKMP such as organizational, technological infrastructures, and external facilitators; 2) to explore the potential favorable organizational outcome of CKMP implementation such as higher knowledge quality, closer relationship with business partners, and superior supply chain performance. The theoretical base for our framework is based on Rogers's diffusion of innovations theory (1983), Tornatzky and Fleisher's (1990) TOE model and the organizational technology adoption model by Iacovou et al. (1995).

3.1 Theoretical Background:

The literature has rich discussions on technology adoption (e.g. Agarwal and Prasad 1999, Pick and Roberts 2005, Verhoef and Langerak 2001, and Venkatesh and Davis 2000). Many of these studies were based on Rogers's (1995) diffusion of innovation theory (DOI) to investigate how organizations absorb new technologies. The DOI theory is concerned with the manner in which a new technological idea, artifact, or technique migrates from creation to use, and describes the patterns of adoption, explains the mechanism of diffusion, and assists in predicting whether and how a new invention will be successful (Hsu et al 2006). As illustrated in figure 3.1, Rogers argued that a firm's adoption and use of innovations such as a new technology was influenced by both the characteristics of such innovation (e.g. relative advantage, compatibility, complexity, trialability, and observability) and organizational characteristics (e.g. centralization, formalization, interconnectedness).

Although Rogers's diffusion of innovation theory seems to be quite applicable to an investigation of new technology use, researchers continue to search other factors influencing the adoption of organizational innovation and combine them with Rogers's theory to provide richer and potentially more explanatory models (Hsu et al 2006). Tornatzky and Fleisher's (1990) TOE model extended Rogers's framework to explain a firm's technological innovation decision making behavior. Three categories - technology, organization, and environment were included in the TOE model. The technology and organizational categories were parallel to the dimensions of innovational and organizational characteristics in Rogers's framework. A major contribution of TOE model was including a new and important component, environmental context. The environment context is the arena in which a firm conducts its business-its industry, competitors, and trading partners in supply chain. The environmental /contextual factors presented both constraints and opportunities for new business process and technology implementation. The Tornatzky and Fleisher's (1990) TOE model was presented in Figure 3.2.

One of the limitations of using TOE framework in supply chain context is its emphasis on within-a-firm innovation diffusion. Over time, when innovations become more complicated and are used beyond the boundaries of any single firm, inter-organizational systems such as CKMP turn out to be significant in the business world. To further understand inter-organizational system adoption and use, Iacovou, Benbasat and Dexter

(1995) applied TOE framework in analyzing 7 case studies to illustrate how EDI was adopted, and extended the framework by adding a new factor to examine the potential impacts of new technology adoption.

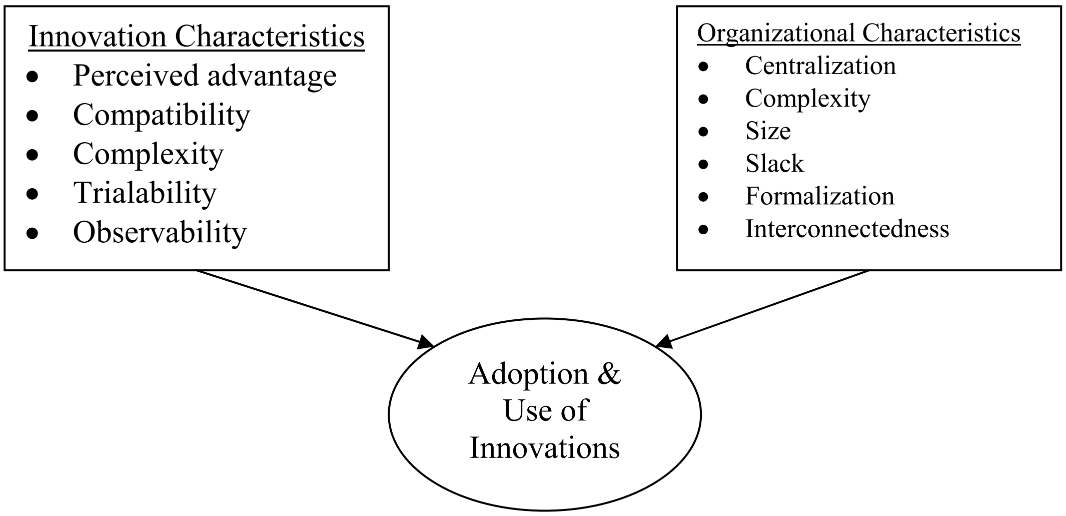


Figure 3.1 Rogers's DOI Framework

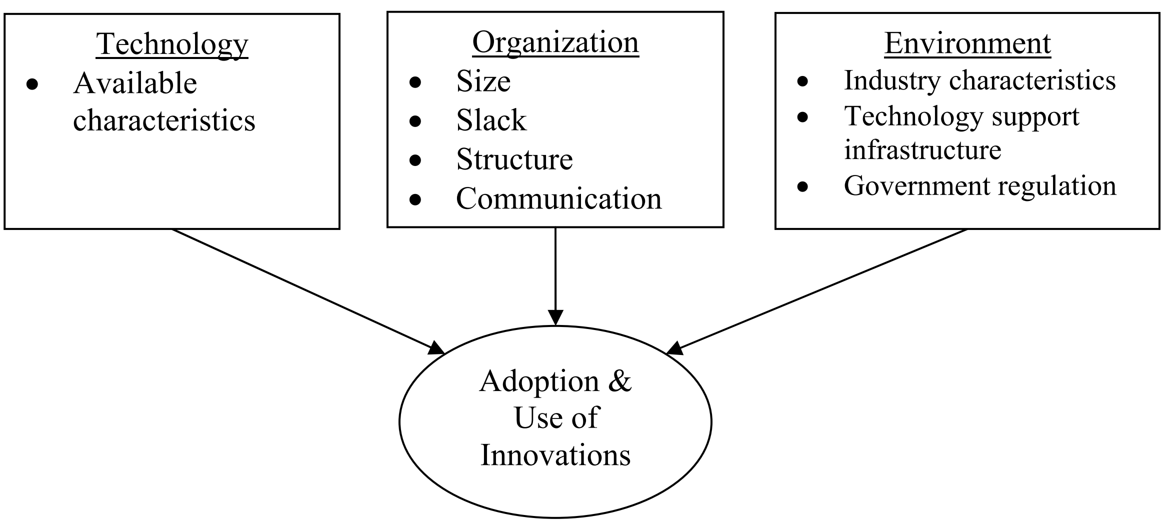


Figure 3.2 Tornatzky and Fleischer's TOE Model

Iacovou et al's (1995) organizational technology adoption model, presented in figure 3.3, is a validate framework to study technology adoption and implementation patterns. Three categories of firm characteristics that promote the adoption and implementation of new technology are identified in the model: 1) Perceived benefits are the only variable that has been consistently identified as one of the most critical adoption factors (Cragg and King, 1993). A firm must have clearly identified the direct the potential benefits of the new technology system to be motivate for the serious commitment to implement a new technology such as CKMP. 2) Organizational readiness: a firm must be structurally and infrastructurally ready to embrace a substantial organizational change. 3) External influences are contextual drivers that push the firm to adopt the new technology. For example, a firm is forced to implement EDI system, if an important trading pattern has recently postulated that EDI is the only way of transaction for doing business with it.

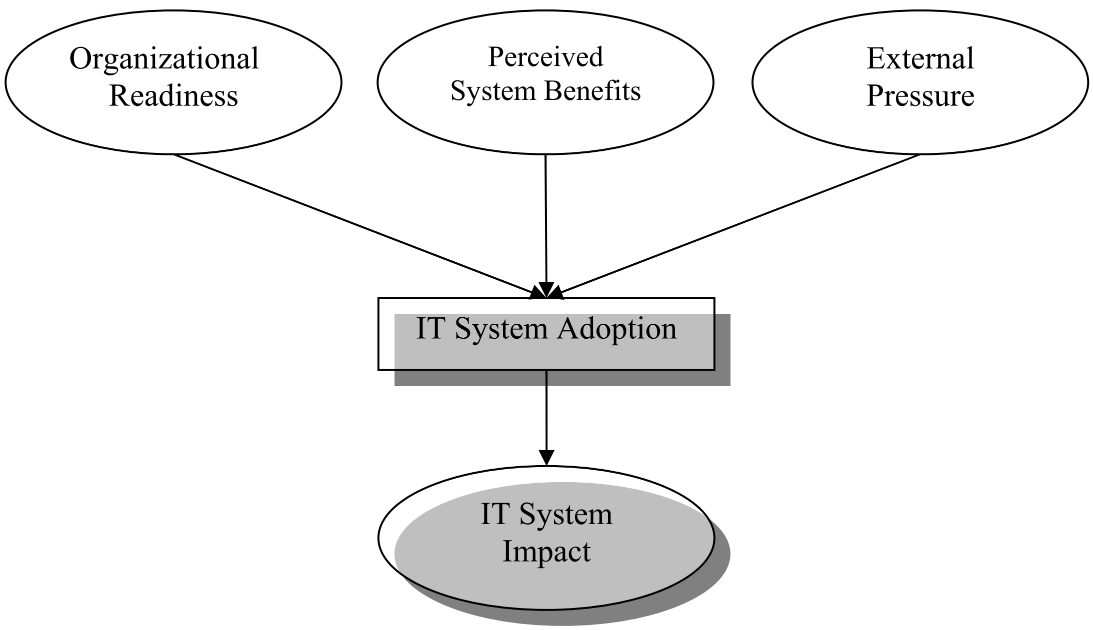


Figure 3.3 Organizational Technology Adoption Model by Iacovou et. al.

Although the original model by Iacovou et al (1995) was first tested in the context of the adoption of EDI for inter-firm transactions, significant empirical research has also shown positive results in applying organizational technology adoption model to various other areas, for example: e-commerce (Chen, Gillenson, & Sherrell, 2002; Koufaris, 2002), digital libraries (Hong, Thong, Wong, & Tam, 2002), tele-medicine technologies (Hu, Chau, Sheng, & Tam, 1999), smart cards (Plouffe, Hulland, & Vandenbosch, 2001), and building management systems (Lowery, 2002). Zhu and Weyant (2003) argued that as a generic theory of technology diffusion, organizational technology adoption model is helpful in understanding the adoption of IS innovation. Swanson (1994) classified IS innovations into three types: Type I are technical task only innovations; Type II innovations support business administration; and Type III innovations are embedded in the core of the business. According to this typology, CKMP with trading partners should be considered as a Type III innovation, because CKMP innovate a firm's core business processes – leveraging two-way communication to improve product offering and customer service. Swanson (1994) further examined the adoption contexts of each innovation type, and contended that typical Type III innovations often requires antecedents such as facilitating technology portfolio, certain organizational attributes, perceived benefits, and external drivers that initiate the firm to adopt such innovation. This theoretical argument can be extended to knowledge management and supply chain management domain: CKMP is being enabled by information and communication technology development, requires organizational enablers, motivated by the potential benefits, and entails environmental drivers of the supply chain context. Thus, upon theoretically examining adoption contexts, innovation types, and CKMP features, we believe that the three contexts in the organizational technology adoption model are well suited for studying CKMP adoption and implementation.

The three organizational technology adoption model antecedents are explored in our model as follow:

- Perceived benefits/relative advantage – expectations of advantages or opportunities reflected by operational and performance improvements related to the adoption of the technology system, such as improved knowledge management operational efficiency, innovation, integrated supply chain relationships. We will operationalize and discuss these items in the later section of construct descriptions.

- Organizational characteristics – We approach this issue from two perspectives: technological Infrastructure looks at the technological preparation of the firm for CKMP implementation; organizational infrastructure studies the whether the firm is structurally and culturally ready for CKMP adopting and implementation.

- External influences – Grandon and Pearson (2004) summarized the technology adoption literature and found that external influences are fairly persistent across different studies. Three dimensions of external influences are identified in our study: environmental characteristics look at factors such as environmental uncertainty, trading partner readiness and perceived external competitive pressure. Knowledge compelmentarity studies the perceived importance and difference of trading partners' knowledge bases. Partner relationship is about the nature of relationship in supply chain (i.e. long term vs. one time partners).

Compared with other IS innovation, CKMP implementation is unique in that it cannot be adopted and used unilaterally. Firms that are motivated to adopt CKMP must either find similarly motivated partners, or persuade their existing market partners into adopting the practice. Moreover, even after CKMP has been adopted, firms must continue making sure the above-discussed antecedents still hold to maintain collaborative relationship with partners in KM to gain sustainable benefits.

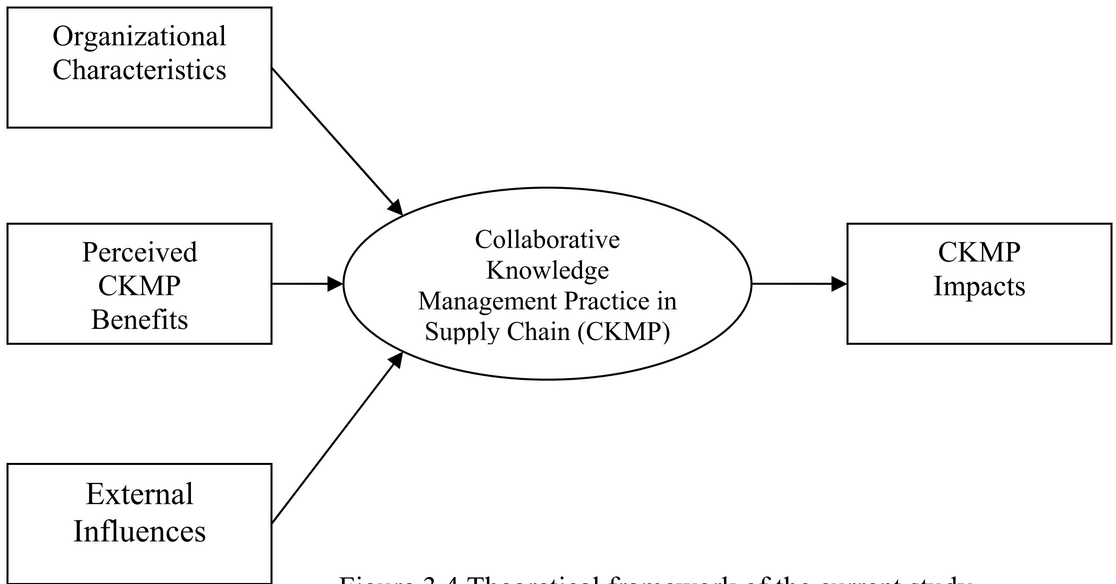


Figure 3.4 Theoretical framework of the current study

Thus, our research will emphasize the implementation process of CKMP by limiting our subject of study to those firms that have already adopted CKMP and explore how these antecedents will facilitate CKMP and what organizational impact CKMP can bring to the supply chain. The following section covers the detailed descriptions and literature review to the constructs in the theoretical research framework presented in figure 3.3.

3.2 Constructs in the Model:

There are 3 CKMP implementation antecedent constructs and 3 impact constructs. The following section would do a through literature review and operationalize these constructs as well as their sub-constructs.

3.2.1 Organizational Characteristics

Organizational characteristics refer to the structural and infrastructural features of the organization related to its readiness to implement CKMP. There are 2 sub-dimensions for this construct: (1) technological infrastructures, the tools and systems that are instrumental to the operation of cross-organizational knowledge communication and management; and (2) organizational infrastructural, the factors that prepare the firm to be collaboration ready and knowledge smart.

3.2.1.1 Technological Infrastructure (TI)

Technological infrastructure has been emphasized as an important antecedent for knowledge management practices by many researchers. For example, Meso and Smith (2000) viewed knowledge management system as an advanced assembly of software, its associated hardware infrastructures for supporting knowledge work and /or organizational learning through the free access to and increased sharing of knowledge. In the current study, TI is defined as a set of information technology tools supporting collaborative knowledge management practices. At the simplest level this means a capable, networked PC for each knowledge user with standardized personal productivity tools so that people can exchange thoughts and documents easily.

Various studies have attempted to identify the key technological components that are critical to the operations of organizational knowledge management systems. Hibbard (1997) and Chaffey (1998) mentioned messaging, video-conferencing and visualization, web browsers, document management, groupware, search and retrieval, data mining, push technology, and intelligent agents group decision support,. Meso and Smith (2000) also identified ten similar key technologies: computer–mediated collaboration, electronic task management, messaging, video conferencing and visualization, group decision support, web browsing, data mining, search and retrieval, intelligent agents, document management. Lin et al (2002) summarized pervious studies and argued that groupware and web-browser technologies are the most prominent.

Followed the works of Alavi and Tiwana (2003) and Smith (2001), this study approaches the technological infrastructure from the knowledge process perspective, which is based on Nonaka's knowledge creation and transfer model (1998). Knowledge generation, storage, access, dissemination and application are the five essential processes that new knowledge is created, transferred and utilized in the business context. Five sub-constructs of technological infrastructure are identified which support the above knowledge processes.

- Communication Support System

Communication support system includes the technological tools such as email, messaging systems, electronic whiteboard, discussion bulletins, and audio/videoconferencing systems. Explicit and factual knowledge can be shared with lean communication tools such as email or threaded discussion; while the more complex, ambiguous and tacit knowledge (e.g. believes, hunch, perspectives) can be transferred with videoconferencing and other rich media format as well. These functions expand system user's reach and scope in knowledge sharing, and significantly improve group collaborative interactions so that group members have greater exposure to each other's thoughts, opinions, and beliefs as well as getting feedback and clarifications from others, thus joint-creation of new knowledge becomes possible.

- Knowledge Database Management System

Organizations generate a large volume of data in their operations, such as customer information, supplier delivery schedules, transaction log etc. Many of these data are functionally different thus needed to be locked in separated databases.

Technology Infrastructure Sub-constructs	**Definitions**	**Literature**	**Corresponding Knowledge processes**	**Supporting Technologies Examples**
Communication Support System	A system that provides communication support to groups of people that are engaged in common tasks or are sharing common resources, goals, values, etc.	Novikov, 2004; Cormican and O'sullivan 2003; Hibbard 1997; Chaffey 1998; Meso and Smith 2000; Lin et al, 2002	*Knowledge Generation*	*Groupware, Electronic whiteboard, Video-conference, Email, Bulletin Board system*
Knowledge Database Management System	A system that transforms knowledge into structured data, controls the organization and storage of data in a database. It supports the structuring of the database in a standard format and provides tools for data input, verification and storage.	Zhu, Tao & Zuzarte, 2005; Gupta, Bhatnagar, & Wasan, 2005; Pai, 2004; Marren 2003, Smolnik and Erdmann, *2003;* Hou, Trappey & Trappey*, 2003;* Shaw, et al 2001; Sanderson, Nixon & Aron*,* 2000; Inmon, 1996	*Knowledge Storage*	*Data Warehousing*
Enterprise Information Portal	A central gateway that enables knowledge users search and access knowledge repositories through retrieval, query, and other manipulations.	Yang, Yang & Wu, 2005; Rose, 2003; Raol, et al 2003; Kim, Abhijit & Rao, 2002;Dias, 2001, Rado Kotorov, Emily Hsu. 2001.	*Knowledge Access*	*Data Mining, Knowledge Server*
Collaborative System	A computer-based system that provides an interface to a shared environment to support multiple users engaged in a common task (or goal) and has a critical need to interact closely with each other.	Baecker 1993; Chidambaram 1996; Dennis, George, and Jessup 1988; Dhaliwal and Tung 2000; Karacapilidis and Pappi; 2000; Cil, Alpturk, and Yazgan, 2005	*Knowledge Dissemination*	*Audio/video conferencing, FTP, Intelligent agent, RSS feed*
Decision Support System	A computer based systems that support unstructured decision-making in organizations through direct interactions with data and analytical models.	NcNurlin and Sprague, 2001; Lado and Zhang 1998	*Knowledge Application*	*Executive Information System, Expert System*

Table 3.1 List of Sub-Constructs for Technological Infrastructure

A data warehouse is introduced as a centralized repository that integrates, summarizes and creates a historical profile of such data, which would otherwise be fragmented (Inmon, 1996). While, data mining is the corresponding set of techniques to uncover the desired information from those in the data warehouse.

The knowledge database management system provides a common repository platform to several distributed databases in different organizations. Summaries and aggregations of unstructured contents then become easier to provide inputs to other knowledge management tools which support managerial decision making. Data-warehousing and data mining stores and reuses knowledge in a common repository, thus reduces cost but increases efficiency in inter-organizational knowledge storage and retrieval. It facilitates across supply chain collaboration and knowledge sharing.

- Enterprise Information Portal

An enterprise information portal is a central access point that enables the transfer of knowledge from knowledge repositories to and from individuals. It often has a web browser interface that looks like an online search engine. A key advantage of enterprise information portal is the ease of use and its ability to transfer knowledge to and from a diverse array of resources and places at any given time.

- Collaborative System

A collaborative system is one where multiple users or agents engage in a shared activity, usually from remote locations. The users in the system are working together towards a common goal and have a critical need to interact closely with each other: sharing information, exchanging requests with each other, and checking in with each other on their status (Baecker, 1993, Cil et al., 2005). The purpose of setting up a collaborative system is to develop a web-based framework for a knowledge management and decision making on a special organizational problem. Cil et al (2005) suggested the five elements of common collaborative systems: 1) asynchronization and collaboration, which are provided by the Web to link all involved users together; 2) many multi-criteria decision making methods and social choice functions; 3) visualizations and the accessibility of data and information; 4) sharing the data among participants; and 5) screening, sifting, and filtering the data, information, and knowledge. All of these elements work together to enhance communication related activities among a team of users and facilitate peer interactions and joint problem solving. Hightower and Sayeed (1995) identified an important feature for collaborative systems is that it supports group discourse tasks by structuring the argumentation, and also provide a formal documentation of the process that is used to arrive at a decision.

- Decision Support System

Decision support system is defined as computer based systems that support unstructured decision-making in organizations through direct interactions with data and analytical models (Sprague and NcNurlin, 2001). The advantage of the technology is its ability to combine existing knowledge with unstructured and context-specific information for problem solving. An expert system can facilitates routine application of knowledge through codification of expert's decision rules and embedding them into software-based systems (Lado and Zhang 1998). The utilization of decision support system can frees knowledge workers from the monotonous reapplication of particular knowledge when such knowledge is relatively stable.

3.2.1.2 Organizational Infrastructure

The second dimension to measure organizational characteristics is organizational infrastructure. An organization can be viewed as a social system of interactions among entities constrained by shared norms and expectations (Bertrand, 1972). Entities in an organization occupy a number of positions and play different roles associated with these positions (Gross, 1958). How these roles related to each other defines the organization's structure and functions. In order to achieve its corporate objectives, organizations have to select and designate appropriate regulations to structure themselves in the right way to control and coordinate activities of interrelated roles. These structure and regulations constituting the underlying foundation or skeleton of an organization form its organizational infrastructure (Holsapple and Luo, 1996). Organizational Infrastructure (OI) thus can be defined as firm's internal configurations and arrangements involving organizational structure, business processes, and work design etc that is intended to support the firm's business and operation strategy (Tapscott and Caston (1993). Examples of the elements of organizational infrastructure are social systems, structures, development processes, communication mechanism, social networks, rewards etc (Anand et al 1998; Finegold et al, 2002; Griffith, 1999; Quinn et al, 1997).

We believe organizational infrastructure both constrains and makes possible what the entities in an organization can accomplish. It defines the organization's management style and philosophy regarding how the employees of the firm are organized into formal and informal teams of departments; how these teams interact formally and informally; and the role and goals of each team and how these relate to the overall corporate strategy (Davenport and Prusak, 1998).

Several studies have attempted to identify the dimensions of OI. Henderson and Venkatraman (1999) classified OI components according to their functions in supporting organization's business process: 1) *Organizational Design*, which includes choices about organizational structure, roles, responsibilities, and reporting relationships; 2) *Processe*s, which articulate the workflow and associated information flows for carrying out key organizational activities; 3) *skills*, which indicate the choices about the capabilities of organizational members needed to accomplish the key tasks that support business strategy. Tapscott and Caston (1993) argued that OI encompasses issues such as sourcing, work design, education, training, and human resource management policies. Thus, they proposed five major components of OI from the perspective of OI's functional objectives: 1) *Common vision* is defined as the collective awareness of the supply chain's overall goal, and consistency in beliefs and assumptions across organizational boundaries. 2) *Cooperation* is referred to as an orientation toward the collective interest where individuals work together to complete tasks. 3) *Empowerment* is about employee's acquisition of relevant skills and knowledge in the work environment and the ability to make and execute business decisions independently. 4) *Adaptation* is defined the flexibility level and the firm's willingness to difference extent of modifications with the changing business environment. 5) *learning* is the firm's objective of supporting individual learning and the establishment of norms hat encourage change and innovation. Organizational infrastructure was operationalized using 42 items adapted from several instruments (Dale, 1999; Balsmeier and Voisin, 1996; Davenport and Prusak 1998; Smith and Farquhar, 2000; Meso and Smith, 2000; Val and Lloyd, 2003). Bertrand (1972) observed organization as a conglomeration of entities, which play different roles based on their positions in the organization. OI defines the social system of all of the organization's entities interacting with each other. OI stipulates the organization's selection structures and regulations etc in order to control and coordinate activities and interrelated roles of these entities for common corporate objectives. Davenport and Prusak (1998) echoed similar understanding and summarized OI as organizations' management style and philosophy and the structures that determines how the employees of the firm are organized into formal and informal teams of departments; how these teams interact formally and informally; and the role and goals of each team and how these relate to the overall corporate strategy. Based on these studies, we believe the scope of OI is very board and general. It includes the entire social systems, structures, development processes, communication mechanism, social networks, rewards et al of corresponding to organization's business and operation strategy (Anand et al 1998; Finegold et al, 2002; Griffith, 1999; Quinn et al, 1996). Because of the objective of this present study, we would limit our emphasis onto the number of OI elements that have direct relationship with knowledge management and intra/inter-organizational collaboration. The selected dimensions are Top management support, Collaboration Supportive Culture, and Organizational Empowerment. All of them are believed to be critical in establishing a set of roles and organizational configurations to support collaborative knowledge management practices.

Organizational infrastructure in this study includes three sub-constructs as presented in table 3.2.

Constructs	Definition	Literature
Top-management Support	The degree of top management's understandings of the specific benefits and their willingness to provide support to CKMP.	Hamel and Prahalad, 1989; Dale, 1999; Balsmeier and Voisin, 1996; Davenport and Prusak 1998; Goldman, et al 2002.
Collaboration Supportive Organizational Culture	the set of norms, values and organizational practices that encourage team work, cross-functional communication, and cooperation	Hart, 2004; Davenport and Prusak, 1998; Smith and Farquhar, 2000; Meso and Smith, 2000; Harrison, 1987
Organizational Empowerment	managerial style where managers share with the rest of the organizational members on their influence in the decision making process	Mitchell, 1973; Vroom and Jago, 1988; Cole et al., 1993; Val and Lloyd, 2003; Cordova, 1982; Dachler and Wilpert, 1978; Harber et al. 1991

Table 3.2. Subcontracts of Organizational Infrastructure

Top Management Support

Top management support is defined as the degree of senior managers' understanding to the benefits of CKMP and the level of support to CKMP. 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.

The vision of top management plays a critical role in shaping an organization's values and orientation. To implement CKMP successfully, top management must understand and embrace the strategically and operational impact of partnering with their supply chain network in knowledge management. Davenport and Prusak (1998) analyzed the types of support top-management can actually provide: 1) Sending messages to and educate the employees that knowledge management and organizational learning are critical to the company's success, so that the entire organization is aware of CKMP and be ready to use and support it. 2) Providing funding and other resources for infrastructure. 3) Clarifying what types of knowledge are most important to the company. This can serve as a guideline for the general direction of knowledge generation and harvesting.

Collaboration Supportive Organizational Culture

Collaboration Supportive Organizational Culture (CSOC) is the set of norms, values and organizational practices that encourage team work, cross-functional communication, and cooperation (Hart, 2004). Davenport and Prusak (1998) identified three major components for a knowledge friendly organization culture: 1) Positive orientation to knowledge -- employees are bright, intellectually curious, willing and free to explore the unknown; and cooperate executives encourage knowledge creation and the use of novel knowledge. 2) Encouragement for knowledge sharing -- employees are not alienated or resentful of the company and don't fear that sharing knowledge will cost them their jobs. 3) Decentralized organizational structure that facilitates the fit and alignment of goals, vision, and operation approaches between entities involved.

A culture with a positive orientation to knowledge is one that highly values learning on and off the job and one in which experience, expertise, and rapid innovation supersede hierarchy. Employees in organizations with such culture are given incentives or rewards for taking the risks exploring the unknown for innovativeness; it will create the hero mentality and motivates the employees for creating more knowledge.

The second component of CSOC deals with the degree of information flow, communication and knowledge transfer. Due to the recent downsizing trends of US companies, it is not uncommon to find that individuals may believe their knowledge is critical to maintaining their value as employees and may be reluctant to share their knowledge with others. CSOC would provide a supportive environment where employees are evaluated and rewarded in teams rather than on the solo basis of individual expertise. Thus without the fear of their values and job security being jeopardized after sharing individual knowledge and expertise with others, employees are more willing to contribute any information about mistakes or failures if this knowledge was valuable to the company to prevent others from making the same errors.

The alignment of goals, vision and approaches among various entities of the knowledge network is the third component for CSOC. The variation of roles each entity plays necessitates their different visions and operation approaches. Collaboration won't thrive if there is conflict among these entities. The organizational structure must be able to accommodate the differences as well as fit everyone toward a commonly accepted mission and operating protocol. A highly centralized/hierarchical company may not support the highly autonomous collaborative knowledge creation type of work. On the other hand a decentralized organizational structure can achieve 1) faster decision-making; and 2) the decision better adapted to local particular condition.

Organizational Empowerment

Empowerment, sometimes called participation or participative management (Val and Lloyd, 2003), is a classical concept that has gained widespread interesting among researchers when studying the organizational infrastructures (e.g. Drucker, 1988, Thomas and Velthouse 1990, Lawler, 1993, Spreitzer 1995, Doll, et al 2003). Organizational empowerment can be understood as a motivational construct of self-efficacy (Conger and Kanungo, 1998). Thus, Spreitzer (1995) explained an organizational environment with high empowerment as such where individuals wish and feel able to shape his or her work role and context. Spreitzer (1995) studied empowerment from its four cognitive dimensions: 1) Meaning: the value of a work goal or purpose, judged in relation to an individual's own ideals or standards; 2) Competence/self-efficacy: an individual's belief in his or her capability to perform activities with skill (Gist, 1987); 3) Self-determination: an individual's sense of having choice in initiating and regulating actions (Deci, Connell, and Ryan, 1989); 4) Impact: the degree to which an individual can influence strategic, administrative, or operating outcomes at work (Ashforth, 1989). All four dimensions must combine together to reflect an active, rather than a passive, orientation to one's work role in the organization (Spreitzer 1995).

Other researchers (Mitchell, 1973, Vroom and Jago, 1988, Cole et al., 1993, Val and Lloyd, 2003) have taken a more pragmatic perspective and regard empowerment as a managerial style where managers share with the rest of the organizational members in their influence on the decision making process. This study is trying to look at the effects of empowerment on organizational knowledge management practice, thus we would follow this perspective and define empowerment as the involvement of employees and collaboration among them in the decision making process.

For an effort of measuring empowerment, Val and Lloyd, (2003) identified two components. Degree of extent, the first component, refers to the people taking part in the empowerment programs, in other words, to what hierarchical level of employees (from first line worker to supervisors and all the way to top management) are offered the opportunity of decision making collaboration. The greater scope of the organizational hierarchy that has been involved into the decision-making process, the more empowered the management practice is.

The second component is “dimensions”, which has three sub-categories: formality of the involvement, relationships in collaboration, and degree of influence. Formality of the involvement gauges how formal the involvement is. If the influence on decision is merely based on personal relationships between manager and the subordinates, it is regarded as informal involvement (Locke and Schweiger, 1979). While an environment where certain rules or norms are imposed to guarantee employee participation is considered a more formal type of involvement (Dachler and Wilpert, 1978). The more formal the channels are, the higher extent of organizational empowerment is. This is simply because the management style with formal regulations makes subordinate empowerment and participation more likely (Harber et al, 1991). Relationships of collaboration, the second category, are about whether employees contribute directly or indirectly to the decision making processes. It is indirect participation, if an employee exerts his or her influences through someone else –someone who acts in his/her name, his/her superior, delegates of his/her group or another colleague (Harber et al., 1991). Both Cole et al. (1993) and Dachler and Wilpert, (1978) considered empowerment is characterized for being direct instead of through intermediaries. Degree of Influence, the third category, measures to what extent employee impose influence along the decision making process. It is a continuum start from a point where managers give order to employees about what they need do exactly to the ending point where managers delegate the decision making to subordinates (Dachler and Wilpert, 1978; Harber et al. 1991).

Many of the literature about organizational empowerment are about employee's level of involvement in decision making. In the knowledge management context, we operationalize it as employee's level of control on how knowledge is created, shared with others and applied to their work, i.e. employees are highly empowered when they are given authority to author knowledge and apply such knowledge to their work. It will be measured by the two components as discussed above (i.e. degree of extent and dimensions).

3.2.2 Perceived Benefits

Perceived benefits refer to the level of recognition of the relative advantage that CKMP can provide to the organization. Many practitioners and researchers have attempted to identify the potential advantages that knowledge management system has to offer. Firms must be able to identify substantial benefits from adopting CKMP to motivate and justify their commitment. Pfeiffer (1992) and Iacovou et al. (1995) argued that these perceived benefits can be understood from two perspectives.

The first perspective looks at the direct benefits from CKMP. These are mostly operational improvements in organizational knowledge management capabilities that the firm believes CKMP can bring. The purpose of knowledge management system is to improve the knowledge management process (Alvai and Leidner, 2001). Therefore, our understanding to firm's perceived knowledge management capability improvement is based on the five activities of the generic knowledge management process identified by Cormican and O'Sullivan (2003), i.e. firm's capabilities on supply chain knowledge generation, storage, access, dissemination and application are all expected to be facilitated by CKMP. With the improve knowledge management process, CKMP adopters expect to achieve superior knowledge outcome. Thus, we believe it is necessary to add another dimension besides the above five knowledge activities to look at the overall supply chain knowledge quality improvements.

The second perspective of perceived CKMP benefits observes the indirect benefits or opportunities from implementing CKMP. It explores to the impact of CKMP on the overall organizational and supply chain performance dimensions. These are mostly tactical and competitive advantages the firm gains indirectly from implementing CKMP. Although the ultimate benefits of implementing CKMP can include large financial savings, better product/service offering, improve customer service etc, these benefits are too remote and too general to be analyzed. Thus, much of our attention has focused on its impact on business operations. In a conceptual paper, Smith (2001) summarized six possible dimensions of CKMP benefits to organizational operations:

- Adapt to a rapidly changing environment

It is obvious that the rapidly changing environment creates significant uncertainties for the supply chain. It requires a flexible system with appropriate business processes that make a company's knowledge assets more explicit and amenable to continual change. The essence of CKMP is unlocking and making accessible knowledge assets that are either embedded in prescriptive processes or carried in people's minds (Smith, 2001). CKMP is expected to create operational routines that allow all trading partners to internalize sources of internally generated uncertainty and to respond more effectively to externally generated uncertainty. Firms believe that CKMP can help them to gain understanding to the external environment such as overall industry trends and market conditions, and adjust supply chain's business solutions more easily and continually.

- Optimize business transactions

Supply chain management involves coordinating with trading partners on business transactions such as ordering, delivering, and billing etc. As an inter-firm system, CKMP is expected to enable participating firms to share expertise and operation information with others, so that firms can better understand each other and be more efficient on routine business transactions. For example, knowing the manufacturer's production plan helps the logistic provider to optimize its delivery truck schedule.

- Enhance supply chain integration

Given the global nature of today's markets, keeping up with the capabilities and limitations of various suppliers and transportation/distribution service providers has already been a daunting task. Besides, firms need to know not only how various trading partners perform but also whether there are opportunities for improvement. CKMP are expected provides an opportunity to understand a firm's trading partners and integrate their expertise to magnify the power of knowledge assets. As Heiman and Nickerson (2004) argued, the aggregated total knowledge potential of all stakeholders in the supply chain can create greater value than the sum of the knowledge if stays apart in various places of the value chain. Without a structured and supportive system, much of stakeholder knowledge stays in fractional pieces and never tapped with their potential value gets wasted. CKMP is believed to be able to leverage the knowledge of all supply chain stakeholders and facilitates them operate together rather than running against each other. Firms can better understand both the short-term challenges they may be encountering in the market, and the longer-term trends that can shape investment decisions and resource allocation.

- Exception handling

Handling internal and external exception is an important mission in today's supply chain. Understanding how to manage unusual circumstances often requires both documented exception guidelines and the knowledge of experienced personnel who can quickly recognize the problem and make the necessary adjustments. Firms can use CKMP to facilitate supply chain–wide information flow and to determine whether the information is reliable and if the assumptions held by each of the parties are consistent. CKMP can also standardize business solutions based on similar past scenarios and the expertise of appropriate personnel. Thus, supply chain can precisely recognize the exception circumstances in a timely manner and operate in a systemized way according to predefined guidelines.

- Be able to innovate

Undoubtedly, in order to remain competitive in the market, firms must innovate on regular basis. Thus getting contributions from trading partners to generate a steady stream of ideas is a key factor in firm's supply chain management agenda. Innovation is not something that can be switched on but only be possible when expertise from various sources get mingled for generating new (Heiman and Nickerson, 2004). However, the traditional knowledge sharing between trading partners is almost entirely confined to senior management who rely heavily on the traditional hierarchy of reporting structures. Such reporting hierarchies rarely support the lateral or downward movement of knowledge and multidimensional interactions among the actual knowledge users for effective knowledge generation and application. CKMP can bring together the expertise from real knowledge users of all trading partners, encourages collaborative work and ignites the innovative business solutions.

- Fully capitalize and develop its people

People are fast becoming the most important asset to many firms. With the pace of change, the rate of innovation, firms are becoming more dependent on their staff, who know and understand the business and essentially drive the business on a day-to-day basis. The dependence isn't confined to senior managements, but can extend into all levels of employees. However, in modern corporate environment, employee's personal characteristics are often buried deep under bureaucratic organizational structures. Individuals are frequently constrained by their job roles and responsibilities or else so that no one realizes that they are there. CKMP can promote the concept of collaborative working, where even simple mechanism like discussion groups, can unleash a wealth of hitherto untapped or hidden knowledge, experience and talent. It can cut across the organizational barriers between trading partners and enables the formation of natural work groups and bring to bear expertise the firms didn't realize they possessed. Thus, CKMP is believed to be able to create an environment in which individuals contributions are valued and encouraged. Employees can develop a real sense of involvement and belonging. This is perhaps one of the biggest factors in motivating and retaining staff. In summary, CKMP is expected create substantial benefits to supply chain trading partners. To a narrow sense, CKMP is a system that can facilitate the generation and transfer of new knowledge; to a boarder sense, it can lead to overall performance improvements. CKMP can provide each trading partner, functional department and individual the ability of continually re-examining their work, seeking ways to improve and making suggestions to peers and managers about ways to improve. It can keep records of past successes and failures so that everyone else might benefit from these experiences thus mobilizing the organizational knowledge assets. Several researchers (e.g. Roper and Crone, 2003; Stewart, 1997; Teece, 1998) argued that CKMP is an important tool for firms to remain competitive. All of these perceived benefits encourage firms to adopt and implement CKMP with their supply chain partners.

3.2.3 External Influences

External influences refer to various external conditions and events that create opportunities and threats to the firm, and exert pressure to adopt and implement CKMP. Follow the studies of Kuan and Chau (2001), Zhu et al (2003) and Nikolaeva (2006), we identified three major external influence factors: 1) environmental characteristics examine the organizational environment such as environmental uncertainty in business, perceived competitive pressure to implement CKMP and trading partner readiness for CKMP; 2) knowledge compelmentarity studies how different each firm's knowledge bases are and how important a firm perceives other's knowledge to its own operations; and 3) trading partner relationship. All three dimensions of external influences have substantial impact on whether a particular firm is willing to implement CKMP with its trading partners.

3.2.3.1 Environmental Characteristics

Three environmental factors are identified that are expected to affect firm's level of CKMP implementation including environmental uncertainties, competitive pressure and partner readiness.

Constructs		Definition	Literature
External Influence		The various external conditions and events that create opportunities and threats to the firm and exert pressure to adopt and implement CKMP.	Iavovou et al. (1995), Premkumar and Ramamurthy (1995), Chau and Tam (1997), Thong (1999), Kuan and Chau (2001), Zhu et al (2003), Nikolaeva (2006)
	Environmental Characteristics	The environmental factors that affect firm's level of CKMP implementation, including environmental uncertainty, competitive pressure, and trading partner readiness.	Provan 1980; Ellram, 1990; , Grover, 1993; Brent, 1994; Iacovou et al., 1995; Premkumar et al., 1997; Fliedner and Vokurka, 1997; Crook & Kumar, 1998; Krause et al., 1998; Juan and Chau 2001; Zhu et al 2003
	Knowledge Complementarity	Knowledge users' perceived difference in the knowledge portfolios of trading partners as well as the perceived importance of a partner's knowledge to other organizations on the supply chain.	Mansfield and Romeo 1980, Young and Lan, 1997, Buckley and Carter 1999, Roper and Crone 2003, Tiwana and McLean, 2005
	Partner Relationship	The degree of trust, commitment, and shared vision between trading partners.	Achrol et al. 1990; Ganesan, 1994; Tan et al., 1998; Sheridan, 1998; Monczka et al., 1998; Wilson & Vlosky, 1998; Handfield and Nichols 1999; McAdam and McCormack, 2001

Table 3.3 Constructs, definition, and supporting literature for external influences

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). Environmental uncertainty has acted as a critical external force driving the implementation of supply chain integration including the collaboration of knowledge management practices between business partners. Most of operational definitions of environmental uncertainty can trace their roots to the work of Aldrich (1979), which proposes five sub-dimensions of environmental uncertainty: 1) capacity, 2) homogeneity-heterogeneity, 3) stability-instability, 4) concentration-dispersion, and 5) turbulence.

Other researchers take a different perspective to study environmental uncertainty by analyzing the source of uncertainty. For example, Miller and Droge (1986) and Vickery et al. (1999) identified 5 dimensions that cause uncertainty: volatile market practices, obsolescent product; unpredictable competitors, customer demands, and change in production or service modes. The study Gupta and Wilemon (1990) considers four factors: increased global competition, continuous new technologies advancement that quickly outdates existing products, changing customer requirements which shorten product life cycles, and the involvement of external trading partners. Ettlie and Reza (1992) and Zhang (2001) perceive environmental uncertainty as unexpected changes of customers, suppliers, competitors, and technology. In her dissertation, Li (2002) followed the 4 sources of environment uncertainty and design and validated measurement instrument for the construct. Consistent with her study, we take the same perspective and define the 4 sub-dimensions of environmental uncertainty as follow:

Customer Uncertainty is the extent of change and unpredictability of the customer's demands and tastes. In the current business world, the fast moving, sophisticated customer-led competition has replaced the traditional seller market, where demand outstripped supply. The customer demand patterns are becoming increasingly volatile and uncertain, as reflected by large changes in volume, mix, timing, and place among orders. As Burgess (1998) and Van Hoek et al. (1999) have argued, customers today want more choices, better service, higher quality, and faster delivery. These uncertainties greatly affect organization's operations and business strategies.

Supplier Uncertainty is the extent of change and unpredictability of the suppliers' product quality and delivery performance. Lee and Billington (1992) studied the potential reasons for supplier uncertainties as such: supplier's engineering level, supplier's lead-time, supplier's delivery dependability, quality of incoming materials, etc. Supplier uncertainty, such as delayed delivery, will postpone or even deadlock an downstream partner firm's production process. In a supply chain context working with Just-In-Time in particular, any uncertainties in the upstream will be magnified through the system in the forms of amplified ordering fluctuation, which will lead to excessive safety stock, increased logistics costs, and inefficient use of resources (Davis, 1993; Yu et al., 2001).

Competitor Uncertainty is the extent of change and unpredictability of the competitors' actions. Li (2002) identified globalization, increasingly demanding customers, and rapid technology advancement as the factors that lead to competitors' unpredictable actions. In today's global economy, organizations are forced to increase their range of competition. Organizations used to compete domestically have to understand the foreign rivals that penetrate their markets. The trend of customization requirements and technology development add more factors into the competition which force organizations to operate even more dynamically. The growing competitiveness of the business environment is likely to continue into the future. Researchers such as Narasimhan and Jayaram (1998) and Mentzer et al. (2000) argue that organizations are facing simultaneous pressures to reduce costs and time to market, and increase product quality and variety, in order to effectively respond to such intense competition. Under this competitive pressure, businesses have no choice but to improve the methods of understanding its customers, partners and competing environment in order to reduce uncertainty. CKMP provides an effective mean learning about the firm's business context, thus offers too many possibilities to be ignored.

Technology Uncertainty is the extent of change and unpredictability of technology development in an organization's industry. Technology development provides organizations with numerous opportunities. For example, Chizzo (1998) and Turner (1993) argued that the breakthroughs in information technology facilitate inter-firm knowledge sharing and supply chain and business process integration. On the other hand, technology advancement also introduces uncertainty factors and threats to organizations. For example, while IT extend organization's operation horizon through easy access to trading partners around the world, it also introduces international competition to the firm's home turf (Evan and Wurster, 1993). Given the quick obsolescence of components in the computer industry, organizations must frequently invest in new systems (Prasad and Tata, 2000). IT is believed to change the level of partner relationships within the supply chain and increasing customer and consumer expectations. IT is accelerating the shift in power from producers to the consumer's demands for responsiveness and flexibility (Tattum, 1999). It is no longer an option but an approach to survive the intense competition that organizations are continuously experiencing the pressure to update their technology.

2) Competitive pressure

The second environment characteristic is competitive pressure, which refers to the coercive force the firm experiences because of the CKMP implementation of the firm's industry, of its competitors and, most importantly, of its major trading partners (Zhu et al 2003). As more and more competitors get involved in CKMP, it becomes an order qualifier that the firm has to adopt in order to maintain its position in the market.

It is a similar occasion when a firm's major trading partners have implemented CKMP, the firm is forced to follow suit if it wants to continue the supply chain relationship. Provan (1980) argued that the pressure exercised by trading partners is a function of two factors: the potential power of the imposing partner and its chosen influence strategy. Naturally, supply chain master firm or powerful partners (e.g., ones that consume a large proportion of sales or generate a large portion of the firm's profits) are expected to be more influential to persuade other firms to adoption CKMP, as compared with similar requests made by less powerful partners.

Different strategies of influence can also affect the extent of pressure a firm can exert. As Kuan and Chau (2001) argued that a partner firm may pursue three different strategies to induce its partner to adopt new technology. The first strategy is "recommendation", where a member (either powerful or less powerful) of the supply chain uses information to alter its trading partners' general perceptions of how their organizations might more effectively operate with the implementation of CKMP. In contrast, the other two strategies are often taken by the powerful member or the leader of the supply chain, because these strategies require compliance from the less powerful firm. "Promises" are all tactics that allow that smaller partners believe that the larger firm will provide specified rewards (such as subsidized adoption and usage fee) for their CKMP implementation. On the other hand, "threats", the third strategy, refer to actions that convey the larger firm's intentions to apply negative sanction (such as discontinuance of the partnership) should the smaller company insist not to implement CKMP. Some large automobile manufacturers and department store chains did invoke similar threats to their partners for not adopting EDI in the 1990s (Brent, 1994).

3) Treading Partner Readiness

The collaborative nature of CKMP implies that it involves the participation from multiple parties in the supply chain. There must be at least one trading partner that is willing to invest in collaboration with the firm for knowledge management. Thus whether the trading partners are ready is critical to successful CKMP implementation. This study defines trading partner readiness as their willingness and organizational preparations for CKMP implementation. Trading partner willingness reflects the extent to which these firms recognize the potential benefits of CKMP (Zhu et al, 2003). It is obvious that when the partner firms understand and internalize these benefits, they are more motivated to embrace the idea of working with other firms for CKMP implementation. The other dimension of organizational preparations includes the logistic capabilities of these firms Kuan and Chau (2001). CKMP involves intensive information technology applications, the design and installation of which often requires work from professional consulting companies (Smith, 2001). During its operations, firms need specially trained IT professional for daily maintenance. All of these tasks are by no means simply. Firms must be technologically capable and dedicate a significant amount of organizational resources to CKMP implementation. It is particularly true for small or medium sized firms; because they often have limited resources available when compared with what is needed for CKMP commitment (Kuan and Chau, 2001). To measure trading partner readiness, Kuan and Chau (2001) also suggested the third dimension, the availability of a clear schedule. Naturally, having a concrete plan is can be regarded as an representation that the firm is serious and ready for adopting CKMP.

3.2.3.2 Knowledge Complementarity (KC)

The concept of knowledge complementarity (KC), sometimes called knowledge gaps (such as Young and Lan, 1997, p 671), knowledge lags (Mansfield and Romeo 1983) or knowledge heterogeneity (Tiwana and McLean, 2005), captures the differences in the stock of knowledge between knowledge sharing partners. Knowledge complementarity can be also understood as the relative strength of knowledge base of the partners in knowledge coordination. It is closely related the patterns of knowledge collaboration and coordination activities between partner firms in supply chain. The past attempts to define KC start from developing taxonomy that distinguishes between different forms of knowledge. Then, KC was studied in terms of differences in the strength of each firm's knowledge base as well as utilization of a range of knowledge and techniques. The current study follows this line of research in understanding KC. However, we find the taxonomy of each knowledge sharing partner's knowledge profile is difficult and sometimes confusing, because trading partners of a supply chain are involved in very different business areas, vary in firm sizes and take different operating structures. This study thus adopts the definition given by Roper and Crone (2003), which emphasize the supply chain context and use knowledge user's perceived difference and strength of each firm's knowledge rather than the comparison from tedious taxonomy. We believe that detailed information on firm's knowledge bases and the extent of knowledge compatibility with suppliers' can only be identified realistically through the eyes of knowledge users. Thus, KC is defined in this study as the knowledge users' perceived difference in the knowledge portfolios of trading partners as well as the perceived importance of a partner's knowledge to other organizations on the supply chain.

We will use the two dimensions to understand and measure the concept of KC: the dimension of perceived knowledge importance will follow the Buckley and Carter's study (1999) in knowledge relationships and measure the impact of the trading partner's knowledge to the firm's operation; the perceived knowledge differences will capture knowledge users' perceived difference between partner organization's knowledge portfolios. Partner firms' knowledge base must be different enough to encourage mutual interest in knowledge exchange. They must also have considerable degree of common knowledge so that knowledge users from each party can understand, communicate, and utilize the knowledge shared. Knowledge Compatibility also refers to the commonality in using terms. Multiple and contradictory meanings for the same term can create barriers to sharing knowledge (Koufteros et al, 2001). On the other hand, a common language provides knowledge community members from different professional backgrounds the means to better understand one another. That is to say those trading partners who always use the same term to refer to the same thing are regarded to have higher knowledge compatibility.

3.2.3.3 Partner Relationships

Partner relationship refers to the degree of trust, commitment, and shared vision between trading partners. Modern technology can easily link together the physical supply chain processes, but not inter-organizational relationships. The successful implementation of CKMP requires part firms have collaborative relationships. Following Li's (2002) study, which provided validated measurement items in supply chain context, we consider partner relationship include 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 3.4.

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 and Vlosky, 1998; Spekman et al., 1998). 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., 1998). The definition of trust reflects two distinct components: (1) credibility, which is based on the extent to which one 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 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.

Trust has been considered by many researchers to be the binding force in most productive partner relationships in supply chain (Wilson and Vlosky, 1998). For example, Deutsch (1960) suggests trust is a critical antecedent for cooperation. Pruitt (1981) argues that a party would undertake high-risk, coordinated behaviors if trust exists. Trust stimulates favorable attitudes and behaviors (Schurr and Ozanne, 1985).

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., 1998; Youngb et al., 1999; Mariotti ,1999; Vokurka & Lummus, 2000; Ballou et al., 2000;
Commitment of Trading Partners	The willingness of each partner to exert effort on behalf of the relationship.	Grittner, 1996; Hicks, 1997; Monczka et al, 1998; Spekman et al., 1998; Wilson & Vlosky, 1998; Mentzer et al., 2000;
Common Vision between Trading Partners	The degree of similarity of the pattern of shared values and beliefs between trading partners.	Alvarez, 1994; Monczka and Morgan ,1997; Farley, 1997; Spekman et al. 1998; Sheridan, 1998; Lee and Kim, 1999; Ballou et al., 2000;

Table 3.4 List of Sub-Constructs for Partner Relationship

Commitment of Trading Partners refers to the buyers and suppliers' willingness to exert effort for their mutual relationship (Spekman et al., 1998; Monczka et al, 1998). Commitment means an enduring intension to maintain a valued and long-term relationship. It incorporates each party's desire and expectation of sustainable relationship, and willingness to invest resources in collaboration with others (Mentzer et al., 2000). Therefore, commitment 1) is a critical factor for long-term relationship; 2) demonstrates one's willingness to should risks associated with deep involvement into other party's operations; and 3) implies the perceived importance of the relationship to the partners (Mentzer et al., 2000). Through commitment, partners dedicate resources to sustain and further improve the effectiveness of CKMP.

Commitment has been identified as the variable that discriminates between relationships that continue and that break down (Wilson and Vlosky, 1998). It involves trusting the partners with proprietary knowledge and other sensitive information. Grittner (1996) echoed similar statement that it's not enough to partner with a supplier simply in the hopes of getting the best possible price, commitment and coordination with a cost-analysis mindset is needed to maximize the supplier chain collaboration.

Common Vision Between Trading Partners is defined as the extent of trading partners' beliefs in common about what behaviors, goals, and policies are important or unimportant, appropriate or inappropriate, and right or wrong (Ballou et al., 2000). It is obvious that when partners have established a common vision, it would be easier to exchange knowledge. On the contrary, if the participants do not have a shared understanding toward the importance of knowledge, they lost a common ground to establish knowledge management collaboration. Any incompatibilities of understanding between allied supply chain partners, in terms of reputations, job stability, strategic horizons, control systems, and goals, will be less likely to maintain strategic partnership (Mentzer et al., 2000); thus, organizational and functional barriers must be removed from successful collaboration.

3.2.4 CKMP Impact

The impact of CKMP implementation refers to the real benefits adopters believe they have received from utilizing CKMP (Iacovou et al, 1995). We assume these impacts are closely associated with the perceived CKMP benefits. All of the expected benefits should be reflected as an outcome from CKMP, providing the implementation is successful.

Thus there are two general dimensions of impacts: the first is the improve knowledge capabilities as represented by high supply chain knowledge quality, and the second dimension is the organizational performance advancement, as reflected by supply chain integration as well as supply chain performance. The definition and supporting literature for the sub-constructs are listed above in table 3.5.

Constructs	Definitions	Literature
CKMP Impact	the actual benefits adopters receive from utilizing CKMP	Iavovou et al. (1995), Premkumar and Ramamurthy (1995), Chau and Tam (1997), Thong (1999), Kuan and Chau (2001), Zhu et al (2003), Nikolaeva (2006)
Supply Chain Knowledge Quality	The extent of fit for use by knowledge consumers for understanding and solving supply chain problems.	Strong, Lee and Wang, 1997; Lillrank (2003); Wong and Strong (2001); Monczka et al., 1998 Wand and Wang, 1996, Wang and Strong, 1996; Huang and Wang ,1999
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.	Peterson et al., 2005; Gunasekaran and Ngai, 2004; Bowersox, 1989; Stevens, 1989; Byrne and Markham, 1991; Lee and Billington, 1995; Hewitt, 1994; Clark and Hammond, 1997; Wood, 1997; Lummus et al., 1998; Stock et al., 2002; Narasimhan and Jayaram, 1998; Johnson, 1999; Frohlich and Westbrook, 2001; Ahmad and Schroeder, 2001;Kim and Narasimhan, 2002; Narasimhan and Kim, 2002; Frohlich and Westbrook, 2002; Frohlich, 2002;
Supply chain Performance	A set of performance measures, to determine the efficiency and/or effectiveness of a system, including partner quality, supply chain flexibility, responsiveness to customers, and supplier performance.	Beamon, 1998, Harland 1996, Garwood 1999, Tompkins and Ang 1999, Bechtel and Jayaram, 1997, Van Hoek 1998, Bechtel and Jayaram 1997, Stevens 1990, Narasimhan and Jayaram 1998, Gunasekaran et al. 2001, Li 2003

Table 3.5 List of constructs for CKMP impact

3.2.4.1 Supply Chain Knowledge Quality

Good knowledge quality has been recognized as an important outcome from knowledge management systems and a factor in facilitating knowledge transfer and supply chain integration (e.g. Kane et al, 2005). However, there is no standard operational definition and measurement available in the literature for this construct. The existing studies have extensive discussions on data quality and information quality (e.g. Wang and Strong, 1996, Wixom and Watson, 2001, Shanks and Darke, 1998, Lillrank, 2003).

Based on the well-known DeLone and McLean (1992) framework, these studies take a user's perspective on data requirements and identified a number of data quality attributes. Since most of these studies are in the IS area, they tend to name anything the system stored, transmitted and processed as data, and use data, information and knowledge interchangeably. Because the current study defines the concept of knowledge as both the explicit and tacit components of what trading partners share with each other, we feel it is acceptable to borrow the attributes and their definitions from those existing studies on data/information quality to our discussions on knowledge quality. We are interested in investigating the knowledge quality in terms of (1) the extent to which it is innovative, new or novel to the firm, and (2) the usefulness and importance to the acquiring firm. The underlying motivation is that we are interested in whether the shared knowledge adds value to, or makes an impact on the performance of the firm acquired it. Thus, we take a "fitness for use" viewpoint in studying the usefulness and usability of knowledge to its users and define knowledge quality as the extent of fit for use by knowledge consumers. It has the following conceivable dimensions of sub-constructs as shown below in Table 3.6.

Construct	Definitions	Literature
Intrinsic Quality	The intrinsic characteristics of knowledge that are independent form the context in which the knowledge is produced and used. It includes the dimensions of accuracy, objectivity, credibility, and reputation.	Strong, Lee and Wang, 1997; Lillrank (2003); Wong and Strong (2001); Monczka et al., 1998 Wand and Wang, 1996, Wang and Strong, 1996; Huang and Wang ,1999
Accessibility Quality	The ease of accessing to the knowledge and the security of knowledge being stored or shared.	Strong, Lee and Wang, 1997; Huang and Wang ,1999; Salmela, 1997 [back of Lillrank]
Contextual Quality	The extent to which the knowledge is related to the context, support user's tasks and add value to such task. Dimensions included are relevance, timeliness, and completeness.	Ballou and Pazer, (1985); Jarrel (1998), Alvarez, 1994; Huang and Wang ,1999
Representational Quality	The format of knowledge and how it is being presented to the knowledge user. Dimensions included are interpretability, ease of understanding, concise representation, consistent representation	Strong, Lee and Wang, 1997; Huang and Wang ,1999; Tozer, 1999 [back of Lillrank], Wang and Strong, 1996

Table 3.6 List of Dimensions for Knowledge Quality

Intrinsic Quality is the most often discussed dimension of knowledge quality. It is an intrinsic characteristic of knowledge as an artifact that is independent of the context in which data is produced and used (Strong et al, 1997, Wand and Wang, 1996, Wang and Strong, 1996). Obviously, it includes evident attributes such as accuracy and objectivity of knowledge to capture the characteristics of the knowledge being free from error and reflect the environment in its true situation. Lillrank (2003) backed up this perspective and viewed knowledge as artifacts and its quality as conformance to the requirements of being accurate and reliable. Deming (1986) advocates that quality cannot be assessed independent of consumers who choose and use products. Thus, the Strong et al (1997) suggest that knowledge quality must also reflect knowledge user's assessment of quality. Wang and Strong (2001) take similar opinion and argue that credibility/believability and reputation of knowledge from user's perspective as integral parts of intrinsic quality as well.

Contextual Quality of knowledge is defined from the deliverable perspective. Lillrank (2003) argued that knowledge contents and applications are defined through the negotiations between producer and receiver. The contextual quality dimension examines the fitness of the knowledge to its context of task, usefulness in decision making at its defined situations, whether the knowledge supports user's tasks and add value to tasks of users. The purpose of creation and transferring knowledge is to meet a specific business needs, solve a business problem, and assist with business decision making. Thus, how the knowledge is related to the context is an important attribute to assess knowledge quality. Ballou and Pazer, (1985) suggested completeness and timeliness of knowledge are critical dimensions of knowledge quality as well. This is simply because missing knowledge, inadequately defined or elaborate concepts, those that could not be appropriately aggregated and out-of-dated knowledge that are not in the same picture with the current business situation are all deemed lack of contextual quality. It is well known that knowledge and information notoriously suffers from delay and distortion as it moves along the supply chain (McAdam and McCormack, 2001; Metters, 1997; Lee et. al., 1997; Mason-Jones and Twill, 1997). For the best supply chain management solution, relevant knowledge shared has to be as accurate as possible (Alvarez and Castell, 1994); organizations must view their knowledge as a strategic asset and ensure that it flows with minimum delay and distortion. This requirement puts a particular emphasis on the contextual quality of knowledge.

Representational Quality captures the aspects related to the format of the knowledge. The meaning of knowledge and how concisely and consistently the knowledge is presented across the system are all decisive factors which will affect knowledge user's ability to comprehend and put to use the knowledge being created or shared. This dimension is particularly important and a challenge in the supply chain context where knowledge partners have drastically different background and expertise. Knowledge consumers will only be able to understand and act on the knowledge that is appropriately presented to them (Lillrank, 2003).

Accessibility Quality defines the ease to access the knowledge needed and the security level of such knowledge. Before information technology boom, early literature on data, information and knowledge tends to take accessibility as presumed because hard copy reports instead of online database was used to store and convey knowledge. Accessibility and security of getting the knowledge from printed media has never been a problem. Later studies on knowledge in database regard accessibility as a technical, computer system issue rather than a quality issue. However, from consumer's perspective, it goes far beyond technical implications. Wixom and Watson (2001) surveyed IS professionals and confirmed that these knowledge consumers acknowledge the importance of the availability of knowledge; the ease and speed of retrieve it from the knowledge exporter or knowledge management system. In the supply chain context when knowledge exchanging across organizational boundaries, security can also be critical to the knowledge quality. Knowledge users have serious concerns on legal issues, the liability of sharing confidential information such as trading partner's patents et al. Thus, knowledge accessibility covers both knowledge security and knowledge retrieval issues.

3.2.4.2 Supply Chain Integration

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 and Tatikonda, 2000; Narasimhan and Jayaram, 1998; Wood, 1997; Li, 2002; Marquez et. al., 2004). Supply chain integration links a firm with its customers, suppliers, and other channel members by integrating their relationships, activities, functions, processes and locations (Kim and Narasimhan, 2002). Having an integrated supply chain provides significant competitive advantage including the ability to outperform rivals on both price and delivery (Lee and Billington, 1995).

Supply chain integration includes two stages: internal integration between functions and external integration with trading partners. Internal integration establishes close relationships between functions such as shipping and inventory or purchasing and raw material management (Turner, 1993; Stevens, 1990; Morash and Clinton, 1997). While external integration has two directions: forward integration for physical flow of deliveries between suppliers, manufacturers, and customers and backward coordination of information technologies and the flow of data from customers, to manufacturers, to suppliers (Frohlich & Westbrook, 2001).

Both internal and external integration can be accomplished by the continuous automation and standardization of each function and by efficient knowledge sharing and strategic linkage with suppliers and customers. Stevens (1989), Byrne and Markham (1991), and Hewitt (1994) suggested that the development of internal supply chain integration should precede the external integration with suppliers and customers. Narasimhan and Kim (2002) examined the effect of chain integration on the relationship between diversification and performance. The supply chain integration instrument they used is comprised of three dimensions: (1) internal integration across supply chain, (2) a company's integration with customers, and (3) a company's integration with suppliers. This study adopts the concept of supply chain integration from previous research by using three sub-constructs to measure supply chain integration; Integration with suppliers, Integration with customers, and Internal integration across supply chain (Frohlich and Westbrook, 2002; Frohlich, 2002, Narasimhan and Kim, 2002). Table 3.7 below shows the constructs and sub-constructs of supply chain integration.

Internal supply chain integration captures the functional collaboration across organizational boundaries. It involves the integration of all internal functions from raw material management through production, shipping, and sales (Narasimhan and Jayaram, 1998). 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). Trading partners integrate their information systems, sharing real-time inventory and logistic-related operating data et al and actively involve in strategic alignments. It enhances system-wide interactions so that the entire supply chain becomes more agile, which enable firms react faster to changes taking place anywhere in the supply chain, reduce uncertainty and cut down waste (Narasimhan and Kim, 2002).

Integration with customers involves determining customer requirements and tailoring internal activities to meet these requirements (Koufteros et al, 2005). As a firm gets to know its customers better and becomes committed to understanding and meeting their needs, a strong linkage is forged between the firm and its customers. Integration with customers ensures that the voice of the customer plays a vital role in the innovative process with in the organization.

Constructs	**Definition**	**Literature**
Internal supply chain integration	The degree of coordination between the internal functions of all the trading partners in the supply chain.	Stevens, 1989; Carter and Narasimhan, 1996; Narasimhan and Carter, 1998; Birou et al; 1998; Wisner and Stanley, 1999
External integration with suppliers	The degree of coordination between manufacturing firm and its upstream partners.	Peterson et al., 2005; Koufteros, Vonderembse, and Jayaram, 2005; Bowersox, 1989; Stevens, 1989; Byrne and Markham, 1991; Lee and Billington, 1995; Hewitt, 1994; Clark and Hammond, 1997; Wood, 1997; Lummus et al., 1998; Stock et al., 2002; Narasimhan and Jayaram, 1998; Johnson, 1999; Frohlich and Westbrook, 2001; Ahmad and Schroeder, 2001;Kim and Narasimhan, 2002; Narasimhan and Kim, 2002; Frohlich and Westbrook, 2002; Frohlich, 2002;
External integration with customers	The degree of coordination between manufacturing firm and its downstream customers.	Koufteros, Vonderembse, and Jayaram, 2005; Bowersox, 1989; Stevens, 1989; Byrne and Markham, 1991; Lee and Billington, 1995; Hewitt, 1994; Clark and Hammond, 1997; Wood, 1997; Lummus et al., 1998; Stock et al., 2002; Narasimhan and Jayaram, 1998; Johnson, 1999; Frohlich and Westbrook, 2001; Ahmad and Schroeder, 2001;Kim and Narasimhan, 2002; Narasimhan and Kim, 2002; Frohlich and Westbrook, 2002; Frohlich, 2002;

Table 3.7 List of Sub-Constructs for Supply chain integration

Integration with suppliers is characterized by a long-term commitment between the collaborators, openness of communication, and mutual trust. Supplier partnering seeks to bring participants early in the product life cycle; thus entailing early supplier involvement in product design or the acquisition of access to superior supplier technological capabilities (Narasimhan and Das, 1999; Peterson et al., 2005).

3.2.4.3 Supply Chain Performance

Supply chain performance is a construct with a set of performance measures to determine the efficiency and/or effectiveness of a system (Beamon, 1998). Different researchers have attempted to assess supply chain performance in different ways, but most measures available in the literature are largely economic performance oriented. Harland (1996) suggests that intangible aspects of performance such as customer satisfaction should also be assessed. Garwood (1999) cautions that new measurement angle must be used on besides the old yardsticks for supply chain performance such as purchase price variance, direct labor efficiency, equipment utilization, and production development budget are no longer adequate. A set of measures has been suggested and used in the literature to respond to the current requirements for a comprehensive supply chain performance measurement. Stevens (1990) suggested such items as inventory level, service level, throughput efficiency, supplier performance, and cost. Pittiglio et al. (1994) summarized four categories of measures: customer satisfaction/quality, time, cost, and assets. Spekman et al. (1998) suggested cost reduction and customer satisfaction. Narasimhan and Jayaram (1998) identified the customer responsiveness and manufacturing performance. Beamon (1998) recommend to use a bundle including several qualitative measures, namely, customer satisfaction, flexibility, information and material flow integration, effective risk management, and supplier performance. Li (2002) summarized many of the existing research findings, and designed a comprehensive measurement instrument. We believe it is appropriate to borrow the four measurement dimension for our current study: Supply Chain Flexibility, Customer Responsiveness, Supplier Performance, and Partnership Quality. Table 3.8 lists the definitions and supporting literature of the above mentioned four dimensions.

Constructs	Definitions	Literature
Supply Chain Flexibility	Flexibility reflects an organization's ability to effectively adapt or respond to change that directly impacts an organization's customer.	Aggarwal, 1997; Vickery, et al., 1999
Customer Responsiveness	The speed of an organization's responses to the customer requests.	Stevens, 1990; Lee and Billington, 1992; Narasimhan and Jayaran, 1998; Beamon, 1998; Spekman, et al., 1998; Kiefer and Novack, 1999; Gunasekaran et al., 2001.
Supplier Performance	Suppliers' consistency in delivering materials, components or products to your organization on time and in good condition.	Stevens, 1990; Davis, 1993; Levy, 1997; Beamon, 1998; Tan, et al., 1998; Vonderembse and Tracey, 1999; Carr and Person, 1999; Shin et al., 2000; Gunasekaran et al., 2001.
Partnership Quality	How well the outcome of supply chain partnership matches the participants' expectation.	Ellram, 1990; Bucklin and Sengupta, 1993; Harland, 1996; Wilson and Volsky, 1998; Lee and Kim, 1999; Ballou et al., 2000; Mentzer et al., 2000.

Table 3.8 List of Sub-constructs for supply chain performance

Supply Chain Flexibility. Flexibility is often used to describe an organization's ability to adapt or respond to change effectively. Aggarwal (1997) believe that flexibility is the organization's ability to meet the market demands without excessive cost, time, organizational disruption, or loss of performance. Many authors have attempted to approach flexibility from supply chain perspective based on the argument of Vickery et al. (1999) that the entire value-adding system must be considered and flexibility should be examined from an integrative, customer-oriented viewpoint. In this study, we define flexibility as a bundle of flexibilities that add value to organization's customers and are shared by two or more functions along the supply chain, both internally among divisions within an organization and externally among suppliers and other channel members. Vickery et al (1999) identify five dimensions of the flexibility bundle to operationalize and measure supply chain flexibility, namely, 1) product flexibility is the organizational ability to handle difficult, nonstandard orders, such as producing products with numerous features, options, sizes, colors, and meeting some special customer specifications; 2) launch flexibility is about the organizational ability to introduce many new products and product varieties in a timely manner; 3) access flexibility is the ability to produce widespread or intensive distribution coverage; 4) volume flexibility refers to the ability to effectively increase or decrease production in response to market change; and 5) the responsiveness to target markets captures the overall ability of the organization to respond to the needs of its target markets.

Customer Responsiveness. Supply chain performance must ultimately be measured by its responsiveness to customers (Lee and Billington, 1992). Thus this study defines customer responsiveness as the speed of an organization's response to customer requirements

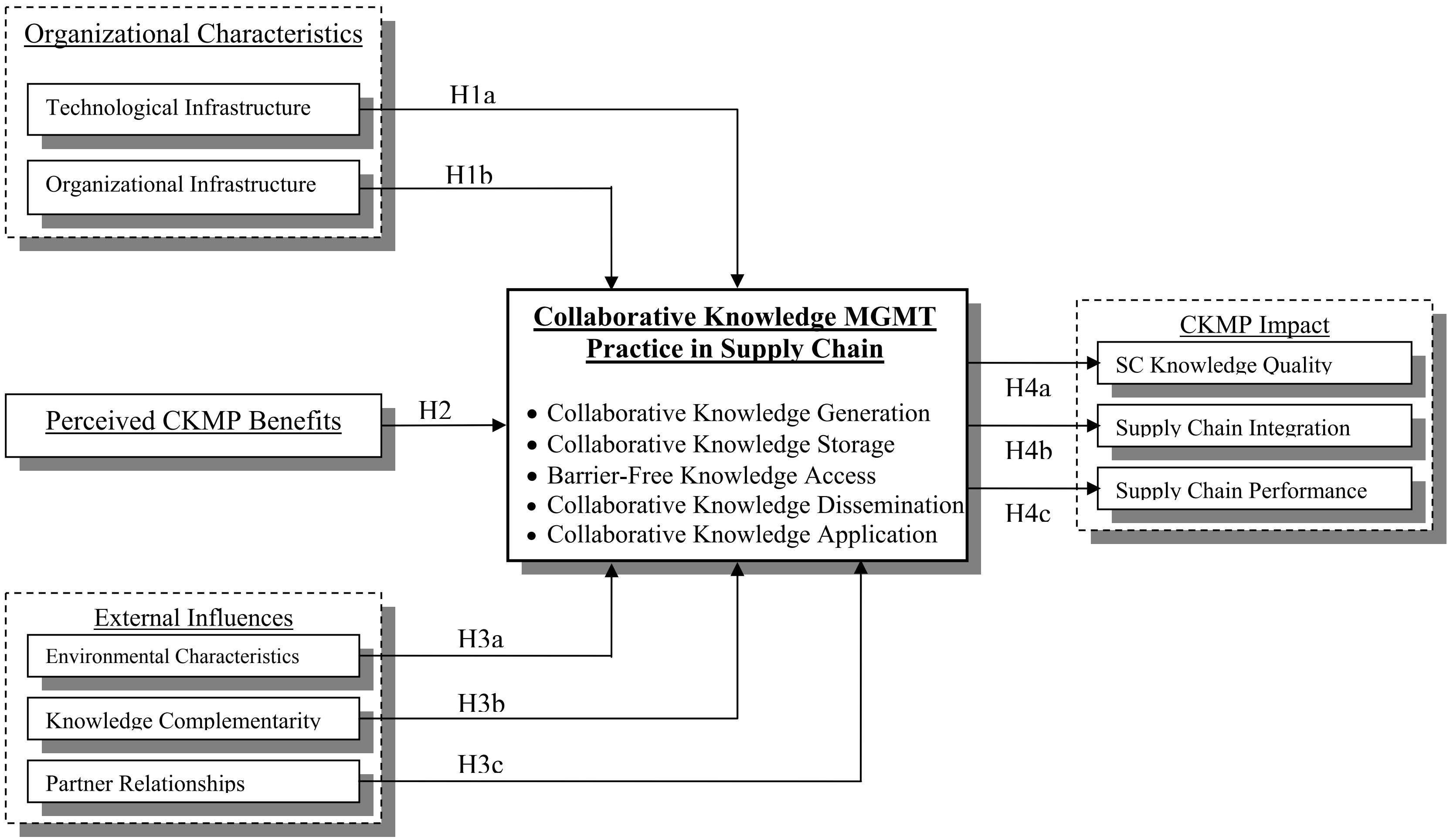
(Narasimham and Jayaram, 1998; Beamon, 1998). Organizations may have different supply chain management strategies from one to others, the overall objectives are always pointing to the same direction: to become increasingly responsive to customer demands, to drive down costs, and to turn savings into value addition to the customer (Owens and Richmond, 1995).

Numerous studies (e.g. Stevens, 1990; Spekman et al., 1998; Kiefer and Novack, 1999) recognize customer responsiveness as one of the major objective of supply chain practice and a good indicator of supply chain performance. Li (2002) formulates instrument to measure customer responsiveness in terms of customer satisfaction, organizational ability to integrate the customer specification into product design, organizational ability to set the quality dimensions, organizational ability to control cost, and customer ability to provide feedbacks.

Supplier Performance is defined as suppliers' consistency in delivering materials, components, or products to an organization on time and in acceptable condition (Beamon, 1998). It has been consistently regarded as one of the determining factors for supply chain success (Davis, 1993; Levy, 1997; Tan et al., 1998; Shin et al., 2000; Carr and Person, 1999; Vonderembse and Tracey, 1999). Other researchers (e.g. Stevens, 1990; Beamon, 1998; Gunasekaran et al., 2001) also consider supplier performance as one of the most important indicator for supply chain performance. Poor vendor quality and delivery performance can result in order backlog, high inventory levels, and unsatisfactory product quality level (Shin et al., 2000). Li (2002) identified 6 sub-dimensions of suppler performance: 3 items are about the timeliness, quantity and consequence of supplier delivery in related to customer requirements. Shin et al (2000) believe that supplier involved operations tend to have reduced cost and overall quality improvement, thus the 3rd and the dimensions are about the quality level and cost of supplier delivery. The last sub-dimension is about the number of suppliers an organization has. Newman (1988) suggests that a reduced supplier base helps eliminate mistrust between buyers and suppliers. This study would follow these 6 dimensions in operationalizing supplier performance.

Partnership quality is defined as how well the outcome of a partnership matches the participants' expectation (Wilson and Vlosky, 1998; Lee and Kim, 1999). The traditional measurement for supply chain performance only focus on objective issues such as time and cost which are actually conflict with the shared destiny principles of partnership and long-term relationships underlying supply chain (Ellram, 1990; Harland, 1996). Christopher and Juttner (2000) proposed market-based and service-based perspective that emphasizes measuring the long-terms supply chain relationships from the customer's perspective. From this standpoint, partnership quality is being measured as a comparison between customer's expectation and the real partner performance. The current study follows this perspective and operationalize the construct as the perceived level of commitment from partner firms to build and maintain the mutual relationships, the willingness to carries out responsibilities to other firms, the perceived fairness in allocating benefit between the partners (Walton, 1996; Ballou et al., 2000), and the overall satisfaction with the relationship (Bucklin and Sengupta, 1993; Mentzer et al., 2000).

Figure 3.5 Detailed Research Model



3.3 Research Hypotheses

In order to understand the mediating role of CKMP on the relationship between its antecedents and organizational outcomes, we elaborate our theoretical framework with nine hypotheses as presented in Figure 3.4 and illustrated below. They enable the predictions to be made about the role of CKMP in supply chain integration context, so that cross organizational knowledge management can be observed and evaluated, therefore provides better explanations of the implications of CKMP and their consequences.

3.3.1 Research Hypothesis 1a (TI and CKMP)

Technology infrastructure provides the foundation of technological capabilities for building successful CKMP applications. As Young and Lan (1997) as well as Mansfield and Romeo (1980) argue that the extent of any knowledge collaboration activity will depend on not only the willingness of partners to share knowledge but also other important factors such as the trading partners' mechanism of knowledge practices and their relative level of technological readiness. For example, knowledge transfer can be severely inhabited between users if the necessary technology components such as communication support tools are not in place or function appropriately, especially for situations where knowledge users are not co-located at the same place. TI can facilitate collaborative knowledge management activities through finding, summarizing, interpreting and analyzing large volumes of data and contextualizing information efficiently and effectively and improving communication and coordination between knowledge users (Lin et al, 2002).

Comican and O'Sullivan (2003) argued that communication formats with different level of media richness could be used to share both explicit and tacit knowledge. The TI component of communication support systems such as videoconferences, electronic whiteboard and emails expand system user's reach and scope in knowledge sharing, thus significantly facilitate collaborative activities with others. Greater exposure to different thoughts, opinions and feedback enhances knowledge user's ability to find novel relationships and combinations of these ideas. Hereby, we believe communication support system promotes collaborative knowledge generation.

The volume of knowledge generated from organizational operations is enormous, especially during occasions such as lunching a new product or adjusting a delivery routine with a trading partner. However, many of the knowledge such as engineering drawings and supplier's marketing promotion plan are functionally different. As Inmon (1996) noted, the TI component of database management system can lock the fragmented data into separated databases while provide a centralized repository to integrate, summarize and maintain historical profile for them (i.e. data-warehousing). Knowledge database management system can reduce operating cost and increase efficiency in inter-organizational knowledge storage activities. Knowledge database management system is a major component of CKMP architect. There are a number of benefits it brings to supply chain knowledge management: 1) it serves as the "corporate memory" of supply chain knowledge to provide users with around-the-clock access to an extensive amount of knowledge, breaking down the walls between people from different organizations who are working on related projects but locating in different time zones and countries; 2) knowledge database management system can also facilitate retaining and reconstructing intellectual capital that would have been otherwise lost due to employee turnover; 3) knowledge database management system can also serve as Expertise Profiling Tools (Wikipedia, 2006), which helps catalog each employee's skills and expertise so that other users can quickly locate the most knowledgeable person available in the system via a simple query function. These technology features make storing, searching and locating supply chain knowledge easier than even before, thus will undoubtedly encourage collaborative knowledge management practices.

The TI component of enterprise information portal provides knowledge users the tools and interface to access stored knowledge by providing central access point and the delivery of knowledge to users. A big advantage of enterprise information portal is its ability to transfer knowledge to and from a diverse array of resources and locations simultaneously. By providing a single entry point to all disparate systems, applications and databases, knowledge users would have a uniform interface which offers common knowledge accessing experience regardless of the highly customizable activities each user brings to the system. It is also possible to use a variety of query functions to display user defined outputs appropriate to each particular user's intention and his/her information security level. Hereby, we believe the processes provided by enterprise information portal facilitate knowledge access activities of CKMP.

Several studies such as Cil et al (2005), Tung 2000; and Karacapilidis and Pappi; 2000 discuss the benefits of collaborative system in facilitating knowledge creation and dissemination processes. An important feature of collaborative system is its ability to support group-wise tasks of argumentation structuring and the formal documentation of the decision making process at the same time. It serves as a tool for knowledge users engaged in a common task to exchange ideas more effectively and stimulate more interactions and combinations of those ideas that ultimately become new supply chain knowledge. Other function of collaborative such as wiki-system and RSS feed can help harvest and structuralize new knowledge and make knowledge more visible to a larger group of potential knowledge users, thus undoubtedly enhances new knowledge dissemination in the supply chain.

The TI component of decision support system has the ability to combine highly structured and unstructured information for a specific business context and provide suggested solution according predefined decision rules. Lado and Zhang (1998) argued decision support system frees knowledge workers from the monotonous reapplication of particular knowledge when such knowledge is relatively stable, thus they can engage in more productive work of analyzing new problems and/or creating innovative new solutions. Decision support system standardize knowledge application process and encourages generating new knowledge, thus we believe it facilitates CKMP.

Based on the above arguments that every TI components support portions of CKM process, we formulate the first hypothesis of the study as follow:

Hypothesis 1a: *Technological infrastructure has a direct positive relationship Collaborative Knowledge Management Practices in supply chain.*

3.3.2 Research Hypothesis 1b (OI and CKMP)

Organizational factors are long being regarded as essential to the success of knowledge management practices (e.g. Rolandi, 1986; Myktytyn et al, 1994; Meso and Smith, 2000). Davenport and Prusak (1998) also echoed similar belief and identified eight factors leading to knowledge project success, four of them, namely knowledge friendly culture, change in motivational practices, multiple channels for knowledge transfer, and senior management support are associated with organizational infrastructures (OI).

Like any new technology endeavor, knowledge collaboration initiatives won't be successful without a strong leadership. The leadership, at the senior executive level in particular, creates the organizational structures that are necessary in developing companywide initiatives for knowledge collaboration. Only when top management becomes and remains champions of knowledge collaboration, can it spread quickly and continue to provide the enterprise with the greatest returns (Goldman et al, 2002). Top management support can integrate CKMP into an organization's business strategy. Top management can educate the employees about the organizational implications of CKMP, provide necessary funding and resources that make establishment and operations of CKMP possible. Furthermore, achieving integrated knowledge management across supply chain 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. The executives are knowledge contributors and users as well. They can establish themselves as role models, and develop a culture that is committed to sharing knowledge and creating new ideas to meet customer needs. Employees may be initially suspicious of knowledge collaboration initiatives, but as they begin to see internal innovators and leaders tapping into the power of collaborative knowledge management tools, they will be drawn to the system, and momentum for the system's use will build. The study of Davenport and Prusak (1998) established empirical evidence that knowledge management projects sponsored by a vice president or higher have a higher successful rate than projects sponsored by directors, which in turn have a higher success rate than projects sponsored by managers. Thus, we believe top-management support is an important driver to CKMP implementation.

While the support from senior executives is key, knowledge can be only nurtured in a collaboration supportive culture, where interpersonal and inter-organizational collaboration is valued. The literature identifies organizational culture as an important driver that influences employee's motivation, behaviors and adaptability for success (such as Meso and Smith, 2000; Smith and Farquhar, 2000). Collaboration supportive culture would provide a supportive environment where employees are evaluated and rewarded in teams rather than on the solo basis of individual performance. Such collaborative culture reduces the employee's fear that their values and job security would be jeopardized by sharing knowledge with others. Thus, with collaboration supportive organizational culture, employees are more willing to contribute valuable knowledge and experiences to the organizational memory to prevent similar errors by others in the futures.

Wyer and Mason (1999) view people management as one of the most prominent challenges for multi-organizational knowledge management practices. This is because supply chain knowledge is holistic in nature. Many specialized knowledge from each trading partners must be integrated. Supply chain knowledge creation and dissemination processes thus heavily rely on the interchange of ideas between specialists and experts in different fields. How to create and maintain an organizational structure that encourages cross-functional and specialist groupings becomes a challenge to CKMP. Organizational empowerment is a propounded mechanism for the efficient and effective utilization of human resources. When empowered, individuals tend to be more engaged in experimentation with new approaches to business and the development of new knowledge skills. Hopper's study (1990) discusses knowledge management practice of American Airlines, and found that empowerment of individuals at all levels increased their participation in collaborative knowledge building process between different divisions. Empowerment removes functional or organizational barriers, encourages cross-boundary communication and partnership, and thus facilitates effective knowledge management practices.

Organizational infrastructure has important implications to CKMP, because it shapes organizational behaviors though the distribution of authority, information and resources; the nature of the formal connections, groupings and roles in the organization; and the tools provided to do the work (Galbraith, 1994). OI is intangible. No two OIs are alike. Thus it is extremely difficult to replicate other organization's OI. From resources based view, OI is identified as a strategic asset (Davenport and Prusak, 1998). Well-developed OI can be a source of sustainable competitive advantages. Based on the above arguments about the critical implication of each component of OI, we formulate the second hypothesis:

Hypothesis 1b: *Organizational infrastructure has a direct and positive relationship with Collaborative Knowledge Management Practices in supply chain.*

3.3.3 Research Hypothesis 2 (Perceived Benefits and CKMP)

In the original Iacovou et al (1995) model, perceived benefits were identified as an important driver for firms to adopt technological innovations. Rogers (1995) also argued that the adoption of innovations is related to the attributes of the innovations as perceived by the potential adopters. In Tornatzky and Klein's (1990) meta-analysis of 75 innovation adoption and implementation studies, the perceived benefits was consistently found to be the only factor positively associated with successful innovation implementation. In this study the perceived benefits were operationalized as the degree to which CKMP is perceived as being better to provide firm the benefits in terms of knowledge quality and organizational outcomes than the case when CKMP is not implemented (Rogers, 1995). This is similar to the definition employed by Iacovou et al (1995). The focus here is on perceived benefits rather than benefits that are actually provided. Among these perceived benefits, some are operational and some are more strategic in nature. The former relates to improvements made to the knowledge management capabilities including improvements in knowledge generation, storage, access, dissemination, and application capabilities. The later refers to the firm's strategic gains through the enhancement of external relationships with supply chain partners. Examples include improving the ability to adapt to environmental changes, improving ability to handle business exceptions, and improving in firm's innovation abilities. Higher managerial understanding of these relative advantages of CKMP increases the likelihood of the allocation of the managerial, financial and technological resources necessary to implement CKMP (Iacovou et al 1995). Therefore, we anticipate that firms with management that recognize the benefits of CKMP will be more likely to implement CKMP and enjoy higher impacts than those whose management has a lower level of recognition of the perceived benefits. The above arguments lead to the following hypothesis:

Hypothesis 2: *Perceived CKMP benefits have direct and positive relationship with Collaborative Knowledge Management Practices in supply chain.*

3.3.4 Research Hypothesis 3a (Environmental characteristics and CKMP)

Three external influences factor are identified in the study. The first is environmental characteristics including environmental uncertainty, perceived competitive pressure and trading partner readiness. Li (2002) identified four sources of environment uncertainty in her study on supply chain management. Variations can come from customer requirements, supplier operations, competitor actions, as well as the changes of technology. Iansiti (1995) suggests that these rapid changes in the external environment increase uncertainty in operation. Many researchers (e.g. Burns and Stalker, 1961; Lawrence and Lorsch, 1967; Huber and Daft, 1987) have argued that environmental uncertainty affects the structuring of the organization. Theoretically, firms will have to employ integrative organizational structure and practices in the face of uncertainty (e.g. Song and Montoya-Weiss, 2001; Tatikonda and Rosenthal, 2000). This is simply because those firms that do not coordinate their information processing and knowledge assimilation practices tend to be bureaucratic with functional structures that inhibit the free flow and processing of information (Song and Montoya-Weiss, 2001). Then, the firm will be incapable of reacting to external uncertainty and ultimately lose its competitive edge. The uncertainty reduction theory of Gupta et al (1984) can help explain the perceived need for integrated knowledge management practice. In order to reduce the negative effects of external variation, firms need process more information and do so more effectively. CKMP integrates knowledge functions, leverages trading partner's expertise and lifts firms' adaptability to external variations. Thus, we propose the higher level of environment uncertainty encourages firms to involve in CKMP.

Competitive pressure has been cited as a critical driver for innovation adoption in many existing studies (e.g. Iacovou et al., 1995; Premkumar et al., 1997; Crook and Kumar, 1998). In the study analyzing the strategic rationale underlying competitive pressure as an innovation adoption driver, Porter and Millar (1985) suggested that the adopting was a process of changing its competitive environment, because to accommodate new innovation, the firm has to alter its operation structure, and to leverage new ways to outperform its competitors. Under the same rationale, we can extend similar analysis to the impacts of perceived competitive pressure to CKMP adoption/implementation.

CKMP can fundamentally change a firm's way of doing business with its trading partners and induce reforms in supply chain management. The pressure can be from the firm's competitor because the firm has to follow the trend of its industry in order to remain competitive. Similarly, the pressure can also come from one's trading partners, because a less powerful firm in the supply chain has little choice but implement CKMP as requested, if such pressure comes from its major partner as a prerequisite for continuing business relationship.

We anticipate that the larger numbers of competitors and partners have adopted CKMP, the higher pressure non-adopters experience, and the more likely they will have to start implement CKMP.

A firm's decision to adopt CKMP may also be influenced by the adoption status and CKMP implementation level of its trading partners along the value chain, since for inter-firm collaborative knowledge management to extend the fullest potential, it is necessary that all trading partners adopt compatible electronic knowledge systems and provide substantial inter-connectivity for each other (Smith, 2001). Trading partner readiness for CKMP can lead to tighter integration with customers and suppliers. The benefits of CKMP initiatives of a firm depends not only on its own efforts to digitize its value chain, but also on the readiness of its business partners to engage in electronic knowledge management interactions simultaneously. Conversely, a lack of trading partner readiness would be a significant inhibitor for CKMP implementation. Hence, we expect that one's trading partner readiness is positively associated with the firm's CKMP implementation. The above arguments about the relationship between the three components of environmental characteristics and CKMP lead to the following Hypothesis:

Hypothesis 3a: *Environmental characteristics have direct and positive relationship with Collaborative Knowledge Management Practices in supply chain.*

3.3.5 Research Hypothesis 3b (Knowledge complementarity and CKMP)

The second external influence factor is knowledge complementarity. We operationalize KC from two dimensions: the *perceived knowledge differences* capture knowledge users' perceived gaps between partner organization's knowledge portfolios; while the dimension of *perceived knowledge importance* follows the study of Buckley and Carter (1999) for knowledge relationships and explores how organizations recognize the strength and usefulness of their trading partners' knowledge. It is obvious that CKMP needs different knowledge feed into the system from multiple technical and functional domains, so that novel recombination of these information and knowledge leads to the creation of new knowledge. What type of knowledge is needed and finally gets into the system is critical to the performance of CKMP. The perceived importance of trading partners' knowledge reflects the firms' recognition of the value of others' knowledge. Apparently, firms are more interested in exchanging knowledge that they believe has strategic or operational significance to them. Roper and Crone (2003) believed that each partner firm's knowledge base must be different enough to motivate knowledge-sharing with others. Hart (2004) analyzed knowledge complementarity issue from the supply chain perspective and also noted that trading partners must recognize their knowledge gap and align their knowledge practice to the business strategy and business process to overcome any existing deficiencies for sustainable competitiveness of the entire chain. From another perspective, Young and Lan (1997) argued that compatibility of knowledge partner's knowledge bases is critical, because compatible knowledge bases enable knowledge acquirers to better understand the knowledge received, otherwise knowledge exchanging activities are simply wasting organizational resources because the acquired knowledge is not applied to its fullest extent to benefit supply chain operations. Knowledge complementarity is also associated with knowledge-presentation commonalities. Multiple and contradictory meanings for the same term can create barriers to sharing knowledge (Koufteros, et. al., 2002). Common definitions are essential for inter-personal and inter-firm knowledge exchange, because the compatible presentation of knowledge establishes the necessary common ground or shared understanding among knowledge community members from various backgrounds to understand one another. The shared understanding in consequence will promote the appreciation of each other's different views and facilitates relationship building for further collaboration. In summary, we anticipate that in order for CKMP to take place, trading partners must recognize the importance of each other's knowledge, has considerable expertise difference, and maintain necessary knowledge compatibility to ensure mutual understanding. The above arguments lead to following hypothesis:

Hypothesis 3b: *Knowledge complementarity has direct and positive relationship with Collaborative Knowledge Management Practices in supply chain*.

3.3.6 Research Hypothesis 3c (Partner relationship and CKMP)

Bassi (1998) believes that without good supply chain partnerships building on trust, commitment, and shared vision, it would cause serious managerial challenge to all forms of supply chain collaboration. CKMP implementation requires partner firms to devote considerable time and resources, align each others' strategies and operations and disclose to other firms ones sensitive information and knowledge. It is totally impossible in a scenario where partner relationship is lacking. As Wright (2001) suggests, technology is often not a major issue for most of the supply chain management problems, since there are a large number of technology tools available to help firms get connected with each other for smooth knowledge and information flow. But managerial issues are most likely responsible for knowledge sharing glitches. Expensive software can only facilitate inter-firm communication and relationship building, but it will not be able to compensate for flawed human thinking or for antagonistic trading partners relationships. However, in practice, practitioners are often trapped to place excessive emphasis upon technology issues, rather than upon fostering strategic alliance with partners to clear up the hurdles for inter-firm knowledge sharing.

A commonly cited obstacle to build successful inter-firm knowledge networks is a lack of trust (e.g. Podolny and Baron, 1997; Davenport and Prusak, 1998; Kramer, 1999; Rolland and Chauvel, 2000). The study of Connelly and Kelloway (2000) empirically confirms that knowledge providers are only willing to share knowledge, tacit knowledge in particular, with knowledge acquirers they trust. Mayer et al (1995) believe that knowledge sharing posed risks for the provider, because it does not know how the shared knowledge would be used and whether the knowledge will be used in such as way to against himself by the knowledge acquirer. Trust, commitment and shared vision would lead to risk sharing in relationship and reduces the fear of opportunism by ones partners (Mayer et al, 1995).

Trust encourages behaviors such as open communication and the willingness to share information (Currall and Judge, 1995). Thus a collegial environment can be fostered between partner organizations to encourage cooperation, providing learning opportunities for knowledge dissemination and new knowledge creation (Gambetta, 1988). Both knowledge acquirer and knowledge provider can benefit from such environment, where protective barriers are dismantled and provider and acquirers can interact more for knowledge communication. Knowledge acquirers drop defensive mechanisms that protect them form making poor decisions and are more likely to listen to and act on the knowledge they received from other parties. Similarly, with the belief that these knowledge will not be used to their detriment, knowledge providers are more likely to engage in sharing all what they know and ensure its transferal in a form that is comprehensible and useful to the recipients (Levin and Cross, 2004). Besides, when trust presents, the cost for knowledge transaction can be reduced with less need for actions to protect one's interests. Thus inter-firm trust is believed to increases the likelihood that newly acquired supply chain knowledge is well absorbed and retained (Curral and Judge, 1995).

The mutual commitment and shared vision are also critical factors for knowledge collaboration. CKMP involves large capital and personnel investments. Trading partners must share a common ground regarding the importance of supply chain knowledge collaboration, and the strategies for dynamic knowledge exchange. Smith (2001) points out that one of the single most important prerequisite for CKMP is to change corporate culture that encourages collaboration. Lack of shared vision between partners would magnify the corporate culture differences. The work of Boddy et al (2000) also empirically proves that lack of shared vision causes difficulty in inter-firm cooperation. Thus, actions must be taken to establish and maintain a common vision between trading partners about supply integration as well as the significance of knowledge community to support inter-firm knowledge collaboration. The above arguments lead to the following hypothesis:

Hypothesis 3c: *Partner relationship has direct and positive relationship with Collaborative Knowledge Management Practices in supply chain.*

3.3.7 Research Hypothesis 4a (CKMP and Supply chain knowledge quality)

The most obvious objective to invest in CKMP is to improve knowledge management efficiency. We anticipate it be able to produce knowledge of high quality. Collaborative knowledge generation combines expertise from multiple sources where the knowledge is original and most up-to-date. Thus based on that, the knowledge stored in the KM system is of high accuracy, objectivity, and reputation. Integrated knowledge storage and access allow users obtain desired knowledge directly from the repository and eliminated the possibility of bias, delays, and distortions from indirect knowledge transfer, thus guarantee knowledge quality dimensions of high reliability, completeness, and timeliness (Ballou and Pazer, 1985). Collaborative knowledge dissemination provides common training programs and easy to understand knowledge index. Knowledge users can benefit from the elevated timeliness, availability and interpretability of the knowledge (Lillrank, 2003). While collaborative knowledge application leverages the value of knowledge because it is used, validated, and updated at multiple occasions, thus increases the knowledge quality characteristics of relevance and timeliness.

Experts' working time can be saved with effective knowledge management practices when they do not have to answer the same questions from different knowledge users in the same way every day, so that they can engage more in the value added knowledge creation activities and generate knowledge with high quality. The direct access to organizational knowledge memory encourages employee to create more knowledge when they can actually feel that they are contributing to the knowledge process – if they resolve an issue not currently available within the KM databases they are motivated to author that solution and add it to the knowledge base. The above arguments lead to the following hypothesis:

Hypothesis 4a: *Collaborative Knowledge Management Practices in supply chain have direct and positive relationship with the quality of supply chain knowledge.*

3.3.8 Research Hypothesis 4b (CKMP and Supply chain integration)

Supply coordination refers to the coordination of production and logistic activities with a firm's suppliers and customers. This type of coordination helps integrated supply chain operation, such as joint-decision making with regard to each company's production, inventory, and delivery activities. Hill and Scudder (2002) argue that a major issue of supply chain integration is to decide how closely supply chain entities consider other entity's needs to arrange their operations and function like a single unit. Effective CKMP allows the entities to get a large amount of high quality supply chain knowledge. Higher degree of supply chain integration occurs when supply chain entities internalize the knowledge and coordinate some aspects of their operation with their trading partners.

A number of studies such as Hill and Scudder (2002), Hult, et al. (2004) and Zimmerman (2002) analyzed how CKMP facilitates supply chain integration: 1) CKMP dynamically connects all trading partners together and allows multiple users to make joint-business decisions that compromise the interests of all involving parties; 2) Real-time communication capability of CKMP encourages knowledge sharing thus simplifies supply chain's integration tasks such as forecasting, order fulfillment, and logistic coordination; 3) Better access to each trading partner's knowledge database give members a clear picture of what is in the organizational memory of the entire supply chain and what is lack, allow the utilization of partner's expertise and reduce duplication, waste and redundancy in knowledge creation (Hult, et al 2004); 4) Automated workflow and knowledge sharing have been incorporated into the system, thus standardize inter-organizational operations (Zimmerman, 2002); 5) CKMP allows firms tap into the wealth of expertise of partners located around the global and facilitates the integration between the geographically remote partner organizations. Based on above arguments, we hypothesize as follows:

Hypothesis 4b: *Collaborative Knowledge Management Practices in supply chain have direct and positive relationship with supply chain integration.*

3.3.9 Research Hypothesis (CKMP and Supply chain performance)

CKMP represents a set of consistent KM practices that supply chain members adopt and exercise to interact with each other. Strategically, the architecture of hardware, software, networks, applications, and management of CKMP are integrated with the fabric of the firm, its business processes, and its organizational life (Bourdreau and Couillard, 1999). Mudie and Schafer (1985) assert that CKMP not only facilitates the process of developing and using knowledge, but also provides flexibility to meet the future business demands. Handfield and Nichols (1999) note that CKMP allows "multiple organizations to coordinate their activities in an effort to truly manage a supply chain". A higher level of alignment in CKMP allows firms to stay competitive in a rapidly changing environment. With intensification of competition, firms have to manage different components of the entire process more closely by integrating and coordinating them into a highly efficient, effective, and responsive system (Sikora and Shaw, 1998). CKMP enables firms to exert certain degree of direct influence over the process value chain, including the portion outside of their organizational boundaries (Rushton and Oxley, 1994). Thus CKMP leverages the value of organizational knowledge and enhances supply chain strategic alliance. CKMP improve the bottom line of supply chain performance. Hill and Scudder (2002) regarded CKMP as a system that can synchronize the information that resides in both formal and informal knowledge management systems of different companies, facilitate new knowledge creation, transferring and application, thus increase market response rate, shorten product and services cycle time, and deliver greater value to both its internal and external customers to give the entire supply chain competitive advantage in the marketplace. CKMP helps firms save costs by eliminating redundant logistic activities, unimportant knowledge management practices, and unnecessary infrastructure investments, which do not contribute to overall performance gain. As Lesser and Butner (2005) has noted, CKMP provides a virtual collaborative platforms that can conveniently manage critical event-based information, so that problems can be solve jointly with supply chain partners in a time manner, while retaining such solution experiences for future references. The above arguments lead to the following hypothesis:

Hypothesis 4c: *Collaborative Knowledge Management Practices in supply chain have direct and positive relationship with supply chain performance.*

This chapter (Chapter 3) discussed the theoretical background of the current study, which is an application of Tornatzky and Fleischer's (1990) TOE theory. A research model was presented, constructs as well their sub-dimensions were thoroughly reviewed, and 9 hypotheses were formulated to explore CKMP's critical antecedents and organizational impacts. The following chapter (Chapter 4) will start the description of research methodology issues for the study.

CHAPTER 4: INSTRUMENT DEVELOPMENT AND PRE-TEST

This chapter discusses the research methodology of testing the hypotheses presented in the previous chapter. The study of the relationships among the constructs in the model depends on the collecting, analyzing, and interpreting data about the real situations in the current business world. A survey research approach was defined by Pinsonneault et al (1993) as data collection and measurement processes to produce quantitative descriptions of some aspects of the studies population. The same group of researchers argued that cross-sectional survey is a convenient and powerful method to in studying business and management issues because it provides neutral observations to different stages of a phenomenon in natural setting at a short period of time. The current study is attempting to explore the knowledge sharing behaviors of supply chain partners. Thus we deem it is appropriate to use cross-sectional survey to obtain candid snap-shot descriptions to the constructs and test the hypotheses derived from the above presented research model.

4.1 Instrument development

In order to collect precise data, a reliable measurement instrument is needed. Out of the 17 constructs presented in the research model, there are existing items in the literature that have been validated and proven to be effective for 5 constructs. Their measurement sources are presented in the table 4-1:

Construct Name	Source	Number of items
Top management support	Li, 2002	5
Environmental uncertainty	Li, 2002	8
Partner Relationships	Li, 2002	11
Supply Chain Performance	Li. 2006	21
Supply Chain Integration	Narasimhan and Kim 2002	18

Table 4.1. Existing measurement instruments

The other 12 constructs were not thoroughly tested in the literature, therefore the next step of this study is to develop measurement items for these constructs: 1) collaboration supportive culture, 2) employee empowerment, 3) perceived CKMP benefits, 4) competitive pressure, 5) partner readiness for CKMP, 6) knowledge complementarity, 7) collaborative knowledge generation, 8) collaborative knowledge storage, 9) barrier-free knowledge access, 10) collaborative knowledge dissemination, 11) collaborative knowledge application, and 12) supply chain knowledge quality. Q sort methods were used to pre-test the generated items. The above12 constructs were developed with a strong theoretical foundation based on a review of available literature. Careful literature review identified 68 items for the above 12 constructs. To ensure brevity, understandability and content validity of the items, a rigorous validation procedure was adopted for preliminary test. Two Ph.D. students in manufacturing Management at the University of Toledo were first invited to read the items and comment on the above mentioned 3 aspects. Two professors in the College of Business Administration at the University of Toledo and two Operations and Supply Chain Management professors at Central Washington University were also invited to read those items and suggest modifications. Based on their feedbacks, items were changed, deleted, and added as necessary.

4.2 Pre-Test: Q-sort Methodology

Q-sort methodology was first introduced by Stephenson (1953) to pre-assess convergent and discriminant validity of measurement instrument by examining how items were sorted in various dimensions by knowledgeable people in the field of study. Nahm and Solis-Galvan et al. (2002) argued that it is an iterative process in which the degree of agreement between objects forms the basis of assessing construct validity and improving the reliability of the construct in questionnaires.

Several supply chain management professionals from the Material Management Division of Boeing Commercial Airplanes were invited to participate into the sorting process. Table 4.2 listed the 12 constructs and the corresponding number of items that enters the Q-sort procedure. All 68 items waiting to be assessed were first mixed and placed in a common pool. The invited judges were first introduced in a face-to-face meeting the conceptual model and the definition of each construct. Then they were given an online sorting form (http://www.cwu.edu/~liy/survey/pilot_instruction.htm) and asked to sort out the 68 items into 13 groups, corresponding to the 12 constructs plus a non-applicable category. The N/A category was to minimize forcing the judges to place any items into a particular category that they did not feel sure.

The sorting results were evaluated based on the inter-judge agreement level, Moore and Benbasat's hit ratio (Moore and Benbasat, 1991) and Cohen's Kappa (Cohen, 1960). The inter-judge agreement level was a raw agreement ratio, calculated by counting the number of items that both judges agree to place into certain category, even if the category might not be the one the researcher intended to measure. The Moore and Benbasat's hit ratio were computed in the similar manner, but only counting the items that were correctly sorted into the intended theoretical construct by the 2 judges and divided by 2 times the total number of the items (2*68=136). Finally, Cohen's Kappa was a measure of the proportion of joint judgment after excluding chance agreement.

Tables 4.3 to 4.11 presented the results of three Q-sort rounds. Two items were deleted and other necessary item revisions were made as necessary at the end of the first and second round.

Construct ID	Description	# of Items
1	Collaboration Supportive Culture	5
2	Employee Empowerment	5
3	Perceived CKMP Benefits	13
4	Competitive Pressure	4
5	Partner Readiness	5
6	Knowledge Complementarily	5
7	Collaborative Knowledge Generation	5
8	Collaborative Knowledge Storage	5
9	Barrier-Free Knowledge Access	5
10	Collaborative Knowledge Dissemination	5
11	Collaborative Knowledge Application	6
12	Supply Chain Knowledge Quality	5

Table 4.2 Number of Items per construct for Q-sort

Inter-judge Raw Agreement Score - 1st Round														
		Judge One												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**NA**
Judge 2	**1**	7	1											
	2		3											
	3			12										
	4				4									
	5			1		4								
	6			1			3							
	7						1	4						
	8							1	4					
	9									6				
	10		1	1							3			
	11						1					5		
	12												5	
	NA													0
Total Items Placement: 68						**Number of Agreement: 60**					**Agreement Ratio: 88%**			

Table 4.3 Inter-judge Raw Agreement Score- First Round

Moore and Benbasat "Hit Ratio"-1st round																
		Actual Categories														
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**NA**	**Total**	**%**
Theoretical Categories	**1**	8	1								1				10	80%
	2	5	7												12	58%
	3			25							1				26	96%
	4				8										8	100%
	5			1		9									10	90%
	6			1			7								8	88%
	7						1	9							10	90%
	8							1	9						10	90%
	9									10					10	100%
	10	2								2	6				10	60%
	11						1					11			12	92%
	12												10		10	100%
	NA													0	0	
Total Items: 136					**Number of Hits: 119**						**Overall Hit Ratio: 87.5%**					

Table 4.4 Moore and Benbasat's Hit Ratio- First Round

		Judge 1		
		Acceptable	**Rejectable**	**Total**
Jg 2	**Acceptable**	56	5	61
	Rejectable	2	5	7
	Total	58	10	68

Cohen's Kappa coefficient Round 1
k=[(68*56)-(58+61)]/[68*68-(58+61)]=85%

Table 4.5 Computations for Cohen's Kappa – First Round.

Inter-judge Raw Agreement Score: 2nd Sorting Round														
		Judge One												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**NA**
Judge 2	**1**	4										1		
	2		3											
	3			14										
	4				4									
	5					4								
	6						3				1			
	7							5						
	8								5					
	9									5	1			
	10										5			
	11											6		
	12												5	
	NA													0
Total Items Placement: 66				**Number of Agreement: 63**					**Agreement Ratio: 95%**					

Table 4.6 Inter-judge Raw Agreement Score- Second Round

		Judge 1		
		Acceptable	**Rejectable**	**Total**
Jg 2	**Acceptable**	62	1	63
	Rejectable	1	2	3
	Total	63	3	66

Cohen's Kappa coefficient Round 2 k=[(66*62)-(63+63)]/[66*66-(63+63)]=94%

Table 4.8 Computations for Cohen’s Kappa – Second Round.

Moore and Benbasat "Hit Ratio"-2nd round																
		Actual Categories														
		1	2	3	4	5	6	7	8	9	10	11	12	NA	Total	%
Theoretical Categories	**1**	8													8	100%
	2	1	6									1			8	75%
	3			26											26	100%
	4				8										8	100%
	5			2		8									10	80%
	6						7				1				8	88%
	7							10							10	100%
	8								10						10	100%
	9									10					10	100%
	10									1	11				12	92%
	11											12			12	100%
	12												10		10	100%
	NA													0	0	
Total Items: 132					**Number of Hits: 126**							**Overall Hit Ratio: 95%**				

Table 4.7 Moore and Benbasat's Hit Ratio- Second Round

Inter-judge Raw Agreement Score: 3rd Sorting Round														
		Judge One												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**NA**
Judge 2	**1**	7												
	2		2											
	3			13										
	4				4									
	5					5								
	6						3							
	7		1					4						
	8								5					
	9									5				
	10										4	1		
	11											6		
	12						1						4	
	NA							1						0
Total Items Placement: 66				**Number of Agreement: 62**						**Agreement Ratio: 94%**				

Table 4.9 Inter-judge Raw Agreement Score- Third Round

Moore and Benbasat "Hit Ratio"-3rd round																
		Actual Categories														
		1	2	3	4	5	6	7	8	9	10	11	12	NA	Total	%
Theoretical Categories	**1**	10													10	100%
	2	2	5					1							8	63%
	3			26											26	100%
	4				8										8	100%
	5					10									10	80%
	6						6								6	88%
	7							9						1	10	90%
	8								10						10	100%
	9									10					10	100%
	10	2									8				10	80%
	11										1	13			14	93%
	12			1									9		10	90%
	NA													0	0	
Total Items: 132					**Number of Hits: 124**								**Overall Hit Ratio: 93%**			

Table 4.10 Moore and Benbasat's Hit Ratio- Third Round

		Judge 1		
		Acceptable	**Rejectable**	**Total**
Jg 2	**Acceptable**	60	1	61
	Rejectable	3	2	5
	Total	63	3	66

Cohen's Kappa coefficient- Round 3
k=[(66*60)-(63+61)]/[66*66-(63+61)]=91%

Table 4.11 Computations for Cohen's Kappa – Third Round.

The third round sorting results yield excellent inter-judge agreement ratio (94%) and Moore and Benbasat's Hit ratio (93%). Nahm and Solis-Galvan et al (2000) argued that a value of Cohen's Kappa great than 0.76 was considered sufficient. Our result had a coefficient of 91%, also indicating a satisfactory result. Thus the Q-sort test confirmed that the 66 new measurement items designed by the researcher successfully formed the 12 constructs as intended. The next section covers using these items in large-scale survey and further validation steps with real data fit.

CHAPTER 5: LARGE-SCALE SURVEY AND INSTRUMENT VALIDATION

5.1 Data Collection Methodology

The large-scale survey is to use the instrument developed in the previous chapter to collect data for the study. The targeted respondents of the study were supply chain professionals, and high-level corporate executives. This is simply because their job function enables them to have a working knowledge about their own organization as well as the partner organizations. They are the most appropriate personnel to answer questions related to organizational infrastructures, knowledge management practices, supply chain integration, and supply chain performance. The following is a detail of the process of selecting the sample, collecting data, and confirming the measurement models for the new constructs.

5.1.1 Survey Respondents

The selection of respondents is considered very critical for obtaining sufficient and good quality data in survey studies. The respondents are expected to have appropriate knowledge on the subject areas of the survey (Quesada, 2004). We were interested in inter-firm knowledge collaboration behaviors in this study. Thus the respondents must have close contact with their firm's trading partners, have experience in knowledge management practices, as well as possess general understanding to firm management and supply chain performance indicators. For the purpose of minimizing response biases and generalizing the results of the study, it was also desirable to have a sample that could represent different geographic areas, industries and firm sizes. The mailing list was obtained from two sources, namely CSCMP (Council of Supply Chain management professional) and Teleservices.com. CSCMP is the preeminent worldwide professional association of supply chain management professionals. The CSCMP United States membership directory was pulled and purged to include those in the following SIC classifications:

28	Chemicals and allied products,
33	Primary metal industries,
34	Fabricated metal products,
35	Industrial and commercial machinery and computer equipment,
36	Electrical equipment and components
37	Transportation equipment.

Targeted respondents were procurement/materials/supply chain/operations vice-presidents, directors and managers. Because the respondents were to be contacted via email to solicit their participation, the mailing list was further refined to exclude those who do not have a valid email address listed on file. The refinement had resulted in 2,687 usable names.

Similar procedures were taken to obtain 1,362 usable names with the same characteristic as discussed above from a mailing list purchased from Teleservices.com. The total targeted respondents from both sources are 4,049.

5.1.2 Survey Administration

How the survey is administered is critical to response rate as well as the validity of the data collected. This study focuses on organization's knowledge management activities, which is achieved by extensive utilization of information and communication technologies. Thus, the researcher expected that the targeted respondents have considerable computer literacy and should feel comfortable with online questionnaires. To take a cautious step, the researcher did include other alternative methods for filling out the questionnaires: respondents could request hard copies and send back the results by fax or regular mail. But as expected, no single respondents used such traditional alternatives. All data were collected through online questionnaire.

To ensure a reasonable response rate, the soliciting emails for the survey were sent in two waves with a two-week interval. The first wave of emails was sent to all 4,049 names inviting them to participate in the study with a brief description of the research, stating that all data collected would be used for academic research only and be handled confidentially. Since the literature has limited discussion on the adoption of CKMP, the researcher was also interested in the adoption rate among the sampled firms and their characteristics as well as potential reasons for those firms' non-adoption. The email included 2 sets of questionnaires: (1) those that have adopted CKMP with their trading partners can take the full-length questionnaire (http://www.cwu.edu/~liy/survey/survey_instruction.htm), (2) those that have not adopted CKMP can take the shorter version collecting data about demographics of the respondents, the firm and brief comments about why it has not yet adopted (http://www.cwu.edu/~liy/survey/survey_non_adopter.htm).

5.1.3 Survey Response Rate

The researcher received 373 non deliverable bounce-back messages in the two weeks after the first wave of emails. There were another 105 replies declining participation to the study due to the following reasons: (1) no longer work for the company and/or (2) no longer in the supply chain/procurement area (3) company policy forbidding disclosing information. Therefore, the working mailing list contained 3,571 valid names.
During the two week period after sending out the emails, a total of 242 responses were collected, including 187 adaptors and 55 non-adopters. Because the date the soliciting emails were sent coincided with the Annual CSCMP National Conference, a large number of out-of-office auto replies were received because of that. Then the second wave emails were sent two weeks later to those who had not yet responded. A total of 172 responses were received, including 138 adopters and 34 non-adopters. Of the total 414 responses received, 3 questionnaires were returned with many unanswered questions thus unusable. Therefore the final number of complete and usable responses was 411, including 323 adopters and 88 non-adopters. It yielded a response rate of 11.6%, indicating a reasonable and acceptable response rate for email surveys (Dillman 2000). The response rate was also comparable with that of the other 2 email survey studies to supply chain professionals conducted by Liao (2006) and Thatte (2006) for their dissertations.

5.1.4 Sample Demographics

The following charts (Figure 5.1-5.4) illustrated the sample characteristics of those who have adopted CKMP with their trading partners. Figure 5.5 to 5.7 displays the respondents' demographic characteristics of the 323 responses from CKMP adopters.

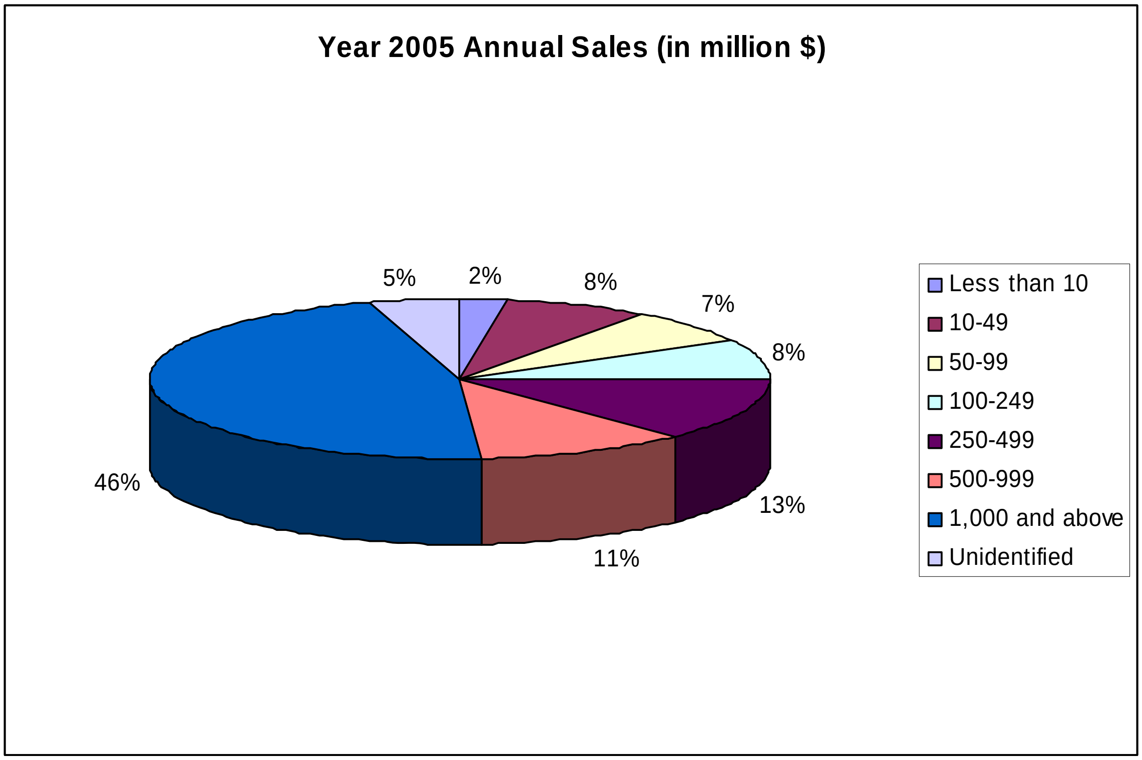


Figure 5.1 Adopter firm 2005 annual sales

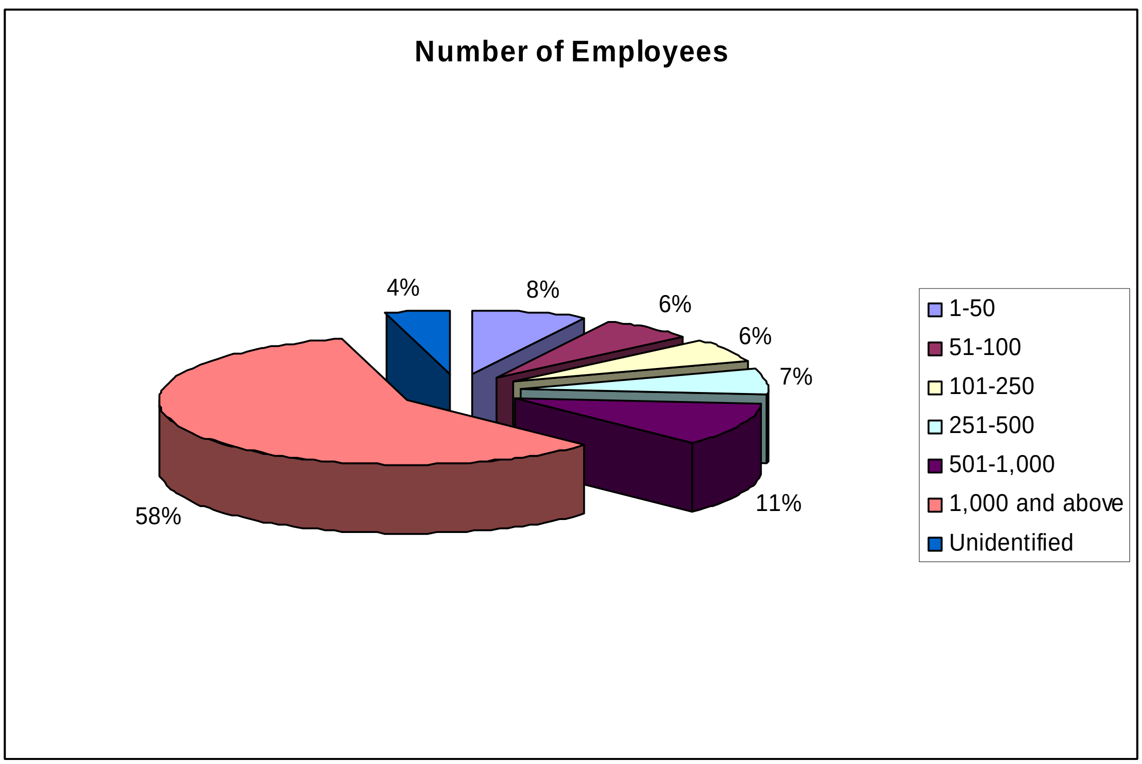


Figure 5.2 Adopter firm size in terms of the number of employees

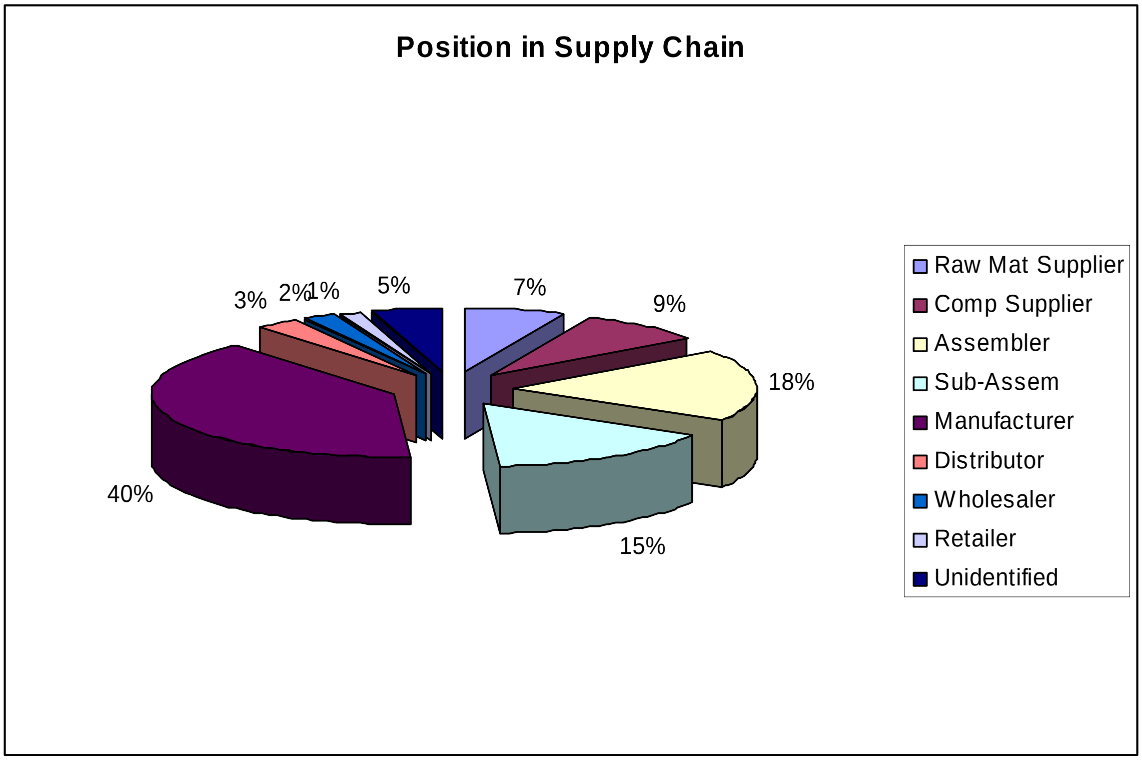


Figure 5.3 Adopter firm's position in supply chain

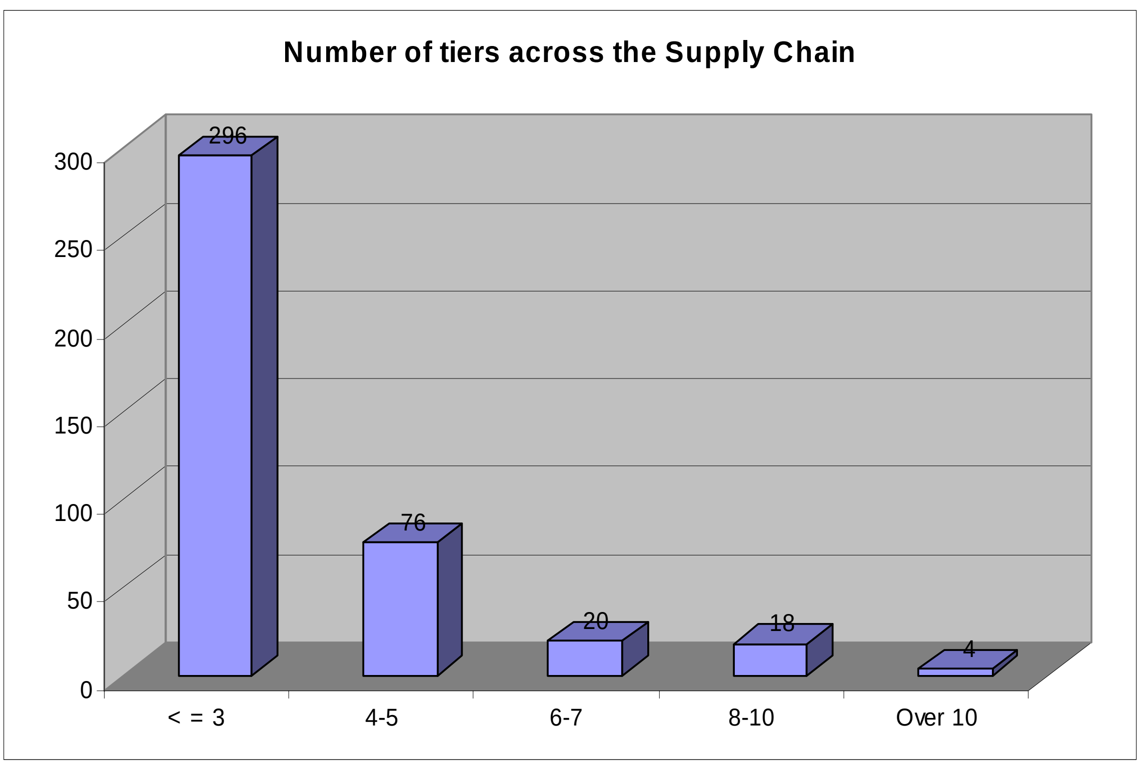


Figure 5.4 Numbers of tiers in adopter firm's supply chain

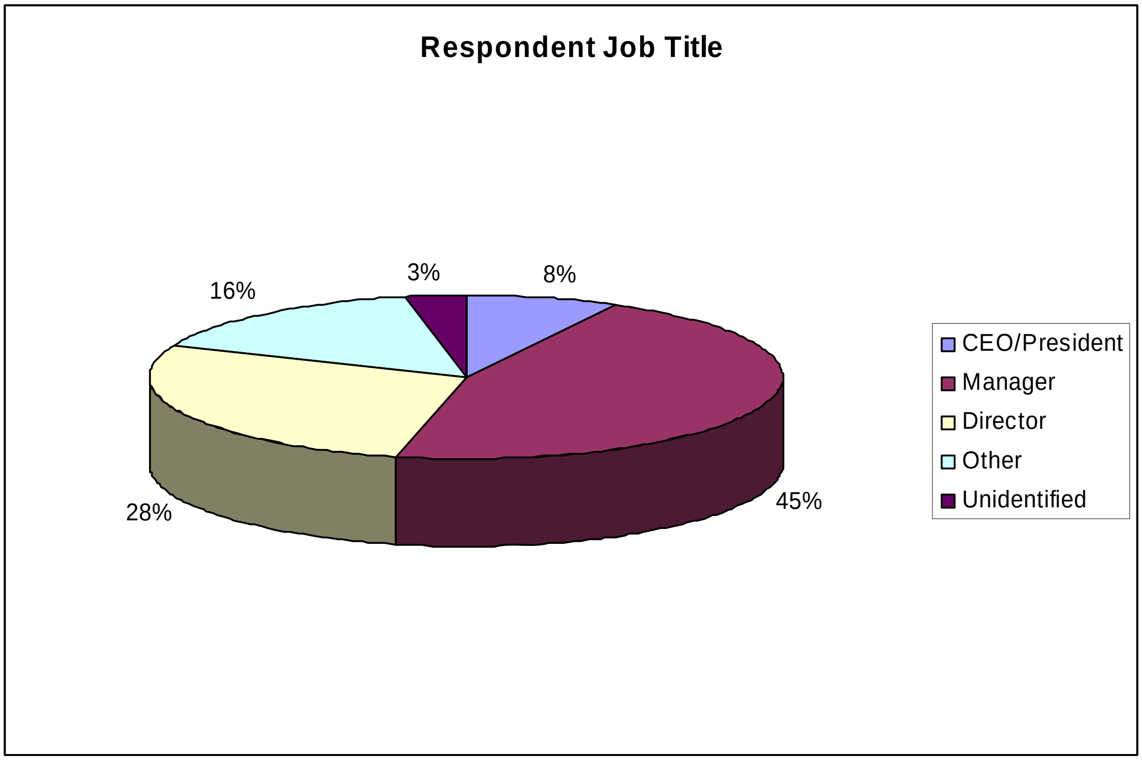


Figure 5.5 Adopter firm respondents job titles

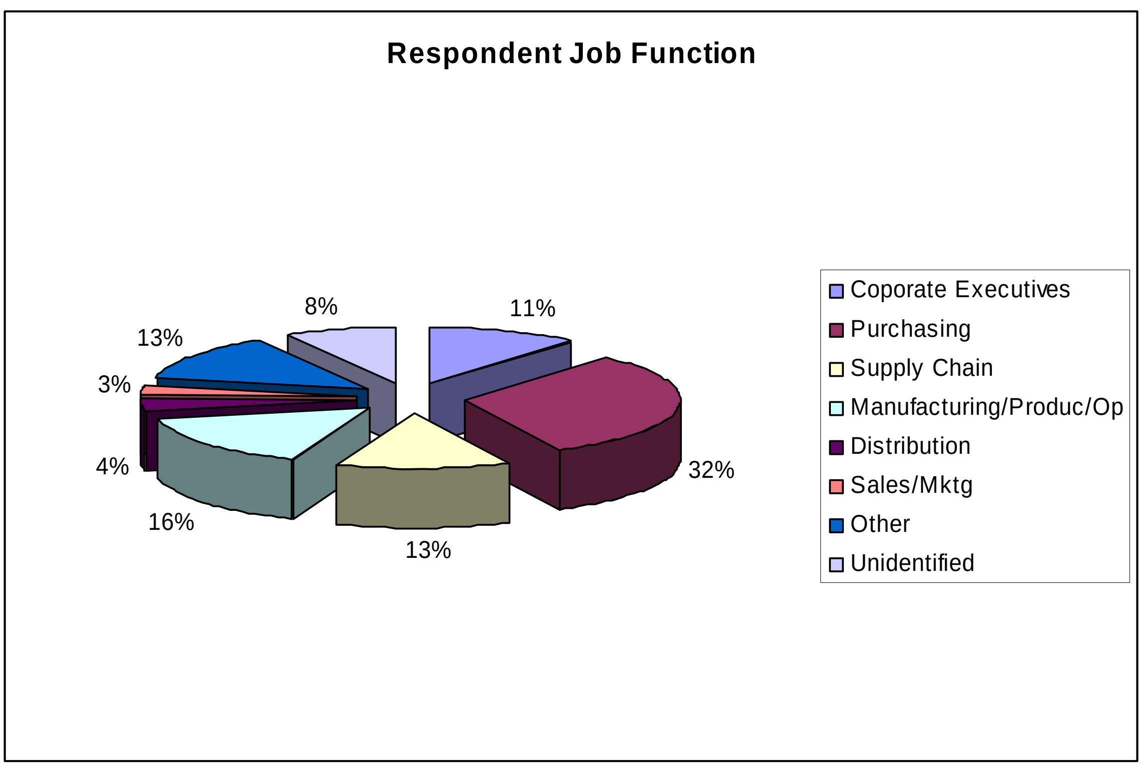


Figure 5.6 Adopter firm respondent job function

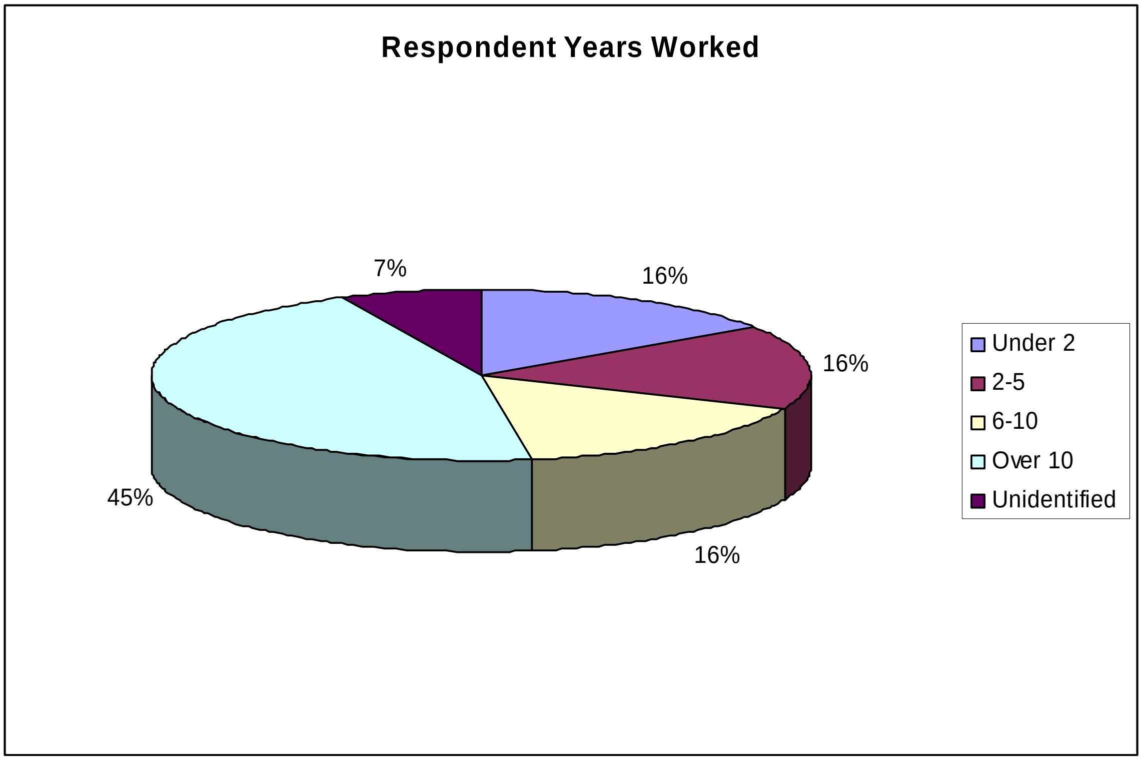


Figure 5.7 Adopter firm respondent years of service

The demographic characteristics of the 88 non-adopting firms were also studied. It did not appear to be very different from the adopter firms except firm's position in supply chain. There were 40% of adopter firms classify themselves as manufacturers, 33% as assembler/sub-assembler, and 16% as raw material suppliers and components makers. However the non adopter firms cluster more in the assemblers/sub-assemblers (43%) category and raw material suppliers and components makers (26%) category. Only 23% of non adopter firms classify themselves as manufacturers (23%).

All respondent's individual characteristics features appeared to fairly similar between adopters and non adopters. The demographic charts for firm characteristics were presented in Figures 5.8-5.11, charts for individual respondent characteristics were presented in Figure 5.12- 5.14.

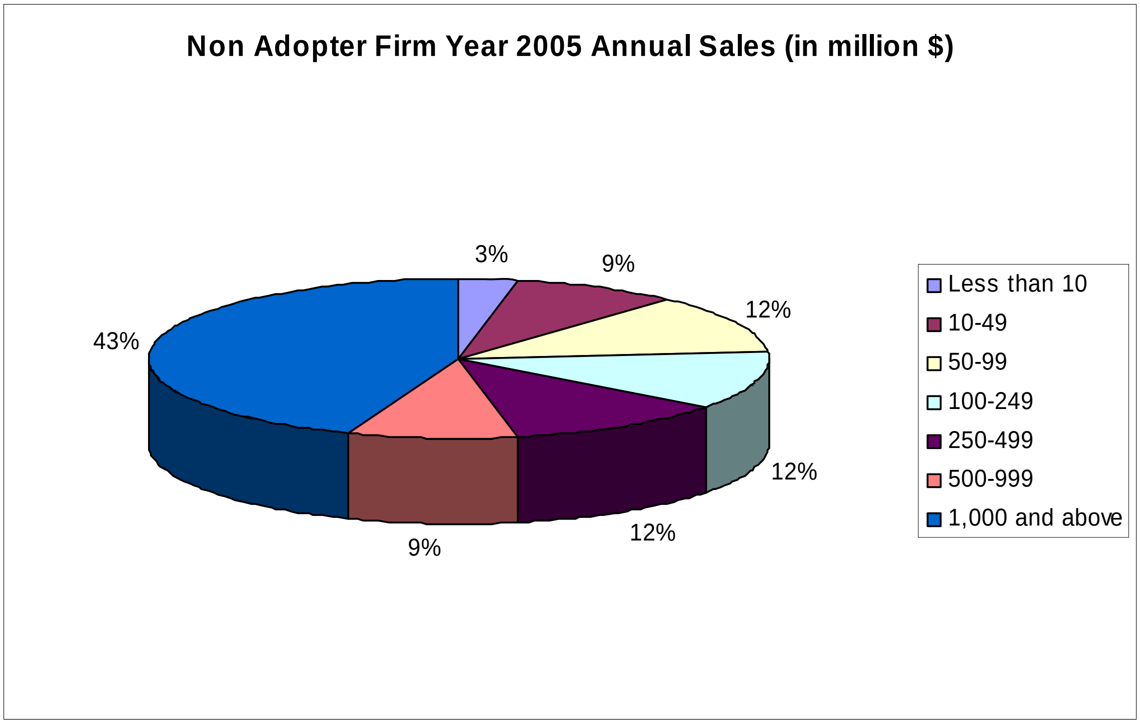


Figure 5.8 Non-adopter firm size in terms of annual sales.

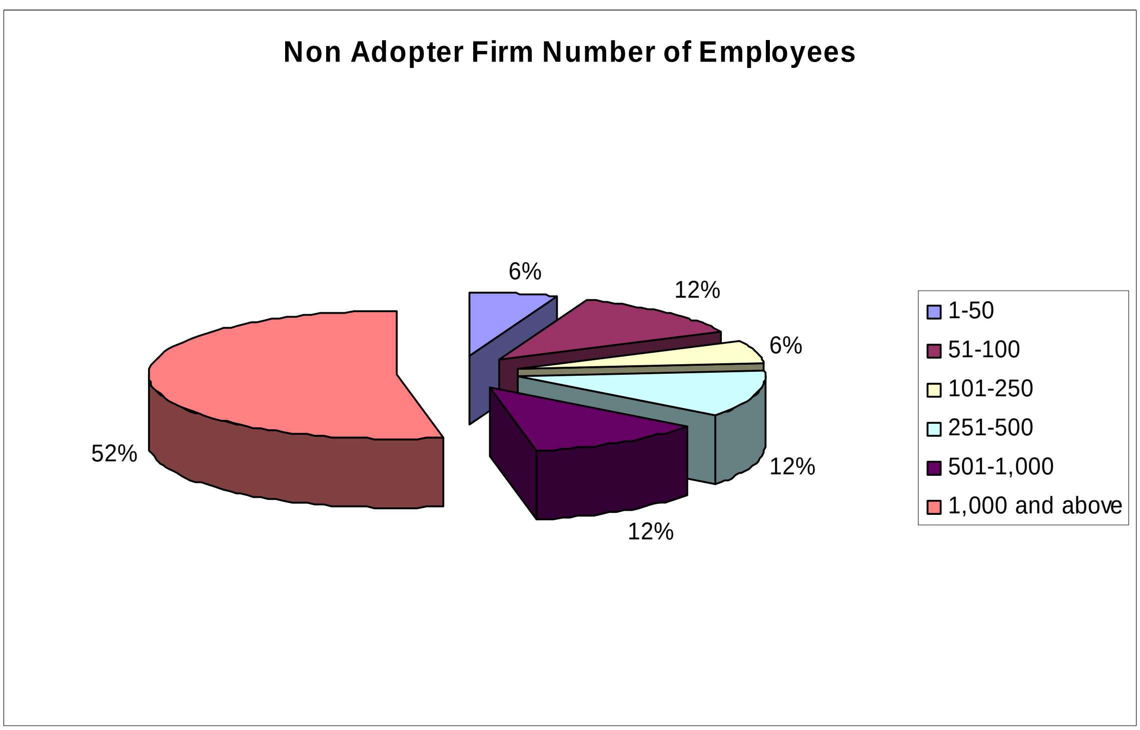
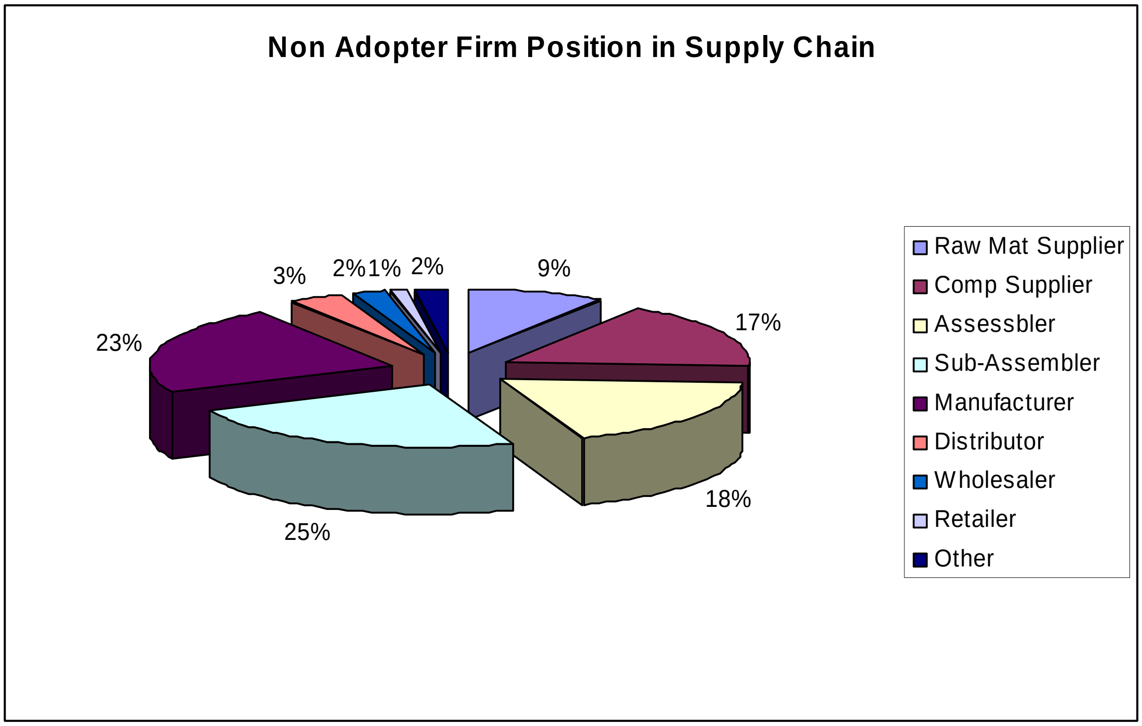


Figure 5.9 Non adopter firm size in terms of the Numbers of employees



5.10 Non adopter firm position in supply chain

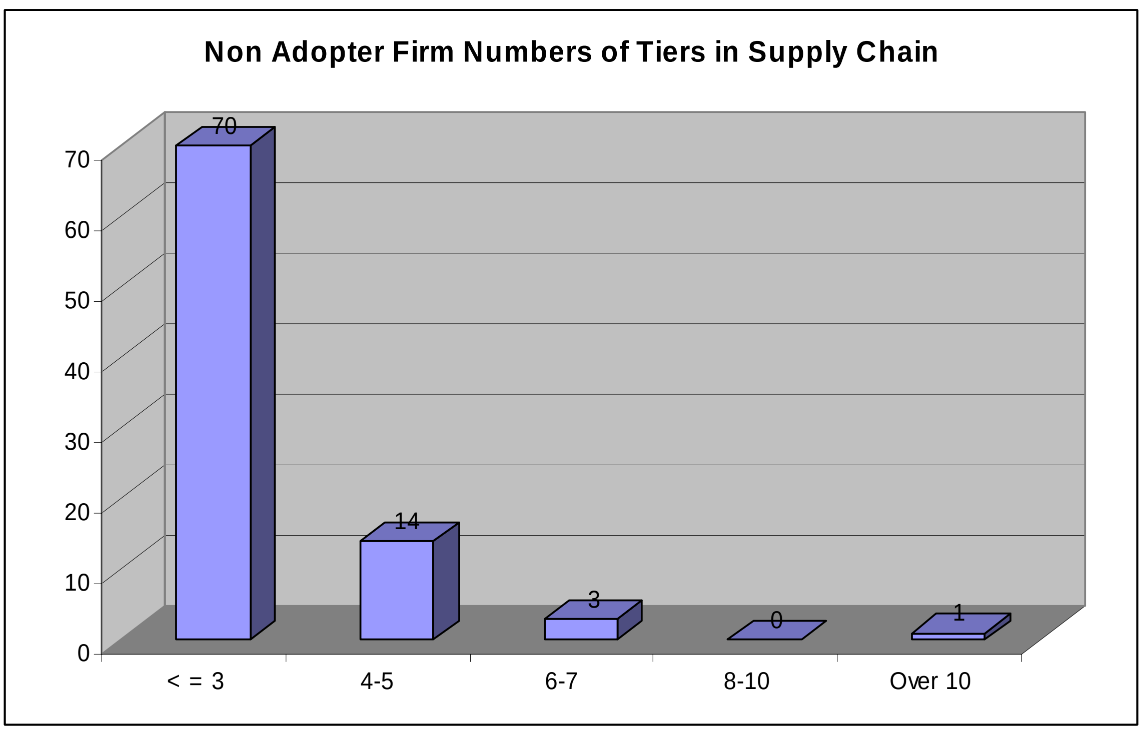


Figure 5.11 Non adopter firms number of tiers in supply chain

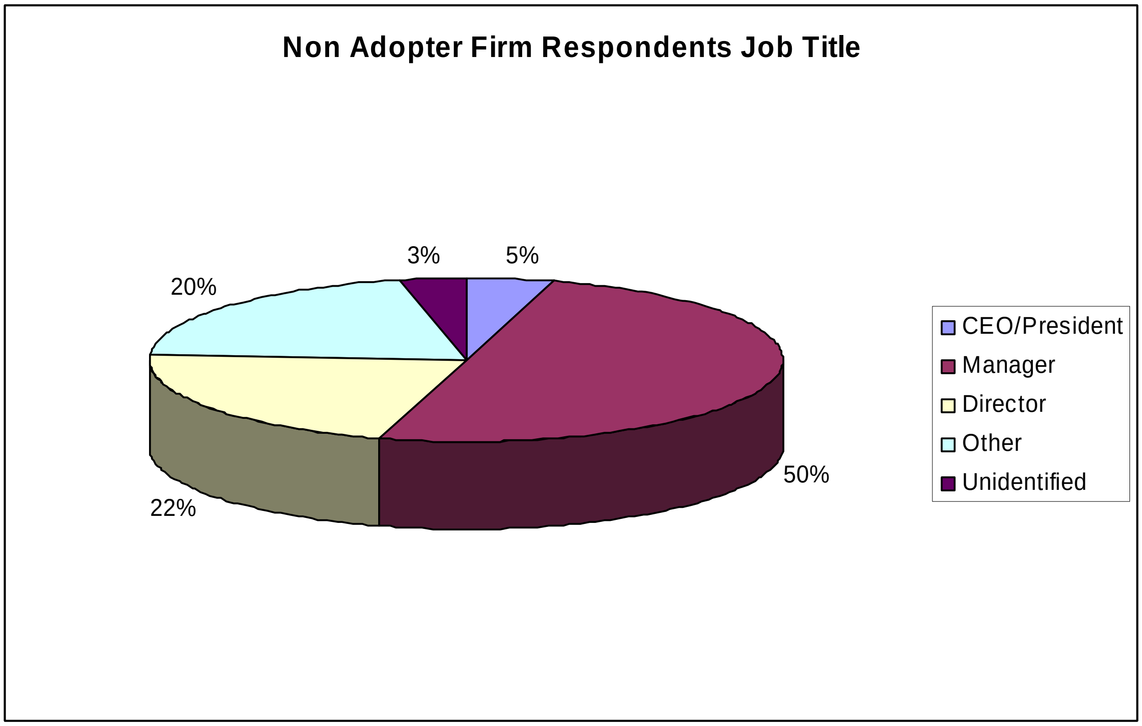


Figure 5.12 Non adopter firm respondents job title

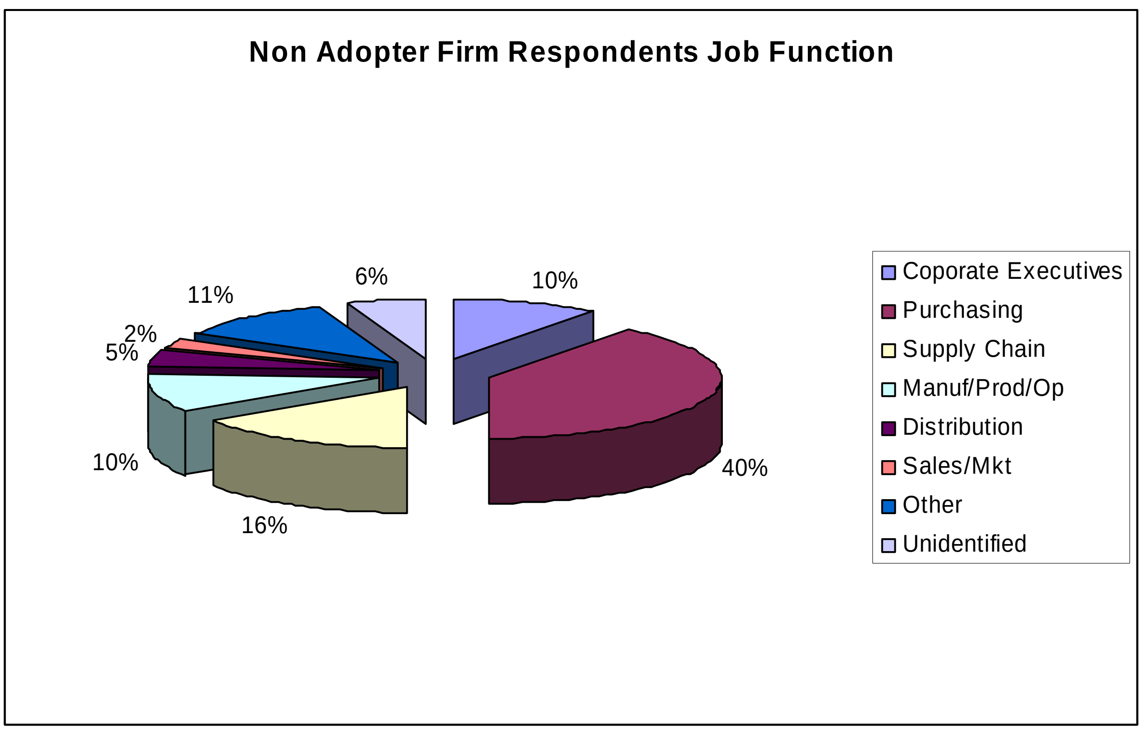


Figure 5.13 Non adopter firm respondents job function

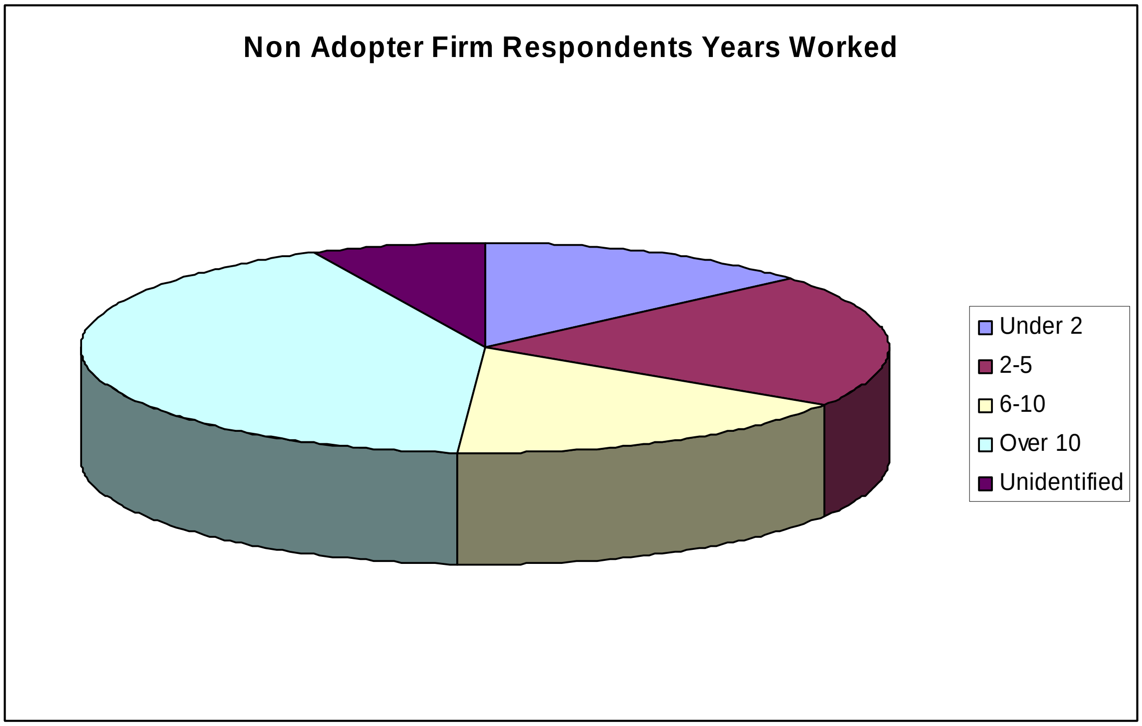


Figure 5.14 Non adopter firm respondents years worked

5.1.5 Non Response Bias Assessment

Non-response bias could be one of the major concerns for survey research methodology. Because when non-response bias exists, the data collected might not be representative to the population the researcher was intended to study. Thus statistical procedures must be taken to assessment the non response bias of the sample. It could be estimated by testing the differences of the means of some variables between the first wave responses and the second wave responses by assuming that the second wave response is a non-response for the first wave. The following table (table 5.1-5.6) presents the comparison between 240 usable responses from the first wave and the 171 usable responses from the second wave. Chi-square tests were used to make the comparisons, as presented in the last column of each table. It was found that no significant difference in annual sales volume, firm size, firm position in the supply chain, respondent's job title, job functions and years worked in the firm. Thus the researcher concluded that non-response bias was not a cause for concern for this study.

Variables	First-wave Frequency	Second-wave Expected Frq	Second-wave Observed Frq	$(f_e-f_o)^2/f_e$
Sales Volume (411)				
<10	7	5	3	0.80
10-49	15	11	16	2.27
50-99	14	10	15	2.50
100-249	21	15	12	0.60
250-499	32	23	20	0.39
500-1000	30	21	16	1.19
>1000	112	80	79	0.01
Unidentified	9	6	10	2.67
Chi-square: df=7, p>.05, critical χ^2= 14.07, Computed χ^2=				**10.43**

Table 5.1. 1st and 2nd wave respondents comparison based on firm sales volume

Variables	First-wave Frequency	Second-wave Expected Frq	Second-wave Observed Frq	$(f_e-f_o)^2/f_e$
Number of Employees (411)				
1-50	16	11	15	1.45
51-100	13	10	12	0.40
101-250	11	8	14	4.50
251-500	19	13	8	1.92
501-1000	24	17	21	0.94
>1000	146	105	95	0.95
Unidentified	11	8	6	0.50
Chi-square: df=6, p>.05, critical χ^2= 12.59, Computed χ^2=				**10.67**

Table 5.2. 1st and 2nd wave respondents comparison based on the firm's number of employees

Variables	First-wave Frequency	Second-wave Expected Frq	Second-wave Observed Frq	$(f_e-f_o)^2/f_e$
Position in Supply Chain (411)				
Raw Mat Supplier	13	9	14	2.78
Comp Supplier	25	18	10	3.56
Assembler	43	31	33	0.13
Sub-Assembler	34	24	29	1.04
Manufacturer	99	71	65	0.51
Distributor	5	4	7	2.25
Wholesaler	5	4	4	0.00
Retailer	3	2	3	0.50
Unidentified	13	9	6	1.00
Chi-square: df=8, p>.05, critical χ^2= 15.51, Computed χ^2=				**11.76**

Table 5.3. 1st and 2nd wave respondents comparison based on firm's position in supply chain

Variables	First-wave Frequency	Second-wave Expected Frq	Second-wave Observed Frq	$(f_e-f_o)^2/f_e$
Respondent Title (411)				
CEO/President	24	17	8	4.76
Manager	106	76	82	0.47
Director	64	46	50	0.35
Other	40	29	24	0.86
Unidentified	6	4	7	2.25
Chi-square: df=4, p>.05, critical χ^2= 9.49, Computed χ^2=				**8.70**

Table 5.4. 1st and 2nd wave respondents comparison based on job title

Variables	First-wave Frequency	Second-wave Expected Frq	Second-wave Observed Frq	$(f_e-f_o)^2/f_e$
Respondent Job Function (411)				
Corp Executive	32	23	15	2.78
Purchasing	80	57	49	1.12
Supply Chain	27	19	27	3.37
Mannf/Operation	35	25	29	0.64
Distribution	13	10	4	3.60
Sales/Mktg	5	4	6	1.00
Other	29	21	26	1.19
Unidentified	19	13	15	0.31
Chi-square: df=7, p>.05, critical χ^2= 14.07, Computed χ^2=				**14.01**

Table 5.5. 1st and 2nd wave respondents comparison based on job function.

Variables	First-wave Frequency	Second-wave Expected Frq	Second-wave Observed Frq	$(f_e-f_o)^2/f_e$
Respondent Years Worked (411)				
<2	35	25	29	0.64
2-5	43	30	22	2.13
6-10	32	23	34	5.26
>10	111	80	77	0.11
Unidentified	19	13	9	1.23
Chi-square: df=4, p>.05, critical χ^2= 9.49, Computed χ^2=				**9.38**

Table 5.6. 1st and 2nd wave respondents comparison based on years of service

5.2 Large-scale Instrument Assessment Methodology

The data analyses of this study involve 2 procedures: 1) measurement models testing for instrument validation, and 2) structural model testing for verifying the hypothesized relationships among constructs. As suggested by Gerbing and Anderson (1988), the researcher decided to test the measurement model first to avoid possible interactions between the measurement and structural models.

Among the 10 constructs presented in our research model, 3 constructs (partner Relationships, Supply Chain Integration and Supply Chain Performance) were measured using existing instrument items from the literature whose effectiveness had been statistically evaluated by their respective authors. Thus the assessment procedures presented in the following section were only performed to those 7 new constructs of this study: 1) Technology Infrastructure, 2) Organizational Infrastructure, 3) Perceived CKMP Benefits, 4) Environmental Characteristics, 5) Knowledge Complementarity, 6) Collaborative Knowledge Management Practice, and 7) Supply Chain Knowledge Quality. The 323 CKMP adopter responses were used to test the reliability and validity of those measurement items.

The validity of a measurement procedure is the degree to which the measurement process measures the variable it claims to measure. The reliability of a measurement procedure is the stability or consistency of such measurement. Although both validity and reliability are criteria for evaluating the quality of a measurement procedure, these two factors are partially related and partially independent. A measure can not be valid unless it is reliable, but a measure can be reliable without being valid. Bagozzi (1980) and Bagozzi and Philips (1982) suggested a instrument evaluation guideline that the measurement properties for reliability and validity include purification, factor structure (initial validity), unidimensionality, reliability, and the validation of second-order construct. The methods for each analysis were corrected-item total correlation (for purification), Cronbach's alpha (for reliability), and CFA (confirmative factor analysis for first and second order factor structure and unidimensionality).

The measurement items for the above mentioned 7 new constructs were first purified by using the Corrected Item-to-Total Correlation (CITC) scores with respect to a specific dimension of a construct. As argued by Churchill (1979), the purposed of the purification process is to get rid of "garbage items" before administering factor analysis. The CITC score captures the degree of each item contributes to the internal consistency of a particular construct dimension as measured by the Cronbach's Alpha coefficient (Cronbach, 1951). Following the guideline established by Nunnally (1978), an alpha score of higher than 0.70 for a construct is generally considered to be acceptable (Robinson et al., 1991; Robinson and Shaver, 1973). The reliability analysis of SPSS 11.0 was used to CITC computation to each of the construct. When the constructs had only 1 dimension, all items designed for such construct was put together at once in computing CITC; while for constructs with multiple sub-dimensions, multiple CITC computing iterations were conducted for each of the sub-dimensions. It is generally believed that less than 0.5 CITC value for each item indicates such item as a candidate for elimination in further analysis. However, a slightly lower CITC score may be acceptable if that particular item is considered to be important to the construct dimension. On the other hand, certain items with CITC score above 0.50 may also be removed if their deletion can improve the overall reliability of the specific dimension. Such effects can be determined from reading the "Alpha if deleted" score.

After purifying the items based on CITC, an exploratory factor analysis (EFA) of the items in each construct was conducted for assessing construct dimensionality. The statistical package SPSS 11.0 for Windows was used to conduct EFA of the items in each construct. Exploratory factor analysis (EFA) is generally used to explore potential latent sources of variance and covariance in observed measurements. Principal Component analysis was used as factor extraction method, and VARIMAX was selected as the factor rotation method. Also, MEANSUB command was used in most cases to replace the missing values with the mean score for that item. All items for each construct were EFA test regardless the existence of proposed sub-dimensions. A unidimensional scale with good internal consistency should have all items load on one factor. If multiple factors emerged, the possibility of splitting the items into multiple dimensions were carefully examined, and theoretical justifications were sought. As a general rule of thumb, when the sample size is 50 or large, factor loadings greater than 0.30 are considered to be significant; loadings of 0.40 are considered more important; and loadings of greater than 0.50 are very significant (Hair, et al., 1992). To ensure the high quality of instrument development process in the current study, 0.50 was used as the cutoff score for factor loadings, i.e., items with loadings lower than 0.50 will generally be removed. Items were further purified if serious cross-loadings (i.e., an item loaded very close to 0.50 on both factors) were observed.

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was calculated for all dimension-level and construct-level factor analysis. This measure ensures that the effective sample size is adequate for the current factor analysis. Generally, a KMO score in the 0.90s is considered outstanding, the 0.80s as very good, the 0.70s as average, the 0.60s as tolerable, 0.50s as miserable, and below 0.50 as unacceptable.

The next step after item-purification is to examine the unidimensionality of the underlying latent constructs. Unidimensionality is the characteristic of a set of indicators that has only one underlying trait or concept in common (Hair et al., 1998). Based on knowledge of the theory, empirical research, or both, the researcher postulates relations between the observed measures and the underlying factors, then tests this hypothesized structure statistically. Confirmatory factory analysis (CFA) is used to determine the adequacy of the measurement model's goodness of fit to the sample data. Due to the robustness and flexibility of structural equation modeling (SEM) in establishing CFA, this research will use SEM to test both the first–order and second order CFA models. First order factor models are those in which correlations among the observed variables can be described by a smaller number of latent variables, each of which may be considered to be one level; these factors are termed primary or first-order factors. Second-order CFA models are to examine the correlations among the first-order factors and to verify whether these first-order factors can be represented by a single second-order factor or at least a smaller set of factors.

LISREL by Joreskog and Sorbom (1989) is one of the most widely used software for SEM analysis. Model-data fitting was evaluated based on multiple goodness-of-fit indexes. Goodness-of-fit measures the correspondence of the actual or observed input (covariance or correlation) matrix with that predicted from the proposed model. Goodness-of-fit measures are of three types: (1) absolute fit measures assess only the overall model fit (both measurement and structural models collectively); (2) Incremental fit measures compare the proposed model to another model specified by the researcher, most often referred to as the null model; and (3) Parsimonious fit measures relate the goodness-of-fit of the model to the number of estimated coefficients required to achieve this model fit. The purpose of the test is to determine the amount of fit achieved by each estimated coefficient.

Chi-square Fit Index is perhaps the most common fit test. It measures the difference between the sample covariance and the fitted covariance. The chi-square value should not be significant if there is a good model fit. However, one problem with this test is that the larger the sample size, the more likely the rejection of the model (Type II error). The chi-square fit index is also very sensitive to violations of the assumption of multivariate normality. Therefore, Joreskog and Sorbom (1989) suggested that the test must be interpreted with caution. For that reason, chi-square/degree of freedom (χ^2 / df) is used with values less than 3 indicate good fit (Carmines and McIver, 1981).

LISREL also reports several other measures of overall model fit: goodness of fit index (GFI), adjusted goodness of fit index (AGFI), comparative fit index (CFI), normed fit index (NFI), root mean square residual (RMR), and root mean square error of approximation (RMSEA). Goodness of fit index (GFI) indicated the relative amount of variance and covariance jointly explained by the model. It can vary from 0 to 1, but theoretically may yield meaningless negative values. Adjusted goodness of fit index (AGFI) is similar to GFI but adjusts for the degree of freedom in the model. NFI is a relative comparison of proposed model to the null model. Comparative fit index (CFI) compares the absolute fit of specified model to the absolute fit of the independence model.

The greater the discrepancy between the overall fit of the two models the larger the values of CFI. CFI avoids the underestimation of fit by NFI often noted in models with small sample size. 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 (Hair et al., 1998; Joreskog and Sorbom, 1998; Bentler and Bonett, 1980). Root mean square residual (RMR) indicates the average discrepancy between the elements in the sample covariance matrix and the model-generated covariance matrix. The value varies from 0 to 1, with smaller values indicating better model; and less than 0.05 indicates good fit (Byrne, 1998). Root mean square error of approximation (RMSEA) has only recently been recognized as one of the most informative criteria in covariance structure modeling. It takes into account the error of approximation in the population and is expressed per degree of freedom, thus making the index sensitive to the number of estimated parameters in the model. Values below .05 signify good fit and the most acceptable value is .08 (Browne and Cudeck, 1993; Byrne, 1989).

As recommended by Joreskog and Sorbom (1989), only one item was allowed to be altered at a time to avoid over-modification of the model, thus iterative modifications were made for first-order and second-order factor models by examining modification indices along with coefficients to improve key model fit statistics. The deletion of an item must be on the basis of enough evidence, both theoretically and empirically. This iterative process continued until all model parameters and key fit indices met recommended criteria.

The target coefficient index was also calculated to all second order constructs to provide evidence of the existence of high-order constructs (Marsh and Hocevar, 1985). It was the ratio of the full first order chi-square to that of the higher order model. This coefficient indicated the extent to which the higher-order factor model accounts for covariation among the first-order factors. Doll and Ragu-Nathan (1995) pointed out that the target coefficient could be interpreted as the percentage of variation in the first-order factors that can be explained by the second-order construct.

Finally, the reliability of the entire set of items comprising the second order constructs was estimated using Cronbach's alpha. Following the guideline established by Nunnally (1978), an Alpha score of higher than 0.70 is generally considered to be acceptable.

5.3 Large-scale Measurement Results

The following section presents the large-scale instrument validation results on each of the new constructs/sub-constructs in the study. 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.

TI Technology Infrastructure

OI Organizational Infrastructure

- TMS Top Management Support
- CSC Collaboration Supportive Organizational Culture
- OEM Organizational Empowerment

BF Perceived CKMP Benefits

EC Environmental Characteristics

EUC Environmental Uncertainty

CMP Competitive Pressure

TPR Trading Partner Readiness

KC Knowledge Complementarity

CP Collaborative Knowledge Management Practice

CKG Collaborative Knowledge Generation

CKS Collaborative Knowledge Storage

BKA Barrier-free Knowledge Access

CKD Collaborative Knowledge Dissemination

CKA Collaborative Knowledge Application

KQ Supply Chain Knowledge Quality

5.3.1 Technology Infrastructure

Technology Infrastructure (TI) is a single dimension construct measured by 5 items representing the 5 important technological tools. CITC score shows that the 5th item (Computer based decision support system) is far below 0.5 (0.2034), and the resulted Cronbach's Alpha is only 0.6884; thus we decided to remove it from further analysis. Although CITC for the first item (communication support system) is below 0.5 (0.4855) too, it is generally understood that items should be deleted one at a time. The second itinerary of reliability analysis after deleting item 5 showed that Cronbach's Alpha has been improved to 0.7479. The CITC for item 1 is still slightly below 0.5. Since communication support system is regarded very important for effective knowledge collaboration, we decided to keep this item. The CITC for each item and its corresponding code name are shown in Table 5.1.

Technology Infrastructure				
Coding	**Items**	**CITC initial**	**CITC-final**	**Cronbach's α**
TI1	Communication support system	0.4585	0.4781	0.7479
TI2	Collaborative system	0.5643	0.5495	
TI3	Knowledge database mgmt system	0.5123	0.6007	
TI4	Enterprise infor portal	0.5533	0.6255	
TI5	Computer-Based decision support sys	0.2043	Item dropped after purification	

Table 5.7 CITI item purification results of TI.

An exploratory factor analysis was then conducted using principal components as means of extraction. The factor results are shown in Table 5.6. The KMO score of 0.63 indicated an acceptable sampling adequacy. The total variance explained by the single factor (TI) is 57.07%. All items loaded on their respective factors and there were no items with cross-loadings greater than .40.

Item	**Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy = 0.63**	
	Technological Infrastructure	**α**
TI1	.63	.7479
TI2	.76	
TI3	.79	
TI4	.81	
Eigenvalue	2.28	
% of Variance	57.07	

Table 5.8. Exploratory factor analysis of TI

The next step is to test the 4 TI items in confirmatory factor analysis for measurement model fit. The CFA model for Technology Infrastructure was then tested using LISREL. The results indicated an acceptable model fit indices: χ^2 / df =2.436, RMR = .03, GFI = .93, AGFI = .91, NFI = .96, RMSEA = .07, and CFI = .96; thus no need of any modifications. The model for Technology Infrastructure (TI) is shown in Figure 5.15. The factor loadings (λ) were all above .50 and significantly important.

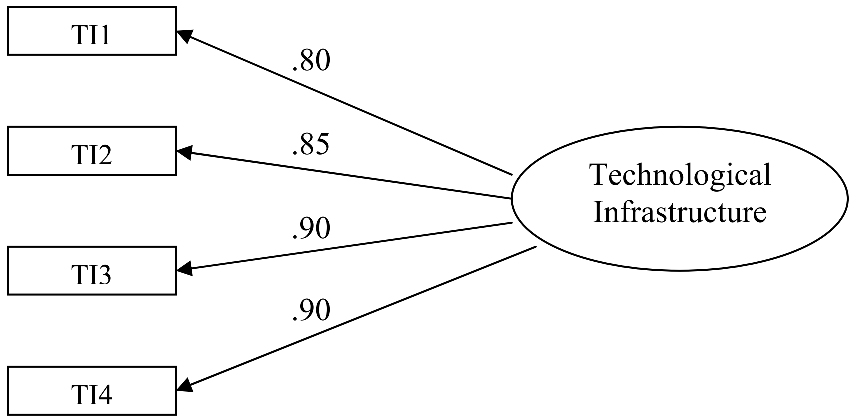


Figure 5.15 Confirmatory factory analysis model of TI.

5.3.2 Organizational Infrastructure (OI)

Organizational Infrastructure was initially represented by three dimensions with a total of 14 measurement items, including Top Management Support (TMS, 5 items), Collaboration Support Culture (CSC, 5 items), and Organizational Empowerment (OEM, 4 items). The reliability analysis revealed that Cronbach's α for OI equaled 0.8286, which was acceptable, but CITC for CSC5 was below 0.5 (0.4031). After removing CSC5, all other CITC items were well above the 0.5 cutoff value, and the Cronbach's α has been improved to 0.8597. The results were presented in Table 5.9

An exploratory factor analysis was then followed using principal components as means of extraction and varimax as method of rotation. The ratio of respondents to items was 29 thus met the general guideline. The factor results were shown in Table 5.10. The KMO score of 0.82 indicated a good sampling adequacy. The cumulative variance explained by the two factors is 69.98%. Three factors emerged from the factor analysis as expected with all factor loadings above 0.50. But there were two items (TMS2 and OEM3) with cross-loadings greater than .40. Hence items TMS2 and OEM3 were dropped.

Organizational Infrastructure				
Coding	**Items**	**CITC initial**	**CITC-final**	**Cronbach's α**
	Top Management Support			
TMS1	mgmt is interested in knowledge sharing	.6905		0.8682
TMS2	mgmt considers kw sharing important	.6401		
TMS3	mgmt supports CKMP with resources	.7678		
TMS4	mgmt regards CKMP as high priority	.7751		
TMS5	mgmt participates in kw sharing	.5950		
	Collaboration Support Organizational Culture			
CSC1	we encourage employee learning	.7074	.7307	0.8597
CSC2	we encourage teamwork	.7377	.7852	
CSC3	we encourage employee help each other	.6346	.7135	
CSC4	we evaluate employees on team basis	.6807	.6024	
CSC5	we have decentralized org structure	.4031	Item dropped after purification	
	Organizational Empowerment			
OEM1	employees are active in generating ideas	.6535		0.8284
OEM2	employees utilize innovative ideas	.6891		
OEM3	encourage employees to create and use kw	.6842		
OEM4	employees of all level can plan their work	.5992		

Table 5.9 CITC item purification results for Organizational Infrastructure

The first-order CFA model for OI was then tested with the statistics presented in Table 5.11. Although all λ coefficients for the initial model were greater than .60, except OEM4 (.54), the model fit was very poor: χ^2 / df =5.59; RMR = 0.07, GFI = .89, AGFI = .82 indicating a possibility of error correlation (Table 5.11). Modification indices indicated a high error correlation between OEM2 and TMS1, TMS5, CSC2, CSC3, and OEM1. Thus it was decided to delete item OEM2 from the model. The model after removing OEM2 was improved but still very poor: large χ^2/df value (5.18), and high RMR (.062) and RMSEA values (0.11). It was still necessary to make further modifications. The LISREL modification indices showed a high error correlation between TMS5 and TMS1 (24.6) and TMS3 (28). TMS5 was then removed from the model. The new model was improved in some fit indices: (χ^2/df = 4.28, RMSEA=0.10), but still below the desire standards, thus further modification was made.

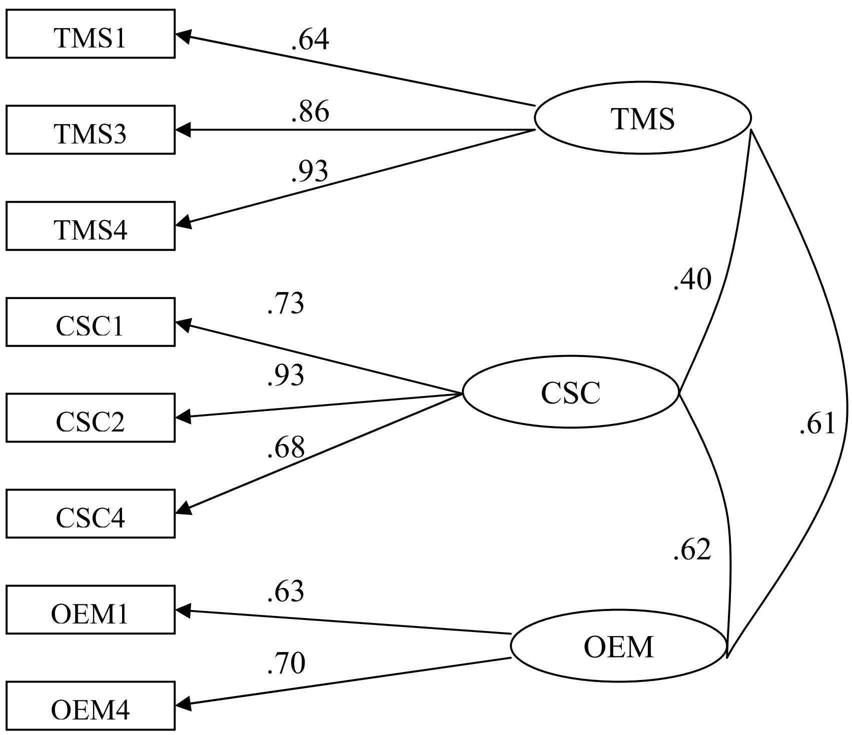
Item	Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy = 0.82			
	Top Management Support	Collaboration Supportive Culture	Organizational Empowerment	α
TMS1	.85			0.8682
TMS2	.64	.52		
TMS3	.79			
TMS4	.79			
TMS5	.66			
CSC1		.86		0.8597
CSC2		.81		
CSC3		.81		
CSC4		.63		
OEM1			.83	0.8284
OEM2			.77	
OEM3		.50	.62	
OEM4			.71	
Eigenvalue	3.19	3.21	2.68	
% of Variance	24.55	24.75	20.68	
Cumulative % of variance	24.55	49.30	69.98	

Table 5.10 Exploratory factor analysis for Organizational Infrastructure

CSC3 was found to have high error correlations with TMS3 (8.6), CSC1 (25.7) and CSC2 (9.8). Thus, it was decided to drop CSC3. The model finally showed good fit: χ^2 / df =2.98, RMSEA =0.080, RMR = 0.050, GFI = .95, AGFI = .90, NFI =0.96, CFI=0.97. There was no need for further modifications. The final first order CFA model for Organizational Infrastructure (OI) is shown in Figure 4. The factor loading (λ) was acceptable with the lowest λ being 0.63 (OEM1).

Fit Indices	χ2	χ2/df	RMSEA	RMR	GFI	AGFI	NFI	CFI
Initial	228.99	5.59	0.119	0.070	0.89	0.82	0.92	0.93
After removing OEM2	165.85	5.18	0.114	0.062	0.91	0.84	0.93	0.94
After removing OEM2 and TMS5	102.82	4.28	0.101	0.050	0.93	0.88	0.95	0.96
After removing OEM2, TMS5, and CSC3	50.79	2.98	0.080	0.050	0.95	0.90	0.96	0.97

Table 5.11. CFA model fit statistics for Organization Infrastructure



5.16. 1st order model for Organizational Infrastructure

In the next step, the second-order model was tested to see if these three sub-constructs (TMS, CSC, OEM) underlie a single higher-order construct – Organizational Infrastructure (OI). The second-order model for OI was shown in Figure 5.17. The model showed very good model fit indices: χ^2 / df =2.98; RMR = .05, RMSEA = .08, GFI = .95, AGFI = .90, NFI = .96, and CFI = .97. The target coefficient ratio was .94, indicating that the second order organizational infrastructure factor accounts for a very large portion of the covariance among the first-order factors. The standardized coefficients (γ) were .63 for Top Management Support (TMS), 0.64 for Collaborative Support Culture (CSC) and .97 for Organizational Empowerment (OEM) and all were statistically significant, hence, the higher-order construct (OI) could be considered.

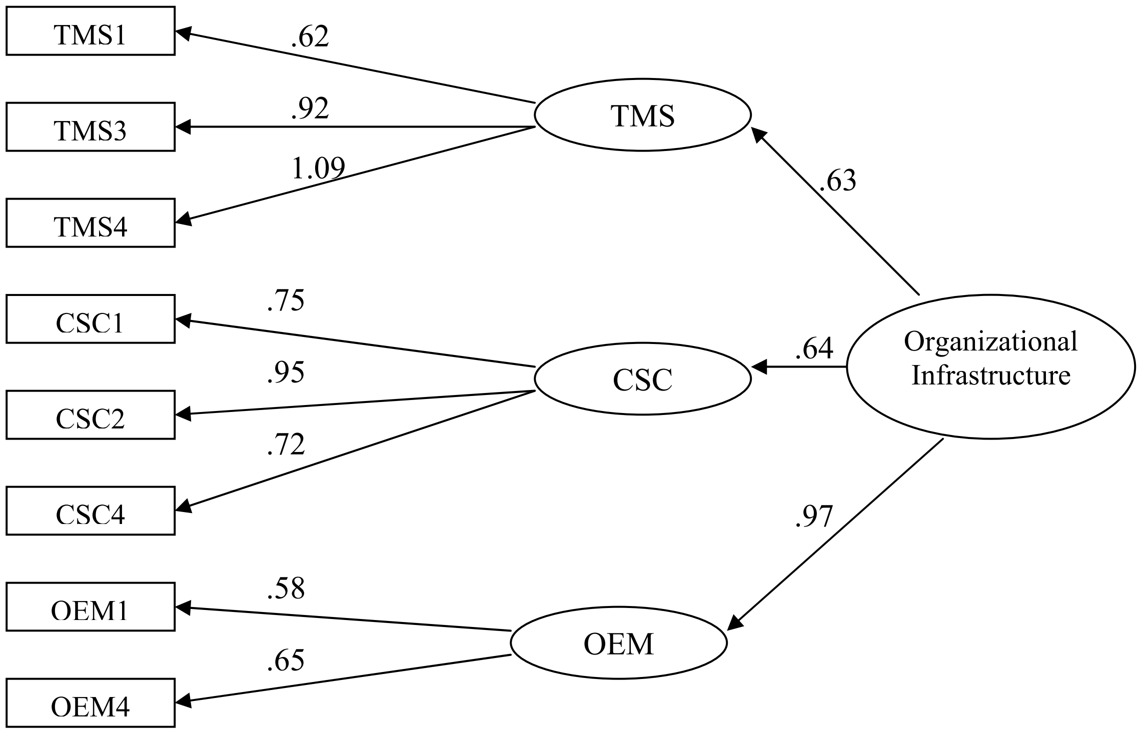


Figure 5.17. The second-order CFA model for Organizational Infrastructure

5.3.3 Perceived CKMP Benefits (BF)

The construct of Perceived CKMP benefits (BF) was initially represented with 13 items in one dimension. The CITC analysis revealed that it had a good Cronbach's α value (0.8992), but BF1 (.3635) and BF7 (0.4338) were below 0.5 CITC cut-off value. After removing them, all other CITC items are still well above the 0.5, and the Cronbach's α had been slightly improved to 0.9010. Table 5.12 presents the results of CITC analysis. An exploratory factor analysis was then conducted. The factor loading results are presented in Table 5.13. The KMO score of 0.82 indicated very good sample adequacy. The analysis demonstrated that two factors were extracted with a cumulative variance of

63%88%. All items loaded on the second factor also have serous cross loading with the first factor; thus items BF2, BF3, and BF5 were removed from the model. The second iteration of exploratory factor analysis with 10 items was conducted, extracting a single factor explaining 48.21% of total variance.

Coding	Items	CITC initial	CITC-final	Cronbach's α
BF1	Improve knowledge creation ability	.3635	Item dropped after purification	
BF2	Improve knowledge storage efficiency	.5228	.5219	Original **α**
BF3	Improve knowledge access	.6280	.6389	.8992
BF4	Facilitate knowledge transfer	.7388	.7307	
BF5	Optimize business decision making	.6337	.6348	
BF6	Improve knowledge quality	.6001	.5744	
BF7	Decrease knowledge management cost	.4770	Item dropped after purification	
BF8	Enhance supply chain relationship	.6830	.6895	Final **α**
BF9	Being innovative	.6696	.6757	0.9010
BF10	Facilitate business transaction	.5799	.5861	
BF11	Improve exception handling	.7299	.7372	
BF12	Adapt to environmental changes	.6391	.6340	
BF13	Improve understanding to business context	.6047	.5957	

Table 5.12 CITC item purification results for Perceived CKMP Benefits

The first-order CFA model for BF was then tested with the 8 measurement items from previous procedures. The model fit statistics were presented in Table 5.14. The initial model was tested indicating all λ coefficients being greater than 0.6, with the exception of BF 6 (λ= 0.47), but with poor model fit: χ^2 / df = 4.80; RMSEA =.16, RMR = .067, and AGFI = .75 indicating a possibility of error correlation. Item BF12 was found to have high error term with BF6 (21.4), BF8 (18.4), BF9 (30.0) and BF11 (50.5) for modification. After removing BF12, the model was improved and demonstrated good fit. λ coefficients for each item were improved, including BF6 (.51), which demonstrated high model fitness (Figure 5.18).

First Iteration Exploratory Factor Analysis		
Item	**Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy = 0.82**	
	Perceived Benefits	**2nd factor**
BF2	.46	.77
BF3	.59	.56
BF4	.74	
BF5	.72	.56
BF6	.53	
BF8	.70	
BF9	.69	
BF10	.63	
BF11	.80	
BF12	.77	
BF13	.68	
Eigenvalue	4.59	.85
% of Variance	56.07	7.80
Cumulative % of variance	56.07	63.88
Second Iteration Exploratory Factor Analysis		
Item	**Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy = 0.85**	
	Perceived Benefits	**2nd factor**
BF4	.73	
BF6	.52	
BF8	.68	
BF9	.73	
BF10	.65	
BF11	.80	
BF12	.72	
BF13	.67	
Eigenvalue	3.85	
% of Variance	48.21	

Table 5.13 Exploratory factor analysis for Perceived CKMP benefits

Fit Indices	χ2	χ2/df	RMSEA	RMR	GFI	AGFI	NFI	CFI
Initial	96.00	4.80	.16	.067	.86	.75	.90	.91
After removing BF12	35.07	2.505	.034	.048	.92	.84	.93	.94

5.14 CFA model fit for Perceived CKMP Benefits.

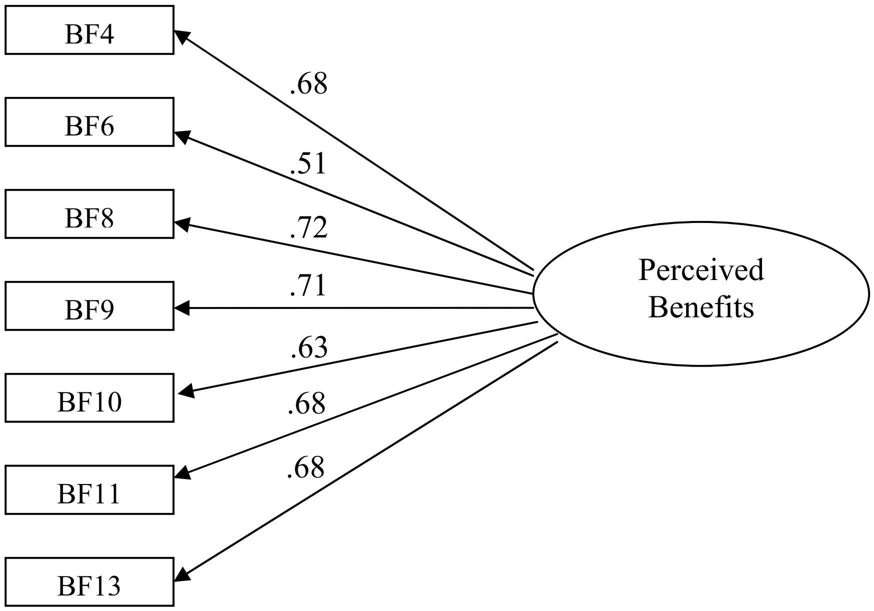


Figure 5.18. The first order CFA model for Perceived CKMP Benefits

5.3.4 Environmental Characteristics (EC)

The construct of environmental characteristics was initially represented with 17 items in three dimensions: Environmental Uncertainty (EUC), Competitive Pressure (CMP) and Trading Partner Readiness (TPR). Although the measurement items for EUC sub-constructs were borrowed from Li (2003), we made appropriate modifications for the purpose of this study. Thus these items were also examined for model fitness.

As illustrated in table 5.15, the reliability analysis revealed that it had an outstanding Cronbach's α value (0.9277) and the CITC values were all above the 0.5 cut-off value. Thus, no items were removed from the test.

The following step is to conduct an exploratory factor analysis. The factor results were shown in Table 5.16. The KMO score of 0.90 indicated very good sampling adequacy.

The cumulative variance explained by the two factors is 71.20%. All items loaded on their respective factors and there were no items with cross-loadings greater than .40.

Environmental Characteristics				
Coding	**Items**	**CITC initial**	**CITC-final**	**Cronbach's α**
Environmental Uncertainty				
EUC1	Unpredictable customer	.6613		.8809
EUC2	Fluctuating orders	.6497		
EUC3	Unpredictable supplier delivers	.6055		
EUC4	Unpredictable product quality from suppliers	.6843		
EUC5	Intense competition	.6273		
EUC6	Unpredictable competitor action	.6700		
EUC7	International competition	.6291		
EUC8	Technology change			
Competitive Pressure				
CMP1	Industry implemented CKMP	.9035		.9276
CMP2	Competitor implemented CKMP	.8727		
CMP3	Partner implemented CKMP	.8724		
CMP4	CKMP incentives/punishments	.6905		
Trading Partner Readiness				
TPR1	CKMP benefits recognized	.8286		.9460
TPR2	Willingness to implement CKMP	.8822		
TPR3	Available CKMP resources	.8739		
TPR4	Technology competence	.8568		
TPR5	Clear CKMP plan	.8266		

Table 5.15 CITC analysis for Environmental Characteristics

The first-order CFA model for environmental characteristics was then tested with the 17 measurement items. The statistics were presented in Table 5.17. The initial model was tested indicating marginally acceptable λ coefficients: all were greater than 0.6, except EUC3 (0.66). Model fit statistics were very poor with χ^2 / df = 5.14; RMR = .073, RMSEA =.113, and AGFI = .76 indicating a possibility of error correlation. LISREL modification indices indicated a high error correlation between EUC8 and EUC1 (20.6), EUC3 (18.5), EUC5 (10.4), EUC7 (45.1) and TPR4 (8.2). EUC8 thus was dropped from the model. The new model improved with a number of fit indices, but still very poor: χ^2/df = 4.59, RMSEA = .106, RMR = .072.

Item	Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy = 0.90			
	Environmental Uncertainty	**Competitive Pressure**	**Trading Partner Readiness**	**α**
EUC1	.74			.8809
EUC2	.74			
EUC3	.60			
EUC4	.65			
EUC5	.67			
EUC6	.59			
EUC7	.72			
EUC8	.68			
CMP1		.67		.9276
CMP2		.64		
CMP3		.66		
CMP4		.49		
TPR1			.83	.9460
TPR2			.86	
TPR3			.84	
TPR4			.78	
TPR5			.76	
Eigenvalue	6.12	3.18	2.78	
% of Variance	36.05	18.74	16.40	
Cumulative % of variance	36.05	54.79	71.20	

Table 5.16 Exploratory factor analysis results for Environmental Characteristics

Further modifications were suggested by the LISREL modification indices which showed high error correlations between TPR4 and a large number of other items: CMP2 (24.0), CMP3 (17.1), CMP4 (32.0) and TPR2 (24.7). TPR4 was obviously the next candidate be deleted. The resulting model was improved in some fit indices: χ^2/df = 3.71, RMSEA=0.092, RMR = .071. EUC7 was also dropped, because of its high error correlation with 4 other items: EUC1 (9.8), EUC3 (21.9), EUC5 (40.1) and EUC6 (10.8). However, the model still showed poor fitness: χ^2/df = 3.22, RMSEA=0.083, RMR = .075.

EUC1 was the next to be dropped because of its high error covariance with EUC2 (12.5), EUC3 (17.3) and EUC4 (9.0). After dropping EUC1, the model finally showed acceptable fitness: χ^2/df =2.79, RMR = 0.047, GFI = 0.92, AGFI = 0.89, NFI=0.97, CFI=0.98. Although RMSEA was not exceptionally good (0.075), According to Browne and Cudeck (1993), a value less than 0.08 is acceptable. In order not to over modify the model, we decided to stop further removing measurement items. All λ coefficients were above .6 cutoff values, which demonstrated acceptable model fitness (Figure 5.19). The set of measurement items for EC was tested using SPSS for its internal consistency. Cronbach's alpha reading was 0.9186, indicating a high reliability of the construct. The first order CFA model was presented at figure

Fit Indices	**χ2**	**χ2/df**	**RMSEA**	**RMR**	**GFI**	**AGFI**	**NFI**	**CFI**
Initial	596.90	5.14	.11	.073	.82	.76	.94	.95
After removing EUC8	464.24	4.59	.106	.072	.85	.79	.95	.96
After removing EUC8, TPR4	323.16	3.71	.092	.071	.88	.84	.96	.97
After removing EUC8, TPR4, EUC7	238.48	3.22	.083	.075	.90	.86	.96	.97
After removing EUC8, TPR4, EUC7, EUC1	173.41	2.79	.075	.047	.92	.89	.97	.98

Table 5.17. Model fit statistics for Environmental Characteristics

The second-order model was then tested to see if these three sub-constructs (EUC, CMP and TPR) underlie a single higher-order construct – Environmental Characteristics (figure E). The second-order model for functional characteristics was shown in Figure 5.20. The model showed very good model fit indices: χ^2 / df =2.79; RMR = .047, RMSEA = .075, GFI = .92, AGFI = .89, NFI = .97, and CFI = .98. The standardized coefficients (γ) were .58 for Environmental Uncertainty (EUC), 0.95 for Competitive Pressure (CMP) and .80 for Trading Partner Readiness (TPR) and all were statistically significant, hence, the higher-order construct (EC) can be considered. The target coefficient was also calculated. The ratio of .87 indicating that the second order construct accounted for a large portion of the covariance among the first-order factors.

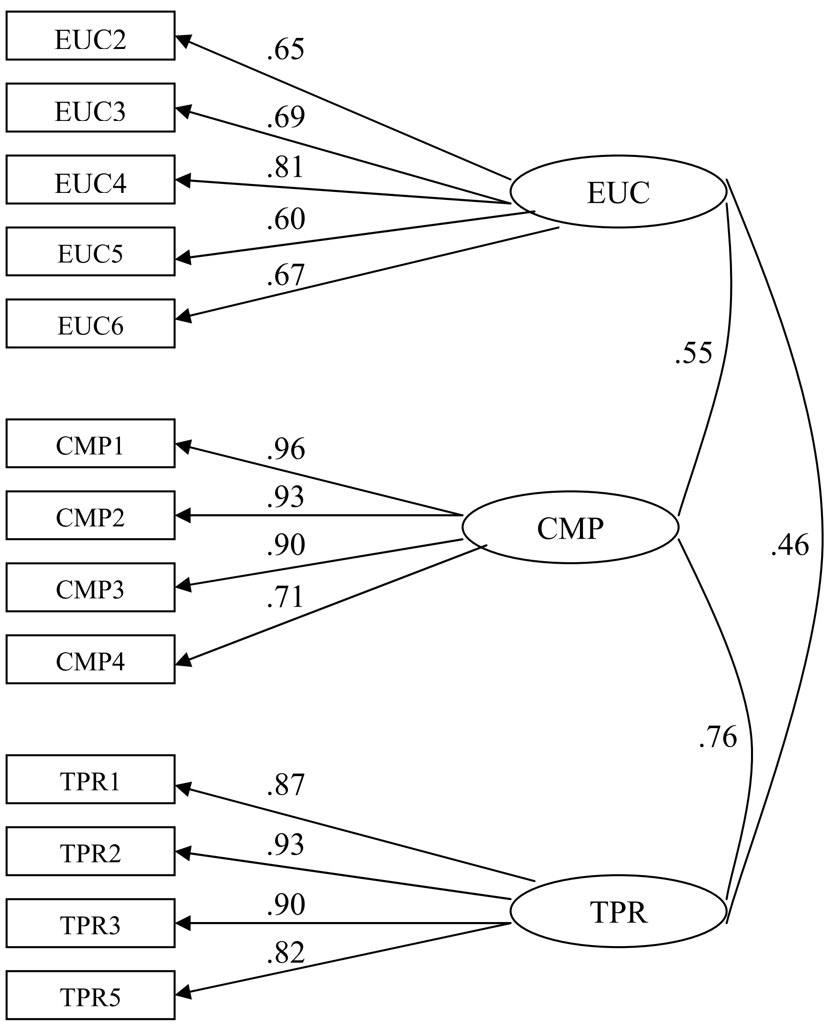


Figure 5.19 First order model for Environmental characteristic

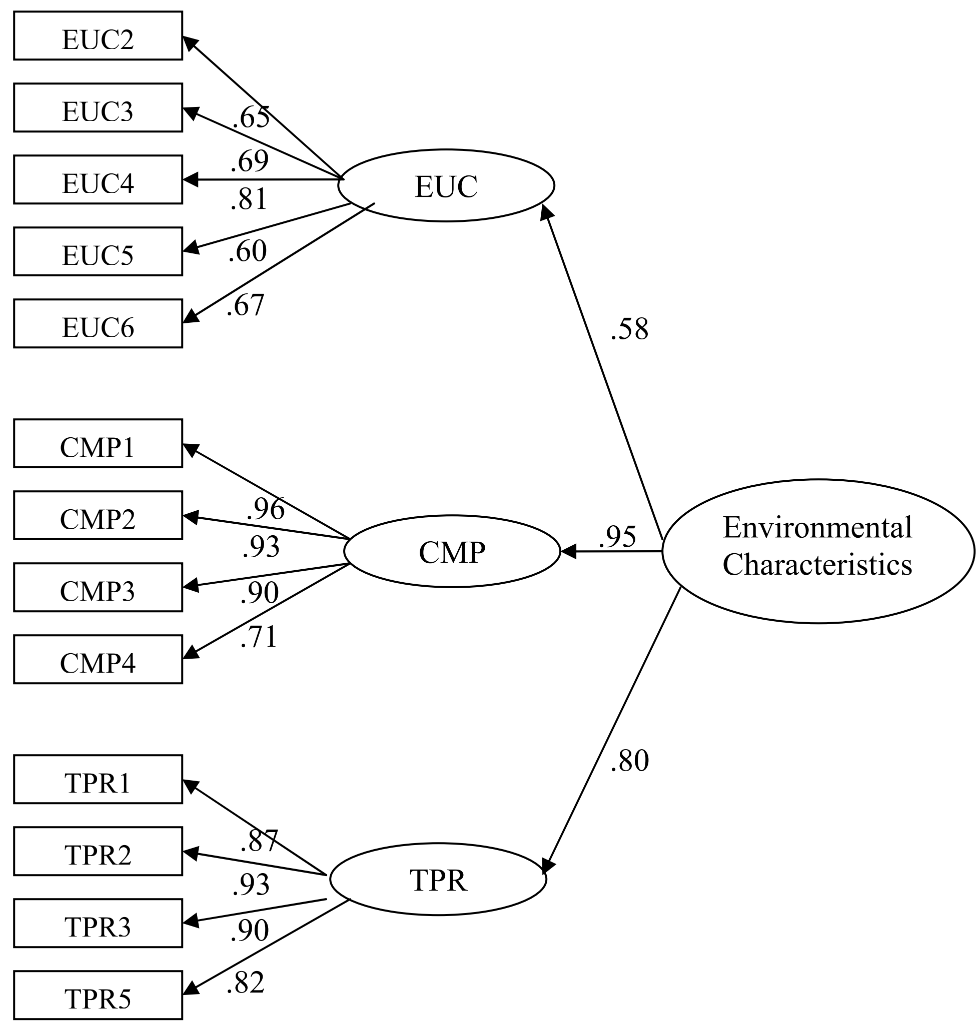


Figure 5.20. Second-order model for Environmental Characteristics

5.3.5 Knowledge Complementarity (KC)

Knowledge Complementarity (KC) is a single dimension construct measured by 4 items. CITC score shows that all items are above 0.5 cut off value, and the resulted Cronbach's Alpha was at acceptable 0.7729. The results are presented in table 5.18.

Knowledge Complementarity				
Coding	**Items**	**CITC initial**	**CITC-final**	**Cronbach's α**
KC1	Different knowledge bases	.5541		.7729
KC2	Understand partners' knowledge	.5843		
KC3	Easy knowledge exchange	.5176		
KC4	Partners' knowledge is valuable	.6640		

Table 5.18 CITC analysis for Knowledge Complementarity

An exploratory factor analysis was then conducted using principal components as means of extraction. The factor results are shown in Table 5.19. The KMO score of 0.73 indicated an good sampling adequacy. The total variance explained by the single factor (KC) is 59.69%. All items loaded on their respective factors and there were no items with cross-loadings greater than .40.

Item	**Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy = 0.73**	
	Knowledge Complementarity	α
KC1	.75	.7729
KC2	.77	
KC3	.72	
KC4	.83	
Eigenvalue	2.38	
% of Variance	59.69	

Table 5.19 Exploratory factor analysis for Knowledge Complementarity

The next step is to test the 4 KC items in CFA model.

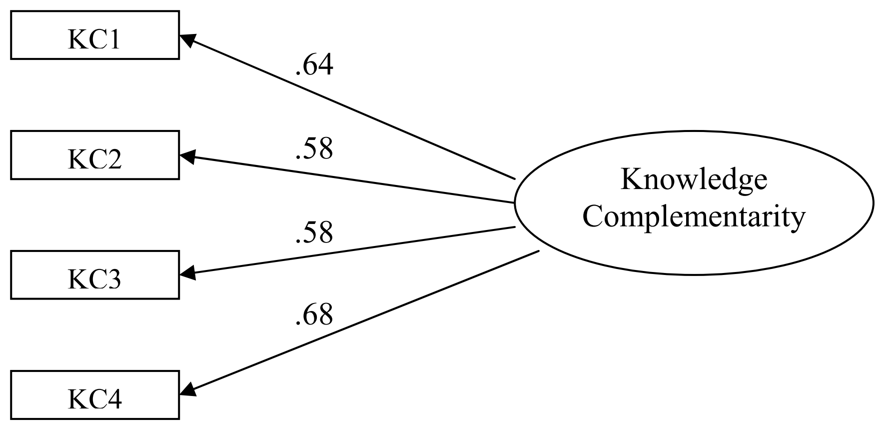


Figure 5.21 CFA model of Knowledge Complementarity

The CFA model for Technology Infrastructure was then tested using LISREL. The model indicated an acceptable fit: χ^2 / df =2.436; RMR = .02, GFI = .97, AGFI = .87, NFI = .93, RMSEA = .07, and CFI = .93. The model for Knowledge Complementarity (KC) is shown in Figure 5.21. The factor loadings (λ) were all above .50 and significantly important.

5.3.6 Collaborative Knowledge Management Practice (CKMP)

The construct of Collaborative Knowledge Management Practice (CKMP) has 25 items in 5 dimensions: Collaborative Knowledge Generation (CKG), Collaborative Knowledge Storage (CKS), Barrier Free Knowledge Access (BKA), Collaborative Knowledge Dissemination (CKD) and Collaborative Knowledge Application (CKA).

The CITC analysis revealed that it had an outstanding Cronbach's α value (.9902). The results are presented in Table 5.20.

Following the CITC analysis, an exploratory factor analysis was conducted using principal component as means of extraction and equamax as method of rotation. The factor results are shown in Table 5.21. The KMO score of 0.90 indicated an outstanding sampling adequacy. All items load on their respective factors. But there were 2 items

(BKA1 and BKA2) with cross-loadings greater than .50, thus were deleted from the model. The cumulative variance explained by the two factors is 78.70%.

Collaborative Knowledge management Practice (CKMP)				
Coding	**Items**	**CITC initial**	**CITC-final**	**Cronbach's α**
Collaborative Knowledge Generation (CKG)				
CKG1	Generate new idea	.6981		.8874
CKG2	Harvest knowledge	.6552		
CKG3	Acquire new knowledge	.7518		
CKG4	Update existing knowledge	.7245		
CKG5	Validate new knowledge	.8084		
Collaborative Knowledge Storage (CKS)				
CKS1	Shared knowledge repository	.8608		.9528
CKS2	Uniform technology platform	.8606		
CKS3	Collaborative repository maintenance	.8705		
CKS4	Coordinate the type of knowledge	.8926		
CKS5	Coordinate the format of knowledge	.8615		
Barrier-free Knowledge Access (BKA)				
BKA1	Uniform technology platform	.7913		.9438
BKA2	Agreement on access knowledge	.8052		
BKA3	Easy access	.8563		
BKA4	Fast access	.8980		
BKA5	Access to sufficient amount of knowledge	.8914		
Collaborative Knowledge Dissemination (CKD)				
CKD1	Employee training	.8203		.9144
CKD2	Publish newsletter	.8255		
CKD3	Set up dissemination events	.8452		
CKD4	Maintain reference desk	.7336		
Collaborative Knowledge Application (CKA)				
CKA1	Coordinate sourcing decisions	.7607		.8963
CKA2	Coordinate CRM	.7491		
CKA3	Coordinate NPD	.6932		
CKA4	Coordinate logistic support	.6525		
CKA5	Coordinate inventory and production	.6770		
CKA6	Coordinate capacity planning	.8025		

Table 5.20 CITC analysis for Collaborative Knowledge Management Practice

The first-order CFA model for CKMP was then tested with the 23 measurement items (BKA 1 and BKA2 were dropped). The statistics are presented in Table 5.22. The initial model was tested indicating marginally acceptable λ coefficients: all were greater than 0.6, except CKA4 (0.50), however a poor model fit: χ^2 / df =7.09; RMSEA =.146, RMR = .07, GFI = .69 and AGFI = .61 indicating a possibility of error correlation.

Item	Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy = 0.90				
	Collaborative Knowledge Creation	**Collaborative Knowledge Storage**	**Barrier-free Knowledge Access**	**Collaborative Knowledge Dissemination**	**Collaborative Knowledge Application**
CKG1	.77				
CKG2	.72				
CKG3	.77				
CKG4	.65			.40	
CKG5	.75				
CKS1		.75			
CKS2		.82			
CKS3		.85			
CKS4		.69	.47		
CKS5		.76			
BKA1		.61	.51		
BKA2		.52	.64		
BKA3			.73		
BKA4			.80		
BKA5			.79		
CKD1				.74	
CKD2				.77	
CKD3				.76	
CKD4				.81	
CKA1					.77
CKA2			.44		.57
CKA3					.54
CKA4					.76
CKA5					.69
CKA6					.75
Eigenvalue	3.68	4.62	3.92	3.74	3.70
% of Variance	14.74	18.50	15.68	14.96	14.81
Cumulative % of variance	14.74	33.24	48.92	63.88	78.69

Table 5.21 Exploratory factor analysis for Collaborative Knowledge Management Practices

LISREL modification indices indicated high error correlations between CKS3 and large number of items: CKG1 (40.5), CKG2 (21), CKG3 (32.1) CKG4 (24.1), CKS1 (44.3) and CKS2 (49.1), thus it was decided to delete item CKS3 from the model. The model after removing CKS3 was slightly improved in terms of χ^2 / df (6.79), RMSEA (.14), RMR (.068), GFI (.73) and AGFI (0.65) but still very poor. It took seven other itinerations as presented in table 5.22 to achieve a model with good fitness. The final model consisted of 14 measurement items: CKG1, CKG3, CKG5, CKS1, CKS4, CKS5, BKA4, BKA5, CKD1, CKD2, CKD3, CKD4, CKA2, and CKA3. All λ coefficients were above .6 cutoff values, which demonstrated acceptable model fitness (Figure 5.22). The set of measurement items for CKMP was tested using SPSS for its internal consistency. Cronbach's alpha reading was 0.9373, indicating a high reliability of the construct.

Fit Indices	**$\chi2$**	**$\chi2$/df**	**RMSEA**	**RMR**	**GFI**	**AGFI**	**NFI**	**CFI**
Initial	1410.91	7.09	.146	.07	.69	.61	.91	.92
After removing CKS3	1249.12	6.79	.14	.068	.73	.65	.92	.93
After removing CKS3, CKA6	969.60	6.06	.133	.067	.75	.68	.92	.93
After removing CKS3, CKA6, CKA4	755.44	5.32	.129	.063	.77	.70	.93	.94
After removing CKS3, CKA6, CKA4, CKA1	564.13	4.513	.0827	.061	.79	.71	.94	.95
After removing CKS3, CKA6, CKA4, CKA1, CKS2	421.61	3.868	.0590	.057	.82	.78	.95	.95
After removing CKS3, CKA6, CKA4, CKA1, CKS2, CKG4	344.28	3.662	.0582	.053	.85	.81	.95	.96
After removing CKS3, CKA6, CKA4, CKA1, CKS2, CKG4, CKG2	245.85	3.05	.0523	.042	.87	.82	.95	.96
After removing CKS3, CKA6, CKA4, CKA1, CKS2, CKG4, CKG2, CKA5	193.63	2.89	.0478	.039	.91	.090	.96	.96

Table 5.22. First-order model fit statistics for Collaborative Knowledge Management Practices

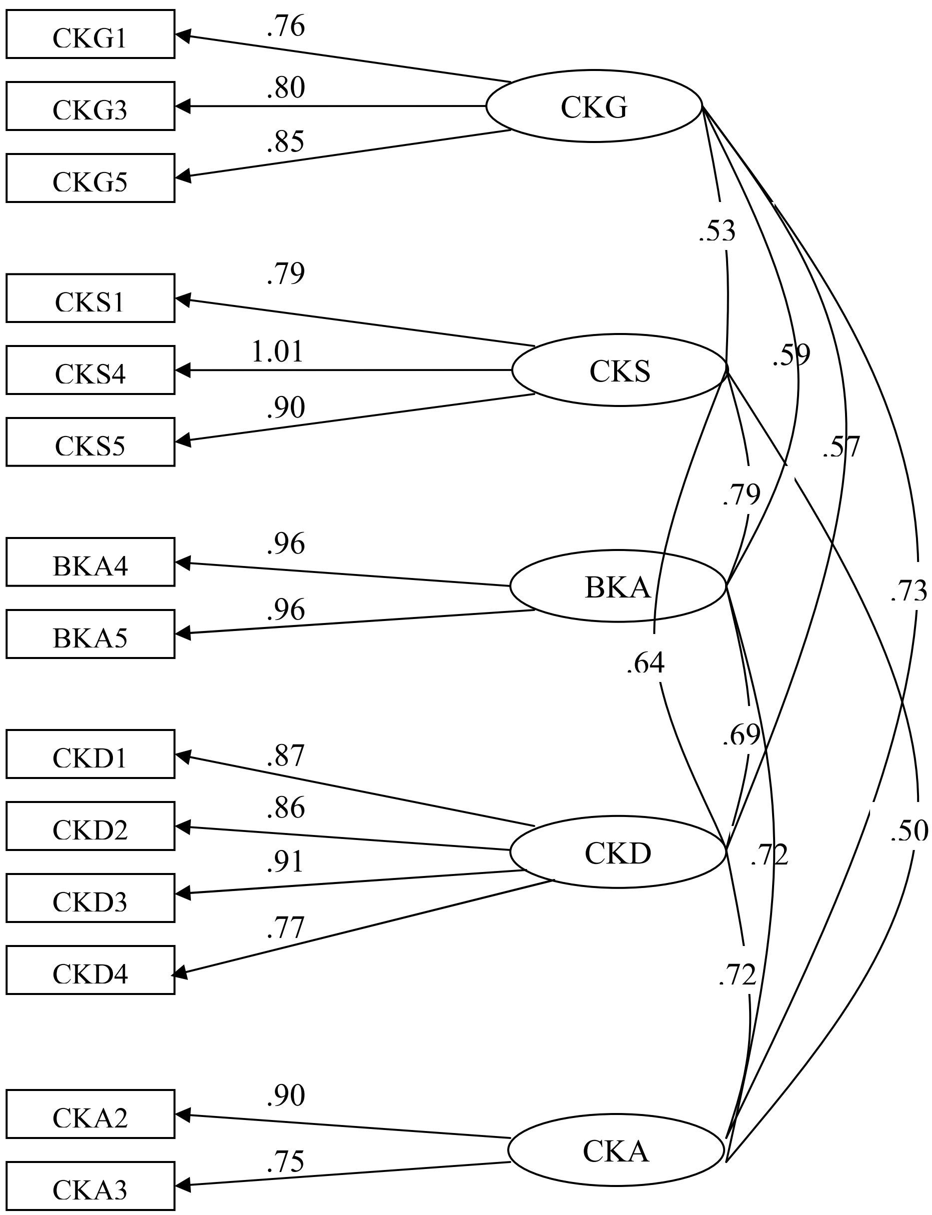


Figure 5.22 First-order CFA model for Collaborative Knowledge Management Practices

The second-order model was then tested to see if these 5 sub-constructs (CKG, CKS, BKA, CKD and CKA) underlie a single higher-order construct – Collaborative Knowledge Management Practices (CKMP). The second-order model for is shown in Figure 5.23. The model showed reasonable model fit indices: χ^2 / df = 2.89, RMR = .039, RMSEA = .0479, GFI = .91, AGFI = .90, NFI = .96, and CFI = .96. The standardized coefficients (γ) were .72 for Collaborative Knowledge Generation (CKG), 0.81 for Collaborative Knowledge Storage (CKS), .91 for Barrier-free Knowledge Access (BKA), 0.79 for Collaborative Knowledge Dissemination (CKD), and 0.76 for Collaborative Knowledge Application (CKA); all were statistically significant, hence, the higher-order construct (CKMP) can be considered. The target coefficient ratio was computed next. A ratio of .83 indicating that a sufficient portion of covariance among the first order factors was also accounted by the second order CKMP model.

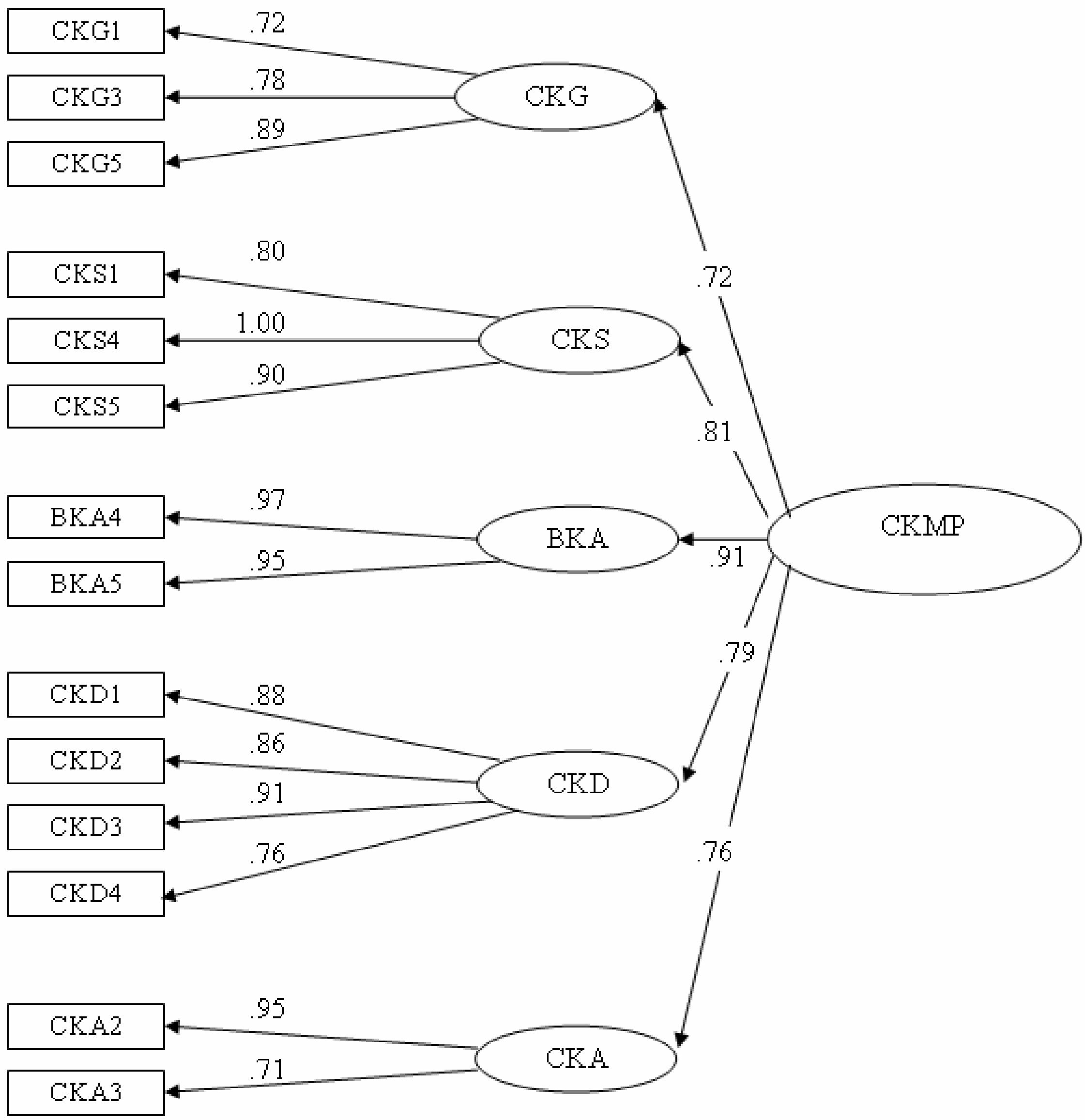


Figure 5.23 Second-order CFA model for Collaborative Knowledge Management Practices

5.3.7 Supply Chain Knowledge Quality (KQ)

The construct of Supply Chain Knowledge Quality (KQ) was initially represented with 5 items in one dimension. The CITC analysis presented in table 5.23 indicating that the measurement model had an outstanding Cronbach's α value (0.9169), and all CITC readings were well above the 0.5 cutoff value, presenting good data reliability.

Perceived CKMP Benefits				
Coding	**Items**	**CITC initial**	**CITC-final**	**Cronbach's α**
KQ1	Knowledge preciseness	.6787		.9169
KQ2	Knowledge completeness	.8879		
KQ3	Knowledge timeliness	.8179		
KQ4	Knowledge understandability	.7974		
KQ5	Knowledge usability	.7601		

Table 5.23 CITC analysis for Knowledge Quality

An exploratory factor analysis was then conducted to explore the internal dimensions of the construct. The results presented in table 5.24 in indicated that good sampling adequacy can be assured with KMO = 0.84. The total variance explained by the single factor (KQ) is 75.39%. All items loaded on their respective factors and there were no items with cross-loadings greater than .40.

Item	**Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy = 0.84**	
	Knowledge Complementarity	α
KQ1	.78	.9196
KQ2	.93	
KQ3	.88	
KQ4	.87	
KQ5	.85	
Eigenvalue	3.77	
% of Variance	75.39	

Table 5.24 Exploratory factor analysis for Supply Chain Knowledge Quality

The next step is to test the 5 KQ items in CFA model. The statistics were presented in Table 5.25. The initial model was tested indicating high λ coefficients being considerably greater than 0.8, with the lowest λ= 0.81 (KQ5) but the model fit was poor with χ^2 / df =4.5; RMSEA =.081, indicating a possibility of error correlation (Table 4.4). Modification indices indicated a high error correlation between KQ4 and KQ5 (20). Since KQ5 also had the lowest λ coefficient, it was decided to remove KQ5 from the model. The updated model demonstrated very good fitness as indicated in Table 5.25 and Figure 5.24.

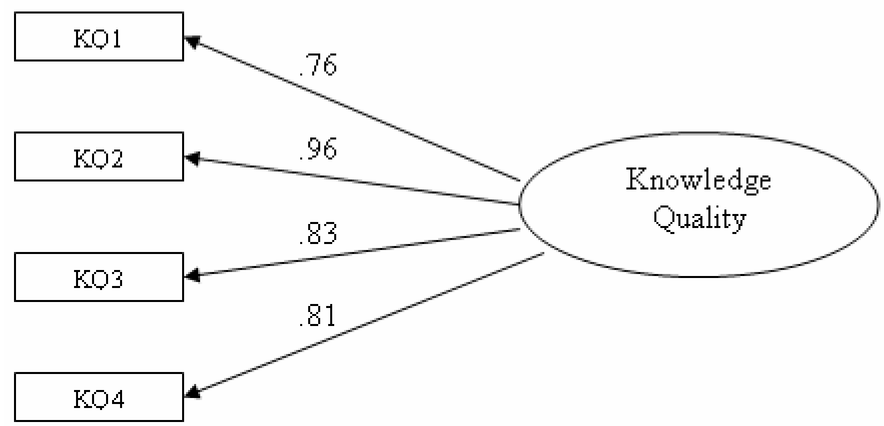


Figure 5.24 CFA model for Supply chain knowledge quality

The CFA model for KQ was then tested with the 5 measurement items.

Fit Indices	χ2	χ2/df	RMSEA	RMR	GFI	AGFI	NFI	CFI
Initial	23.40	4.68	.081	.062	.86	.85	.92	.92
After removing KQ5	5.08	2.54	.047	.041	.95	.93	.96	.97

Table 5.25 CFA model fit statistics for Supply Chain Knowledge Quality

Finally, the set of measurement items for KQ was tested using SPSS, which yielded a Cronbach's alpha reading of 0.9035, indicating a high reliability of the construct.

This chapter covers the validation processes of the measurement instruments we designed to measure the constructs in the research model. The next section continues the discussion about using the validated instrument to study the structural relationships among the constructs with LISREL path analysis.

CHAPTER 6: CAUSAL MODEL AND HYPOTHESES TESTING

This chapter is the second portion of data analysis. Shin and Collier (2000) stated that structural equation models decompose the empirical correlation or covariance among the variables to estimate the path coefficients. In order to provide the literature with a good causal model, the researcher first provides accepted measurement models as validated in the previous chapter. Secondly, the final structural equation model with the substantial hypothesis about the relationships among the constructs is presented. This chapter focuses on the assessment of structural model of the study (the set of depend relationships linking the model constructs). Structural equation modeling (SEM) has wildly been used to study the complex interrelations among variables (Joreskog, 1977). The chapter describes path analysis using LISREL software for the SEM model. The significance of each path in the proposed structural model was tested and overall goodness-of-fit of the entire structural equation model was assessed. All 323 cases collected were used in the analysis. First, the averaged score of the items loaded for each dimension of each construct was computed. Second, these scores were used as indicators for the corresponding construct. In the case the construct is in single dimension (i.e. Perceived CKMP Benefits), all the items were put together into the model.

The testing principle for structural equation model is that the researcher states a model based on theoretical foundations as presented in chapter 3. Then, the data oriented model from the observed samples will be compared with the theoretical model. If the discrepancy between those two models is small, the theoretical model is statistically well fit, and thus substantially meaningful (Zhang, 2001).

6.1 The Structural Equation Model

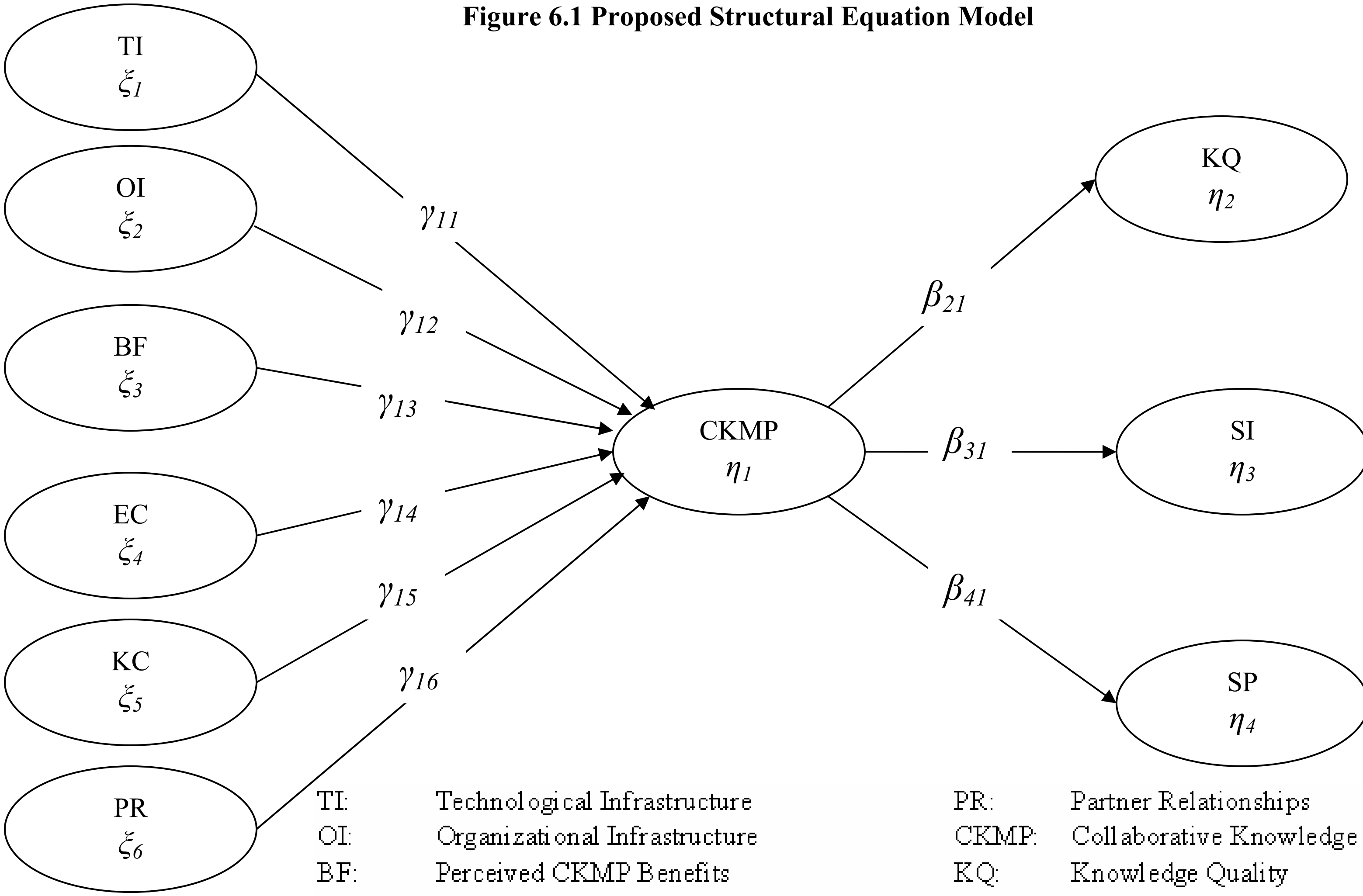
The proposed structural model depicted in Figure 6.1 is a replication of the framework presented in Figure 3.4 using the mathematical notation in the structural equation model. There are ten variables in the model: Technological Infrastructure (TI) – ξ_1, Organizational Infrastructure (OI) - ξ_2, Perceived CKMP Benefits (BF) – ξ_3, Environmental Characteristics (EC) – ξ_4 , Knowledge Complementarity (KC) – ξ_5, Partner Relationships (PR) – ξ_6, Collaborative Knowledge management Practice (CKMP) – η_1, Supply Chain Knowledge Quality (KQ) – η_2, Supply Chain Integration (SI) – η_3, and Supply Chain Performance (SP) – η_4. TI, OI, BF, EC, KC and PR are regarded as independent (exogenous) variables, while CKMP, KQ, SI, SP are dependent (endogenous) variables. Endogenous latent variables are affected by exogenous variables in the model, either directly or indirectly. They are explained by the model because their causal antecedents are specified within the model under consideration.

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

$$\eta = \beta\eta + \tau\xi + \zeta$$

Where η is a (4×1) vector of latent endogenous variables, ξ is a (6×1) vector of the latent exogenous variables; τ is a (4×6) vector of coefficients relating the 6 exogenous variables to the 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.

Figure 6.1 Proposed Structural Equation Model



TI:	Technological Infrastructure	PR:	Partner Relationships
OI:	Organizational Infrastructure	CKMP:	Collaborative Knowledge Management Practices
BF:	Perceived CKMP Benefits	KQ:	Knowledge Quality
EC:	Environmental Characteristics	SI:	Supply Chain Integration
KC:	Knowledge Complementarity	SP:	Supply Chain Performance

The 9 hypotheses proposed in Chapter 3 are represented by the 9 causal relationships in the model. Hypothesis 1a is represented in Figure 6.1 by the relationship γ_{11} (TI → CKMP); Hypothesis 1b is represented by the relationship γ_{12} (OI → CKMP); Hypothesis 2 is represented by the relationship γ_{13} (BF → CKMP); Hypothesis 3a is represented by the relationship γ_{13} (EC → CKMP); Hypothesis 3b is represented by the relationship γ_{15} (KC → CKMP); Hypothesis 3c is represented by the relationship γ_{16} (PR → CKMP); Hypothesis 4a is represented by the relationship β_{21} (CKMP → KQ); Hypothesis 4b is represented by the relationship β_{31} (CKMP → SI); and Hypothesis 4c is represented by the relationship β_{21} (CKMP → SP).

The research model presented in chapter 3 postulated that Collaborative Knowledge Management Practice in supply chain is affected by Technological Infrastructure, Organizational Infrastructure, Perceived Benefits, Environmental Characteristics, Knowledge Complementarity between trading partners, and partner Relationships. The casual paths are presented in equation 1 below. Supply Chain Knowledge Quality the organizations obtain is affected by Collaborative Knowledge Management Practices. This causal relation is presented in equation 2 below. Supply Chain Integration with partners and Supply Chain Performance are both related with Collaborative Knowledge Management Practices. Their corresponding causal paths are presented in equation 3 and 4 respectively in below.

$$\eta_1 = \gamma_{11}\xi_1 + \gamma_{12}\xi_2 + \gamma_{13}\xi_3 + \gamma_{14}\xi_4 + \gamma_{15}\xi_5 + \gamma_{16}\xi_6 + \zeta_1 \quad (1)$$

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

$$\eta_3 = \beta_{31}\eta_1 + \zeta_3 \quad (3)$$

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

Fit indices such as Chi-square, GFI, AGFI, CFI, NFI, RMR and RMSEA are used to measure the model fitness. If the model fits the data adequately, the magnitudes and t-values of the γ and β coefficients will be evaluated to test the hypotheses. Using one-tail 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 displays the path diagram resulting from the structural modeling analysis from LISREL. The model fit measures are χ^2/df = 2.86, RMR = .044; RMSEA = .042; GFI = .92; AGFI = .90; NFI = .91; CFI = .92, indicating a good fit of the proposed model to data. The findings for the structural equation model are presented in table 6.1. Out of the 9 hypothesized relationships, 7 were found to be significant at the 0.01 level.

The following research hypotheses are supported: Technological Infrastructure (H1a), Organizational Infrastructure (H1b), Environmental Characteristics (H3a), and knowledge complementarity (H3b) are driving forces of collaborative knowledge management practices in supply chain (as illustrated in structural equation 1 below). Collaborative knowledge management practices in supply chain leads to supply chain Knowledge Quality (H4a), Supply Chain Integration (H4b), and Supply Chain Performance (H4c) (as illustrated in structural equation 2, 3, 4 below).

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

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

$$\eta_3 = \beta_{31}\eta_1 + \zeta_3 \quad (3)$$

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

Among the 7 supported relationships, the standard coefficients between CKMP and Supply Chain Knowledge Quality (.83) and between CKMP and Supply Chain Integration (.76) are exceptionally high. It can be concluded that implementing CKMP is an effective way to obtain high quality knowledge throughout supply chain and to close relationships with trading partners.

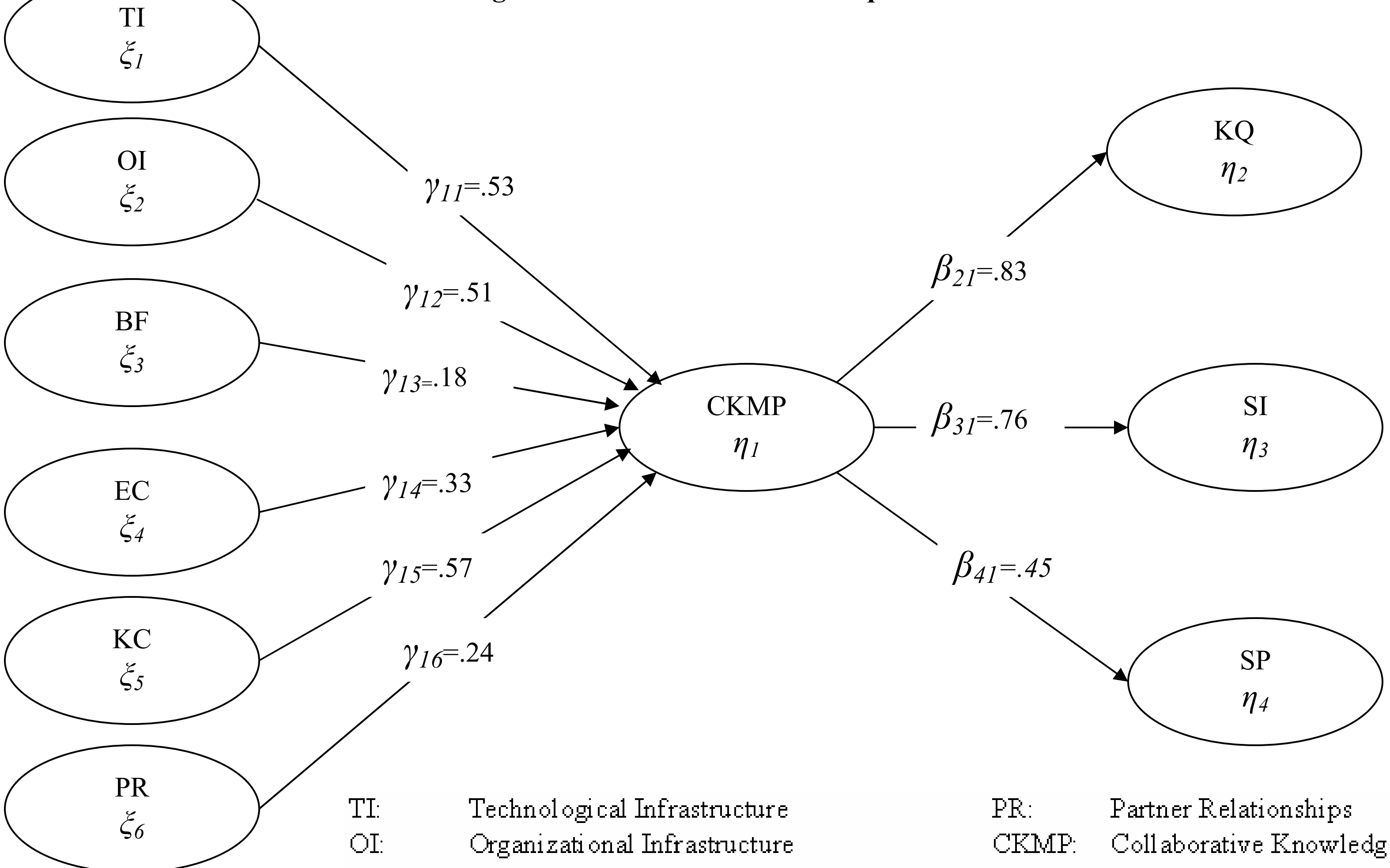
The results indicate that there are no significant or direct relationships between Perceived Benefits (H2), Partner Relationships (H3c) and Collaborative Knowledge Management Practices in supply chain.

Hypotheses	**Relationships**	**Path**	**Standardized Estimate**	**t-value**	**Significant?**
H1a	TI → CKMP	γ_{11}	.53	6.95	Yes
H1b	OI → CKMP	γ_{12}	.51	3.35	Yes
H2	BF → CKMP	γ_{13}	.18	.72	No
H3a	EC → CKMP	γ_{14}	.33	3.72	Yes
H3b	KC → CKMP	γ_{15}	.57	3.32	Yes
H3c	PR → CKMP	γ_{16}	.24	1.02	No
H4a	CKMP → KQ	β_{21}	.83	10.29	Yes
H4b	CKMP → SI	β_{31}	.76	8.86	Yes
H4c	CKMP → SP	β_{41}	.45	6.15	Yes

Note: 1. t-value is at one tail test. 2. All t-values are significant at .05 level (t>1.65), if not otherwise noted.

Table 6.1 Results for the Proposed Structural Equation Model

Figure 6.2 Results - Structural Equation Model



TI:	Technological Infrastructure	PR:	Partner Relationships
OI:	Organizational Infrastructure	CKMP:	Collaborative Knowledge Management Practices
BF:	Perceived CKMP Benefits	KQ:	Knowledge Quality
EC:	Environmental Characteristics	SI:	Supply Chain Integration
KC:	Knowledge Complementarity	SP:	Supply Chain Performance

6.3 Summary of Hypotheses Testing Using SEM

The LISREL structural equation modeling and hypothesis testing results have been reported in the previous section. The researcher will explain the theoretical and practical implications of accepting/rejecting each hypothesis.

Hypothesis 1a: Technological infrastructure has a direct positive relationship with collaborative knowledge management practices in supply chain.

The relationship was found being supported by SEM. The strength of the relationship between the 2 constructs is .53, significant at .01 level. Theoretically, it means that technology is an important driver to the implementation of CKMP. The relationship is very easy to understand since both the adoption and successful operations of knowledge management system is heavily depended on the availability of advanced information technology to organizations. They must take full use of communication and collaborative technology to coordinate knowledge management activities with supply chain partners within and out of organizational boundaries, particularly when these partners are timely and geographically located apart from each other. Database management technologies and information portals also have substantial implications to the implementation of CKMP, because users depend on them to keep the knowledge, sort through and access the knowledge that the supply chain partners are creating continuously.

Hypothesis 1b: Organizational infrastructure has a direct and positive relationship with collaborative knowledge management practices in supply chain.

This relationship between organizational infrastructure and CKMP was found to be significant at .01 level with a relationship strength of .51. It postulates that organizational factors have substantial impacts on the successful CKMP implementation. Numerous researchers have echoed similar arguments (e.g. Davenport et al, 1998, Meso and Smith, 2000 Hart, 2004). Support for top management can facilitate CKMP through distribution of resources, authority and information. Without the involvement of top executives, it would be extremely difficult to coordinate the knowledge operations of various functions and parties of interest in an organization, not mentioning the integration with outside partners. Similarly, we confirmed the importance of a favorable organizational culture. A collaboration supportive culture encourages employee to generate new knowledge, relieve their potential worries of applying and sharing knowledge with fellow workers. As what is argued by Wyer and Mason (1999), managing an organization is a people business. Empowerment of employees give them freedom and authority to their work, thus they are willing to participate in collaborative knowledge building and sharing (e.g. Kaizen in Just-in-time). The test result implies that firms should work on optimize their organizational infrastructure and should establish a knowledge friendly environment to be able to implement CKMP successfully.

Hypothesis 2: Perceived CKMP benefits have direct and positive relationship with collaborative knowledge management practices in supply chain.

This relationship is found to be not significant at .05 level ($\gamma = .18$, t-value = .72), which indicates that what benefits organizations perceive has little affects on their implementation of CKMP. This result was out of the researcher's expectation, however, could be understood as such: First, organizations' perception to CKMP change along the process of using the system. During the decision making stage when organizations are weighing the probability of adopting CKMP, they may have perceived many of the potential benefits that CKMP can bring, such as facilitating business transactions, increasing understanding to business context etc. However, after the organization has made a huge investment to put up a collaborative knowledge management system, they may find that CKMP is not omnipotent as initially expected to solve all of their business problems, particularly during the initial implementation stage when the system is not stable and users are not familiar with CKMP operations. It is natural when the organization has not fully taken advantage of the benefits of CKMP, people do fell certain level of disappointment, which could be exaggerated in answering survey questions. Second, a considerable numbers of our questionnaire respondents were from medium sized non-supply chain master organizations. A major reason for their adoption of CKMP was the requirement from their major trading partners (supply chain master) for continuing doing business with. For these organizations, they were pushed to implement CKMP (not by their own choice), and tended to ignore many of the possible operational benefits from CKMP.

Hypothesis 3a: Environmental characteristics have direct and positive relationship with collaborative knowledge management practices in supply chain.

This relationship is found to be significant at .01 level (t-value =3.72). But the strength of relationship is considerably weaker in the model than the rest of the CKMP antecedents ($\gamma = .33$). The result empirically confirms the proposal that not all organizations which meet the pre-requisite of CKMP will actually jump onto the wagon of CKMP. Contextual factors do act as drivers to initiate organizations' commitment to CKMP. Considering the large investment and efforts required in implementing CKMP, the practical implication is that organizations should carefully gauge their operating environment when planning CKMP initiations. Decision makers should analyze the level of environmental uncertainty the organization is facing. If the uncertainty level is high in their operation, it is worthwhile to embrace CKMP to facilitate knowledge creation and sharing capabilities and strengthen its adaptability to external changes. Organizations should also conduct thorough analysis to competitors in its industry. CKMP is a long term initiation that will bring sustainable competitive advantages to the organization that is not easily copied by others. If knowledge collaboration has become an industry-wide standard practice, an organization is likely to lose the competition if it does not have it on board. Similarly, a clear understanding to ones trading partners is also essential in CKMP implementation, because CKMP is a supply-chain-wide attempt. All involved partner firms must be interested in and be ready for CKMP, otherwise the system will not function to its fullest advantage.

As argued by Jimmy and Lam (2006), different types of supply chains should take different approaches in managing organizational knowledge. An efficiency supply chain operates in a relatively stable environment, thus they are not active in seeking collaboration and knowledge exchange with their trading partners. While the responsive supply chains are facing considerable amount of environmental uncertainty, they would be very willing to pursue any possible methods to collaborate with their partners. It is naturally that the level of environmental characteristics is a major driver for organizations' implementation of CKMP.

Hypothesis 3b: Knowledge complementarity has direct and positive relationship with collaborative knowledge management practices in supply chain.

As expected, the relationship is found to be significant at the .01 level (t-value = 3.32). The relationship strength is .57. The result demonstrated that the type of knowledge trading partners possess is important to organizations' willingness to implement CKMP. It is obvious that organizations must perceive the other party's knowledge asset to be important to motivate their attempts to collaborate with the other party for knowledge exchange. The other's knowledge must be different to some extent, otherwise why bother with sharing knowledge that is already known. The partner firms must also have considerable degree of knowledge overlap; otherwise the knowledge communication can be fairly hard to understand. Practically, organizations must understand their supply chain partners and start CKMP initiation with a thorough SWOT analysis to their partners and themselves.

Hypothesis 3c: Partner relationship has direct and positive relationship with collaborative knowledge management practices in supply chain.

The relationship was found to be not significant at .05 level (t-value = 1.02). This was an unexpected result; the literature has numerous studies available that indicating positive effects of partner relationship to an inter-organizational system such as CKMP (e.g. Ibbott and Keefe, 2004; Finnegan et al., 1998). A possible reason might be the considerable numbers of respondents from non-supply chain master organization. Out of 323 usable samples, only 30% answered the chain master question; and 24% of those clearly identified themselves as non-masters in their supply chains. Thus we might have fairly significant non-master organizations in our study. These firms were implementing CKMP because they were pushed by their supply chain master partners and simply have to. They were more passive contributors to whatever the chain masters were asking for, rather than active knowledge seekers from the collaboration in supply chain. Thus how much they value partner relationship had little to do with whether they would implement CKMP.

Hypothesis 4a: Collaborative knowledge management practices in supply chain have direct and positive relationship with the quality of supply chain knowledge.

This relationship was found to be significant at .01 level (t-value = 10.29) with high strength (β = .83). It revealed that high knowledge quality level was a direct outcome of successful CKMP implementation. In a competitive business world, organizations must have fully control over its knowledge assets and leverage the expertise of the entire supply chain to operate effectively. The study confirmed that implementing CKMP is the right approach to maintain knowledge quality. CKMP can help generate more knowledge in timely manner, make knowledge accessible and easy to use. It justified the considerable resources and efforts that organizations devoted to adoption and implementation of collaborative knowledge management systems.

Hypothesis 4b: Collaborative knowledge management practices in supply chain have direct and positive relationship with supply chain integration.

This relationship was found to be significant at .01 level (t-value = 8.86) with high strength (β = .76). Internal functional integration and external integration with upstream suppliers and downstream customers are major issues in supply chain management (Hill and Scudder, 2002). As an inter-organizational system, CKMP requires joint commitment from all involving partners. The process of integrating each other's knowledge activities is also a relationship building process between trading partners. Knowledge users get connected by CKMP tend to know each better, and more willing to work together. The practical implication is that interested organization can view CKMP adoption as an approach to facilitate supply chain integration. Management should seriously consider educate employees and encourage them to work as teams and collaborate across functional and organizational boundaries.

Hypothesis 4c: Collaborative knowledge management practices in supply chain have direct and positive relationship with supply chain performance.

As expected, this hypothesis was also supported (significant at .01 level, t-value = 6.15) with relationship strength of .45 (β). The ultimate objective of all supply chain management activities is to improve the supply chain relationship as well as enhance its performance. The finding demonstrated that implementation of collaborative knowledge management practices with trading partners has direct and tangible effects on improving supply chain relationship, system flexibility to internal and external changes, responsiveness to customer requirements and so on. Therefore, supply chain managers can regard knowledge collaboration as one of the approaches to boost supply chain performance.

6.4 Summary of Results

Cross organizational knowledge management is increasingly gaining attentions among academic researchers and business practitioners. This study represents a large-scale efforts to systematically investigate the issue of supply-chain-wide knowledge collaboration. It aims to identify the important antecedents to successful adoption and implementation of collaborative knowledge management practices, and its corresponding performance outcomes. The above section presented results demonstrated that the success of CKMP is built on 1) technology capability to handle such a large scale inter-organizational system, 2) organizational factors such as managerial engagement, supportive culture, employee devotedness, 3) facilitating environmental factors such as high operational uncertainty and collaborative trading partners, as well as 4) compatible knowledge bases of all parties. Moreover, the result reveals that collaborating with trading partners in knowledge management can improve the quality of knowledge, integration with partners and supply chain performance.

The following chapter continues the discussion on the detailed implication of the structural equation results. The emphasis will be on dimension-level analysis of each construct to explore how they affect CKMP and the 3 performance consequences.

CHAPTER 7: DIMENSION LEVEL ANALYSIS

In the previous chapter, the researcher used structure equation modeling to prove causal relationship proposed in chapter 3. There were direct and positive relationship between internal/external drivers, collaborative knowledge management practices, and the organizational performance impacts. Despite the validation of the pervious hypotheses, there were important theoretical and practical implications that remain unexplored that happen when multiple dimensions were grouped into a single construct. For example, what specific organizational infrastructure factor leads to higher levels of CKMP? Besides, each of the CKMP dimension may affect one or more performance impact in terms of knowledge quality, supply chain integration and performance with varying degrees of importance. This chapter attempts to conduct a dimension-level analysis to further explore these relationships using additional statistical tool, namely, multivariate analysis of variance (MANOVA) to assess three issues: (1) whether an overall differences in set of collaborative knowledge management practices dimensions (CKG – collaborative knowledge generation, CKS – collaborative knowledge storage, BKA – barrier-free knowledge access, CKD – collaborative knowledge dissemination, and CKA – collaborative knowledge application) are to be found between groups formed by dimension-level drivers (TI – technological infrastructure, OI/TMS – top management support, OI/CSC – collaboration supportive culture, OI/OEM – organizational empowerment, BF – perceived CKMP benefits, EC/EUC – environmental uncertainty, EC/CMP – competitive pressure, EC/TPR – partner readiness, KC – knowledge complementarity, and PR/TST – Partner Trust, PR/CMT – partner commitment, PR/VSN - vision); and (2) whether an overall differences in sets of supply chain integration dimensions (SI/IIT – internal integration, SI/SIT – supplier integration, and SI/CIT – customer integration) are to be found between groups formed by dimension-level supply CKMP dimensions; (3) whether an overall differences in sets of supply chain performance dimensions (SP/SCP – supply chain partnership, SP/SPR – supplier performance, SP/FLX – supply chain flexibility, and SP/RSP – customer responsiveness) were to be found between groups formed by dimension-level supply CKMP dimensions. If multivariate significance was found, univaraiate test (ANOVA) tests were employed to address (1) the individual drive dimension significant importance for each CKMP dimensions; (2) the individual CKMP dimension significant importance for each supply chain integration dimensions; and (3) the individual CKMP dimension significant importance for each supply chain performance integration dimensions. The classifications between low and high levels of the drivers and CKMP were done by using the median. The following presents in detail the results obtained for each of the dimension-level CKMP, supply chain integration and supply chain performance.

7.1 Dimension level analysis of the impacts of implementation drivers on CKMP

The structural equation model verified in the pervious chapter confirmed that organizational readiness and external contextual factors directly lead to successful CKMP implementation. However, the strength and nature of relationship among dimensions across variables may vary. Thus, the researcher would like to raise more in-depth questions such as which particular driver dimension (i.e. collaborative technology, top management support, environmental uncertainty etc.) has greater impact on particular CKMP dimensions (i.e. collaborative knowledge generation, dissemination, application etc.). This section aims at evaluating the significance of mean differences on all dimensions of CKMP between groups defined by various levels of the implementation driver dimensions.

7.1.1 Technology Infrastructure

Technology infrastructure is a set of technological tools supporting the functions of collaborative knowledge management in supply chain. Without these technology components (communication support technology, collaborative system, knowledge database management system, and enterprise information portal), CKMP will not operate to its fullest advantage. The dimension level analyses were done between the TI and the 5 dimensions of CKMP, namely, CKG, CKS, BFA, CKD, and CKA about how technology affects these CKMP dimensions.

7.1.1.1 Role of TI on CKG

Collaborative knowledge generation (CKG) relates to supply-chain wide joint efforts for knowledge addition and the correction and validation of existing knowledge. How technology is effectively used is believed to affect organization's knowledge generation capability. Three CKG items purified in confirmatory factor analysis discussed in chapter 5 were used as dependent variables. The MANOVA results indicated significant differences among high and low technology infrastructure categories on the depend variables (CKG1 – new idea generation, CKG3 – external knowledge acquisition, and CKG5 – knowledge validation): Wilks' Lambda = .91, $F(3, 319) = 9.94$, $p < .001$, multivariate $\eta^2 = .08$.

Analysis of univariate ANOVA revealed that high and low categories of technology infrastructure significantly differ for all three CKG dimensions: new idea generation (CKG1 $F(1, 321) = 11.11$, $p < .001$, partial $\eta^2 = .03$), external knowledge acquisition (CKG3 $F(1, 321) = 16.32$, $p < .001$, partial $\eta^2 = .04$), knowledge validation (CKG5 $F(1, 321) = 29.52$, $p < .001$, partial $\eta^2 = .08$). Table 7.1 presented means and standard deviations for new idea generation, external knowledge acquisition, knowledge validation by levels of technological infrastructure.

The result illustrated that organizations with high technology infrastructure level had significantly better performance in collaborative knowledge generation. Thus, for those firms that are planning for collaborative knowledge generation implementation, technology infrastructure is proven to be one of their focuses.

Collaborative Knowledge Generation (CKG) Dimensions						
Level of TI	CKG1		CKG3		CKG5	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Low	3.13	0.89	2.98	0.91	2.89	0.84
High	3.44	0.81	3.29	0.86	3.4	0.80

Table 7.1 Differences among levels of Technology Infrastructure by Collaborative Knowledge Generation Dimensions

7.1.1.2 Role of TI on CKS

Three collaborative knowledge storage items from the confirmatory factor analysis discussed in chapter 5 were used as dependent variables for the MANOVA analysis. The results indicated significant differences between high and low technology infrastructure levels on the depend variables (CKS1 – shared knowledge repositories, CKS4 – coordinate knowledge type for storage, and CKS5 – coordinate knowledge format for storage): Wilks' $\lambda = .89$, $F(3, 319) = 12.95$, $p < .001$, multivariate $\eta^2 = .10$.

Analysis of univariate ANOVA revealed that high and low levels of technology infrastructure significantly differ for all three CKS dimensions: shared knowledge repositories (CKS1 $F(1, 321) = 35.43$, $p < .001$, partial $\eta^2 = .09$), coordinate knowledge type for storage (CKS4 $F(1, 321) = 33.42$, $p < .001$, partial $\eta^2 = .09$), coordinate knowledge format for storage (CKS5 $F(1, 321) = 25.50$, $p < .001$, partial $\eta^2 = .07$). Table 7.2 presented means and standard deviations for the 3 CKS dimensions by levels of technological infrastructure.

The result implies that high levels of technological infrastructure were significantly associated with better performance in collaborative knowledge storage efforts. Firms should improve their technological competencies to improve their practices of collaborating with trading partners for supply chain knowledge storage.

Collaborative Knowledge Storage (CKS) Dimensions						
Level of TI	CKS1		CKS4		CKS5	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Low	2.07	.89	2.07	.81	2.06	.78
High	2.72	1.07	2.70	1.13	2.59	1.10

Table 7.2 Differences among levels of Technology Infrastructure by Collaborative Knowledge Storage Dimensions

7.1.1.3 Role of TI on BKA

There were two barrier-free knowledge access items from CFA analysis discussed in chapter 5: BKA4 – fast knowledge access, and BKA5 – access to sufficient knowledge, which were used as dependent variables in the MANOVA test. Significant differences among high and low technology infrastructure categories on the depend variables were found from the study: Wilks' $\lambda = .85$, $F(2, 320) = 27.13$, $p < .001$, multivariate $\eta^2 = .14$. Univariate ANOVA results indicated that high and low levels of technology infrastructure significantly differ for both BKA dimensions: fast knowledge access

(BKA4 $F(1, 321) = 50.94$, $p < .001$, partial $\eta^2 = .13$), access to sufficient knowledge (BKA5 $F(1, 321) = 52.94$, $p < .001$, partial $\eta^2 = .14$). Means and standard deviations for BKFA4 and BKA5 by levels of technological infrastructure were presented in table 7.3. It was obvious that organizations with high technology infrastructure level had significantly better performance in providing fast and convenient access to supply chain knowledge. Thus, for those firms that are planning for facilitating cross organization knowledge access, technology infrastructure is proven to be one of the areas require their focuses.

Barrier-free Knowledge Access (BKA) Dimensions				
Level of TI	BKA4		BKA5	
	Mean	Std Dev	Mean	Std Dev
Low	2.14	.92	2.23	.90
High	2.94	1.07	2.97	.94

Table 7.3 Differences among levels of Technology Infrastructure by Barrier Free Knowledge Access Dimensions

7.1.1. 4 Role of TI on CKD

All original four items designed for collaborative knowledge dissemination were maintained in CFA analysis and put into the MANOVA test as dependent variables. High and low levels of technology infrastructure were significantly different on the depend variables with the following statistics: Wilks' $\lambda = .85$, $F(4, 318) = 13$, $p < .001$, multivariate $\eta^2 = .14$.

The significance was found in both CKD dimensions: employee training (CKD1 $F(1, 321) = 50.94$, $p < .001$, partial $\eta^2 = .13$), knowledge newsletters (CKD2 $F(1, 321) = 28.98$, $p < .001$, partial $\eta^2 = .08$), knowledge dissemination events (CKD3 $F(1, 321) = 32.99$, $p < .001$, partial $\eta^2 = .09$), and knowledge helpline (CKD4 $F(1, 321) = 14.55$, $p < .001$, partial $\eta^2 = .04$. Table 7.4 presented means and standard deviations for all CKD dimensions by levels of technological infrastructure.

The result illustrated that technology infrastructure level had statistically significant and positive relationship with firm's collaborative knowledge dissemination activities. Thus, it is a good idea to take full advantage of one's technological infrastructure in setting up all sorts of knowledge dissemination activities for smooth inter-organizational knowledge management.

Collaborative Knowledge Dissemination (CKD) Dimensions								
Level of TI	CKD1		CKD2		CKD3		CKD4	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Low	2.43	.87	2.46	.85	2.56	.92	2.47	.85
High	3.14	.93	3.01	.97	3.19	1.05	2.84	.89

Table 7.4 Differences among levels of Technology Infrastructure by Collaborative Knowledge Dissemination Dimensions

7.1.1.5 Role of TI on CKA

CFA analysis in chapter 5 yielded just 2 items for collaborative knowledge application: CKA2 – collaborative customer relationship management, and CKA3 –collaborative new product development. The results from MANOVA test indicated significant differences among high and low technology infrastructure categories on the depend variables: Wilks' $\lambda = .87$, $F(2, 320) = 23.28$, $p < .001$, multivariate $\eta^2 = .12$.

Univariate ANOVA results revealed that high and low levels of technology infrastructure significantly differ for both CKA dimensions: collaborative customer relationship management (CKA2 $F(1, 321) = 46.54$, $p < .001$, partial $\eta^2 = .12$), collaborative new product development (CKA3 $F(1, 321) = 22.18$, $p < .001$, partial $\eta^2 = .06$). Table 7.5 presented statistics for means and standard deviations for CKA2 and CKA3 by levels of technological infrastructure.

The implication for the above analysis is that if firms want to apply their supply chain knowledge more effectively, they should work on improving their organizational readiness in terms of technological capabilities.

Collaborative Knowledge Application (CKA) Dimensions				
Level of TI	CKA2		CKA3	
	Mean	Std Dev	Mean	Std Dev
Low	2.76	1.16	2.92	1.13
High	3.60	1.05	3.47	.96

Table 7.5 Differences among levels of Technology Infrastructure by Collaborative Knowledge Application Dimensions

7.1.2 Organizational Infrastructure

Organizational infrastructure (OI) for CKMP is the firm's internal configurations and arrangements involving organizational structure, business processes, and work design etc. that it intended to support the firm's efforts for collaborative knowledge management practices with its trading partners. Three sub-dimensions were discussed in this study: TMS – top management support, CSC – collaboration supportive culture, and OEM – organizational empowerment. The dimension level analysis was conducted and presented below to provide further conclusion on the main effects of the 3 OI dimensions as well as their interaction effects on each of the five CKMP components.

7.1.2.1 Role of OI on CKG

As presented in table 7.6, the MANOVA results indicated collaboration supportive culture (CSC) and organizational empowerment (OEM), as well as their interactions (CSC*OEM and TMS*CSC*OEM) significantly affect collaborative knowledge generation. However, the multivariate effective sizes were very small. Top management support and other interactions effects were not significant.

Multivariate Test Results- CKG				
	F	p	η^2	Significant
TMS	F(3, 313)=.24	.86	.00	No
CSC	F(3, 313)=2.91	< .001	.03	Yes
OEM	F(3, 313)=3.24	< .001	.04	Yes
TMS*CSC	F(3, 313)=3.18	.31	.04	No
TMS*OEM	F(3, 313)= 3.44	.06	.05	No
CSC*OEM	F(3, 313)=4.34	< .001	.06	Yes
TMS*CSC*OEM	F(3, 313)=1.93	.01	.04	Yes

Table 7.6 Multivariate results of Organizational Infrastructure dimension over Collaborative knowledge Generation

Then ANOVA was performed for each dimension of collaborative knowledge generation with CSC and OEM as independent variables. The results are presented in table 7.7. Since the significant effects were found, planned contrast analyses were done in order to see different impact of organizational infrastructure on all dimensions of collaborative knowledge generation across groups (Table 7.8).

Univariate ANOVA Test Results – CKG					
		F	p	η^2	Significant
CSC	CKG1	F(1, 315)=.80	.04	.01	Yes
	CKG3	F(1, 315)=1.38	< .001	.03	Yes
	CKG5	F(1, 315)=1.57	< .001	.03	Yes
OEM	CKG1	F(1, 315)=1.10	< .001	.04	Yes
	CKG3	F(1, 315)=2.23	< .001	.05	Yes
	CKG5	F(1, 315)=.80	.09	.01	No
CSC*OEM	CKG1	F(1, 315)=10.0	.06	.02	No
	CKG3	F(1, 315)=3.93	.14	.02	No
	CKG5	F(1, 315)=12.76	< .001	.05	Yes
TMS*CSC*OEM	CKG1	F(1, 315)=3.90	< .001	.04	Yes
	CKG3	F(1, 315)=3.04	.04	.01	Yes
	CKG5	F(1, 315)=4.54	< .001	.05	Yes

Table 7.7 Univariate results of significant OI dimensions over Collaborative Knowledge Generation items

Collaborative Knowledge Generation (CKG) Dimensions						
Level of **TMS**	CKG1		CKG3		CKG5	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Low	3.23	.88	3.05	.86	3.10	.81
High	3.32	.86	3.10	.94	3.16	.89
Level of **CSC**	CKG1		CKG3		CKG5	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Low	3.30	.82	2.95	.92	2.89	.86
High	3.47	.68	3.37	.64	3.41	.71
Level of **OEM**	CKG1		CKG3		CKG5	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Low	3.08	.83	3.08	.83	3.12	.79
High	3.59	.72	3.41	.71	3.14	.90

Table 7.8 Differences among levels of Organizational Infrastructure by Collaborative Knowledge Generation Dimensions

The dimensional analysis implies that the establishment of collaboration supportive culture and organizational empowerment are very important to stimulate new knowledge generation. Although top management support along does not shown to statistically affect organization's knowledge creation ability, it does help when work together with collaborative culture and employee empowerment.

7.1.2.2 Role of OI on CKS

Top management support (TMS) and collaboration supportive culture (CSC) were found in MANOVA test to significantly affect collaborative knowledge storage, although with fairly small effective sizes were small. None other main or interactions revealed significance. The results were presented in table 7.9.

Since significance was found in multivariate analysis, the ANOVA univariate test was then performed for each dimension of collaborative knowledge storage with TMS and CSC as independent variables. The results (presented in table 7.10) demonstrated that support from top management could encourage knowledge users to coordinate the content of knowledge as well as its format to be stored in the shared knowledge repositories. A supportive culture which values teamwork and collaboration was also confirmed to stimulate maintaining common knowledge databases and unify its storage processes.

Multivariate Test Results- CKS				
	F	p	η^2	Significant
TMS	F(3, 313)=2.25	< .001	.04	Yes
CSC	F(3, 313)=2.87	< .001	.05	Yes
OEM	F(3, 313)=.4	.75	.00	No
TMS*CSC	F(3, 313)=1.94	.12	.01	No
TMS*OEM	F(3, 313)= .56	.63	.01	No
CSC*OEM	F(3, 313)=.13	.94	.02	No
TMS*CSC*OEM	F(3, 313)=.54	.65	.03	No

Table 7.9 Multivariate rest results of Organizational Infrastructure dimensions over Collaborative Knowledge Storage

Univariate ANOVA Test Results - CKS					
		F	p	η^2	Significant
TMS	CKS1	F(1, 315)=2.68	.10	.01	No
	CKS4	F(1, 315)=5.40	.02	.05	Yes
	CKS5	F(1, 315)=5.07	.02	.09	Yes
CSC	CKS1	F(1, 315)=4.91	.02	.06	Yes
	CKS4	F(1, 315)= 4.70	.03	.05	Yes
	CKS5	F(1, 315)= 6.27	.01	.08	Yes

Table 7.10. Univaraite test result of significant OI dimensions over CKS

Since the significant effects were found, planned contrast analyses were done in order to see different impact of organizational infrastructure on all dimensions of collaborative knowledge generation across groups (Table 7.11).

7.1.2.3 Role of OI on BKA

Top management support (TMS) and collaboration supportive culture (CSC), as well as their interactions (TMS*CSC) were shown significantly related to collaborative knowledge generation from the multivariate test as presented in table 7.12.

Collaborative Knowledge Storage (CKS) Dimensions						
Level of **TMS**	CKS1		CKS4		CKS5	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Low	2.28	.98	2.21	.99	2.21	.93
High	2.45	1.06	3.04	1.12	2.71	1.16
Level of **CSC**	CKS1		CKS4		CKS5	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Low	2.24	.98	2.18	.98	2.19	.95
High	2.91	1.10	2.80	1.20	2.54	1.19
Level of **OEM**	CKS1		CKS4		CKS5	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Low	2.35	1.11	2.35	1.04	2.32	.98
High	2.40	1.03	2.38	1.01	2.31	.98

Table 7.11 Differences among levels of Organizational Infrastructure by Collaborative Knowledge Storage Dimensions

Then ANOVA test was followed for each dimension of barrier-free knowledge access with the OI dimensions that displayed significant relationship in the multivariate analysis (TMS and CSC) as independent variables. The results are presented in table 7.13. Except top management support to fast access to desire knowledge (BKA4), TMS, CSC as well as their interactions had significant relationship with both BKA4 and BKA5 (access to sufficient amount of supply chain knowledge).

Multivariate Test Results- BKA				
	F	p	η^2	Significant
TMS	F(2, 314)=3.33	< .001	.07	Yes
CSC	F(2, 314)=3.67	< .001	.07	Yes
OEM	F(2, 314)=1.57	.30	.03	No
TMS*CSC	F(2, 314)=4.02	< .001	.08	Yes
TMS*OEM	F(2, 314)=1.93	.14	.02	No
CSC*OEM	F(2, 314)=2.26	.28	.03	No
TMS*CSC*OEM	F(2, 314)=1.11	.68	.04	No

Table 7.12 Multivariate rest results of Organizational Infrastructure dimensions over Barrier-Free Knowledge Access.

Univariate ANOVA Test Results - BKA					
		F	p	η^2	Significant
TMS	BKA4	F(1, 315)= 1.36	.06	.03	No
	BKA5	F(1, 315)= 2.33	.01	.07	Yes
CSC	BKA4	F(1, 315)= 2.46	< .001	.03	Yes
	BKA5	F(1, 315)= 2.33	< .001	.05	Yes
TMS*CSC	BKA4	F(1, 315)= 3.87	< .001	.04	Yes
	BKA5	F(1, 315)= 3.41	< .001	.05	Yes

Table 7.13 Univaraite test result of significant OI dimensions over BKA

Planned contrast analyses were done based on the significant effects presented above in order to see different impact of organizational infrastructure on all dimensions of collaborative knowledge generation across groups (Table 7.14). These analyses implied that top management support could help knowledge user get access to a large amount of knowledge. While, collaboration supportive culture facilitates quick access to sufficient amount of supply chain knowledge. If top management support and a favorable culture get combined, the efficiency to access knowledge would be even better.

Barrier – Free Knowledge Access (BKA) Dimensions				
Level of **TMS**	BKA4		BKA5	
	Mean	Std Dev	Mean	Std Dev
Low	2.41	1.07	2.33	.98
High	2.62	1.10	2.86	.92
Level of **CSC**	BKA4		BKA5	
	Mean	Std Dev	Mean	Std Dev
Low	2.37	1.03	2.40	.99
High	2.63	1.07	2.88	.94
Level of **OEM**	BKA4		BKA5	
	Mean	Std Dev	Mean	Std Dev
Low	2.40	1.05	2.51	.98
High	2.83	.97	2.91	.82

Table 7.14 Differences among levels of Organizational Infrastructure by Barrier-Free Knowledge Access dimensions

7.1.2.4 Role of OI on CKD

Although the multivariate effective sizes were small for all OI sub-dimensions and there interaction effects, the MANOVA test did indicate top management support (TMS) and 3 2-term interaction effects significantly affect collaborative knowledge dissemination. The results were presented in table 7.15.

Multivariate Test Results- CKD				
	F	P	η^2	Significant
TMS	F(4, 312)=4.43	< .001	.04	Yes
CSC	F(4, 312)=3.78	.13	.01	No
OEM	F(4, 312)=3.14	.07	.01	No
TMS*CSC	F(4, 312)=2.73	.05	.02	Yes
TMS*OEM	F(4, 312)=2.34	.03	.02	Yes
CSC*OEM	F(4, 312)=2.81	.02	.02	Yes
TMS*CSC*OEM	F(4, 312)=3.36	.08	.02	No

Table 7.15 Multivariate rest results of Organizational Infrastructure dimensions over Collaborative Knowledge Dissemination.

The ANOVA univariate test displayed significant relationship between top management support (TMS) to every items of collaborative knowledge dissemination. The results (presented in table 7.16) demonstrated that support from top management could facilitate the firm to engage in various sorts of knowledge sharing and transferring activities such as providing training, publish newsletters about new knowledge, set up knowledge sharing events, and maintaining knowledge reference and help line.

Univariate ANOVA Test Results - CKD					
		F	p	η^2	Significant
TMS	CKD1	F(1, 315)=6.28	.01	.01	Yes
	CKD2	F(1, 315)=5.00	.02	.04	Yes
	CKD3	F(1, 315)=5.18	.02	.03	Yes
	CKD4	F(1, 315)=5.54	.01	.03	Yes

Table 7.16 Univaraite test result of significant OI dimensions over CKD

Since the significant effects were found, planned contrast analyses were done to showcase the different impact of organizational infrastructure on all dimensions of collaborative knowledge generation across groups (Table 7.17).

Collaborative Knowledge Dissemination (CKD) Dimensions								
Level of **TMS**	CKD1		CKD2		CKD3		CKD4	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Low	2.54	.99	2.42	.93	2.69	1.03	2.47	.93
High	3.10	.94	2.92	.94	3.00	1.01	2.92	.83
Level of **CSC**	CKD1		CKD2		CKD3		CKD4	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Low	2.78	.96	2.71	.91	2.88	1.00	2.63	.89
High	2.75	.97	2.72	.97	2.84	1.06	2.67	.89
Level of **OEM**	CKD1		CKD2		CKD3		CKD4	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Low	2.66	.98	2.71	.91	2.76	1.07	2.59	.89
High	2.86	.94	2.85	.95	2.95	.99	2.70	.88

Table 7.17 Differences among levels of Organizational Infrastructure by Collaborative Knowledge Dissemination dimensions

7.1.2.5 Role of OI on CKA

Only organizational empowerment (OEM) and interaction of top management support and collaboration supportive culture were found in MANOVA test to significantly affect collaborative knowledge application. However, as presented in table 7.18, multivariate effective sizes for both were small. The ANOVA univariate test was done to look at how OEM and TMS*CSC interactions were related to the sub dimensions of CKA. The results (presented in table 7.19) demonstrated that organizational empowerment facilitates collaborative knowledge application by enhancing supply chain wide customer services. When top management support and collaboration supportive culture combined, knowledge sharing during new product development could also be stimulated. Table 7.20 presented the planned contrast analyses for the 2 items of CKA in related to the high and low levels of the 3 OI sub-dimensions.

Multivariate Test Results- CKA				
	F	P	η^2	Significant
TMS	F(2, 314)=.94	.39	.04	No
CSC	F(2, 314)=1.69	.18	.03	No
OEM	F(2, 314)=2.68	< .001	.04	Yes
TMS*CSC	F(2, 314)=2.89	.01	.01	Yes
TMS*OEM	F(2, 314)=1.05	.52	.01	No
CSC*OEM	F(2, 314)=1.21	.08	.03	No
TMS*CSC*OEM	F(2, 314)=1.69	.08	.02	No

Table 7.18 Multivariate rest results of Organizational Infrastructure dimensions over Collaborative Knowledge Application

Univariate ANOVA Test Results – CKA					
		F	p	η^2	Significant
OEM	CKA2	F(1, 315)= 3.49	.10	.3	No
	CKA3	F(1, 315)= 6.17	.02	.4	Yes
TMS*CSC	CKA2	F(1, 315)= 7.08	.02	.7	Yes
	CKA3	F(1, 315)= 1.05	.33	.09	No

Table 7.19 Univaraite test result of significant OI dimensions over CKA

Collaborative Knowledge Application (CKA) Dimensions				
Level of **TMS**	CKA2		CKA3	
	Mean	Std Dev	Mean	Std Dev
Low	3.01	1.21	3.05	1.13
High	3.28	1.13	3.28	1.02
Level of **CSC**	CKA2		CKA3	
	Mean	Std Dev	Mean	Std Dev
Low	3.21	1.15	3.21	1.05
High	3.10	1.20	3.14	1.10
Level of **OEM**	CKA2		CKA3	
	Mean	Std Dev	Mean	Std Dev
Low	3.00	1.27	3.00	1.06
High	3.29	1.07	3.42	.99

Table 7.20 Differences among levels of Organizational Infrastructure by Collaborative Knowledge Application dimensions

7.1.3 Perceived CKMP Benefits

Although the causal relationship between perceived benefits and CKMP had been shown non-significant in structural equation model discussed in the chapter 6, a dimension level analysis was still conducted to provide further conclusion on whether these benefits have any different effects on individual dimensions of collaborative knowledge management practices. The multivariate analysis was done and indicating that no significance could be found in perceived benefits with respect to any of the 5 CKMP dimensions. The results were presented in Table 21. Because of the non-significance in multivariate analysis, it is not necessary to conduct univariate ANOVA test or planned contrast test for comparing means.

Multivariate Test Results (IV: perceived benefits)				
DVs	F	p	η^2	Significant
CKG	$F(3, 319)=1.43$	.23	.01	No
CKS	$F(3, 319)=.38$	.76	.00	No
BKA	$F(2, 320)=2.43$	.08	.01	No
CKD	$F(4, 318)=1.03$	.39	.01	No
CKA	$F(2, 320)=.14$	.86	.00	No

Table 7.21 Multivariate test results of Perceived CKMP Benefits over CKMP dimensions

7.1.4 Environmental Characteristics

Environmental characteristics include three sub-dimensions: environmental uncertainty (EUC), competitive pressure (CMP), and trading partner readiness (TPR). The structural equation model in the previous chapter demonstrated causal relationship environmental characteristics have toward collaborative knowledge management practices. The section was attempting to analyze the dimension level differences of the above three environmental characteristics categories in terms of the 5 CKMP dimensions. In other words, we want to understand how the 3 environmental characteristics affect each individual collaborative knowledge management practice and their relationship strength.

7.1.4.1 Role of EC on CKG

As presented in table 7.22, all main effects of the 3 environmental characteristics as well as their interactions were significantly related to collaborative knowledge generation. Since all EC dimenstions were found significance with CKG as a construct, the ANOVA univariate test was then performed for each collaborative knowledge generation items. The results (presented in table 7.23) demonstrated that environmental uncertainty, competitive pressure, and trading partner readiness directly affect all sub-dimension of collaborative knowledge generation, except CKG3 (collaboration in acquiring external knowledge). This may be explained as such: firms would focus more attention to internal functions when the environment is volatile, competition is fierce; and firms feel less control over their external business context. The interactions of the three EC categories were significant with large effect size in related to all CKG dimensions. It implied that when environment is uncertain, competition level is high, and trading partners are supportive, firms are more likely engaged in collaborative knowledge generation.

Multivariate Test Results- CKG				
	F	P	η^2	Significant
EUC	F(3, 313)= 3.20	.02	.04	Yes
CMP	F(3, 313)=4.36	.01	.03	Yes
TPR	F(3, 313)=5.17	.00	.04	Yes
EUC*CMP	F(3, 313)=3.79	.02	.02	Yes
EUC*TPR	F(3, 313)=3.95	.02	.02	Yes
CMP*TPR	F(3, 313)=3.71	.01	.03	Yes
EUC*CMP*TPR	F(3, 313)=5.47	.00	.05	Yes

Table 7.22 Multivariate test results of EC over CKG dimensions

Univariate ANOVA Test Results – CKG					
		F	p	η^2	Significant
EUC	CKG1	F(1, 315)=3.53	.01	.04	Yes
	CKG3	F(1, 315)=1.13	.07	.02	No
	CKG5	F(1, 315)=8.35	< .001	.03	Yes
CMP	CKG1	F(1, 315)=2.63	< .001	.05	Yes
	CKG3	F(1, 315)=1.64	.06	.01	No
	CKG5	F(1, 315)=3.85	< .001	.05	Yes
TPR	CKG1	F(1, 315)=6.36	< .001	.06	Yes
	CKG3	F(1, 315)=4.75	< .001	.07	Yes
	CKG5	F(1, 315)= 2.04	< .001	.05	Yes
EUC*CMP	CKG1	F(1, 315)= 5.13	< .001	.06	Yes
	CKG3	F(1, 315)= 4.99	< .001	.05	Yes
	CKG5	F(1, 315)= 4.56	.02	.07	Yes
EUC*TPR	CKG1	F(1, 315)= 7.95	< .001	.09	Yes
	CKG3	F(1, 315)= 5.34	< .001	.08	Yes
	CKG5	F(1, 315)= 4.48	.04	.08	Yes
CMP*TPR	CKG1	F(1, 315)= 4.20	< .001	.09	Yes
	CKG3	F(1, 315)= 4.39	.03	.06	Yes
	CKG5	F(1, 315)= 10.28	< .001	.13	Yes
EUC*CMP*TPR	CKG1	F(1, 315)= 4.10	< .001	.10	Yes
	CKG3	F(1, 315)= 5.17	.04	.07	Yes
	CKG5	F(1, 315)= 8.74	< .001	.11	Yes

Table 7.23 Univaraite test result of significant EC dimensions over CKG

In order to demonstrate the differences of means for the 3 CKG items in related to high and low levels of EC, planned contrast analyses were followed, and presented in Table 7.24.

7.1.4.2 Role of EC on CKS

The MANOVA results indicated that competitive pressure (CMP), trading partner readiness (TPR), and interactions of all 3 EC categories were significantly related to CKS. Environment uncertainty (EUC) as well as the 2 terms interactions were revealed not significant across high and low levels. The results are presented in table 7.25.

Collaborative Knowledge Generation (CKG) Dimensions						
Level of **EUC**	CKG1		CKG3		CKG5	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Low	3.02	1.01	2.77	.97	2.89	.91
High	3.54	.85	3.09	.91	3.59	.90
Level of **CMP**	CKG1		CKG3		CKG5	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Low	3.08	.85	2.96	.88	2.87	.75
High	3.42	.86	3.09	.93	3.61	.83
Level of **TPR**	CKG1		CKG3		CKG5	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Low	3.00	.75	2.87	.92	3.02	.90
High	3.66	.90	3.43	.91	3.70	.87

Table 7.24 Differences among levels of EC by Collaborative Knowledge Generation dimensions

Multivariate Test Results- CKS				
	F	p	η^2	Significant
EUC	F(3, 313)=1.94	.09	.03	No
CMP	F(3, 313)=3.81	< .001	.06	Yes
TPR	F(3, 313)=4.16	< .001	.06	Yes
EUC*CMP	F(3, 313)=4.13	.21	.04	No
EUC*TPR	F(3, 313)= 5.28	.33	.06	No
CMP*TPR	F(3, 313)=8.36	.60	.07	No
EUC*CMP*TPR	F(3, 313)=7.07	.02	.12	Yes

Table 7.25 Multivariate test results of EC over CKS dimensions

The ANOVA univariate test was then performed for those EC categories that showed significance in multivariate test presented above (CMP, TPR, EUC*CMP*TPR) with the three dimensions of collaborative knowledge storage as dependent variables. The results were presented in table 7.26, demonstrating that high level of competitive pressure would motivate a firm to share knowledge repositories and coordinate the type of knowledge being shared with trading partners. A more ready trading partner would also leads to knowledge database sharing, collaboration in the type and format of knowledge being shared. In a scenario where environmental uncertainty, competitive pressure and partner readiness happen simultaneously, all collaborative knowledge storage activities would be further strengthened. Thus it was suggested that firms intended to implement collaborative knowledge storage should be aware of the joint effects of environmental characteristics. Table 7.27 presented the planned contrast analyses, which compared the different impact of environmental characteristics on all dimensions of collaborative knowledge storage across groups.

Univariate ANOVA Test Results – CKS					
		F	P	η^2	Significant
CMP	CKS1	F(1, 315)=6.07	.00	.04	Yes
	CKS4	F(1, 315)=4.27	.02	.03	Yes
	CKS5	F(1, 315)=2.60	.09	.07	No
TPR	CKS1	F(1, 315)=5.42	.00	.06	Yes
	CKS4	F(1, 315)= 3.12	.04	.05	Yes
	CKS5	F(1, 315)= 9.00	.00	.05	Yes
EUC*CMP*TPR	CKS1	F(1, 315)=4.06	.04	.07	Yes
	CKS4	F(1, 315)= 3.87	.03	.04	Yes
	CKS5	F(1, 315)= 5.05	.00	.09	Yes

Table 7.26 Univaraite test result of significant EC dimensions over CKS

Collaborative Knowledge Storage (CKS) Dimensions						
Level of **EUC**	CKS1		CKS4		CKS5	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Low	2.37	.90	2.20	.97	2.31	1.01
High	2.53	1.06	2.54	1.00	2.44	.98
Level of **CMP**	CKS1		CKS4		CKS5	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Low	2.18	1.00	2.25	1.16	2.23	.96
High	2.81	1.03	2.79	1.03	2.60	1.17
Level of **TPR**	CKS1		CKS4		CKS5	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Low	2.21	.89	2.26	1.02	2.27	.95
High	2.69	.95	2.72	1.04	2.66	.94

Table 7.27 Differences among levels of EC by Collaborative Knowledge Storage dimensions

7.1.4.3 Role of EC on BKA

The MANOVA test was conducted to examine how each environmental characteristics dimensions were affecting barrier-free knowledge access activities of CKMP. The multivariate results presented in table 7.28 indicated that only the main effects of environmental uncertainty (EUC) and competitive pressure (CMP) revealed statistical significance. Treading partner readiness (TPR) and the interactions didn't display significance with BKA. Then ANOVA test was followed to analyze the relationships of each dimension of barrier-free knowledge access with EUC and CMP as independent variables. The results presented in table 7.29 implied that higher level of environmental uncertainty was positive associated with the amount of supply chain knowledge trading partners access; and the higher level of competitive pressure firms experiencing was related to their access to both faster speed and larger amount of supply chain knowledge. The comparison of the means and standard deviation of knowledge access activities in terms of high and low levels of environmental characteristics were conducted with planned contrast analyses as shown in Table 7.30. The results indicated that in an uncertain environment, organizations tend to more active in access trading partners' knowledge databases. Competitive pressure in a firm's industry also affects its practices in sharing knowledge databases with trading partners.

Multivariate Test Results- BKA				
	F	P	η^2	Significant
EUC	F(2, 314)=3.23	.04	.03	Yes
CMP	F(2, 314)=3.99	< .001	.02	Yes
TPR	F(2, 314)=2.15	.37	.02	No
EUC*CMP	F(2, 314)=2.33	.07	.01	No
EUC*TPR	F(2, 314)=2.35	.69	.01	No
CMP*TPR	F(2, 314)=2.12	.38	.00	No
EUC*CMP*TPR	F(2, 314)=3.52	.59	.02	No

Table 7.28 Multivariate test results of EC over BKA dimensions

Univariate ANOVA Test Results – BKA					
		F	p	η^2	Significant
EUC	BKA4	F(1, 315)= 2.44	.08	.03	No
	BKA5	F(1, 315)= 3.46	.04	.03	Yes
CMP	BKA4	F(1, 315)= 5.30	< .001	.08	Yes
	BKA5	F(1, 315)= 4.71	< .001	.07	Yes

Table 7.29 Univaraite test result of significant EC dimensions over BKA

Barrier – Free Knowledge Access (BKA) Dimensions				
Level of **EUC**	BKA4		BKA5	
	Mean	Std Dev	Mean	Std Dev
Low	2.46	1.05	2.35	.97
High	2.57	1.16	2.81	1.02
Level of **CMP**	BKA4		BKA5	
	Mean	Std Dev	Mean	Std Dev
Low	2.34	1.00	2.39	1.11
High	2.80	.93	2.81	.98
Level of **TPR**	BKA4		BKA5	
	Mean	Std Dev	Mean	Std Dev
Low	2.51	.94	2.57	.98
High	2.64	.97	2.66	.89

Table 7.30 Differences among levels of EC by Barrier-Free Knowledge Access dimensions

7.1.4.4 Role of EC on CKD

The MANOVA results conducted with CKD items as dependent variables and the dimensions of EC as independent variables demonstrated that only trading partner readiness (TPR) significantly affect collaborative knowledge dissemination with a small effect size. None other main or interactions revealed significance. The results are presented in table 7.31. The ANOVA univariate test was then performed with TPR as the only independent variable to study its effects on each CKD dimensions. 4 CKD dimensions were found significant relationship with TPR. Table 7.32 presents the ANOVA results demonstrating that the level of trading partners readiness were significantly related to the many dimensions of knowledge dissemination activities. When partners are ready, firms tend to be more successful with provide joint training, publishing knowledge newsletters and setting up knowledge dissemination events. However, the results did not indicate the dimension of maintaining knowledge reference desk and help line to be statistically significant.

Multivariate Test Results- CKD				
	F	P	η^2	Significant
EUC	F(4, 312)=4.43	.08	.01	No
CMP	F(4, 312)=3.78	.10	.01	No
TPR	F(4, 312)=4.45	.02	.04	Yes
EUC*CMP	F(4, 312)=2.73	.09	.00	No
EUC*TPR	F(4, 312)=2.34	.07	.02	No
CMP*TPR	F(4, 312)=2.81	.06	.02	No
EUC*CMP*TPR	F(4, 312)=3.36	.08	.02	No

Table 7.31 Multivariate test results of EC over CKD dimensions

Univariate ANOVA Test Results – CKD					
		F	p	η^2	Significant
TPR	CKD1	F(1, 315)=5.15	.02	.04	Yes
	CKD2	F(1, 315)=5.13	.02	.04	Yes
	CKD3	F(1, 315)=5.99	.00	.06	Yes
	CKD4	F(1, 315)=3.12	.06	.01	No

Table 7.32 Univaraite test result of significant EC dimensions over CKD

Since the significant effects were found in above MANOVA and ANOVA tests, planned contrast analyses were done in order to see different impact of environmental characteristics on collaborative knowledge dissemination across groups (Table 7.33).

Collaborative Knowledge Dissemination (CKD) Dimensions								
Level of **EUC**	CKD1		CKD2		CKD3		CKD4	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Low	2.64	.94	2.65	.93	2.79	1.12	2.53	.89
High	2.80	.99	2.89	.94	2.79	1.09	2.87	.93
Level of **CMP**	CKD1		CKD2		CKD3		CKD4	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Low	2.73	.98	2.71	.99	2.88	1.02	2.59	.91
High	2.78	1.13	2.74	.96	2.84	1.00	2.68	1.05
Level of **TPR**	CKD1		CKD2		CKD3		CKD4	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Low	2.59	.90	2.51	.98	2.66	1.01	2.57	.90
High	3.00	1.23	2.95	.92	2.98	1.05	2.72	.89

Table 7.33 Differences among levels of EC by Collaborative Knowledge Dissemination dimensions

7.1.4.5 Role of EC on CKA

Although the multivariate effective sizes were small, the MANOVA results indicated that all three EC dimensions and their interactions significantly affect collaborative knowledge application as a combined single construct. The results are presented in table 7.34.

Multivariate Test Results- CKA				
	F	P	η^2	Significant
EUC	F(2, 314)=6.00	< .001	.03	Yes
CMP	F(2, 314)=5.65	.01	.04	Yes
TPR	F(2, 314)=6.31	< .001	.03	Yes
EUC*CMP	F(2, 314)=7.65	< .001	.02	Yes
EUC*TPR	F(2, 314)=7.57	< .001	.04	Yes
CMP*TPR	F(2, 314)=6.42	.02	.02	Yes
EUC*CMP*TPR	F(2, 314)=5.40	.04	.03	Yes

Table 7.34 Multivariate test results of EC over CKA dimensions

The next step was to conduct ANOVA univariate test to examine how EC categories were associated with individual collaborative knowledge application activities, which had

2 dimensions from CFA model discussed in chapter 5. The results were presented in table 7.35 showing that environmental characteristics were closely associated with collaborative knowledge application. Significance was observed for almost all 3 EC dimensions and some of their interactions. Planned contrast analyses were also conducted and presented in Table 7.36. When levels of environmental uncertainty, competitive pressure were high, firms were more likely to looking ways to get a better understanding to their business context and to develop the right type of products or services to meet customer demands. Trading partner readiness was also shown to facilitate the application of knowledge in terms of collaborative customer service and new product development, since CKG requires commitment and efforts from multiple partner firms.

Univariate ANOVA Test Results – CKA					
		F	P	η^2	Significant
EUC	CKA2	F(1, 315)=8.99	.00	.09	Yes
	CKA3	F(1, 315)= 7.67	.00	.05	Yes
CMP	CKA2	F(1, 315)= 7.67	.00	.04	Yes
	CKA3	F(1, 315)= 5.27	.03	.03	Yes
TPR	CKA2	F(1, 315)= 8.39	< .001	.08	Yes
	CKA3	F(1, 315)= 8.96	.01	.06	Yes
EUC*CMP	CKA2	F(1, 315)= 15.10	< .001	.11	Yes
	CKA3	F(1, 315)= 3.60	.06	.03	No
EUC*TPR	CKA2	F(1, 315)= 5.20	.02	.04	Yes
	CKA3	F(1, 315)= 3.19	.08	.04	No
CMP*TPR	CKA2	F(1, 315)= 4.78	.09	.04	No
	CKA3	F(1, 315)= 4.43	.12	.04	No
EUC*CMP*TPR	CKA2	F(1, 315)= 3.32	.016	.04	No
	CKA3	F(1, 315)= 12.96	.03	.12	Yes

Table 7.35 Univaraite test result of significant EC dimensions over CKA

Collaborative Knowledge Application (CKA) Dimensions				
Level of **EUC**	CKA2		CKA3	
	Mean	Std Dev	Mean	Std Dev
Low	2.76	1.34	2.85	.97
High	3.29	1.22	3.48	1.02
Level of **CMP**	CKA2		CKA3	
	Mean	Std Dev	Mean	Std Dev
Low	2.97	1.22	3.04	1.09
High	3.45	1.04	3.34	1.02
Level of **TPR**	CKA2		CKA3	
	Mean	Std Dev	Mean	Std Dev
Low	3.03	1.20	2.93	1.13
High	3.66	.97	3.55	.70

Table 7.36 Differences among levels of EC by Collaborative Knowledge Application dimensions

7.1.5. Knowledge Complementarity

Knowledge complementarity is the perceived relative knowledge strength and the perceived differences in the stock of knowledge between knowledge sharing partner firms. It was measured with 4 items. The dimension level analysis attempted to study the differences of the 5 CKMP activities related to the high and low levels of KC. The multivariate and univariate results were summarized in Table 3.37. All CKMP dimensions except CKS revealed statistic significance. ANOVA tests for those significant dimensions demonstrated that most of the items (except CKG3, BKA4 and CKD4) were significant. It implied that knowledge complementarity was a critical factor to many of the identified collaborative knowledge management activities. Organizations which are planning to implement CKMP should take close look at their knowledge relationships with trading partners. Since significant effects were found, planned contrast analyses were done in order to see different impact of KC on all dimensions of CKMP across groups. The results were displayed in Table 7.38.

Multivaraite Test Results (Wilks' Lamda)					Univaraite ANOVA Test Results				
	F	P	η^2	Significant		F	P	η^2	Significant
CKG	F(3, 319)= 2.29	.02	.04	Yes	CKG1	F(1, 321)= 5.97	.01	.05	Yes
					CKG3	F(1, 321)= .77	.20	.01	No
					CKG5	F(1, 321)=2.62	.01	.03	Yes
CKS	F(3, 319)= 1.29	.28	.00	No	CKS1				
					CKS4				
					CKS5				
BKA	F(2, 320)= 2.23	.04	.03	Yes	BKA4	F(1, 321)= 2.56	.41	.04	No
					BKA5	F(1, 321)= 4.87	.04	.05	Yes
CKD	F(4, 318)= 5.56	.03	.13	Yes	CKD1	F(1, 321)= 5.19	.02	.4	Yes
					CKD2	F(1, 321)= 5.22	.02	.4	Yes
					CKD3	F(1, 321)= 8.32	<001	.12	Yes
					CKD4	F(1, 321)= .63	.92	.00	No
CKA	F(1, 321)= 4.11	.00	.10	Yes	CKA2	F(1, 321)= 6.96	.00	.07	Yes
					CKA3	F(3, 321)= 6.07	.04	.07	Yes

Table 7.37 Multivariate and Univariate tests results of knowledge complementarity over the dimensions of CKMP

KC Levels	Low		High		KC Levels	Low		High	
	Mean	Std Dev	Mean	Std Dev		Mean	Std Dev	Mean	Std Dev
CKG1	2.75	.86	3.38	.86	CKD1	2.48	.91	3.04	1.00
CKG3	2.93	.93	3.12	.88	CKD2	2.53	.91	2.89	.97
CKG5	2.66	.87	3.58	.84	CKD3	2.61	1.01	3.08	1.03
BKA4	2.40	1.02	2.54	1.11	CKD4	2.55	.90	2.74	.88
BKA5	2.12	.96	3.04	1.00	CKA2	2.82	1.14	3.46	1.20
					CKA3	2.95	1.09	3.48	1.06

Table 7.38 Differences among levels of KC by Collaborative Knowledge Management Practices dimensions

7.1.6 Partner Relationships

Partner relationships (PR) between trading partners included 3 categories: trust to partner firms (TST), commitment to mutual relationships (CMT), and common vision (VSN). The structural equation modeling discussed in the chapter 6 found no significant causal relationships between partner relationships and CKMP. The dimension level analysis in this chapter was attempting to re-examine the relationships of the 3 PR categories with the individual CKMP dimensions. Based on medians, TST, CMT, and VSN were converted to high and low levels. Table 7.39 presented the differences of high and low levels of PR categories in terms of the 5 collaborative knowledge management practices. The multivariate results confirmed the non-significant relationship between PR and CKMP. The dimensional level analyses revealed only 2 significant relationships with very low effect size: trust (TST) and collaborative knowledge generation (CKG), and interaction of all 3 PR (TST* CMT*VSN) categories with collaborative knowledge dissemination (CKD). ANOVA tests were then conducted for those 2 pairs to identify what specific CKG and CKD items were affected by the independent variables. Only very few items for each pair revealed statistic significance with low effect size: TST and CKG1 ($F(1, 315) = 5.50$, $p=.02$, $\eta^2 = .01$). This could be understood that partners could not work together to come up with new idea if they did not trust each other. The interaction effects of all 3 PR dimensions were found to have significant relationships with collaboration in employee training (CKD1: $F(1, 315) = 7.75$, $p=.00$, $\eta^2 = .02$) and collaboration in setting up knowledge dissemination events (CKD3: $F(1, 315) = 4.05$, $p=.04$, $\eta^2 = .01$). It implied that mutual trust, commitment and common vision must work together could enable firms to collaborate in the above mentioned 2 types of knowledge dissemination activities.

Collaborative Knowledge Generation (CKG)				
	F	P	H^2	Significant
TST	F(3, 313)=2.81	.03	.02	Yes
CMT	F(3, 313)=.21	.88	.00	No
VSN	F(3, 313)=.08	.97	.00	No
TST*CMT	F(3, 313)=1.35	.25	.01	No
TST*VSN	F(3, 313)=2.20	.08	.02	No
CMT*VSN	F(3, 313)=1.93	.12	.01	No
TST*CMT*VSN	F(3, 313)=.04	.98	.00	No
Collaborative Knowledge Storage (CKS)				
	F	P	η^2	Significant
TST	F(3, 313)=2.02	.11	.01	No
CMT	F(3, 313)=.61	.60	.00	No
VSN	F(3, 313)=.83	.47	.00	No
TST*CMT	F(3, 313)=.61	.60	.00	No
TST*VSN	F(3, 313)=.15	.92	.00	No
CMT*VSN	F(3, 313)=.74	.52	.00	No
TST*CMT*VSN	F(3, 313)=1.74	.15	.01	No
Barrier-Free Knowledge Access (BKA)				
	F	P	η^2	Significant
TST	F(3, 313)=.60	.54	.00	No
CMT	F(3, 313)=.64	.52	.00	No
VSN	F(3, 313)=.56	.56	.00	No
TST*CMT	F(3, 313)=2.03	.13	.01	No
TST*VSN	F(3, 313)=1.49	.22	.00	No
CMT*VSN	F(3, 313)=.73	.48	.00	No
TST*CMT*VSN	F(3, 313)=1.50	.22	.00	No

Collaborative Knowledge Dissemination (CKD)				
	F	P	η^2	Significant
TST	F(3, 313)=1.48	.20	.01	No
CMT	F(3, 313)=1.72	.14	.02	No
VSN	F(3, 313)=1.11	.35	.01	No
TST*CMT	F(3, 313)=1.85	.11	.02	No
TST*VSN	F(3, 313)=.71	.58	.00	No
CMT*VSN	F(3, 313)=1.28	.27	.01	No
TST*CMT*VSN	F(3, 313)=2.79	.02	.03	Yes
Collaborative Knowledge Application (CKA)				
	F	P	η^2	Significant
TST	F(3, 313)=2.30	.10	.01	No
CMT	F(3, 313)=.05	.94	.00	No
VSN	F(3, 313)=.06	.94	.00	No
TST*CMT	F(3, 313)=1.01	.36	.00	No
TST*VSN	F(3, 313)=.01	.98	.00	No
CMT*VSN	F(3, 313)=.76	.46	.00	No
TST*CMT*VSN	F(3, 313)=.12	.88	.00	No

Table 7.39 Multivariate test results of PR over CKMP dimensions

7.2 Dimension level Analysis of CKMP on the impacts

The next set of dimension level analyses was conducted between CKMP and the 3 impact factors of CKMP: knowledge quality (KQ), supply chain integration (SI), and supply chain performance (SP). Each of the 5 CKMP categories was classified as high or low levels according their respective medians. We would try to understand whether high levels of CKG, CKS, BKA, CKD and CKA were different from low levels in terms of each individual impact factor items and how CKMP was affect these items.

7.2.1 Knowledge quality

Knowledge quality has 4 dimensions based on the confirmatory factor analysis discussed in chapter 5: knowledge preciseness (KQ1), knowledge completeness (KQ2), knowledge timeliness (KQ3) and knowledge usability (KQ4). The structural equation modeling in the previous chapter identified CKMP's strong causal relationship to supply chain knowledge quality. The multivariate and ANOVA analyses presented in table 7.40 demonstrated how each CKM activities related to KQ and their effects on each KQ dimensions.

As expected by the researcher, the results revealed that all CKMP activities were significantly related to KQ, except barrier-free knowledge access. Most of the relationships between CKMP and individual KQ dimensions were significant as well. However, collaborative knowledge dissemination was only significantly related to knowledge preciseness (KQ1), but not the other 3. Collaborative knowledge application also showed non significant relationship with knowledge usability (KQ4). Since significant effects were found, planned contrast analyses were done in order to see different impact of the dimensions of CKMP on KQ across groups (Table 7.41).

Multivariate-Wilks' Lambda					ANOVA- Between subjects				
	F	p	η^2	Sig		F	p	η^2	Sig
CKG	F(4, 294)=2.8	.02	.03	Yes	KQ1	F(1, 297)=7.36	.00	.02	Yes
					KQ2	F(1, 297)=8.56	.00	.02	Yes
					KQ3	F(1, 297)=8.75	.00	.02	Yes
					KQ4	F(1, 297)=4.65	.03	.01	Yes
CKS	F(4, 294)=4.92	.00	.06	Yes	KQ1	F(1, 297)=6.82	.00	.02	Yes
					KQ2	F(1, 297)=18.89	.00	.06	Yes
					KQ3	F(1, 297)=5.46	.02	.01	Yes
					KQ4	F(1, 297)=10.84	.00	.03	Yes
BKA	F(4, 294)=1.72	.14	.02	No	KQ1				
					KQ2				
					KQ3				
					KQ4				
CKD	F(4, 294)=2.42	.04	.03	Yes	KQ1	F(1, 297)=4.00	.04	.01	Yes
					KQ2	F(1, 297)=.27	.59	.00	No
					KQ3	F(1, 297)=.50	.47	.00	No
					KQ4	F(1, 297)=.11	.73	.00	No
CKA	F(4, 294)=4.52	.00	.05	Yes	KQ1	F(1, 297)=16.97	.00	.05	Yes
					KQ2	F(1, 297)=3.76	.05	.01	Yes
					KQ3	F(1, 297)=6.38	.01	.02	Yes
					KQ4	F(1, 297)=2.30	.13	.00	No

Table 7.40 Multivariate and Univariate tests results of CKMP over the dimensions of supply chain knowledge quality

		KQ1		KQ2		KQ3		KQ4	
		Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
CKG	High	3.56	.94	3.68	.89	3.56	.87	3.47	.96
	Low	2.63	1.07	2.62	1.04	2.61	.98	2.68	.93
CKS	High	3.70	.87	3.73	.90	3.61	.80	3.53	1.02
	Low	2.59	1.02	2.68	1.01	2.66	1.02	2.71	.86
BKA	High	3.67	.95	3.74	.90	3.66	.84	3.59	.96
	Low	2.63	.99	2.68	1.00	2.62	.94	2.66	.87
CKD	High	3.59	1.03	3.59	1.00	3.46	.86	3.43	1.08
	Low	2.66	.96	2.78	1.03	2.78	1.08	2.78	.85
CKA	High	3.67	.91	3.57	1.01	3.49	.91	3.41	1.09
	Low	2.50	.96	2.76	1.02	2.70	1.01	2.76	.82

Table 7.41 Differences among levels of CKMP dimensions by knowledge quality dimensions

7.2.2 Supply Chain integration (SI)

Supply chain integration has 3 sub-dimensions: internal integration (IIT), integration with suppliers (SIT), and integration with customers (CIT). Structural equation model presented in chapter 6 revealed strong direct causal relationship between CKMP and supply chain integration. The dimension analysis in this section was to study how CKMP activities affect each of the 3 SI dimensions mentioned above as well as the relationships with individual items of these dimensions.

7.2.2.1 Role of CKMP on IIT

As presented in Table 42, The MONOVA test revealed that 4 of the 5 CKMP dimensions had significant relationship with supply chain internal integration. Only collaborative knowledge storage didn't return significant results.

Multivariate Results -Wilks' Lambda (IIT)				
	F	P	η^2	Significant
CKG	F(7, 291)=2.06	.04	.04	Yes
CKS	F(7, 291)=1.36	.22	.03	No
BKA	F(7, 291)=2.98	.00	.06	Yes
CKD	F(7, 291)=4.17	.00	.09	Yes
CKA	F(7, 291)=7.26	.00	.14	Yes

Table 7.42 Multivariate test results of CKMP over IIT dimensions

Then, ANOVA test were conducted to those 4 pairs with significant relationships to illustrate how CKMP dimensions affect the 7 IIT factors. Results presented in table 7.43 illustrated that no significant relationships were found between the 7 IIT items and CKG, indicating collaborative knowledge generation activities were not observed to be able to enhance functional integration within the supply chain. BKA was shown significantly facilitating inter-functional production synchronization (IIT4), accounting and purchasing systems integration (IIT6) and automatic order refill (IIT7). CKD was also shown significantly relates to IIT factors associated with passing around knowledge and information: inventory management integration (IIT2), production synchronization (IIT4), and inter-functional data-sharing (IIT5). Automated data-sharing (IIT1), accounting and purchasing systems integration (IIT6) and automatic order refill (IIT7) were shown to be significantly associated with CKA: the use of knowledge in the supply chain context. Planned contrast analyses were done in order to explore different impact of the dimensions of CKMP on IIT across groups (Table 7.44).

7.2.2.2 Role of CKMP on SIT

Supply chain integration has 6 factors. MONOVA test was first done to evaluate the affects of each CKMP dimensions to SIT as a single construct. Table 7.45 presented the results that CKS, BKA, and CKD were significantly associated with SIT; and BKA demonstrated a relatively strong relationship (effect size =.10).

The dimension level analysis for the 6 factors of SIT was examined with ANOVA test (presented in table 7.46). CKS significantly affected 3 SIT dimensions: information exchange (SIT1), supplier participation in procurement (SIT4), and automated ordering system with suppliers (SIT5). BKA displayed 4 significant relationships: long term partnership (SIT2), supplier participation in production planning (SIT3), supplier participation in procurement (SIT4), and automated ordering system with suppliers (SIT5). Among those 4, the affect size for SIT3 is fairly large; indicating that free access to partners' knowledge would significantly enhancing inter-organizational aggregate production planning efforts. CKD was shown significantly affect only 1 SIT dimension: supplier participation in production planning (SIT3). In order to understanding different impact of the dimensions of CKMP on IIT across groups, planned contrast analyses were performed and presented in Table 7.47. SIT3, SIT4, SIT5 seemed to be the supplier integration dimensions that were most sensitive to CKMP.

Univariate ANOVA Test Results – IIT					
		F	P	η^2	Significant
CKG	IIT1	F(1, 297)=.06	.79	.00	No
	IIT2	F(1, 297)=.04	.83	.00	No
	IIT3	F(1, 297)=1.33	.25	.00	No
	IIT4	F(1, 297)=.24	.61	.00	No
	IIT5	F(1, 297)=1.03	.30	.00	No
	IIT6	F(1, 297)=.11	.73	.00	No
	IIT7	F(1, 297)=3.06	.08	.01	No
BKA	IIT1	F(1, 297)=1.57	.21	.00	No
	IIT2	F(1, 297)=3.27	.07	.01	No
	IIT3	F(1, 297)=1.64	.20	.00	No
	IIT4	F(1, 297)=12.60	.00	.04	Yes
	IIT5	F(1, 297)=2.87	.09	.01	No
	IIT6	F(1, 297)=7.00	.00	.02	Yes
	IIT7	F(1, 297)=12.64	.00	.04	Yes
CKD	IIT1	F(1, 297)=3.31	.07	.01	No
	IIT2	F(1, 297)=24.36	.00	.07	Yes
	IIT3	F(1, 297)=3.20	.07	.01	No
	IIT4	F(1, 297)=10.58	.00	.03	Yes
	IIT5	F(1, 297)=6.59	.01	.02	Yes
	IIT6	F(1, 297)=1.54	.21	.00	No
	IIT7	F(1, 297)=.04	.83	.00	No
CKA	IIT1	F(1, 297)=12.00	.00	.03	Yes
	IIT2	F(1, 297)=.02	.87	.00	No
	IIT3	F(1, 297)=.01	.90	.00	No
	IIT4	F(1, 297)=.02	.86	.00	No
	IIT5	F(1, 297)=.09	.76	.00	No
	IIT6	F(1, 297)=17.63	.00	.05	Yes
	IIT7	F(1, 297)=11.63	.00	.03	Yes

Table 7.43 Univaraite test result of significant CKMP dimensions

Multivariate Results -Wilks' Lambda (SIT)			
F	P	η^2	Significant
F(6, 292)=1.02	.41	.02	No
F(6, 292)=3.38	.00	.06	Yes
F(6, 292)=5.81	.00	.10	Yes
F(6, 292)=2.83	.01	.05	Yes
F(6, 292)=1.61	.14	.03	No

Table 7.45 Multivariate test results of CKMP over SIT dimensions

Univariate ANOVA Test Results – SIT					
		F	P	η^2	Significant
CKS	SIT1	F(1, 297)=4.11	.04	.01	Yes
	SIT2	F(1, 297)=.15	.69	.00	No
	SIT3	F(1, 297)=.07	.78	.00	No
	SIT4	F(1, 297)=11.53	.00	.03	Yes
	SIT5	F(1, 297)=3.94	.04	.01	Yes
	SIT6	F(1, 297)=.40	.52	.00	No
BKA	SIT1	F(1, 297)=.65	.41	.00	No
	SIT2	F(1, 297)=4.82	.02	.01	Yes
	SIT3	F(1, 297)=27.15	.00	.08	Yes
	SIT4	F(1, 297)=8.04	.00	.02	Yes
	SIT5	F(1, 297)=10.34	.00	.03	Yes
	SIT6	F(1, 297)=1.41	.23	.00	No
CKD	SIT1	F(1, 297)=.62	.43	.00	No
	SIT2	F(1, 297)=2.58	.10	.00	No
	SIT3	F(1, 297)=4.24	.04	.01	Yes
	SIT4	F(1, 297)=.04	.83	.00	No
	SIT5	F(1, 297)=2.20	.13	.00	No
	SIT6	F(1, 297)=.65	.41	.00	No

Table 7.46 Univaraite test result of significant CKMP dimensions

		IIT1		IIT2		IIT3		IIT4		IIT5		IIT6		IIT7	
		mean	σ	mean	σ	mean	σ	mean	σ	mean	σ	mean	σ	mean	σ
CKG	High	3.39	.92	3.26	.99	3.37	.80	3.23	1.01	3.25	.77	3.23	.93	3.19	.91
	Low	2.91	1.08	2.82	1.10	2.93	1.06	2.71	1.11	2.63	.94	2.82	1.10	2.93	1.15
CKS	High	3.43	.96	3.35	.95	3.38	.88	3.34	.99	3.28	.74	3.36	.84	3.31	.91
	Low	2.93	1.03	2.79	1.10	2.97	.98	2.66	1.07	2.67	.95	2.73	1.11	2.84	1.08
BKA	High	3.40	.99	3.36	.97	3.41	.85	3.43	.92	3.30	.75	3.40	.87	3.42	.84
	Low	2.96	1.01	2.78	1.08	2.94	.98	2.57	1.07	2.65	.93	2.69	1.05	2.73	1.09
CKD	High	3.53	.96	3.46	.95	3.42	.89	3.32	1.05	3.30	.80	3.35	.87	3.32	.91
	Low	2.80	.95	2.65	1.02	2.91	.94	2.64	1.01	2.62	.88	2.71	1.08	2.80	1.09
CKA	High	3.54	.98	3.38	1.06	3.35	.97	3.35	1.05	3.27	.79	3.42	.91	3.36	.95
	Low	2.73	.90	2.68	.94	2.95	.87	2.56	.97	2.61	.91	2.58	.98	2.71	1.01

Table 7.44 Differences among levels of CKMP by IIT dimensions

		SIT1		SIT2		SIT3		SIT4		SIT5		SIT6	
		mean	σ	mean	σ	mean	σ	mean	σ	mean	σ	mean	σ
CKG	High	3.44	.90	3.47	.86	3.19	.98	3.33	.88	3.07	.99	3.28	.88
	Low	3.31	.93	3.28	.89	2.60	.98	2.54	.95	2.76	1.14	3.06	.91
CKS	High	3.48	.91	3.49	.90	3.34	.95	3.33	.93	3.15	1.02	3.28	.92
	Low	3.28	.91	3.29	.85	2.52	.93	2.63	.92	2.71	1.08	3.08	.87
BKA	High	3.50	.90	3.49	.89	3.40	.94	3.40	.89	3.20	.96	3.27	.91
	Low	3.26	.91	3.29	.86	2.47	.89	2.57	.92	2.67	1.11	3.09	.88
CKD	High	3.42	.92	3.37	.90	3.16	.97	3.23	.89	3.13	1.01	3.12	.91
	Low	3.33	.91	3.41	.85	2.47	.89	2.71	1.02	2.71	1.09	3.23	.88
CKA	High	3.42	.92	3.36	.90	3.11	1.04	3.20	.93	3.03	.98	3.22	.90
	Low	3.38	.91	3.43	.86	2.70	.96	2.70	1.00	2.81	1.16	3.13	.89

Table 7.47 Differences among levels of CKMP by SIT

7.2.2.3 Role of CKMP on CIT

Supply chain integration with customers was a construct with 5 sub-dimensions. The MANOVA results presented in table 7.48 demonstrated that CIT as a single construct was significantly associated with every CKMP factor, and relationship with CKA was fairly strong (effect size = .10). The ANOVA test was conducted with CKMP factors as independent variables to analyze their effects on each CIT dimensions.

Multivariate Results -Wilks' Lambda (CIT)				
	F	P	η^2	Significant
CKG	F(5, 293)=3.28	.00	.05	Yes
CKS	F(5, 293)=2.26	.04	.03	Yes
BKA	F(5, 293)=3.38	.00	.05	Yes
CKD	F(5, 293)=3.40	.00	.05	Yes
CKA	F(5, 293)=6.90	.00	.10	Yes

Table 7.48 Multivariate test results of CKMP over CIT dimensions

Table 7.49 presented the ANOVA test results. Surprisingly, very few significant relationships were found. CKS was shown to have no significant effect on any of the CIT dimensions. Customer providing feedbacks (CIT1) was shown to significantly relate to CKA. It might be because partner firms coordinate new product development for CKA encourages customer firm to give feedback. Customer providing inputs to production planning (CIT4) was found significantly associated with CKG and BKA. While Regular communication with customer (CIT5) was found being significantly associated with CKD and CKA. This could be understood as that collaborative knowledge dissemination and application practices were actually communication processes with trading partners, thus high levels of CKD and CKA were associated with high level of CIT. Since significant relationships were found, planned contrast analyses were done in order to compare the different impact of the dimensions of CKMP on CIT across groups (Table 7.50).

Univariate ANOVA Test Results – IIT					
		F	P	η^2	Significant
CKG	CIT1	F(1, 297)=.07	.78	.00	No
	CIT2	F(1, 297)=.21	.64	.00	No
	CIT3	F(1, 297)=.01	.89	.00	No
	CIT4	F(1, 297)=6.39	.01	.02	Yes
	CIT5	F(1, 297)=.90	.34	.00	No
CKS	CIT1	F(1, 297)=.05	.81	.00	No
	CIT2	F(1, 297)=1.14	.28	.00	No
	CIT3	F(1, 297)=1.12	.28	.00	No
	CIT4	F(1, 297)=1.86	.17	.00	No
	CIT5	F(1, 297)=.24	.62	.00	No
BKA	CIT1	F(1, 297)=.00	.96	.00	No
	CIT2	F(1, 297)=2.13	.12	.00	No
	CIT3	F(1, 297)=1.60	.20	.00	No
	CIT4	F(1, 297)=8.22	.00	.02	Yes
	CIT5	F(1, 297)=1.33	.24	.00	No
CKD	CIT1	F(1, 297)=1.84	.17	.00	No
	CIT2	F(1, 297)=1.17	.28	.00	No
	CIT3	F(1, 297)=.54	.46	.00	No
	CIT4	F(1, 297)=.74	.38	.00	No
	CIT5	F(1, 297)=8.59	.00	.02	Yes
CKA	CIT1	F(1, 297)=17.90	.00	.05	Yes
	CIT2	F(1, 297)=.04	.83	.00	No
	CIT3	F(1, 297)=.34	.55	.00	No
	CIT4	F(1, 297)=.67	.41	.00	No
	CIT5	F(1, 297)=10.53	.00	.03	Yes

Table 7.49 Univaraite test result of significant CKMP dimensions over CIT

		CIT1		CIT2		CIT3		CIT4		CIT5	
		mean	σ	mean	σ	mean	σ	mean	σ	mean	σ
CKG	High	3.28	1.14	3.34	1.10	3.17	1.17	2.97	1.23	3.51	1.19
	Low	3.32	.99	3.11	.97	3.06	1.01	3.08	1.06	3.56	.91
CKS	High	3.31	1.16	3.32	1.14	3.04	1.17	2.99	1.18	3.54	1.16
	Low	3.28	.99	3.15	.94	3.20	1.02	3.05	1.02	3.52	.98
BKA	High	3.29	1.09	3.37	1.09	3.17	1.09	3.15	1.14	3.55	1.12
	Low	3.30	1.07	3.10	.99	3.07	1.11	2.90	1.15	3.51	1.02
CKD	High	3.20	1.08	3.22	1.13	3.05	1.10	2.98	1.18	3.50	1.08
	Low	3.40	1.07	3.25	.95	3.20	1.09	3.06	1.13	3.57	1.07
CKA	High	3.14	1.13	3.23	1.10	3.11	1.09	3.02	1.18	3.46	1.11
	Low	3.49	.98	3.24	.97	3.13	1.11	3.02	1.12	3.62	1.01

Table 7.50 Differences among levels of CKMP by CIT dimensions

7.2.3 Supply Chain Performance

Supply chain performance (SP) was the last of the three impact-constructs in the research model. It measures 4 performance criteria of supply chains that have implemented CKMP. The sub-dimensions were: supply chain partnership (SCP), supplier performance (SPR), supply chain flexibility (FLX), and customer responsiveness (RSP). The structural equation model presented in the last chapter confirmed the causal relationship of CKMP to SP. The researcher conducted dimension-level analyses in section to look at the effects of CKMP to each of the above 4 SP dimensions.

7.2.3.1 Role of CKMP on SCP

Supply chain partnership (SCP) is about how well the outcome of supply chain partnership matches the participants' expectation. As presented in table 7.51, the multivariate test results indicated that only CKG and CKS were significantly related to SCP as a single construct.

Multivariate Results -Wilks' Lambda (SCP)				
	F	P	η^2	Significant
CKG	F(5, 293)=3.15	.00	.05	Yes
CKS	F(5, 293)=2.86	.01	.04	Yes
BKA	F(5, 293)=2.02	.07	.03	No
CKD	F(5, 293)=.75	.58	.01	No
CKA	F(5, 293)=1.87	.09	.03	No

Table 7.51 Multivariate test results of CKMP over SCP dimensions

The researcher then continued the analysis on how each dimension of SCP was affected by the 2 CKMP categories which displayed significance in the multivariate test. The ANOVA results presented in table 7.52 indicated that only 1 item (SCP3: risk sharing among trading partners) was marginally significant with CKS. The effect size was small

(η^2=.01). Thus we believe based on the current data, CKMP is not a strong factor to improve supply chain partnership.

7.2.3.2 Role of CKMP on SPR

Supplier performance (SPR) measures the suppliers' consistency in delivering materials, components, products to customer companies on time and in good condition to supply chain partner firms. Multivariate results (table 7.53) demonstrated that CKG, BKA, and CKA were significantly related to SCP as a single construct.

Univariate ANOVA Test Results – SCP					
		F	P	η^2	Significant
CKG	SCP1	F(1, 297)=.60	.43	.00	No
	SCP2	F(1, 297)=2.34	.12	.00	No
	SCP3	F(1, 297)=1.77	.18	.00	No
	SCP4	F(1, 297)=1.25	.26	.00	No
	SCP5	F(1, 297)=.04	.82	.00	No
CKS	SCP1	F(1, 297)=.40	.52	.00	No
	SCP2	F(1, 297)=.03	.85	.00	No
	SCP3	F(1, 297)=3.71	.05	.01	Yes
	SCP4	F(1, 297)=1.25	.10	.00	No
	SCP5	F(1, 297)=.04	.95	.00	No

Table 7.52 Univaraite test result of significant CKMP dimensions over SCP

Among those, the effect size of CKA was fairly large (η^2=.15), indicating a very strong relationship. It implied that based on current data set, CKG, BKA, and CKA appeared to be strong facilitators for supplier performance. ANOVA test were then conducted to further analyze the relationship of the above 3 CKMP factors to the 6 individual SCP dimensions.

Multivariate Results -Wilks' Lambda (SPR)				
	F	P	η^2	Significant
CKG	F(6, 292)=3.10	.00	.06	Yes
CKS	F(6, 292)=1.46	.19	.02	No
BKA	F(6, 292)=2.90	.00	.05	Yes
CKD	F(6, 292)=1.50	.17	.03	No
CKA	F(6, 292)=8.82	.00	.15	Yes

Table 7.53 Multivariate test results of CKMP over SPR dimensions

ANOVA test results presented in table 7.54 revealed that CKG had significant relationship with none of the SCP dimensions. BKA was significant with 2 SPR dimensions: on time delivery (SPR1), and reasonable cost (SPR5). CKA was significantly related to 3 SCP factors with higher effect sizes: delivery with precise quantities (SPR2), delivery in right sequence (SPR3), and reasonable cost (SPR5), indicating collaborative knowledge application practices as significant facilitators for improving supplier performance. Because of the significant relationships found, planned contrast analyses were conducted to study the different impacts of the CKMP dimensions on SPR across groups (Table 7.55).

Univariate ANOVA Test Results – SPR					
		F	P	η^2	Significant
CKG	SPR1	F(1, 297)=3.09	.08	.01	No
	SPR2	F(1, 297)=.72	.39	.00	No
	SPR3	F(1, 297)=.69	.40	.00	No
	SPR4	F(1, 297)=.10	.74	.00	No
	SPR5	F(1, 297)=1.97	.16	.00	No
	SPR6	F(1, 297)=2.79	.09	.00	No
BKA	SPR1	F(1, 297)=6.51	.01	.02	Yes
	SPR2	F(1, 297)=1.19	.27	.00	No
	SPR3	F(1, 297)=.70	.40	.00	No
	SPR4	F(1, 297)=095	.33	.00	No
	SPR5	F(1, 297)=4.00	.04	.01	Yes
	SPR6	F(1, 297)=.36	.54	.00	No
CKA	SPR1	F(1, 297)=1.91	.16	.00	No
	SPR2	F(1, 297)=10.87	.00	.03	Yes
	SPR3	F(1, 297)=17.03	.00	.05	Yes
	SPR4	F(1, 297)=.06	.80	.00	No
	SPR5	F(1, 297)=11.42	.00	.03	Yes
	SPR6	F(1, 297)=.26	.60	.00	No

Table 7.54 Univaraite test result of significant CKMP dimensions over SPR

		SPR1		SPR2		SPR3		SPR4		SPR5		SPR6	
		mean	σ	mean	σ	mean	σ	mean	σ	mean	σ	mean	σ
CKG	High	3.25	.82	3.45	.84	3.39	.82	3.56	.90	3.26	.91	3.44	1.04
	Low	3.20	.94	3.51	.77	3.40	.99	3.41	.96	3.23	.86	3.20	1.05
CKS	High	3.34	.82	3.45	.89	3.42	.84	3.54	.95	3.28	1.02	3.35	1.10
	Low	3.12	.92	3.51	.72	3.37	.96	3.45	.91	3.22	.73	3.33	1.00
BKA	High	3.34	.87	3.47	.94	3.41	.89	3.52	.93	3.32	.99	3.37	1.11
	Low	3.12	.87	3.49	.66	3.38	.91	3.47	.93	3.17	.77	3.31	.99
CKD	High	3.26	.84	3.44	.90	3.41	.87	3.42	.95	3.19	1.04	3.23	1.10
	Low	3.19	.91	3.52	.70	3.37	.93	3.57	.90	3.30	.68	3.45	.99
CKA	High	3.32	.90	3.55	.90	3.53	.83	3.46	.91	3.28	1.02	3.24	1.08
	Low	3.11	.83	3.39	.66	3.23	.95	3.53	.95	3.20	.68	3.45	1.01

Table 7.55 Differences among levels of CKMP by SPR dimensions

7.2.3.3 Role of CKMP on FLX

The 3rd supply chain performance factor is supply chain flexibility (FLX), which is about organization's ability to effectively adapt or respond to change that directly impacts its customer. The researcher first conducted the MONOVA multivariate test to examine the relationship of the 5 CKMP dimensions and FLX as a single construct. Table 7.56 presented the results indicating universal significance across all CKMP dimensions. ANOVA test was then conducted to study how the CKMP dimensions were related to the 6 FLX categories.

Multivariate Results -Wilks' Lambda (FLX)				
	F	P	η^2	Significant
CKG	F(6, 292)=2.59	.01	.05	Yes
CKS	F(6, 292)=3.34	.00	.06	Yes
BKA	F(6, 292)=2.20	.04	.04	Yes
CKD	F(6, 292)=4.86	.00	.09	Yes
CKA	F(6, 292)=2.07	.05	.04	Yes

Table 7.56 Multivariate test results of CKMP over FLX dimensions

Table 7.57 presented the ANOVA test results: CKG was significantly associates with ability to handle non-standard orders (FLX1). CKS was significantly related to 2 FLX dimensions- ability to meet special customer requirements (FLX2) and ability to the requirements of target markets (FLX6). BKA showed significant relationships with the requirements of target markets (FLX6). CKD was found related to ability to adjust production capacity (FLX4) and ability to introduce new product quickly (FLX5). CKA had significant relationship with none of the FLX dimensions. Planned contrast analyses were followed to compare the means and standard deviations of each FLX dimensions in high and low levels of CKMP dimensions (Table 7.58).

Univariate ANOVA Test Results – FLX					
		F	P	η^2	Significant
CKG	FLX1	F(1, 297)=5.63	.01	.01	Yes
	FLX2	F(1, 297)=.48	.48	.00	No
	FLX3	F(1, 297)=.11	.73	.00	No
	FLX4	F(1, 297)=.77	.38	.00	No
	FLX5	F(1, 297)=.00	.96	.00	No
	FLX6	F(1, 297)=.71	.39	.00	No
CKS	FLX1	F(1, 297)=1.21	.27	.00	No
	FLX2	F(1, 297)=7.87	.00	.02	Yes
	FLX3	F(1, 297)=.05	.82	.00	No
	FLX4	F(1, 297)=.00	.98	.00	No
	FLX5	F(1, 297)=2.03	.15	.00	No
	FLX6	F(1, 297)=3.86	.05	.01	Yes
BKA	FLX1	F(1, 297)=.93	.33	.00	No
	FLX2	F(1, 297)=.28	.59	.00	No
	FLX3	F(1, 297)=.18	.67	.00	No
	FLX4	F(1, 297)=.16	.68	.00	No
	FLX5	F(1, 297)=.12	.72	.00	No
	FLX6	F(1, 297)=6.04	.01	.02	Yes
CKD	FLX1	F(1, 297)=.04	.82	.00	No
	FLX2	F(1, 297)=.00	.95	.00	No
	FLX3	F(1, 297)=1.09	.29	.00	No
	FLX4	F(1, 297)=12.22	.00	.04	Yes
	FLX5	F(1, 297)=16.75	.00	.05	Yes
	FLX6	F(1, 297)=2.25	.13	.00	No
CKA	FLX1	F(1, 297)=.11	.73	.00	No
	FLX2	F(1, 297)=.29	.58	.00	No
	FLX3	F(1, 297)=2.10	.14	.00	No
	FLX4	F(1, 297)=1.42	.23	.00	No
	FLX5	F(1, 297)=.50	.48	.00	No
	FLX6	F(1, 297)=.00	.97	.00	No

Table 7.57 Univaraite test result of significant CKMP dimensions over FLX

7.2.3.4 Role of CKMP on RSP

The last factor of supply chain performance is customer responsiveness (RSP), which is the speed of an organization's responses to the customer requests. The MANOVA multivariate test results presented in table 7.59 demonstrated that only CKS and CKA were marginally related to RSP ($\eta^2 = .03$). ANOVA tests were presented in table 7.60 and the planned contrast analyses were reported in table 7.61. CKS was significantly related to only 2 RSP dimensions- high customer service level (RSP3), and short customer response time (RSP4). CKA showed significant relationships with one dimension - short customer response time (RSP4), indicating weak relationship of CKMP implementation with customer responsiveness in supply chain.

		FLX1		FLX2		FLX3		FLX4		FLX5		FLX6	
		mean	σ	mean	σ	mean	σ	mean	σ	mean	σ	mean	σ
CKG	High	3.34	1.03	3.47	.99	3.47	.90	3.15	1.03	3.21	.95	3.28	.90
	Low	2.95	.87	3.10	.91	3.44	.94	3.04	1.20	3.02	.96	3.08	.82
CKS	High	3.19	1.03	3.37	.99	3.41	.92	3.13	.98	3.23	.93	3.35	.87
	Low	3.14	.94	3.23	.95	3.50	.92	3.07	1.23	3.01	.98	3.03	.85
BKA	High	3.18	1.01	3.37	1.02	3.44	.86	3.16	.98	3.19	.95	3.32	.84
	Low	3.15	.95	3.24	.92	3.47	.97	3.04	1.22	3.06	.97	3.06	.88
CKD	High	3.16	1.06	3.33	.99	3.53	.94	3.36	.95	3.37	.90	3.28	.90
	Low	3.17	.89	3.27	.95	3.37	.89	2.82	1.19	2.86	.96	3.09	.83
CKA	High	3.11	1.04	3.28	.99	3.48	.92	3.28	1.01	3.20	.93	3.22	.91
	Low	3.23	.91	3.33	.94	3.43	.91	2.87	1.18	3.02	.98	3.15	.81

Table 7.58 Differences among levels of CKMP by FLX dimensions

Multivariate Results -Wilks' Lambda (RSP)				
	F	P	η^2	Significant
CKG	F(4, 294)=1.94	.10	.02	No
CKS	F(4, 294)=2.34	.05	.03	Yes
BKA	F(4, 294)=.80	.52	.01	No
CKD	F(4, 294)=1.20	.31	.01	No
CKA	F(4, 294)=2.30	.05	.03	Yes

Table 7.59 Multivariate test results of CKMP over RSP dimensions

Univariate ANOVA Test Results – RSP					
		F	P	η^2	Significant
CKS	RSP1	F(1, 297)=1.21	.27	.00	No
	RSP2	F(1, 297)=2.87	.09	.01	No
	RSP3	F(1, 297)=3.87	.05	.01	Yes
	RSP4	F(1, 297)=7.91	.00	.02	Yes
CKA	RSP1	F(1, 297)=.06	.79	.00	No
	RSP2	F(1, 297)=1.34	.24	.00	No
	RSP3	F(1, 297)=1.25	.26	.00	No
	RSP4	F(1, 297)=4.01	.04	.01	Yes

Table 7.60 Univaraite test result of significant CKMP dimensions over RSP

		RSP1		RSP2		RSP3		RSP4	
		mean	σ	mean	σ	mean	σ	mean	σ
CKG	High	3.42	1.04	3.33	1.10	3.54	.98	3.32	1.10
	Low	3.42	.93	3.05	1.12	3.43	.99	3.27	1.18
CKS	High	3.55	1.00	3.46	1.00	3.63	.94	3.50	1.03
	Low	3.29	.97	2.95	1.16	3.36	1.01	3.11	1.20
BKA	High	3.52	.96	3.50	.98	3.64	.88	3.44	1.00
	Low	3.32	1.01	2.92	1.16	3.34	1.06	3.17	1.24
CKD	High	3.53	.95	3.40	1.06	3.62	.94	3.50	1.04
	Low	3.30	1.02	3.00	1.14	3.35	1.02	3.08	1.19
CKA	High	3.48	.97	3.45	1.08	3.64	.92	3.49	1.02
	Low	3.34	1.01	2.91	1.08	3.30	1.03	3.06	1.21

Table 7.61 Differences among levels of CKMP by RSP dimensions

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 8: SUMMARY AND RECOMMENDATIONS FOR FUTURE RESEARCH

This chapter provides 1) a summary of the major research findings, 2) theoretical contributions of the study, 3) practical implications for practitioners, 4) limitations of the research, and 5) recommendations for future research.

8.1 Summary of Findings

Knowledge management has been gaining increasing attention from both practitioners and academia. However, the existing studies on managing knowledge across organizational boundaries are sparse in quantity and limited in scope. The current study represents one of the first large-scale empirical efforts to systematically investigate the complex knowledge management practices in the supply chain context. It attempted to answer the following questions: 1) what is collaborative knowledge management practices in supply chain, 2) how to measure it, 3) what are the drivers for organizations to implement CKMP, 4) what performance outcome CKMP can bring to the supply chain. Built on organizational technology adoption framework, the researcher developed an integrated model to examine knowledge throughout its entire life cycle, and formulated a theoretical framework to explore the antecedents and consequences of collaborative knowledge management. Based on the data collected from 323 procurement/materials/supply chain managers and executives, the model was tested using structural equation modeling methodology. The test results confirmed that 1) technological infrastructures, organizational infrastructures, environmental context and knowledge complementarity significantly had causal relationships with CKMP implementation; and 2) by involving CKMP with one's trading partners would significantly improve knowledge quality, the level of supply chain integration as well as the performance level of the entire supply chain.

8.2 Theoretical Contributions

Although rich deposits of studies on organizational knowledge management issue exist in the literature, there are very limited discussions on inter-organizational knowledge collaboration, particularly in the supply chain management context. The study presented and tested a research model empirically and made the following theoretical contributes:
First, it provided a clear definition to collaborative knowledge management practices in supply chain and identified its five dimensions: collaborative knowledge generation, collaborative knowledge storage, barrier-free knowledge access, collaborative knowledge dissemination, and collaborative knowledge generation. This definition could contribute to better understanding to cross-boundary knowledge sharing transactions in supply chain environment. It opened a new research path in supply chain relationship management. The study could stimulate more research to be done on how trading partners collaborate to leverage knowledge assets for supply chain competitiveness.

Second, the study provides valid and reliable measurement instrument to a number of constructs: collaboration supportive organizational culture, organizational empowerment, knowledge complementairty, collaborative knowledge management practices, and supply chain knowledge quality. Scales for these constructs were vigorously tested through statistical methodology of CITC purification, factorial validity, unidimensionality, reliability, and the validation of second-order construct, thus were ready for use in future research.

Third, the research investigated the critical roles of a number of organizational and contextual antecedents to CKMP. Technological tools including communication support systems, collaborative systems, knowledge database systems and enterprise information portals, and favorable organizational infrastructures including top management support, collaborative culture, and organizational empowerment were found significantly facilitating CKMP. Moreover, contextual factors of perceived knowledge compelemtarity and environmental characteristics, including environmental uncertainty, competitive pressure and trading partner readiness for knowledge sharing were also found affect CKMP directly and positively. These were very valuable findings since organizational issues and contextual influences are often ignored in the organization. The study provides a reference on identifying the related areas for efforts of improving supply-chain-wide knowledge sharing capabilities.

Fourth, the research reveals the potential direct results of CKMP. It confirmed the hypotheses that exerting efforts on implementing CKMP would reward organizations with higher knowledge quality, greater level of supply chain integration between internal functions and with customers and suppliers, as well as better supply chain performance in terms of supplier performance, market responsiveness, operation flexibility and partner quality. These findings would greatly stimulate and facilitate theory development in the fields of supply chain management and knowledge management.

In summary, the research linked two popular fields of supply chain management and knowledge management. It prints out a roadmap for organizations to collaborate with trading partners for knowledge management and improve performance. All three hypotheses for CKMP outcomes were confirmed with high effect sizes. It suggested that investment in CKMP would undoubtedly reward organizations with direct and sizable positive results. Out of the six CKMP antecedent hypotheses, four were proven significant. It might imply that simply perceiving CKMP had benefits and had favorable partnership with other firms were not enough for CKMP success. Organizations must be serious with CKMP attempts; they must invest in infrastructural technology, substantially change organizational culture, and establish knowledge collaboration with selected trading partners whose knowledge is perceived complementary.

8.3 Implications for Practitioners

One of the goals of any business related theoretical research is to find and highlight the practical implications for managers. The current study has the following contributions in this aspect that are worth mentioning.

First, this study provided a better understanding as to the current adoption rate of CKMP and their characteristics. Among the 411 useable samples we obtained from the large scale survey, 323 identified themselves as CKMP adopters, which indicated that roughly 80% of the organizations in US manufacturing sectors have started collaborating at various extents with their trading partners for knowledge management activities. Many of the non-adopters cited small organization size and perceived potential high cost as reasons hindering their adoption. Analysis of the demographic features of the adopters also confirmed similar results: 46% of the sampled adopters had 2005 annual sales larger than 1000 million, and 58% had employee size larger than 1,000. However, this result should not discourage small and medium sized organizations considering implementing CKMP, since it is clear from this study that there are substantial benefits associated with CKMP; and some of the medium sized non adopters also mentioned that they were actually in the planning processes of sharing knowledge with their supply chain partners. Second, the research identified key dimensions of collaborative knowledge management practices that organizations could set as guidelines in embracing supply chain level knowledge collaboration. As Roper and Crone (2003) argued that due to the lack of clear definition to supply chain knowledge collaboration, firms found it difficult to handle cross-boundary knowledge management, even if they had realized the tremendous potential of CKMP. The findings demonstrated to practitioners that inter-firm knowledge collaboration should focus on collaborative knowledge generation, storage, access, dissemination and application.

Third, the study identified the antecedents of successful CKMP implementation and the potential direct performance outcomes. Practitioners could use it to as a roadmap to plan their CKMP adoption and implementation: identifying potential knowledge sharing partners by looking at complemenatarity level of both parties' knowledge bases, evaluating partner readiness, providing technical training to employees about the essential technological components, committing to organizational changes such as empowering employees. The positive and strong relationship the study found between CKMP and the 3 impacts (knowledge quality, supply chain integration and supply chain performance) could be used by supply chain managers as a reference to persuade upper level management for the large investment required for implementing CKMP and attracting partner firms to jump on board.

Fourth, the finding provided a set of valid and reliable measurements for evaluating an organization's level of knowledge collaboration with partner firms, and further benchmarking and comparing collaborative knowledge management practices across difference organizations. The measurements developed in this research captured various activities associated with the entire life cycle of supply chain knowledge. Organizations can use the measurement to identify strength and weakness in knowledge management collaboration for future improvement.

8.4 Limitations of the Research

While the current research made significant contributions from both theoretical and practical perspective, it also has some limitations as described below.

First, a number of sub-dimensions in CKMP suffered from measurement issues. Thus the researcher had to eliminate a large number of items to improve its discriminate validity. Because of this limitation, we were not able to analyze the effects of those aspects. Further revision to the measurement items might be necessary.

Second, the study is done at the firm level, thus the researcher attempted to include one respondent from each organization. However, some of the respondents were from different units/division of the same company. Although most of the units/divisions operate independently, but it was still possible that some units were sharing the same knowledge management system, in which case there might be multiple respondents referred to the same system and practices. It might confound the results.

Third, in this research, single respondent in an organization was asked to respond to the entire questionnaire which covers both supply chain management issues as well as knowledge management issues. Our targeted respondents were corporate executives and middle to upper level purchasing, supply chain, and material managers. Although they do extensively involve in knowledge management and relationship with partner firms, it is possible that they might not know every details as clear as we would expect. Therefore, the use of single respondent may generate some measurement inaccuracy.

Fourth, the research design and method employed may constraint the results found and the implications of this research. The study is intended to explore the longitudinal effects of the causal relationships proposed. But due to the availability of data and time constrains in conducting the study, cross-sectional research design was used instead. Readers must take caution in generalizing the results from this study.

8.5 Recommendations for Future Research

Based on the limitation discussed above and careful examination of the research potential to this topic, a number of interesting future research directions are suggested as follow.

First, the wording of those deleted CKMP sub-dimension measurement items could be re-examined. Some of those activities are believed to be essential in collaborative knowledge management. As pointed out previously, the structural effects of these items were not evaluated in the current study. It is worthwhile to redesign question items for those and eliminate the measurement errors so that their impacts can be studied.

Second, the three impact constructs (supply chain knowledge quality, supply chain integration, and supply chain performance) were treated as independent results of CKMP implementations. It is possible that there are interactions among themselves. Future research can look at whether there is significant level of casual relationship and how CKMP affects them as a whole.

Third, the current study look at how organizations collaborate in knowledge management regardless of the type of industry they are in. As pointed out by Randall et al (2003), efficient and responsive supply chains have different requirements for information. Organizations in efficient supply chain are believed to less depend on information from supplier and customers for planning their operations. It would be an interesting study to compare how different the practices will be toward organizational knowledge and how knowledge is management across organizational boundaries in those two types of supply chains.

Finally, future research can expand the research to an international context. This current study limited its scope to US manufacturing sector. With the trend of globalization, more and more supply chains have international participants. Foreign companies have different culture, different way of approaching problems, thus it would be challenging for these firms to collaborate for knowledge management. Future studies can include additional contextual variables in the model to evaluate how cross-national and cross-culture supply chain knowledge sharing can be handled.

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Appendix A: Sample emails for pilot test

Mail From: Yulong Li

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Close Reply Forward

Mail | Properties | Personalize

From: Yulong Li 9/25/2006 10:29 PM

To: karen.r.jones@boeing.com

Subject: CWU research help

Dear Ms. Jones,

Let me introduce myself first. I am an Assistant professor of Operations Management at College of Business in CWU. We have had some brief discussions when you were in Ellensburg for a lecture about your work at Boeing and student internship opportunities early this year.

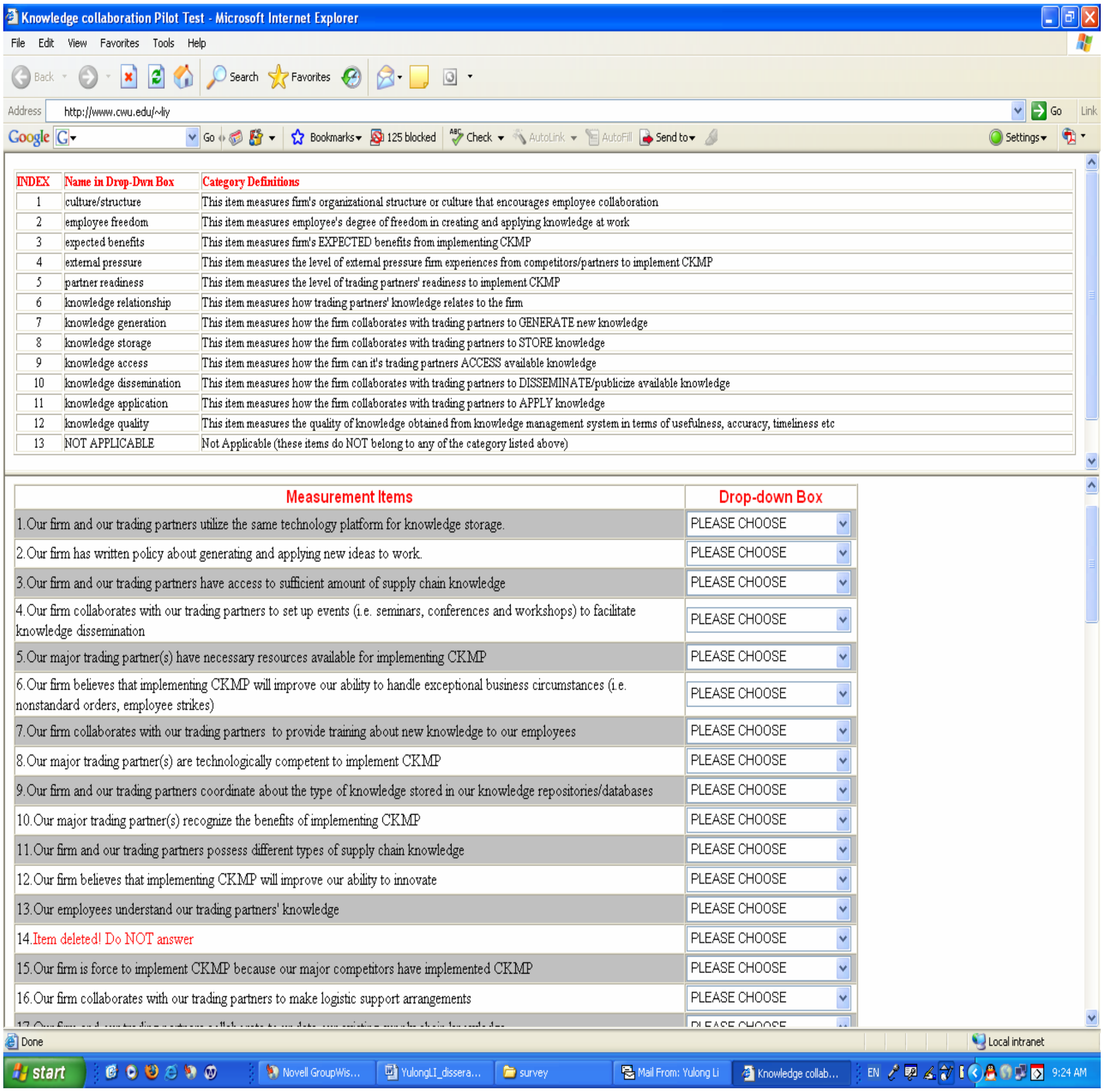
I am currently conducting a research project studying firm collaboration with their supply chain partners for knowledge creation and sharing. Boeing is a perfect organization for this study. As far as I know, the new 787 will have the same interface for both RR & GE engines to make them interchangeable. There must be active knowledge exchange between Boeing and it engin suppliers in design phase to make that possible. I believe you, as a director for material management, have great knowledge about the relationship with Boeing suppliers.

For a generalizable research result, I will conduct a large scale survey to operations/supply chain managers in many manufacturing companies across the nation early next month. At the current stage, I need purify my questionnaire items, that is I must make sure the questions I will use for the large scale survey is easily understood and clearly presented to my potential respondents (like you). I wonder if you can kindly help me with this questionnaire purifying task? It will take you about <u>15 minutes</u> at <u>your office or home</u> to sort 70 question items into different categories. This will be a very important step to my study, which, I hope, will help companies like Boeing better collaborate with their partner firms for better performance.

Please kindly reply if you are able to help. I will really appreciate your assistance. I am looking forward to hearing back from you soon. Once you acknowledges, I will email you the instructions etc.

Yulong

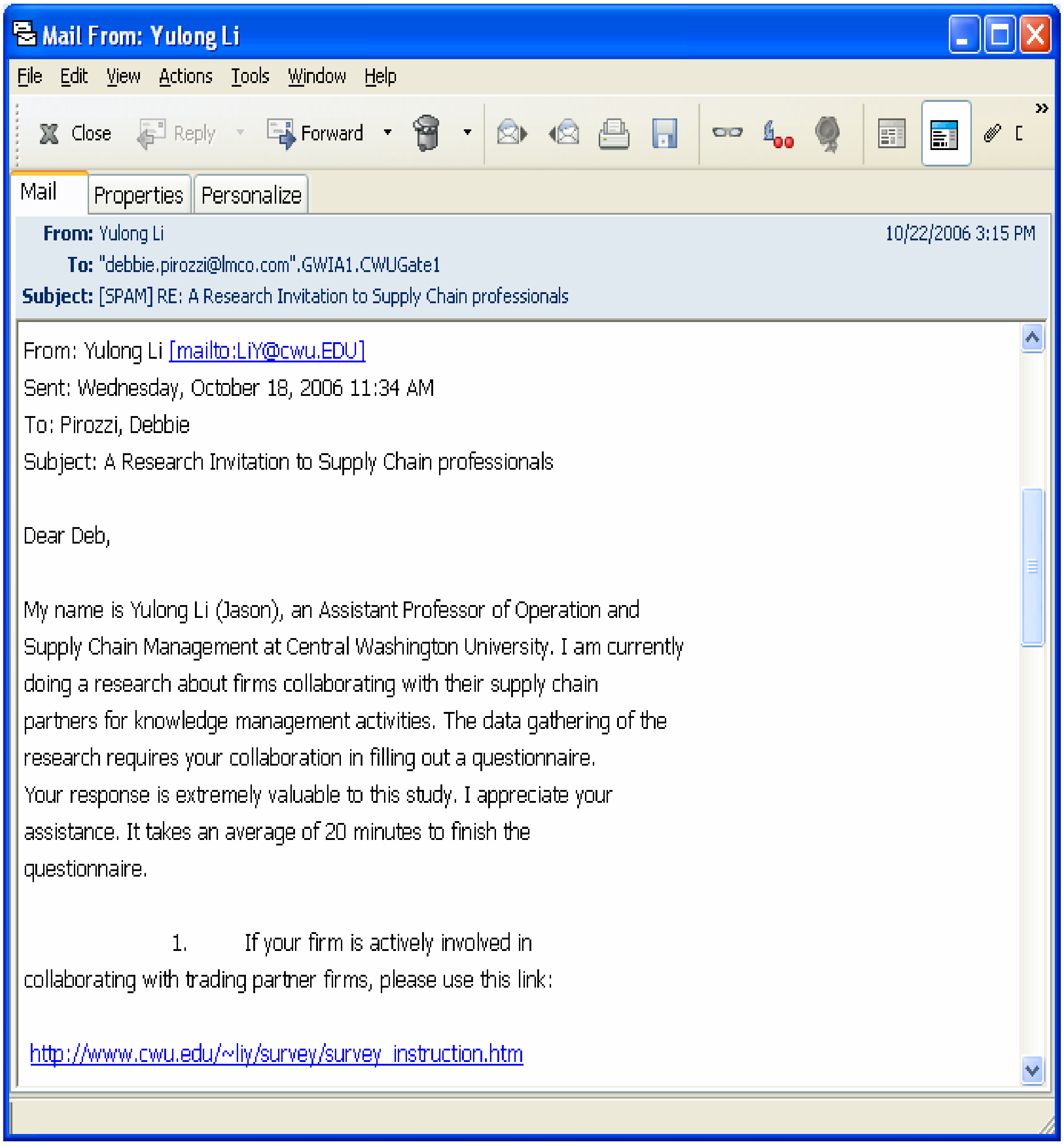
Appendix B: Online Pilot test (Q-sort)



INDEX	Name in Drop-Dwn Box	Category Definitions
1	culture/structure	This item measures firm's organizational structure or culture that encourages employee collaboration
2	employee freedom	This item measures employee's degree of freedom in creating and applying knowledge at work
3	expected benefits	This item measures firm's EXPECTED benefits from implementing CKMP
4	external pressure	This item measures the level of external pressure firm experiences from competitors/partners to implement CKMP
5	partner readiness	This item measures the level of trading partners' readiness to implement CKMP
6	knowledge relationship	This item measures how trading partners' knowledge relates to the firm
7	knowledge generation	This item measures how the firm collaborates with trading partners to GENERATE new knowledge
8	knowledge storage	This item measures how the firm collaborates with trading partners to STORE knowledge
9	knowledge access	This item measures how the firm can it's trading partners ACCESS available knowledge
10	knowledge dissemination	This item measures how the firm collaborates with trading partners to DISSEMINATE/publicize available knowledge
11	knowledge application	This item measures how the firm collaborates with trading partners to APPLY knowledge
12	knowledge quality	This item measures the quality of knowledge obtained from knowledge management system in terms of usefulness, accuracy, timeliness etc
13	NOT APPLICABLE	Not Applicable (these items do NOT belong to any of the category listed above)

Measurement Items	Drop-down Box
1. Our firm and our trading partners utilize the same technology platform for knowledge storage.	PLEASE CHOOSE
2. Our firm has written policy about generating and applying new ideas to work.	PLEASE CHOOSE
3. Our firm and our trading partners have access to sufficient amount of supply chain knowledge	PLEASE CHOOSE
4. Our firm collaborates with our trading partners to set up events (i.e. seminars, conferences and workshops) to facilitate knowledge dissemination	PLEASE CHOOSE
5. Our major trading partner(s) have necessary resources available for implementing CKMP	PLEASE CHOOSE
6. Our firm believes that implementing CKMP will improve our ability to handle exceptional business circumstances (i.e. nonstandard orders, employee strikes)	PLEASE CHOOSE
7. Our firm collaborates with our trading partners to provide training about new knowledge to our employees	PLEASE CHOOSE
8. Our major trading partner(s) are technologically competent to implement CKMP	PLEASE CHOOSE
9. Our firm and our trading partners coordinate about the type of knowledge stored in our knowledge repositories/databases	PLEASE CHOOSE
10. Our major trading partner(s) recognize the benefits of implementing CKMP	PLEASE CHOOSE
11. Our firm and our trading partners possess different types of supply chain knowledge	PLEASE CHOOSE
12. Our firm believes that implementing CKMP will improve our ability to innovate	PLEASE CHOOSE
13. Our employees understand our trading partners' knowledge	PLEASE CHOOSE
14. Item deleted! Do NOT answer	PLEASE CHOOSE
15. Our firm is force to implement CKMP because our major competitors have implemented CKMP	PLEASE CHOOSE
16. Our firm collaborates with our trading partners to make logistic support arrangements	PLEASE CHOOSE

Appendix C: Sample email for data collection


Mail From: Yulong Li

File Edit View Actions Tools Window Help

Close Reply Forward

Mail Properties Personalize

From: Yulong Li 10/22/2006 3:15 PM

To: "debbie.pirozzi@lmco.com".GWIA1.CWUGate1

Subject: [SPAM] RE: A Research Invitation to Supply Chain professionals

From: Yulong Li [mailto:LiY@cwu.EDU]

Sent: Wednesday, October 18, 2006 11:34 AM

To: Pirozzi, Debbie

Subject: A Research Invitation to Supply Chain professionals

Dear Deb,

My name is Yulong Li (Jason), an Assistant Professor of Operation and Supply Chain Management at Central Washington University. I am currently doing a research about firms collaborating with their supply chain partners for knowledge management activities. The data gathering of the research requires your collaboration in filling out a questionnaire. Your response is extremely valuable to this study. I appreciate your assistance. It takes an average of 20 minutes to finish the questionnaire.

1. If your firm is actively involved in collaborating with trading partner firms, please use this link:

http://www.cwu.edu/~liy/survey/survey_instruction.htm

Each email is personalized addressing respondent by first name

Appendix D: Online survey instruction

A Survey of Collaborative Knowledge Management Practice in Supply Chain

by

The College of Business Administration of the University of Toledo
and
The College of Business of Central Washington University

The research is to examine how your firm is collaborating with your trading partners for managing knowledge of the supply chain. We believe supply chain partners not only exchange pure transaction information. They also need to exchange more advanced knowledge such as their expertise and know-hows about market predictions, product/service design, sourcing and logistics arrangements etc. to retain competitive advantages. We need your help to empirically define Collaborative Knowledge Management Practices (CKMP), identify their antecedents/drivers, and the potential performance outcomes.

We kindly ask you to fill out this questionnaire and thank you in advance for your responses. The data collected in this survey will be treated as confidential, it will be stored in a secure place and it will be used only for this study and in related reports. Information in reports will only be discussed at the aggregate level so that information about any particular firm cannot be ascertained or deduced by readers.

Please route this query to the individual in your firm who could most appropriately and accurately provide the pertinent information sought.

INSTRUCTIONS

- **To move between fields in this form, use the TAB key or click the mouse pointer in the next field to be filled in. The ENTER key can be used ONLY to insert hard returns in open-ended text fields. If you use the ENTER key to move between fields, you might submit your responses before you intend to.**
  - **Please fill out the questionnaire completely since you CANNOT save it and finish it later.**
- **Clicking the "Reset" button will erase all your responses and allow you to start over.**
- **After you finish, you must click the "Submit" button below to send your responses.**
- **If you prefer to complete the questionnaire and send it by regular mail, please send an email to liy@cwu.edu requesting the hard copy and a pre-paid envelop to return the questionnaire.**

When you are ready, please click the button below to start the questionnaire. Thanks again for your assistance.

>>>Go to the Test>>>

If you have questions, please don't hesitate to contact:

Yulong Li
Assistant Professor of Operations Management
Department of Finance and OSC
Central Washington University
Ellensburg, WA 98926
Phone: (509)963-3336
Fax: (509)963-2875
Email: liy@cwu.edu

A research project sponsored by The College of Business Administration, the University of Toledo & The College of Business, Central Washington University

Appendix E: Online Survey Questionnaire for CKMP Adopters

The numbers used in the scale represent the strength or degree of your assessment, agreement, perception or opinion, as the case may be to the question item. The scales used in the study are as follow:

1	2	3	4	5
Very low	Low	Medium	High	Very high

Section 1: Technology Infrastructure

Please rate the extent of the **availability** and **utilization** of the following technological tools in your firm to support knowledge collaboration with your trading partners.

#	Item	Very low 1	Low 2	Medium 3	High 4	Very high 5
1	**Communication support system** A system that provides communication support to groups of people that are engaged in common tasks or are sharing common resources, goals, values, etc. For example: web-conferencing, email, paging system	○	○	○	○	○
2	**Collaborative system** A computer-based system that provides an interface to a shared environment to support multiple users engaged in a common task (or goal) and have a critical need to interact closely with each other: sharing information, exchanging requests with each other, and checking in with each other on their status. For example: groupware, wiki system, XML/RSS feed	○	○	○	○	○
3	**Knowledge database management system** A system that transforms knowledge into structured data, controls the organization and storage of such data in knowledge databases. The purpose of the system is to support the structuring of knowledge database in a standard format and to provide tools for knowledge input, verification, storage and retrieval.	○	○	○	○	○
4	**Enterprise information portal** A central gateway that enables knowledge users to search and access knowledge repositories through retrieval, query, and other manipulations.	○	○	○	○	○
5	**Computer-based decision support system** An interactive, flexible, and adaptable computer-based information system, specifically developed for supporting the solution of a non-structured management problem for improved decision making. It utilizes data, provides an easy-to-use interface, and allows for the decision maker's own insights. For example: a system used by an engineering firm to analyze its bids on several projects and help the firm to decide if the bids are competitive with their costs.	○	○	○	○	○

Section 2: Organizational Infrastructure

These statements deal with your firm's organizational and cultural readiness in implementing **Collaborative Knowledge Management Practices (CKMP)**.

Please rate the extent of support from your firm's top management to the adoption and implementation of CKMP.		Very low	Low	Medium	High	Very high
Top management of our firm		1	2	3	4	5
1	Is interested in sharing knowledge with our trading partners	○	○	○	○	○
2	Considers sharing knowledge with our trading partners to be important	○	○	○	○	○
3	Supports CKMP with resources needed	○	○	○	○	○
4	Regards CKMP as a high priority item	○	○	○	○	○
5	Directly participates in sharing knowledge with others.	○	○	○	○	○

Please rate the extent of employee collaboration and shared practice in your firm		Very low	Low	Medium	High	Very high
ii		1	2	3	4	5
6	Our firm encourages employee learning	○	○	○	○	○
7	Our firm encourages teamwork for problem solving	○	○	○	○	○
8	Our firm encourages employees to help each other in their work	○	○	○	○	○
9	Our firm evaluates employees on the basis of work-team performance	○	○	○	○	○
10	Our firm has a decentralized organizational structure	○	○	○	○	○

Please rate the extent of your employees' freedom in creating and applying new knowledge to their work		Very low	Low	Medium	High	Very high
ii		1	2	3	4	5
11	Our employees are active in generating innovative ideas about their work	○	○	○	○	○
12	Our employees utilize innovative ideas to their work.	○	○	○	○	○
13	Our firm encourages employees to generate and apply new knowledge to their work.	○	○	○	○	○
14	Our employees of all level have the freedom to plan their own work.	○	○	○	○	○

Section 3: Perceived Collaborative Knowledge Management Practices (CKMP) Benefits

The following statements are about your firm's PERCEIVED benefits of collaborating with trading partners for knowledge management practices.

Please rate the extent of your aggreement with each of the following statements.

Our firm believes that collaborating with trading partners for knowledge management will		Very low 1	Low 2	Medium 3	High 4	Very high 5
1	Improve our ability to create new supply chain knowledge	○	○	○	○	○
2	Improve knowledge storage efficiency	○	○	○	○	○
3	Improve our access to supply chain knowledge	○	○	○	○	○
4	Facilitate knowledge transfer with our trading partners	○	○	○	○	○
5	Enable us to make better business decisions	○	○	○	○	○
6	Improve the overall quality of our firm's supply chain knowledge	○	○	○	○	○
7	Decrease our knowledge management costs	○	○	○	○	○
8	Enhance the relationship with our trading partners	○	○	○	○	○
9	Improve our ability to innovate	○	○	○	○	○
10	Facilitate business transactions with our trading partners (i.e. simplified billing and delivery processes and shorter order-to-delivery times)	○	○	○	○	○
11	Improve our ability to handle exceptional business circumstances (i.e. nonstandard orders, employee strikes)	○	○	○	○	○
12	Improve our firm's ability to adapt to environmental changes (i.e. changes in industrial trend or market conditions)	○	○	○	○	○
13	Increase our understanding to business context (i.e. increase our knowledge of the external environment, competitors and trading partners)	○	○	○	○	○

Section 4: External Influences

The following statements are about the external events and conditions that your firm faces.

Please rate the extent of your agreement with each statement about the ENVIRONMENTAL UNCERTAINTY your firm experiences						
ii		Very low	Low	Medium	High	Very high
		1	2	3	4	5
1	Our customers' needs are unpredictable	○	○	○	○	○
2	Our customers' orders fluctuate (i.e. in terms of quantity, product features)	○	○	○	○	○
3	Our suppliers' deliveries are unpredictable (i.e. in terms of delivery time, quantity)	○	○	○	○	○
4	Our suppliers' product quality is unpredictable	○	○	○	○	○
5	Competition is intense in our industry	○	○	○	○	○
6	Our competitors' actions are unpredictable	○	○	○	○	○
7	Our firm faces international competition	○	○	○	○	○
8	Product technology changes in our industry	○	○	○	○	○

Please rate the extent of your agreement with each statement about the COMPETITIVE PRESSURE your firm experiences for implementing CKMP						
Our firm is pushed to implement CKMP because		Very low	Low	Medium	High	Very high
		1	2	3	4	5
9	Many other firms in our industry have implemented CKMP	○	○	○	○	○
10	Our major competitors have implemented CKMP	○	○	○	○	○
11	Our major trading partners have implemented CKMP	○	○	○	○	○
12	Our trading partners give us incentives (or punishments) for implementing (or not implementing) CKMP.	○	○	○	○	○

Please rate the extent of your agreement with each statement about your TRADING PARTNERS' READINESS for implementing CKMP						
Our major trading partner(s)		Very low	Low	Medium	High	Very high
		1	2	3	4	5
13	Recognize the benefits of implementing CKMP	○	○	○	○	○
14	Want to implement CKMP	○	○	○	○	○
15	Have necessary resources available for implementing CKMP	○	○	○	○	○
16	Are technologically competent to implement CKMP	○	○	○	○	○
17	Have clear plans for implementing CKMP	○	○	○	○	○

Please rate the extent of your agreement with each statement about the RELATIONSHIP between your firm's KNOWLEDGE and that of your trading partners'						
ii		Very low	Low	Medium	High	Very high
		1	2	3	4	5
18	Our firm and our trading partners possess different supply chain knowledge	○	○	○	○	○
19	Our employees understand our trading partners' knowledge	○	○	○	○	○
20	Exchanging knowledge with our trading partners is easy	○	○	○	○	○
21	Our trading partners' knowledge is valuable to our firm	○	○	○	○	○

Please rate the extent of your agreement with each statement about your firm TRUST in your trading partners						
ii		Very low	Low	Medium	High	Very high
		1	2	3	4	5
22	Our trading partners have been open and honest in dealing with our firm	○	○	○	○	○
23	Our trading partners respect the confidentiality of the knowledge and information they receive from our firm	○	○	○	○	○
24	Our firm does NOT have to closely supervise transactions with our trading partners	○	○	○	○	○

Please rate the extent of your agreement with each statement about your trading partner's COMMITMENT to the relationship with your firm						
i i		Very low	Low	Medium	High	Very high
		1	2	3	4	5
25	Our trading partners have made sacrifices for our firm in the past	○	○	○	○	○
26	Our trading partners are willing to provide assistance to our firm	○	○	○	○	○
27	Our trading partners abide by agreements that we have with them	○	○	○	○	○
28	Our trading partners have invested a lot of resources in the relationship with our firm	○	○	○	○	○
29	Our trading partners keep their promise to us	○	○	○	○	○

Please rate the extent of your aggreement with each statement about your firm and your trading partners' VISION on mutual relationship						
Our firm and our trading partners have a shared understanding about		Very low	Low	Medium	High	Very high
		1	2	3	4	5
30	The aims and objectives of the supply chain	○	○	○	○	○
31	The importance of collaboration across the supply chain	○	○	○	○	○
32	The ways to improve the supply chain	○	○	○	○	○

Section 5: Collaborative Knowledge Management Practice (CKMP)

The following statements are about the extent of collaboration in knowledge management activities between your firm and your trading partners

Please rate the extent to which your firm collaborates with your trading partners for CREATING new supply chain knowledge

	Our firm and our trading partners collaborate	Very low 1	Low 2	Medium 3	High 4	Very high 5
1	To generate new ideas	○	○	○	○	○
2	To harvest knowledge from daily work	○	○	○	○	○
3	To acquire new knowledge from external sources	○	○	○	○	○
4	To update our existing supply chain knowledge	○	○	○	○	○
5	To validate our new supply chain knowledge	○	○	○	○	○

Please rate the extent to which your firm collaborates with your trading partners for supply chain knowledge STORAGE

	Our firm and our trading partners	Very low 1	Low 2	Medium 3	High 4	Very high 5
6	Maintain shared knowledge repositories/databases	○	○	○	○	○
7	Utilize the same technology platform for knowledge storage	○	○	○	○	○
8	Collaborate for knowledge repository /database maintenance	○	○	○	○	○
9	Coordinate about the type of knowledge stored in our knowledge repositories/databases	○	○	○	○	○
10	Coordinate about the format of knowledge stored in our knowledge repositories/databases	○	○	○	○	○

Please rate the extent to which your firm collaborates with your trading partners for ACCESSING supply chain knowledge

	Our firm and our trading partners	Very low 1	Low 2	Medium 3	High 4	Very high 5
11	Utilize the same technology platform for accessing knowledge repositories/databases	○	○	○	○	○
12	Have mutual agreements on accessing to each other's knowledge	○	○	○	○	○
13	Have easy access to the desired knowledge	○	○	○	○	○
14	Have fast access to desired knowledge	○	○	○	○	○
15	Have access to sufficient amount of knowledge	○	○	○	○	○

Please rate the extent to which your firm collaborates with your trading partners for DISSEMINATING supply chain knowledge						
Our firm collaborates with our trading partners to		Very low	Low	Medium	High	Very high
		1	2	3	4	5
16	Provide training to our employees about new knowledge	○	○	○	○	○
17	Publish newsletters etc. to disseminate knowledge	○	○	○	○	○
18	Set up events (i.e. seminars, conferences and workshops) to facilitate knowledge dissemination	○	○	○	○	○
19	Maintain reference desk or help line to facilitate knowledge dissemination	○	○	○	○	○

Please rate the extent to which your firm collaborates with your trading partners for APPLYING supply chain knowledge						
Our firm coordinates with our trading partners for		Very low	Low	Medium	High	Very high
		1	2	3	4	5
20	Making sourcing decisions	○	○	○	○	○
21	Customer relationship management	○	○	○	○	○
22	New product/process development	○	○	○	○	○
23	Making logistic support arrangements	○	○	○	○	○
24	Production and inventory planning	○	○	○	○	○
25	Facility capacity planning	○	○	○	○	○

Section 6: Collaborative Knowledge Management Practice (CKMP) Impacts

The following statements are about the quality of knowledge and the performance outcomes of CKMP.

Please rate the extent of your satisfaction from the supply chain knowledge that you obtain from CKMP						
The knowledge I obtain from our knowledge management system is		Very low	Low	Medium	High	Very high
		1	2	3	4	5
1	Free from error	○	○	○	○	○
2	Complete and thorough	○	○	○	○	○
3	Up-to-date	○	○	○	○	○
4	Easy to understand	○	○	○	○	○
5	Useful for its purpose	○	○	○	○	○

Supply Chain Integration of Your Firm with Your Trading Partners

Your firm may be involved in multiple supply chains and have multiple suppliers and customers, please consider ONLY those where/with whom your firm has implemented CKMP to answer the following questions (Q6 - Q23).

Please rate the extent of integration between the FUNCTIONS of these supply chains (i.e. between shipping and inventory or purchasing and raw material management)						
ii		Very low	Low	Medium	High	Very high
		1	2	3	4	5
6	The internal functions have automated data-sharing systems	○	○	○	○	○
7	These supply chains have integrated inventory management systems	○	○	○	○	○
8	These supply chains have integrated logistics support systems (i.e. share real-time delivery and shipment status from multiple suppliers)	○	○	○	○	○
9	These supply chains synchronize production schedules across organizational boundaries	○	○	○	○	○
10	These supply chains support inter-functional data sharing	○	○	○	○	○
11	These supply chains have accounting systems that are integrated with purchasing	○	○	○	○	○
12	These supply chain have automatic order refilling systems	○	○	○	○	○

Please rate the extent of integration of your firm with these SUPPLIERS		Very low	Low	Medium	High	Very high
ii		1	2	3	4	5
13	Our firm exchanges information with these suppliers	○	○	○	○	○
14	Our firm and these suppliers form long term partnerships	○	○	○	○	○
15	These suppliers participate in our production planning processes	○	○	○	○	○
16	These suppliers participate in our procurement process	○	○	○	○	○
17	Our firm has an automated ordering system with these suppliers	○	○	○	○	○
18	Our firm has a stable procurement relationship with these suppliers	○	○	○	○	○

Please rate the extent of integration of your firm with these CUSTOMERS		Very low	Low	Medium	High	Very high
		1	2	3	4	5
19	These customers give us feedback about our products	○	○	○	○	○
20	Our firm has a convenient ordering system for these customers	○	○	○	○	○
21	These customers share market information with our firm	○	○	○	○	○
22	These customers provide inputs for our production planning processes	○	○	○	○	○
23	Our firm has regular communication with these customers	○	○	○	○	○

Supply Chain Performance

Your firm may be involved in multiple supply chains and have multiple suppliers and customers, please consider ONLY those where/with whom your firm has implemented CKMP to answer the following questions (Q24 - Q44).

Please rate the extent of your agreement with the following statements about your SUPPLY CHAIN PARTNERSHIP

ii		Very low	Low	Medium	High	Very high
		1	2	3	4	5
24	Our firm wishes to strengthen our relationships with these trading partners	○	○	○	○	○
25	Our firm believes that our relationship with these trading partners is profitable	○	○	○	○	○
26	Our firm and these trading partners share the risks that occur in the supply chain	○	○	○	○	○
27	Our firm and these trading partners share benefits obtained from knowledge collaboration	○	○	○	○	○
28	Our firm has harmonious relationships with these trading partners	○	○	○	○	○

Please rate the extent of your agreement with the following statements about SUPPLIER PERFORAMINCE in these supply chains

ii		Very low	Low	Medium	High	Very high
		1	2	3	4	5
29	These suppliers deliver materials to us on time	○	○	○	○	○
30	These suppliers deliver materials to us in the quantities we order	○	○	○	○	○
31	These suppliers deliver materials to us in the sequence we order	○	○	○	○	○
32	These suppliers provide high quality materials to us	○	○	○	○	○
33	These suppliers provide materials to us at reasonable cost	○	○	○	○	○
34	The numbers of our suppliers have reduced over the past three years.	○	○	○	○	○

Please rate the extent of your agreement with the following statements about the FLEXIBILITY of these supply chains						
These supply chains are able to		Very low	Low	Medium	High	Very high
		1	2	3	4	5
35	Handle non-standard orders	○	○	○	○	○
36	Meet special customer requirements	○	○	○	○	○
37	Produce products with multiple features (e.g. options, sizes and colors)	○	○	○	○	○
38	Rapidly adjust production capacity in response to changes in customer demand	○	○	○	○	○
39	Introduce new products quickly	○	○	○	○	○
40	Respond to the requirements of our firm's target markets	○	○	○	○	○

Please rate the extent of your agreement with the following statements about the CUSTOMER RESPONSIVENESS of these supply chains						
ii		Very low	Low	Medium	High	Very high
		1	2	3	4	5
41	Our firm fills customer orders on time	○	○	○	○	○
42	Our firm has a short order-to-delivery cycle time	○	○	○	○	○
43	Our firm has high customer service levels	○	○	○	○	○
44	Our firm has a short customer response time	○	○	○	○	○

Section 7: Demographics Information

Please answer the following questions about your firm	
1	Annual Sales (year 2005 in US million $) [Please Choose ▾]
2	Number of employees [Please choose ▾]
3	Type of Industry your firm is in [Please choose ▾] If other industry, please specify: [ ]
4	Please rank the position of your company in your supply chain (mark all that apply) ☐ Raw material supplier ☐ Component supplier ☐ Assembler ☐ Sub-assembler ☐ Manufacturer ☐ Distributor ☐ Wholesaler ☐ Retailer
5	Please indicate the number of tiers across your supply chain: [Please choose ▾]
6	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
7	Some supply chains have a channel master (hub company), which is a company that determines the structure and operations of the whole supply chain, and coordinates the activities across it. Does the supply chain of your firm is in have a channel master? ○ Yes ○ No If Yes, is your firm the channel master in the supply chain? ○ Yes ○ No

Please answer the following information about yourself (the respondent):

8. Your present job title is	9. Your Present job functions (mark all that apply)
○ CEO/President ○ Manager ○ Director ○ Other, Please specify [ ]	☐ Corporate executive ☐ Purchasing manager ☐ Purchasing supervisor ☐ Manufacturing/production ☐ Distribution ☐ Sales ☐ Other, please specify [ ]
10 The years you have worked for this company:	Please Choose

Please indicate your email address if you would like to receive a summary report of the findings of this research (optional):

Thank you for your cooperation and response!

Submit Reset

Definitions of some of the terms used in the questionnaires:

Collaborative Knowledge Management Practices (CKMP) is a set of practices enabling individuals from different organizations to collectively create, share, access, and apply knowledge across company boundaries to achieve the business objectives of the entire supply chain.

Knowledge or Supply Chain Knowledge in this survey refers to any expertise and know-how possessed by supply chain participants about market predictions, product/service design, purchasing, sourcing, fabrication, logistics, and delivery that are essential to create and retain competitive advantage for the entire supply chain. Examples are tips for a successful sales promotion campaign, design concepts of a new product, shipping schedule of available trucks for on-time delivery.

Trading partner is the participant of a firm¡¯s supply chain. It refers to any external organization that plays an integral and critical role in the firm and whose business fortune depends all or in part on the success of the firm. This includes customers, suppliers, contract manufacturing, subassembly plants, distribution centers, wholesalers, retailers, carriers, freight forwarding services and so on.

Appendix F Online Questionnaire for CKMP Non-Adopters

ATTENTION:

This questionnaire is designed for those firms that are NOT currently involved in collaborating with their supply chain partners for knowledge management activities. Please take the time to answer the following questions. Thank you very much.

If you believe you entered this site in error. You firm is actually sharing knowledge with your trading partners, please click here to get into another questionnaire.

		ii
Please answer the following questions about your firm		
1	Annual Sales (year 2005 in US million $) [Please Choose]	
2	Number of employees [Please choose]	
3	Type of Industry your firm is in [Please choose] If other industry, please specify: [ ]	
4	Please rank the position of your company in your supply chain (mark all that apply) ☐ Raw material supplier ☐ Component supplier ☐ Assembler ☐ Sub-assembler ☐ Manufacturer ☐ Distributor ☐ Wholesaler ☐ Retailer	
5	Please indicate the number of tiers across your supply chain: [Please choose]	
6	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	
7	Some supply chains have a channel master (hub company), which is a company that determines the structure and operations of the whole supply chain, and coordinates the activities across it. Does the supply chain of your firm is in have a channel master? ○ Yes ○ No If Yes, is your firm the channel master in the supply chain? ○ Yes ○ No	

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Please answer the following information about yourself (the respondent):					
8. Your present job title is		9. Your Present job functions (mark all that apply)			
ii	○ CEO/President ○ Manager ○ Director ○ Other, Please specify ☐	☐ Corporate executive ☐ Distribution	☐ Purchasing manager ☐ Sales	☐ Purchasing supervisor ☐ Other, please specify	☐ Manufacturing/production ☐
10	The years you have worked for this company: Please Choose				

ii

What do you think are the reasons that your firm is not engaged in collaborating with partner firms for knowledge management activities?

Submit Reset