IMPACT OF KNOWLEDGE MANAGEMENT ON SUPPLY CHAIN PERFORMANCE IN MANUFACTURING INDUSTRIES

A THESIS

Submitted in partial fulfilment of the requirements for the award of the degree

of

DOCTOR OF PHILOSOPHY

in

MANAGEMENT STUDIES

by

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DECEMBER, 2010

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
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CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in this thesis entitled **IMPACT OF KNOWLEDGE MANAGEMENT ON SUPPLY CHAIN PERFORMANCE IN MANUFACTURING INDUSTRIES** in partial fulfilment of the requirements for the award of the Degree of Doctor of Philosophy and submitted in the Department of Management Studies, Indian Institute of Technology Roorkee, Roorkee is an authentic record of my own work carried out during the period from July 2007 to December 2010 under the supervision of Dr. S. Rangnekar, Associate Professor, Department of Management Studies, Indian Institute of Technology Roorkee, Roorkee, India.

The matter presented in this thesis has not been submitted by me for the award of any other degree of this or any other Institute.

(AVADHESH DALPATI)

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

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ABSTRACT

Knowledge is nowadays being regarded as the most important strategic resource in organizations, and the management of this knowledge is considered critical to organizational success. If organizations have to take strategic advantage of the knowledge they possess, they have to understand how the knowledge is created, shared, and used within and across the organizations. More and more organizations are attempting to set up knowledge management (KM) systems and practices to more effectively use the knowledge they have and numerous publications have discussed the importance of knowledge in organizations. Even so, there is much to learn and understand about how knowledge is created, shared, and used along the supply chain.

In addition, manufacturing industries tend to focus specifically on their core business functions and way out more and more to outsourcing several of their non-core functions. In turn, this practice has lead to larger and more complex supply chains. The successful management of these chains is one of the primary objectives for manufacturing organizations to sustain competitiveness (Haq and Kannan, 2006). Therefore, value addition through supply chain management (SCM) has become a potentially valuable way of securing competitive advantage and improving organizational performance, as it is believed nowadays that competition is no longer between organizations, but among their supply chains. The integration of supply chains not only focuses on tangible resources and assets, but also on intangibles such as knowledge. Therefore, it can be emphasized that knowledge is becoming the primary resource capable of offering competitive advantage and continued growth for supply chain partners. Hence, the effective management of knowledge assets has become a top priority in a supply chain. However, the extant literatures have not specifically focused on empirically elaborating the impact of KM processes and SCM practices on supply chain performance. Looking to this gap in the

literature, this study is focused on investigating the relationship among the measures of KM processes, SCM practices and supply chain performance in the context of manufacturing industries in India.

Data are collected with the use of both random and non-random samples of 357 respondents belonging to top and middle level management executives in the area of supply chain management and knowledge management. The database consists of valid responses of 357 respondents from 88 manufacturing firms spread over 11 states in India. For data collection, a structured questionnaire comprising of 66 items using a 5-point Likert scale is developed. The kinds of validity of the measures in particular content-related (face and content validity), and construct-related (convergent and discriminant validity) have been thoroughly analyzed. The reliability of the entire measure is found to be satisfactory. The statistical analyses such as correlation analysis, exploratory factor analysis, and simple and hierarchical regression analysis were performed with the help of SPSS 15.0 to achieve study objectives, also confirmatory factor analysis was carried out with the help of LISREL 8.7 package to investigate the role of KM processes and supply chain practices in their relationship with the supply chain performance measures.

The results of these analyses show that among the variables of firm's characteristics, firm's position in the supply chain is positively correlated with supply chain flexibility performance. In addition to this, firm's position in supply chain has substantial positive association with all factors of KM process and SCM practices. Firm's size in terms of employee strength has significant positive correlation with overall KM processes and SCM practices. Importantly, all the studying variables show a significant positive relationship with constructs of supply chain performance.

The findings of hierarchical regression analysis (HRA) supported hypotheses related with objective 7. In general, the mediation implies a causal hypothetical relationship in which an independent variable causes a mediator that causes a dependent variable. The HRA results observed that SCM practice factors supply chain integration (SCI), Just-In-Time capabilities (JIT), and customer service management (CSM) significantly predicted supply chain flexibility performance. The mediators knowledge acquisition (KA) and knowledge protection (KP) cause for the diminishing effect of supply chain practices on supply chain flexibility performance. The main effects of SCM practice factors supply chain information sharing (IS), JIT, and CSM significantly predicted supply chain resource performance while knowledge application (KAP) and KP are found to mediate between SCM practices and supply chain resource performance. The effects of SCM practice factors SCI, JIT, and CSM significantly predicted supply chain output performance while KM processes, KA and KAP, act as mediators in the relationship between supply chain practices and output performance. Thus, these findings provide strong support for concerned hypotheses.

Confirmatory factor analysis is conducted to assess the model fit with collected data and prove the developed models as statistically accepted models. This analysis is carried out for the model of (1) predictors of KM processes, supply chain practices and supply chain performance (2) mediating and moderating role of KM process factors in between SCM practices and supply chain performance, and (3) mediating role of SCM practices factors in between KM processes and supply chain performance. In line with Hair *et al.* (1998) and Joreskog and Sorbom (1993) the goodness-of-fit statistics of the analyses indicated that each model except moderating roles of KM processes and SCM practices (that are partially supported) are well confirmed with the data.

ACKNOWLEDGMENT

I wish to express deep sense of gratitude and indebtedness to my supervisor, **Dr. Santosh Rangnekar,** Associate Professor, Department of Management Studies, Indian Institute of Technology Roorkee, Roorkee for his proficient guidance, whole-hearted cooperation and help in carrying out this work. This thesis could not have attained its present form, both in content and presentation, without his active interest, direction, and guidance. His unmatched excellence in the subject, prolific energy, and personal care has been the source of inspiration. His encouragement throughout the work and pains taking effort in providing valuable suggestions in giving final shape to this text are gratefully acknowledged.

I would like to thank Prof. V. K. Nangia, Professor and Head of the Department of Management Studies and Prof. T. R. Gulati, Prof. M. L. Kansal, Doctoral Research Committee (DRC) members, for their continuous administrative support, recommendations, and useful suggestions in every possible way that helped me to accomplish the thesis work as per schedule. I want to acknowledge the help from the staff of Department of Management Studies to provide administrative support and facilities for my work.

Thanks are due to Professor and Coordinator, Q.I.P. Centre, IIT Roorkee for providing necessary facilities to carry out research and granting fellowship.

I am thankful to the Director, Shri G.S. Institute of Technology and Science (SGSITS) Indore, (M.P.) for providing the sponsorship for PhD under QIP Scheme of Govt. of India.

I am immensely grateful to Prof. R.C. Gupta, Professor and Head, Department of Industrial and Production Engineering, SGSITS, Indore for his persistent encouragement and affection towards me.

Words of appreciation are due to my colleagues Mr. Praveer Agrawal, Mr. Rakesh Kaul, Mr. Sandeep Garg, Mr. Suyog Jhawar, and Mr. Bhupendra More at SGSITS, Indore, who have supported and helped me to collect data from industries, without whom the data collection process would have surely been a nightmare.

Thanks are also due to Mr. Devender Singh, Ms. Shigufta Henna Uzma, Mr. Rajiv Mishra, Mr. Rudra Rameshwar, Ms. Geeta Rana, Mr. Umesh Kumar, Mr. C.S.K. Reddy, Mr. Kottala Sriyogi, Col. Mohd. Azam, Mr. Alok Goyal, Mr. Ajay Bhargava, Mr. Kesheo Prasad, Mr. Sanjeev Kumar, Mr. Sabin Mishra, Mr. Sandeep Bhongade, Mr. Suman Kant, Mr. Kaleem Jaidi, Mr. Sanjay Burele and all the friends who extended their support, whenever it was needed.

Special words of thanks are short to express the feelings for my friends Dr. M.K. Barua, Prof. D.S. Ajnar, Dr. K.R. Aharwal, Dr. M. Birasnav, Dr. Shyam Narayan, Prof. M.P.S. Chawla, and Dr. R.D. Patidar for inducing the initial flux and subsequent support for this research work.

My parents deserve special mention because they are greatly instrumental in bolstering my determination to achieve my goal. Finally, I wish to express my great indebtedness to my wife (Neeluji) for her loving support. I wholeheartedly dedicate this work to my kids (Riya and Baba) who are like angels to me.

Last but not the least, I offer my greatest gratitude to the almighty, Shree Satguru Gajanan Maharaaj, one for bestowing with dexterity and wisdom, and his gracious presence throughout the research work.

AVADHESH DALPATI

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INTRODUCTION

1.1 Introduction

Today, there is a profound recognition by academicians and practitioners about the importance of managing knowledge in order to survive a constantly changing and fierce marketplace (Davenport *et al.*, 1998; Desouza, 2002; Desouza and Evaristo, 2003). It is argued by many that organizations enjoy a competitive edge if they know how to create, store, disseminate and exploit organizational knowledge. Drucker (1993) suggested that in the new economy knowledge is not just another resource as other factors of production- land, labour, and capital- it is 'the' strategic resource. Knowledge management (KM) systems are therefore becoming increasingly popular in business organizations. In a supply chain it is very crucial to comprehend information and knowledge sharing from one end to the other in the required format. In a supply chain for organizations with many suppliers the effective use of KM system is critical to effectively plan and forecast for future operations. In addition, manufacturing industries tend to focus specifically on their core business functions and way out more and more to outsourcing several of their non-core functions. In turn, this practice has lead to larger and more complex supply chains. The successful management of these chains is one of the primary objectives for manufacturing organizations to sustain competitiveness (Haq and Kannan, 2006).

The supply chains in general form vast networks that extend both on the upstream side into a network of suppliers and on the downstream side into a network of customer companies, distributers, retailers and end consumers. The multidirectional flow of knowledge across the supply chain makes the interactions among the supply chain members highly decentralized. A supply chain is considered to be successful only when all the products, services, money, and information flow smoothly across the supply chain. If any member in the supply chain is a poorly managed unit, the entire chain suffers from the disruptions in the flow. Disrupted flow of these attributes leads to critical problems in coordination, such as delayed deliveries, inventory pileups, manufacturing downtime, inadequacies in supplies, empty store shelves, late payments etc. Nowadays organizations depend quite heavily on their supply chains and therefore smooth and sophisticated supply chains are a key element to successful global business and hence effective KM systems along the supply chains are inevitable in the twenty-first century. Desouza *et al.* (2003) regard KM systems as the life-blood of the supply chains. Synchronization of information leads to minimum product cycle times, lower costs and deliver greater value to all of its customers thereby organizations achieving competitive advantage in the marketplace.

Complexity in capturing, organizing, and disseminating vital knowledge along the supply chain increases by several magnitudes as the members increase in the supply chain. The management of knowledge among interfaces of suppliers, manufacturers, distributers, retailers and customers is critical to the success of the supply chain as each supply chain member has disparate knowledge based applications. Therefore, for a supply chain to be optimized all members of the chain must be interconnected to enable the smooth flow of knowledge. The first attribute is the connectivity in the supply chain to allow knowledge flow throughout the supply chain. The second attribute is the communication of this knowledge that helps all members in the supply chain to make effective decisions. The third attribute is the ability to collaborate in a real-time fashion, encouraging knowledge sharing and allowing the supply chain to adjust to marketplace dynamics that may have an impact to supply chain's demand forecasting, order fulfillment production and logistics requirements (Desouza and Evaristo, 2003).

In summary, KM systems in supply chains need to support the following key atrributes:

- Support a supply chain wide vocabulary to facilitate a common understanding of knowledge shared;

- Each member in the supply chain must identify, model and explicitly represent their knowledge; and
- The supply chain shares and reuses their knowledge among differing applications for various types of uses that enables sharing of existing knowledge sources and also future ones.

Desouza (2003) elaborates the challenges of deploying KM system within supply chains to create competitive advantage become critical due to:

- the marketplace is progressively becoming more competitive and accordingly pace of innovation is growing, so that knowledge must evolve and be assimilated at ever-faster rate.
- competitive pressures are reducing the size of the knowledgeable workforce.
- organizations are managing their business activities focused on creating customer value. Staff functions are being reduced, as are management hierarchical structures.
- there is a need to replace informal KM practices with a formal method in customer oriented business processes.
- it takes time to acquire and experience knowledge.
- nowadays, there is a trend for employees to get retire earlier for better future options leading to loss of vital organizational knowledge.
- current practices of outsourcing business activities such as engineering, IT services, and operations result into heavy reliance on other organization's expertise and it sometimes leads to diminishing customer value. KM systems could help organizations strike a balance between critical make or buy decisions.

Desouza (2003) further emphasize that KM and supply chain management (SCM) are at a crossroads in industries across the globe. Pressures to provide escalating customer value at reduced cost and shorter cycle times are at the heart of strategic initiatives in almost every industry. These initiatives become very difficult to achieve in today's dynamic business environment that rewards downsizing of thousands of employees in hope of accomplishing cost reduction without realizing its impact on their business and customers.

SCM is now seen as an important element in strategy (Fuller *et al.*, 1993). Similarly Information technology (IT) has emerged as a critical enabler of effective SCM. IT along with providing mechanism to collect and store huge quantity of supply chain data also provides opportunity to analyze this abundant for decision making. Effective data analysis can help in reducing the operating costs and enable efficient use of resources within the supply chain. Integrated IT systems are being adopted by supply chain members and customers allowing the firms to share relevant information more effectively with its supply chain partners. Firms can increase the benefits by improving information sharing, planning and execution in IT enabled supply chains that include distributors and customers (Sodhi, 2001).

More and more firms have started collaborating with their supply chain partners to share information and carry online transactions which require real-time decision making. It has become important to have better insight of the impact of collaboration on supply chain performance parameters such as inventory policies, customer service levels and related costs. Cachon and Fisher (2000) have identified that with information sharing the supply chain will function in a more efficient and cost effective manner. But effective collaboration can only occur if easy access is given to the desired supply and demand information and all partners are willing to share the benefits of collaboration. The members in the supply chain benefits from significantly reduced demand uncertainties and hence safety stocks, reduced inventory holding and stock-out costs, reduced transportation costs and improved service levels. The distributer on the other hand can benefit due to improved service levels and also from a possible share of savings in terms of discounts and other revenues sharing mechanism that serve as an incentive to share the desired information (Lee *et al.*, 2000). Lee and Whang (2000) have discussed various types of information that can be shared across the supply chain such as inventory, sales, demand forecast, order status, dispatch details and production schedules.

1.2 Knowledge Management

KM is based on the belief that an organization's most valuable asset is the knowledge of its employees. This is not a new idea - organizations have been managing "human resources" for years. What is new is the focus on knowledge. This focus is being driven by the prevailing accelerated pace of change in organizations as well as in society as a whole. KM recognizes that today nearly all jobs involve "knowledge work" and so all employees are "knowledge workers" to some extent - meaning that their job depends more on their knowledge than their working skills. Therefore, most important KM activities in an organization are creating, sharing and using knowledge. As managers and KM practitioners, we all rely on our know-how to perform jobs effectively. Technological advances are being made continually so there are opportunities for learning new knowledge. Accordingly, Government policies as well as management practices are also evolving. The current modernization programme requires us to let go of what we knew and to learn and apply new knowledge.

1.2.1 Evolution of Knowledge Management

Knowledge management evolved from the thinking of academics and pioneers such as Peter Drucker in the 1970s, Karl-Erik Sveiby in the late 1980s, and Nonaka and Takeuchi in the 1990s. As a discipline it appeared somewhere during early 1990s. By the early 1990s, a growing body of academics and professionals recognized KM as the new business practice, and it began to appear on agendas of conference and business journals. During this time, economic, social, and technological changes were transforming the organizations' work environment. Globalization brought new opportunities and increased competition, which was responded by downsizing, merging, acquiring, reengineering and outsourcing strategies. Many organizations rationalized their workforce, enhanced their productivity and profits by adopting advances in computer and network technology. By the mid-1990s, it became widely acknowledged that the competitive advantage of some of the world's leading organizations was being carved out from organizational knowledge assets such as competencies, customer relationships and innovations.

Managing knowledge therefore became a mainstream business objective as other organizations sought to follow the market leaders. Many of these organizations took the approach of implementing "KM solutions", focusing almost entirely on KM technologies. However, they achieve limited success and therefore, questions began to be asked about whether KM wasn't simply another fad that looked great on paper, but in reality did not deliver. However, on closer inspection, organizations realized that it wasn't the concept of KM that was the problem as such, but rather the way that they had gone about approaching it. Reasons for the limited success of KM systems, particularly at early stage, in organizations included:

- The focus was on the technology rather than the business functions and its employees.
- There was too much hype - with technology vendors and consultants cashing in on the latest management fad.
- Companies spent too much money (usually on state of the art technologies) with little or no return on their investments.
- Most of the KM literatures were very conceptual and lacking in realistic recommendations.
- KM was not integrated into business processes and work behaviour.
- Lack of incentives

- There wasn't sufficient and sincere involvement of top level management in the initiation and implementation of KM.

Fortunately, organizations are now recognizing these early mistakes and are beginning to take a appropriate approach towards KM implementation - one in which the emphasis is more on people, behaviours and ways of working, than on technology. A more popular view is that KM may not remain as a distinct discipline, rather will become embedded in the organizational work culture.

1.2.2 Knowledge

To define KM, it is necessary first to define knowledge. Knowledge is a broad and abstract notion that has directed epistemological debates in the literatures. Since we have an applied orientation, the following working definition of knowledge is found to be suitable, based on the work of Nonaka (1994) and Huber (1991). Nonaka and Takeuchi (1995) provide a more philosophical distinction, starting from the traditional definition of knowledge as 'justified true belief'; they define knowledge as 'a dynamic human process of justifying personal belief toward the truth' (p. 58). They contend that in order to produce innovation, it is necessary to create knowledge. For them, organizational knowledge creation is 'the capability of a company as a whole to create new knowledge, disseminate it throughout the organization and embody it in products, services, and systems' (p. 58).

The concept of tacit knowledge has been explained by Polanyi (1966), who stresses the importance of the 'personal' way of knowledge construction, affected by emotions and acquired at the end of the process involving every individual's active creation and organization of the experiences. Polanyi (1966) posits that all knowledge is either tacit or embedded in tacit knowledge. On one hand, tacit knowledge is not easily expressed in formalized ways, and is context-specific, personal, and difficult to communicate. On the other hand, explicit knowledge is the codified one, expressed in formal and linguistic ways, easily transmittable and storable, and expressible in words and algorithms. Table 1.1 shows the comparison of the properties of tacit and explicit knowledge.

Table 1.1: Comparison of Properties of Tacit and Explicit Knowledge

Properties	**Tacit Knowledge**	**Explicit Knowledge**
Approach	Coaching and mentoring to transfer experiential knowledge on a one-to-one, face-to-face basis	Transfer of knowledge via products, services, and documented processes
Usability	Ability to adapt, to deal with new and exceptional situations	Ability to disseminate, to reproduce, to access, and to reapply throughout the organization
Content	Expertise, know-how, know-why	Ability to teach, to train
Sharing capability	Ability to collaborate, to share a vision, to transmit a culture	Ability to organize, to systematize; to translate a vision into a mission statement, into operational guidelines

Alavi and Leidner (1999) describe Knowledge as a justified personal belief that increases an individual's capacity to take effective action. Action in this context requires physical skills and competencies (e.g., playing tennis), cognitive/intellectual action (e.g., problem solving), or both (p. 5). The definitions of knowledge in the literature explicitly make a distinction among knowledge, information and data. For example, Vance (1997) defines information as data interpreted into a meaningful framework while knowledge is the information that has been validated and thought to be true. Maglitta (1996) suggests that data is raw numbers and facts, information is processed data, and knowledge is actionable information. Figure 1.1 shows these three factors in the knowledge value chain as suggested by Shankar *et al.* (2003).

While each conceptualization makes inroads into understanding differences among the three terms, they fall short of providing a means to readily determine when information becomes knowledge. The problem appears to be the assumption of a hierarchy from data to information to knowledge with each varying along some dimension, such as context, usefulness/insight, or interpretability. What we consider key to distinguishing effectively between information and knowledge is not found in the content, structure, accuracy, or utility of the supposed information or knowledge. Rather, knowledge is information possessed in the mind of an individual: it is personalized or subjective information related to facts, procedures, concepts, interpretations, ideas, observations and judgments (which may or may not be unique, useful, accurate, or structurable). We are basically positing that knowledge is not a radically different concept than information, but rather that information becomes knowledge once it is processed in the mind of an individual (tacit knowledge in the words of Polanyi, 1962 and Nonaka, 1994). This knowledge then becomes information again (or "explicit knowledge" as inferred by Nonaka, 1994) once it is articulated or communicated to others in the form of text, computer output, spoken, or written words or other means. The recipient can then cognitively process and internalize the information so that it is converted back to tacit knowledge. This is consistent with Churchman's (1972) conceptualization of knowledge and his statement that "knowledge resides in the user and not in the collection (of information)".

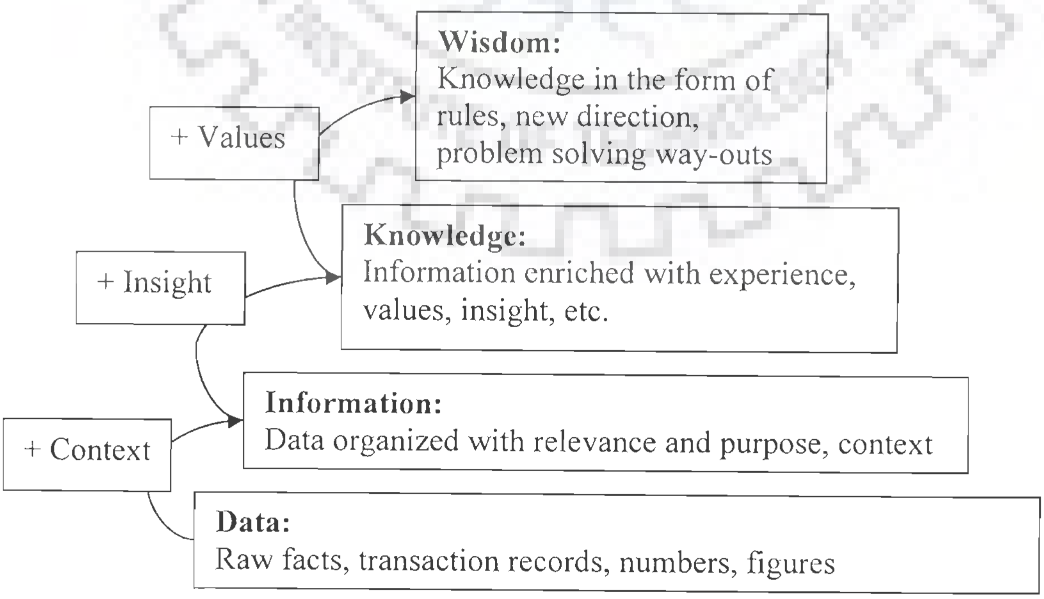

Figure 1.1: Knowledge value chain (Shankar *et al.*, 2003)

Two major points emerge from this conceptualization:

1. Because knowledge is personalized, in order for one person's knowledge to be useful for another individual, it must be communicated in such a manner as to be interpretable and accessible to the other individual.

2. Hoards of information is of little value: only that information which is actively processed in the mind of an individual through a process of reflection, enlightenment, and learning can be useful.

KM was initially defined as the process of applying a systematic approach to the capture, structure, manage, and dissemination of knowledge throughout an organization in order to work faster, reuse best practices, and reduce costly rework from project to project (Nonaka and Takeuchi, 1995; Pfeiffer and Sutton, 1999; Ruggles, 1998). As a field of study, KM has been undergoing expanded and updated definitions that builds on past institutional experiences and creates new mechanisms for exchanging and creating knowledge (Lytras *et al.*, 2002). Many of the definitions in the literature focus on similar fundamental ideas, including the concept that KM involves information technologies, business processes, knowledge repositories and individual behaviors. A detailed framework of some significant definitions is presented in chapter 2.

1.2.3 KM Process and Cycle

Here we will focus on a number of key processes that are central to the management of knowledge in organizations. Generic processes, especially communication and learning, underpin many of the more focused processes, such as knowledge sharing, acquiring, integrating, mapping, and capturing etc. It is revealing that arguably the most important process - that of knowledge creation - is often ignored by the KM professionals. Differing priorities are observed in the variety of ways that firms approach their KM initiatives. For the majority of firms, the priorities are the "capture" of employees' knowledge, exploitation of existing knowledge resources or assets, improved access to expertise, transferring knowledge among projects, and building and mining knowledge stores.

Quintas *et al.,* (1999) summarized some important insights to the cluster of KM projects:

- knowledge sharing (targeted on communicating, learning, reviewing, capturing and sharing knowledge);
- use of stories to communicate experience (targeted on transferring learning);
- after-action reviews (capturing learning from experience);
- intelligent agents (identifying specific and tailored information or contacts);
- people database (providing access to expertise);
- expert interviews (capturing expertise);
- learning from mistakes (surfacing and capturing learning in a non-blame culture, avoiding costly repetition); and
- expert master classes (sharing expertise).

Effective KM requires an organization to identify, generate, acquire, diffuse, and capture the benefits of knowledge that provide a strategic advantage to that organization. One of the major KM processes aims at identifying and locating knowledge and knowledge sources within the organization. Valuable knowledge is then translated into explicit form, often referred to as codification of knowledge, in order to facilitate more widespread dissemination. Networks, practices, and incentives are instituted to facilitate person-to-person knowledge transfer as well as person-to-person knowledge content connections in order to solve problems, make decisions, or otherwise act based on the best possible knowledge foundation. Once this valuable, field-tested knowledge and know-how is transferred to an organizational knowledge repository, it is said to become part of "corporate memory." As was the case with a generally accepted definition of KM, a similar lack of consensus exists with respect to the terms used to describe the major steps in the

KM cycle. Table 1.2 summarizes the major KM cycles found in the KM literature. Six models of KM cycles were selected based on their ability to meet the following criteria:

- They are implemented and validated in real-world settings.
- They are comprehensive with respect to the different types of steps found in the KM literature.
- They include detailed descriptions of the KM processes involved in each step.

These models are propounded by Wiig (1993), Meyer and Zack (1996), Nickols (1999), Bukowitz and Williams (2000), Rollet (2003), and McElroy (2003).

Meyer and Zack KM cycle: The Zack (1996) KM cycle is derived from work on the design and development of information products. They propose that research and knowledge about the design of physical products can be extended into the intellectual realm to serve as the basis for a KM cycle. The KM cycle consists primarily of creating a higher value-added "knowledge product" at each stage of knowledge processing. Meyer and Zack analyzed the major developmental stages of a knowledge repository and mapped these stages onto a KM cycle. The stages are acquisition, refinement, storage/retrieval, distribution, and presentation/use.

Acquisition of data or information addresses the issues regarding sources of "raw" materials such as scope, breadth, depth, credibility, accuracy, timeliness, relevance, cost, control, and exclusivity. The guiding principle is the well-known proverb of "garbage in, garbage out." That is, source data must be of the highest quality; otherwise the intellectual products produced downstream will be inferior.

Refinement is the primary source of value addition; it may be physical (e.g., migrating from one medium to another) or logical (restructuring, relabeling, indexing, and integrating.) Refining also refers to cleaning up (e.g., "sanitizing" the content so as to ensure complete anonymity of sources involved) or standardizing (e.g., conforming to templates of a best practice or lessons learned as used within that particular organization). This stage of the Meyer and Zack cycle adds value by creating more readily usable knowledge objects and by storing the content more flexibly for future use.

Storage/retrieval forms a bridge between the upstream acquisition and refinement stages that feed the repository and downstream stages of product generation. Storage may be physical (file folders, printed information) or digital (database, KM software).

Distribution describes how the product is delivered to the end user (e.g., fax, print, e-mail) and encompasses not only the medium of delivery but also its timing, frequency, form, language, and so on.

The final step is presentation or use. It is at this stage that context plays an important role. The effectiveness of each of the preceding value-added steps is evaluated here: does the user have enough context to be able to make use of this content?

The Bukowitz and Williams KM Cycle: Bukowitz and Williams (2000) describe a KM process framework that outlines "how organizations generate, maintain and deploy a strategically correct stock of knowledge to create value" (p. 8). The get, learn, and contribute phases are tactical in nature. They are triggered by market-driven opportunities or demands, and they typically result in day-to-day use of knowledge to respond to these demands. The assess, build/sustain, or divest stages are more strategic, triggered by shifts in the macro environment.

The first stage, *get*, consists of seeking out information needed for decision making, problem solving, or innovation. The challenge today is not so much in searching information but in dealing effectively with the enormous volume of available information.

The next stage, *use*, deals with how to combine information in new and interesting ways in order to foster organizational innovation.

The *learn* stage refers to the formal process of learning from experiences as a means of creating competitive advantage. An organizational memory is created so that organizational learning becomes possible from both successes (best practices) and failures (lessons learned). Learning in organizations is important as it represents the transition step between the application of ideas and the generation of new ones.

The *contribute* stage of the KM cycle deals with getting employees to post what they have learned to the communal knowledge base (e.g., a repository). Only in this way can individual knowledge be made visible and available across the entire organization, where appropriate. The theory of the organization needs to be expanded to include capturing the impact of knowledge on organizational performance. This includes identifying new forms of capital such as human capital (competencies), customer capital (the customer relationship), organizational capital (knowledge bases, business processes, technology infrastructure, values, norms, and culture), and intellectual capital (the relationship between human, customer, and organizational capital). Assessment must take these new types of assets into account and focus on how easily and flexibly the organization can convert its knowledge into products and services of value to the customer.

The *build and sustain* step in the KM cycle ensures that the organization's future intellectual capital will keep the organization viable and competitive. Resources must be allocated to the growth and maintenance of knowledge, and they should be channeled in such a way as to create new knowledge and reinforce existing knowledge.

The final step in the Bukowitz and Williams KM cycle is the *divest* step. The organization should not hold on to assets—physical or intellectual—if they are no longer creating value. In this step of the KM cycle, organizations need to examine their intellectual capital in terms of the resources required to maintain it and whether these resources would be better spent elsewhere.

Table 1.2: Comparison of KM Cycles

Wiig (1993)	Zack (1996)	Nickols (1999)	McElroy (1999)	Bukowitz & Williams (2000)	Rollet (2003)
Creation	Acquisition	Acquisition	Individual and group learning	Get	Planning
Sourcing	Refinement	Organization	Knowledge claim validation	Use	Creating
Compilation	Store/retrieve	Specialization	Information acquisition	Learn	Integrating
Transformation	Distribution	Store/access	Knowledge validation	Contribute	Organizing
Dissemination	Presentation	Retrieve	Knowledge integration	Assess	Transferring
Application		Distribution		Build/sustain	Maintaining
Value realization		Conservation		Divest	Assessing
		Disposal			

This involves understanding the why, when, where, and how of formally divesting parts of the knowledge base. It is necessary to be able to understand which parts of the knowledge base will be unnecessary for sustaining competitive advantage and industry viability. Traditional divestiture decisions regarding knowledge include obtaining patents, spinning off companies, outsourcing work, terminating a training program and/or employees, replacing/upgrading technologies, and ending partnerships, alliances, or contracts. The Bukowitz and Williams KM cycle introduces two new critical phases: the learning of knowledge content and the decision as to whether to maintain this knowledge or divest the organization of this knowledge content.

The McElroy KM Cycle: McElroy (1999) describes a knowledge life cycle that consists of the processes of knowledge production and knowledge integration, with a series of feedback loops to organizational memory, beliefs, and claims and the business-processing environment. McElroy emphasizes that organizational knowledge is held both subjectively in the minds of individuals and groups and objectively in explicit forms. Together, they comprise the distributed organizational knowledge base of the company. Knowledge use in the business-processing environment results in outcomes that either match expectations or fail to do so. Matches reinforce existing knowledge, leading to its reuse, whereas mismatches lead to adjustments in business-processing behavior via single-loop learning (Argyris and Schon, 1978). Successive failures from mismatches will lead to doubt and ultimately rejection of existing knowledge, which will in turn trigger knowledge processing to produce and integrate new knowledge. Problem claim formulation represents an attempt to learn and state the specific nature of the detected knowledge gap. Knowledge claim formulation follows as a response to validated problem claims via information acquisition and individual and group learning. New knowledge claims are tested and evaluated via knowledge claim evaluation processes. Evaluation of knowledge claims leads to surviving knowledge claims that will be integrated as new organizational knowledge or falsified/undecided knowledge claims. The record of all such outcomes becomes part of the distributed organizational knowledge base via knowledge integration. Once integrated, they are used in business processing. Experience gained from the use of knowledge in the organizational knowledge base gives rise to new claims and resulting beliefs, triggering the cycle to begin all over again. Knowledge claim validation involves codification at an organizational level.

Information acquisition is the process by which an organization deliberately acquires knowledge claims produced by others, usually external to the organization. *Knowledge claim evaluation* is the process by which knowledge claims are evaluated to determine their veracity and value. This implies that they are of greater value than existing knowledge in the organizational knowledge base. *Knowledge integration* is the process by which an organization introduces new knowledge claims to its operating environment and retires old ones. This includes all knowledge transmission such as teaching, knowledge sharing, and other social activities that either communicate an understanding of previously produced organizational knowledge to knowledge workers or integrate newly minted knowledge.

One of the great strengths of the McElroy cycle is the clear description of how knowledge is evaluated and a conscious decision is made as to whether or not it will be integrated into the organizational memory. The validation of knowledge is a step that clearly distinguishes knowledge management from document management. The KM cycle does more than address the storage and subsequent management of documents or knowledge that has been warehoused "as is." The KM cycle focuses on processes to identify knowledge content that is of value to the organization and its employees.

The Wiig KM Cycle: Wiig (1993) identifies the major purpose of KM as an effort "to make the enterprise intelligent-acting by facilitating the creation, accumulation, deployment and use of quality knowledge" (p. 39).

Knowledge creation may occur through R&D projects, innovations by individuals to improve the way they perform their tasks, experimentation, reasoning with existing knowledge, and hiring of new people. Knowledge may also be created through knowledge importing (e.g., elicit knowledge from experts and from procedure manuals, engage in joint ventures to obtain technology, or transfer people between departments). Finally, knowledge may be created through observing the real world (e.g., making site visits, observing processes after the introduction of a change).

Knowledge synthesis or reconstruction consists of generalizing analyzed material to obtain broader principles, generating hypotheses to explain observations, establishing conformance between new and existing knowledge (e.g., corroborating validity in light of what is already known), and updating the total knowledge pool by incorporating the new knowledge.

Knowledge Codification and modeling involves how we represent knowledge in our minds (mental models, for example), how we then assemble the knowledge into a coherent model, how we document the knowledge in books and manuals, and how we encode it in order to post it to a knowledge repository. Finally, knowledge is organized for specific uses and according to an established organizational framework (such as standards and categories). Examples include a help desk service or a list of frequently asked questions (FAQs) on the company intranet.

1.3 Supply Chain Management

As product life cycle shrank and global competition intensified in the 1990s, many manufacturers collaborated with their suppliers to improve product quality and lead time. Accordingly, many wholesalers, distributers, and retailers also integrated their logistics activities to achieve competitive advantage. Eventually, these two major functional areas of the manufacturing organizations evolved and merged into a holistic and strategic approach to materials and logistics management. Many buzzwords such as supply base management, supply chain synchronization, supplier integration, partnerships, etc. can be found in the literature to address the elements of this new management philosophy. The term supply chain management (SCM) is most widely used to represent this area of business management (Tan *et al.*, 2002). Despite its popular applications, there is dearth of an explicit and commonly agreed standard set of specific activities and practices, and the way in which SCM impacts the performance of the organization as a whole. However, as pointed by Christopher (1992), it has been immensely emphasized among the researchers and professionals that organizations will not seek to achieve cost reductions or profit improvement at the expense of their supply chain partners, but rather seek to make the supply chain as a whole more competitive. In short, the argument that it is supply chains, and not individual firms, that compete is at central focus in the field of supply chain management.

1.3.1 Evolution of Supply Chain Management

In the 1950s and 1960s, most manufacturers put emphasis on mass production as the primary operations strategy to reduce the cost of unit production, with little product or process flexibility. During this time horizon, new product development was slow and relied exclusively on the capacity of in-house production. Surplus inventory was used to cushion bottleneck operations to keep a balanced flow on production lines, thus leading to huge investment in work-in-process (WIP) inventory. Sharing technology and knowledge with suppliers and customers was considered too risky and therefore unacceptable, thus little importance was placed on cooperative and strategic buyer-supplier partnerships. Later, material requirements planning (MRP) was developed in the 1970s and managers realized the adverse effect of huge WIP inventories on manufacturing cost, quality, product development, as well as delivery lead-time. Manufacturers shifted to new concepts of materials management to improve performance.

In the light of intense global competition of the 1980s most of the manufacturing organizations world-wide were forced to offer low-cost, high-quality, and reliable products with greater design flexibility. To improve manufacturing efficiency and cycle time manufacturers relied on Just-In-Time (JIT) and other similar management programs. Using JIT production strategy with very low level of inventory to cushion production problems, manufacturers began to realize the potential benefits of maintaining strategic and cooperative relationships with their suppliers. Subsequently, the concept of SCM emerged as manufacturers practiced strategic partnerships with immediate suppliers. Tan (2001) posits that logistics experts advanced the SCM concept incorporating the physical distribution, transportation, and warehousing functions.

The advancement of SCM continued into the 1990s as organizations further extended best practices in managing corporate resources to include strategic suppliers and the logistics function (Tan, 2001). Manufacturers started trusting certified suppliers' quality control capabilities instead of performing non-value-adding activities such as receiving inspection etc. (Inman and Hubler, 1992). In today's competitive scenario, most of the manufacturers and retailers are taking up the concept of SCM to improve efficiency and effectiveness across the supply chain. Morgan and Monczka (1995) emphasize that manufacturers are exploiting suppliers' technological capabilities to support new product development process, and St. Onge (1996) elaborates further that retailers also integrate with their logistics providers to achieve direct store delivery without the need for receiving inspection.

1.3.2 Definitions and Key Ideas of Supply Chain Management

It is necessary to note how the term 'supply chain' is defined before any attempts are made to understand the term 'supply chain management'. Table 2.1 highlights some of the definitions and key ideas of the term 'supply chain management'. A supply chain is a set of integrated production process wherein raw materials are transformed into useful finished products as per the requirements of customers. Beamon (1998) described supply chain comprising of two basic integrated processes: (1) the production planning and inventory control process, and (2) the distribution and logistics process (p. 282). As illustrated in Figure 1.2, these processes provide the basic framework for the conversion and movement of raw materials into final products. The general objective of every supply chain is to maximize the overall value generated that is the difference between worth of the finished product to the customer and the total effort the supply chain invests in filling the respective customer demands. Chopra *et al.* (2003) highlighted that for manufacturing supply chains, value will be strongly correlated with supply chain profitability that is the difference between the revenue generated from the customers and the overall costs across the supply chain. One of the simplest definitions presented for the SCM as the physical network that begins with the supplier and ends with the customer (Patricia, et *al.*, 1996). Similar to this definition, earlier, Scott and Brook (1991) also suggested incorporating all the organizations involved until the end user. According to these definitions, SCM encompasses the entire value chain and addresses materials and supply management from the extraction of raw materials to the end of useful life. Baatz (1995) further expands SCM to include recycling or re-use. Figure 1.3 shows the flow patterns and firms involved in such a value chain as portrayed by New and Payne (1995).

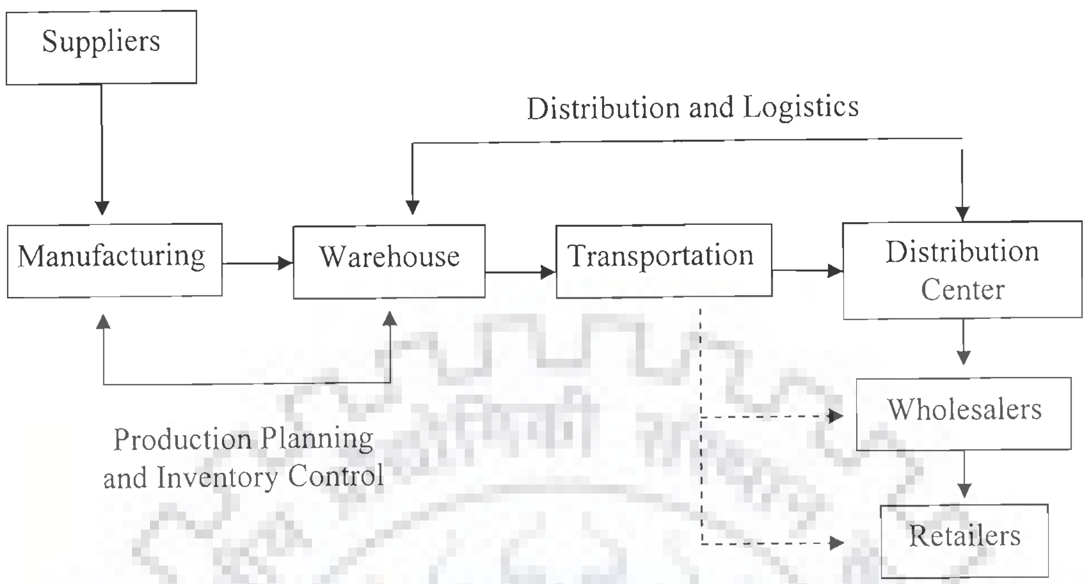

Figure 1.2: Supply chain process (Beamon, 1998)

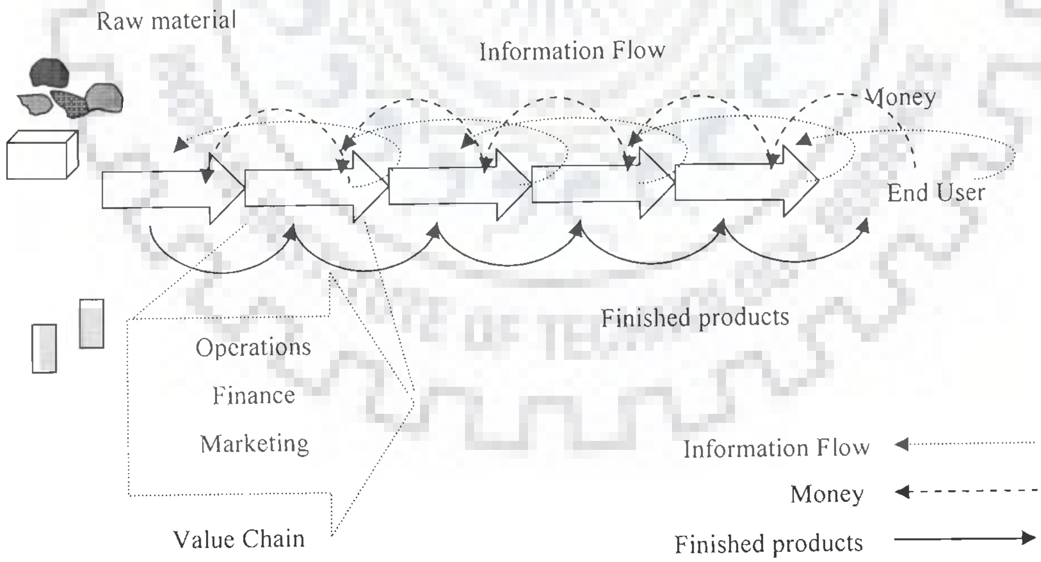

Figure 1.3: Supply Chain (New and Payne, 1995)

It begins with the extraction of raw materials, through the manufacturers, wholesalers, retailers, and the final users. Where appropriate, supply chain also encompasses recycling or re-use of the products or materials. Tan (2001) thought of SCM as to consider all organizations within the supply chain as an integrated virtual business entity. He posits that it includes activities such as planning, product design and development, sourcing, manufacturing, fabrication, assembly, transportation, warehousing, distribution, and post delivery customer support.

While in principle, the above discussion of SCM addresses all the activities, processes and firms throughout the supply chain, a practical approach to SCM is to consider only strategically important suppliers in the chain (Tan, 2000). Technically, the supply chain is too complex to achieve a full integration of all business entities within it in order to reap the benefits offered by SCM. This approach leads to a slightly modified version of definition of SCM. Cox *et al.* (1995) and Houlihan and Houlihan (1999)'s definition of SCM reflects this approach. Another definition of SCM emerges from the transportation and logistics literature of the wholesale and retail industry. Ellaram (1991)'s definition focuses on the necessity of integration among various units of supply chain and elimination of waste among them. This emphasizes the importance of physical distribution and integrated logistics. There is no doubt that logistics is an important function of SCM, however, the physical transformation of the products is not a component of this definition.

Generally these definitions link SCM with the integration of systems and processes within and between organizations, which include the upstream suppliers, and downstream customers. SCM is also viewed as the coordination of manufacturing, logistics, and materials management functions across the organizations (Harland, 1996). SCM focuses on how firms utilize their suppliers' capabilities regarding processes and technology to enhance competitive advantage (Farley, 1997) and the coordination of the manufacturing, logistics, and materials management functions within an organization (Lee and Billington, 1992). It is very important to identify the strategically significant business units and the integration among them within a supply chain. Hence 'integration' becomes the key term in all the supply chain activities. This is the common theme among various definitions of SCM. Also, the focus is not only limited to increasing the internal efficiency of organizations but has been broadened to include methods of reducing waste and adding value across the whole supply chain (New and Ramsay, 1997).

Vollman *et al.* (1997) describe SCM as a concept that extends the view of operations from a single business unit to the entire supply chain. This holistic approach is concerned with effective management of the interfaces among all the organizations involved, and the integration of both upstream and downstream processes in the supply chain (Christopher and Juttner, 2000). The objective is to develop greater synergy through collaboration rather than focusing improvement on an individual business unit (New and Ramsay, 1997; Tan, 2000). Collaborations combined with long-term relationships with suppliers are increasingly perceived as a means to utilize resources better through the whole supply chain (Dubois and Gadde, 2000). The outcome of such collaborations and relationships would achieve more profitable outcome for all parties in the chain. Hence, SCM coordinates and integrates all of these activities into a seamless process. A key point in SCM is that the complete process must be viewed as one system. When all strategic organizations in the value chain 'integrate' and act as a single unified entity, performance is enhanced throughout the system of suppliers along the supply chain.

In summary, three distinct descriptions dominate the literature, which are: SCM may be used as a synonym to describe the purchasing and supply activities of organizations; it may be used to describe the transportation and logistics functions of the organizations, distributors and retailers; and it may also be used to describe all the value-adding activities of all the strategic suppliers to the customer's customer in such a way that enhanced customer value is achieved.

1.3.3 Supply Chain Management - Issues and Challenges

Successful implementation of SCM is seen as closely dependent upon the need for breaking down barriers not only between internal departments and business processes, but also across companies within the whole supply chain (Vollman *et al.*, 1997). Such arrangements require considerable commitment and resources, and take time to develop. Its success is also associated with the challenging development of a new culture based on empowerment and on-going and shared learning and continuous improvement. Another challenging and difficult feature of SCM is linked with the emergence of the network organization, which can lead to a complex web of linkages to be coordinated and managed. This can imply difficulties which include lack of common purpose, multiple and hidden goals, power imbalances, culture and procedures, conflict over autonomy and accountability, over-dependence and a continuing lack of openness and opportunistic behaviour (Cox and Townsend, 1998). Despite the recognition of the great benefits of SCM and partly due to the restrictive misapprehensions, growth of integrated SCM can be considered as being at a slower pace. The reasons for the slow growth of integrated SCM include lack of guidelines for creating alliances with supply chain partners, failure to develop measures for monitoring alliances, inability to broaden the supply chain vision beyond procurement and product distribution, inability to integrate the company's internal procedures, lack of trust inside and outside an organization, organizational resistance to the concept, and lack of integrated information systems linking firms.

1.4 Supply Chain Performance

1.4.1 Significance of Performance Evaluation

Performance evaluation is a strategic tool that provides means to achieve the objectives and fulfilling organization's mission. As highlighted in the earlier section, major task in performance measurement is to identify, evaluate and select the performance measures, which are appropriate to assess inter-organizational performance. A general tendency in many firms has been to measure performance, primarily on the basis of cost and efficiency (Skinner, 1971). This has resulted in most measures focusing on financial data such as return on investment, return on sales, price variances, sales per employee, productivity and profit per unit production etc.

To succeed in these conditions, Kanter (1995) suggests that organizations need abundant stocks of three global assets of concepts, competence, and connections, which derive from investments in innovation, learning, and collaboration. Also, Tincher (1994) argues that world class organizations have to practice some crucial strategies and policies in response to the challenge of global competition. One such critical policy is performance evaluation incorporating non-financial performance measures (Sheridan, 1990). With the emergence of global competition since the late 1980s performance measurement has become very relevant with ever-increasing interest in the subject. As discussed earlier in the introduction, the impact of global competition in the current business environment has imposed considerable changes in the way organizations function and therefore, created changes in the nature of work by adopting new management practices, for example JIT, TQM, and SCM, which are targeted at performance improvement. Changing customer demands, quality awareness and growing advances in information and communication technology (ICT) have also led to substantial changes in the market places. In line with above reasons, Dangayach and Deshmukh (2001) argue that, performance evaluation is required to have a strategic input to the above issues. Neely *et al.* (1995) explained performance evaluation as the process of quantifying the efficiency and effectiveness of action; they defined performance measure as 'a metric used to quantify the efficiency and effectiveness of an action'. There are other definitions for performance measurement such as the one provided by Marshall *et al.* (1999), who define performance measurement as the 'development of indicators and collection of data to describe, report on and analyze performance'. Hence, the design and development of performance measurement framework includes development of indicators to measure performance and its evaluation.

Effectively measuring and managing of supply chain performance is a complex and difficult task. If performance measurement is to lead to long-term and continuous performance improvement, then different stages of the performance measurement and management processes such as design of measurement systems, their implementation, and identification of appropriate measures to be used are to be successfully implemented. Organizational support in terms of knowledge sharing, leadership, structure and learning is immensely required for successful implementation.

1.4.2 Supply Chain Performance Measures

Performance measurement is very important as a strategic tool and also provides means to achieve the objectives required, fulfilling a firm's mission/strategy statement. Many firms have been observed to evaluate performance, primarily on the basis of cost and efficiency (Skinner, 1971). Therefore, traditional performance measures have been primarily based on management accounting systems and financial measures (Alaa and James, 1996). This has resulted in most measures focusing on financial data such as return on investment, return on sales, price variances, sales per employee, productivity and profit per unit production etc. As a result of globalization and competition the organizations have started adopting innovative business practices and performance improvement initiatives such as TQM, JIT and SCM. The traditional cost-based measures are found to be inadequate as they fail to incorporate the basic principles of continuous improvement and intangible aspects of performance. Therefore, firms can't manage properly if they can't measure the intangible and non-financial performance also. And hence, performance measurement incorporating non-financial measures has been a topic of great interest throughout most of the 1990s.

1.4.3 Performance Measures: Classification

De Toni and Tonchia (2001) conceptually classified the performances of the operations into two broad categories of 'Cost performances' (financial measures) and 'Non-Cost performances', (non-financial measures) which have further divisions as shown in Figure 1.4.

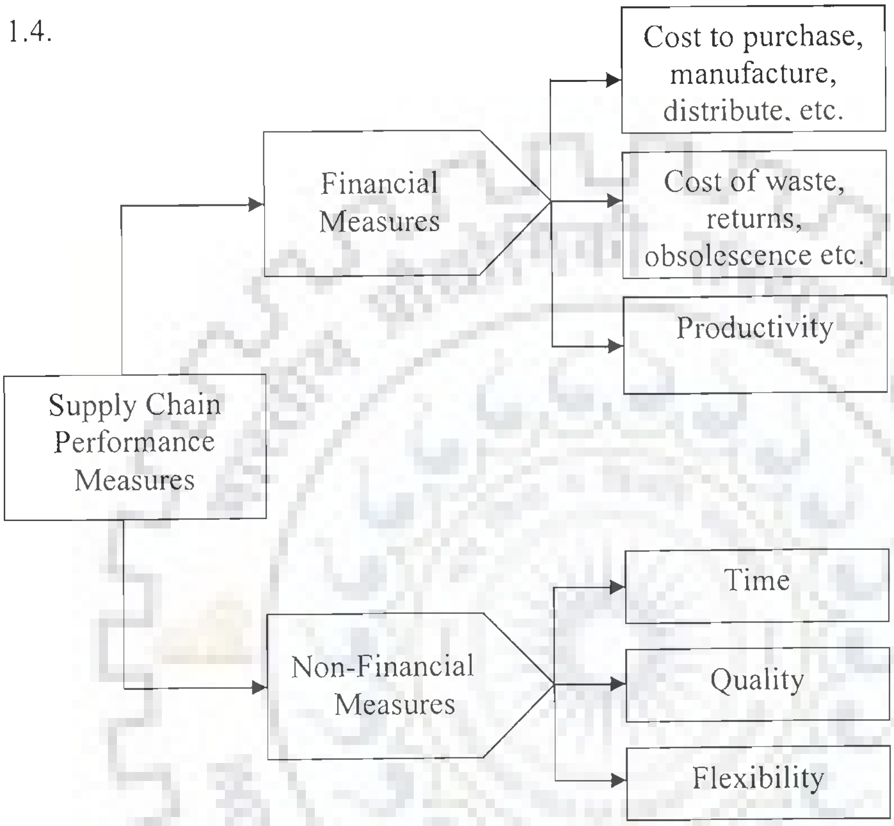

Fig 1.4: Classification of performance measures (De Toni and Tonchia, 2001)

Non-financial performance measures

Non-financial performances include measures related to time, flexibility and quality. It is an important move towards a multi criteria approach, which can correspond to the need of holistic and strategic approach. Non-monetary units of measures generally measure the non-cost performances and as far as they influence the economic and financial performances (net income and profitability), the link with them cannot be calculated in a precise manner as for the cost performances. For example, an average delivery time five days shorter or a product of better quality (which consumes 4 per cent less) surely has a positive impact on the economic and financial performances, but such an impact cannot be quantified in terms of increment in net income and/or profitability. As discussed earlier, non-cost measures are divided into three categories, namely quality, time and flexibility related measures.

Time related measures

Time element has strategic importance in business and hence 'time' has to be used as a strategic metric in performance measurement (Stack *et al.*, 1990). These authors argue that measuring, controlling and compressing time shall improve quality, reduce costs, improve responsiveness to customer orders, enhance delivery, increase productivity, increase market share and increase profits. Time is not a lagging metric and it is always beneficial to reduce time. Supporting this view, Krupka (1992) argues that 'time' is a more important metric than cost and quality since it can be used to drive improvements in both of them. Earlier, Azzone *et al.* (1991) suggested that time measures have to be applied in research and development, operations and sales and marketing as well.

Flexibility related measures

Flexibility (to measure the ability to deal with the dynamic nature of the business) is a performance apart, since it is an ability to change something (for example, the production volume or mix) in relation to all the three performances of cost, time and quality (De Toni and Tonchia, 1998). Being flexible refers to making available the products and services to meet the individual demands of the customers. This has been made possible by the technological developments such as flexible manufacturing systems, group technology, computer integrated manufacturing and also ICT systems development. Various kinds of flexibility include volume flexibility, product mix flexibility, product modification flexibility, process modification flexibility, and expansion flexibility.

Gunasekaran *et al.* (2001) outlined six sets of performance metrics. The emphasis is also on the importance of measuring the non-financial aspects and the non-quantifiable and intangible aspects of performance. These parameters and metrics include the measures at strategic, operational and tactical level and these metrics are aligned to the four basic links that constitute the supply chain: plan, source, make and deliver. The measure sets incorporate measures for the issues related to supplier's relations.

1.5 The Need of Knowledge Management in Supply Chain

In supply chain management, the focal point for the partners is that the unit of analysis is changed from an individual business unit to a supply chain (including parts suppliers, manufacturers, distributors, logistics service providers, wholesalers and retailers). The integration and optimization of three -- material, information and financial-- flows in the supply chain form the core concern of supply chain management. It suggests extensive coordination among multiple functions and independent companies engaged in the delivery of a product or a service to end consumers. Traditional transaction-based intra-organizational relationships give way to partnerships in which information, processes, decisions and resources are shared among partner companies.

There are several major underlying trends that have formed the key drivers for supply chain management. The first is the globalization of businesses. Modern businesses attempt to deploy global resources to maximize the potential opportunities in the global community. This, however, entails the challenges of dealing with long delivery lead times, high buffer stock, complex logistics and high cost of coordination, as companies try to coordinate the three flows across the globe. Another driver is the innovations in the retail landscape. General merchandise store chains like Wal-Mart, wholesale clubs like Price Club, category specialist chains like Toys-R-Us, mail order companies like Lands' End, and virtual electronic stores like Amazon have revolutionized the retail side of supply chains. Innovations like Vendor-Managed Inventory (VMI), everyday low pricing, activity-based costing and cross-docking have triggered industry-wide efforts in supply chain management.

On the supply side, a key driver of SCM is the availability of cost-effective information technologies (IT). In fact, although it is accepted that a supply chain that makes decisions on the basis of global information would clearly dominate one with disjoint decisions by individual members in the supply chain, a well coordinated supply chain has not been easy to achieve. Top level management support in terms of significant investments are required to allow information and knowledge to be shared across supply chain so that the activities and decisions throughout the supply chain can be coordinated. Dyer and Nobeoka (2000) report that various experts have recognized that inter-organizational learning is critical to competitive success, noting that organization learning takes place by collaborating with other firms as well as by observing and importing their practices (see March and Simon, 1958; Powell *et al.*, 1996; Levinson and Asahi, 1996).

1.6 Motivation for this Research

Is Indian manufacturing industries on the right path of managing its supply chain to enhance its competitiveness in this changing economic environment? Addressing this basic question is at the heart of this research. The research study is borne out of the felt need by managers, expert professionals and academicians, to address supply chain issues at the national level. The objective was set out to not only trace the reasons for role of KM processes in supply chain performance, but also to gauge the current status of knowledge management and supply chain management in Indian manufacturing industry in order to address the felt concern of Indian policy makers and professionals. Moreover another important purpose behind this research study was to contribute and enrich the literature of supply chain knowledge management supported by the empirical findings. This research attempts to draw links between the literatures on knowledge management processes, supply chain management practices, and performance measurement in supply chains in the context of Indian manufacturing industries.

1.7 Organization of the Thesis

Chapter 1 is focused on introduction that consists of basics such as brief history, definitions, processes involved, issues and challenges of knowledge management, supply chain management, and supply chain performance. Also, motivation for the present research is highlighted.

Chapter 2 presents a detailed review of extant literature and significant contribution in the area of knowledge management processes, supply chain practices, and supply chain performance. The variables for these measures are identified.

Chapter 3 consists of research methodology employed in this study. This chapter includes detailed description of steps such as research models, data sample, data analysis, organization characteristics; hypotheses are presented to achieve the research objectives.

Chapter 4 illustrates the results of the statistical analysis performed to provide empirical support for accomplishment of research objectives. This chapter contains results from descriptive statistics, exploratory factor analysis, multivariate regression analysis, and confirmatory factor analysis.

Chapter 5 covers the discussion of the theoretical and practical implications of the results as well as the authors' thoughts about research limitations and future study directions.

Chapter 6 presents the conclusions and findings of the research study. It includes managerial implications of the findings and the directions for future research. Appendix 1 consists of the measurement instrument for the study, the structured questionnaire, which was used in this research.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

The overview of the importance and relevance of the research area was described in the previous chapter. This chapter highlights the types of KM processes, prevailing SCM practices in the context of Indian manufacturing industries. To explore the review findings, this chapter covers literary contributions on KM processes (knowledge acquisition, knowledge conversion, knowledge application, and knowledge protection), SCM practices (supply chain integration and characteristics, supply chain information sharing, just-in-time, and customer support management), and factors of supply chain performance (flexibility performance, resource performance, and output performance). Additionally, this chapter includes the importance of inter-relationships among these measures.

2.2 Knowledge Management

Knowledge is critical for organizations to satisfy customer needs for customized products and services, and speedier and improved service (Davenport and Klahr, 1998). Knowledge indicates a firm's intellectual capital: including work-related experience, expertise, know-how, and best practices, that can be acquired and shared. Knowledge may be explicit, and it can be expressed in codified form and thus can be diffused throughout an organization in the form of rules and guidelines. In contrast, knowledge that resides within individuals is frequently termed tacit knowledge. Being inferred from individual action, and being difficult to verbalize and codify, tacit knowledge is obtained through imitation and practice (Nonaka, 1994). KM involves individuals and groups, both within and between firms, managing tacit and explicit knowledge to make better decisions, take actions and deliver results to support the underlying business strategy (Horwitch and Armacost, 2002).

Table 2.1: KM Definitions Framework

Expert	Definition	Focus
Grey, (1996)	KM is a collaborative and integrated approach to the creation, capture, organization, access and use of an enterprise intellectual asset.	Business perspective
Maglitta, (1996)	KM in general tries to organize and make available information knowhow, whatever and wherever it is needed. This includes processes, intranets, groupware, procedures, reference works, formulas, best practices forecasts etc.	Holistic nature
O'Dell and Grayson, (1998)	KM is a conscience strategy for moving the right knowledge to the right people at the right time to assist sharing and enabling the information to be translated into action to improve the organizational performance.	Process based
O'Leary, (1998)	Enterprise KM entails formally managing knowledge resources in order to facilitate access and reuse of knowledge typically by using advanced information technology. KM is formal in that knowledge is classified and categorized according to a pre-specified, but evolving, ontology into structured and semi structured data and knowledge base. (p.55)	Need based
Bair, (1997)	KM aims to capture the knowledge that employees really need in a central repository and filter out the surplus. Use of technology to capture the knowledge residing in the minds of the employees so that it can be easily shared across the enterprise. (p.28)	Need based
Zuckerman and Buell, (1998)	KM is the strategic application of collective company knowledge and know-how to build profits and market share. Knowledge assets, both ideas or concepts and knowhow, are created through the computerized collection, storage, sharing and linking of corporate knowledge pools.	Holistic nature

Table 2.1: KM Definitions Framework (contd.)

Expert	Definition	Focus
CPA Journal, (1998)	KM is concerned with organizing and analyzing information in a company's computer databases so this knowledge can be readily shared throughout a company, instead of languishing in the department where it was created, and inaccessible to others. (p.72)	Need based
Alavi and Leidner, (1999)	KM refers to a systematic and organizationally specified process for acquiring, organizing and communicating both tacit and explicit knowledge of employees so that other employees may make use of it to be more effective and productive in their work. (p.2)	Holistic nature
Lytras *et al*., (2002)	The cumulative ability to utilize the value incorporated in the various stakeholders in of an organization. KM is the integration of knowledge assets in reusable formats that sets a win-win relation for all the parts of the knowledge web. (p.42)	Holistic nature
Information Week, (2003)	KM is the concept under which information is turned into actionable knowledge and made available effortlessly in a usable form to the people who can apply it.	Process based
Kimiz Dalkir, (2005)	KM is the deliberate and systematic coordination of an organization's people, technology, processes, and organizational structure in order to add value through reuse and innovation. This coordination is achieved through creating, sharing, and applying knowledge as well as through feeding the valuable lessons learned and best practices into corporate memory in order to foster continued organizational learning. (p.42)	Holistic nature

Alavi and Leidner, (1999) defined KM as the systematic and organizationally specified process of acquiring, organizing, and communicating knowledge so that employees can use it to become more effective and productive in their work. Numerous attempts have been made to define KM processes; some significant and relevant contributions are described in the following section.

2.3 Knowledge Management Processes

KM processes refer to organizational processes undertaken to collectively create, store, access, disseminate and apply knowledge across organizational boundaries to accomplish business objectives of the entire supply chain. The purpose of KM processes is simply to facilitate intra and inter-organizational KM system and to create and leverage knowledge resources and intellectual assets collaboratively (Cormican and O'Sullivan, 2003).

Many studies take knowledge process perspective to examine organizational KM processes (for example 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 processes can be understood as supply chain wide systematic attempts to generate, store and use knowledge collaboratively in order to improve overall performance. Significant contributions by the researchers for these KM processes in organizations are summarized in Table 2.2.

Table 2.2: Significant contributions for KM processes

Author	**Findings**
Spender, (1996), DeLong, (1997), Skyrme and Amidon, (1998),	Capture, Transfer, and Use
Davenport ,(1994)	Capture, Distribute, and Use
Garvin, (1994)	Creation, Acquisition, and Transfer.
Leonard, (1995)	Acquire, Collaborate, Integrate, and Experiment.
Albert, (1998)	Collect, Organize, Classify, and Disseminate.
Teece, (1998)	Capture, Transfer, Assemble, Integrate, and Exploit
Filius *et al.*, (2000)	Acquisition, Documentation, Transfer, Creation, and Application.
Davenport and Grover, (2001)	Generation, Codification, and Transfer/Realization.
Darroch, (2003)	Acquisition, Dissemination, Use/Responsiveness.

At this stage it is worthy to highlight the contribution of Nonaka and Takeuchi (1995) who have described SECI model of knowledge creation, which includes socialization, externalization, combination, and internalization. Each process involves converting certain forms of knowledge (tacit or explicit) into other forms (tacit or explicit). This model focuses on the important issue of knowledge creation through organizational sharing, and can help identify and evaluate certain key activities in KM practices. Bhatt (2001) identified five steps in KM process activities: knowledge creation, knowledge validation, knowledge formatting, knowledge distribution, and knowledge application. This model covers the full range of activities involved in organizational knowledge flow. From an organizational capabilities perspective, Gold *et al.* (2001) argued that the KM process consists of four dimensions, namely knowledge acquisition (KA), knowledge conversion

(KC), knowledge application (KAP), and knowledge protection (KP). This model is considered to be sufficiently broad to permit complete analysis of organizational KM capabilities. Bukowitz and Williams (2000) elaborated KM processes from the tactical and strategic perspectives as shown in Figure 2.1.

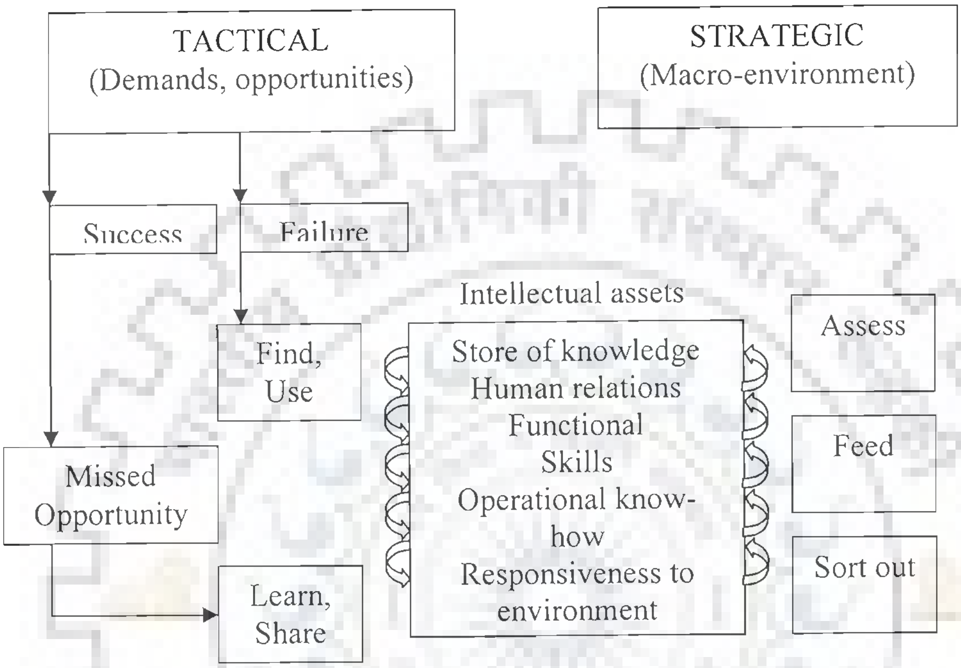

Figure 2.1: KM process framework (Bukowitz and Williams, 2000)

This study adopts the work by Gold *et al.* (2001) for the following reasons. First, their work has become widely accepted in various management fields, such as learning organizations, multinational corporations, and information systems (Cui *et al.*, 2005; Lin and Lee, 2005; Ju *et al.*, 2006). Second, their work emphasizes that firms must develop an 'absorptive capacity', meaning the ability to use prior knowledge to recognize the value of new information, assimilate it, apply it, and protect it to create new knowledge and capabilities (Lin, 2007). Conceptual framework for KM processes in Figure 2.2 illustrates that all KM processes used in this study are interconnected and dependent on each other. These KM processes are elaborated in the following sections.

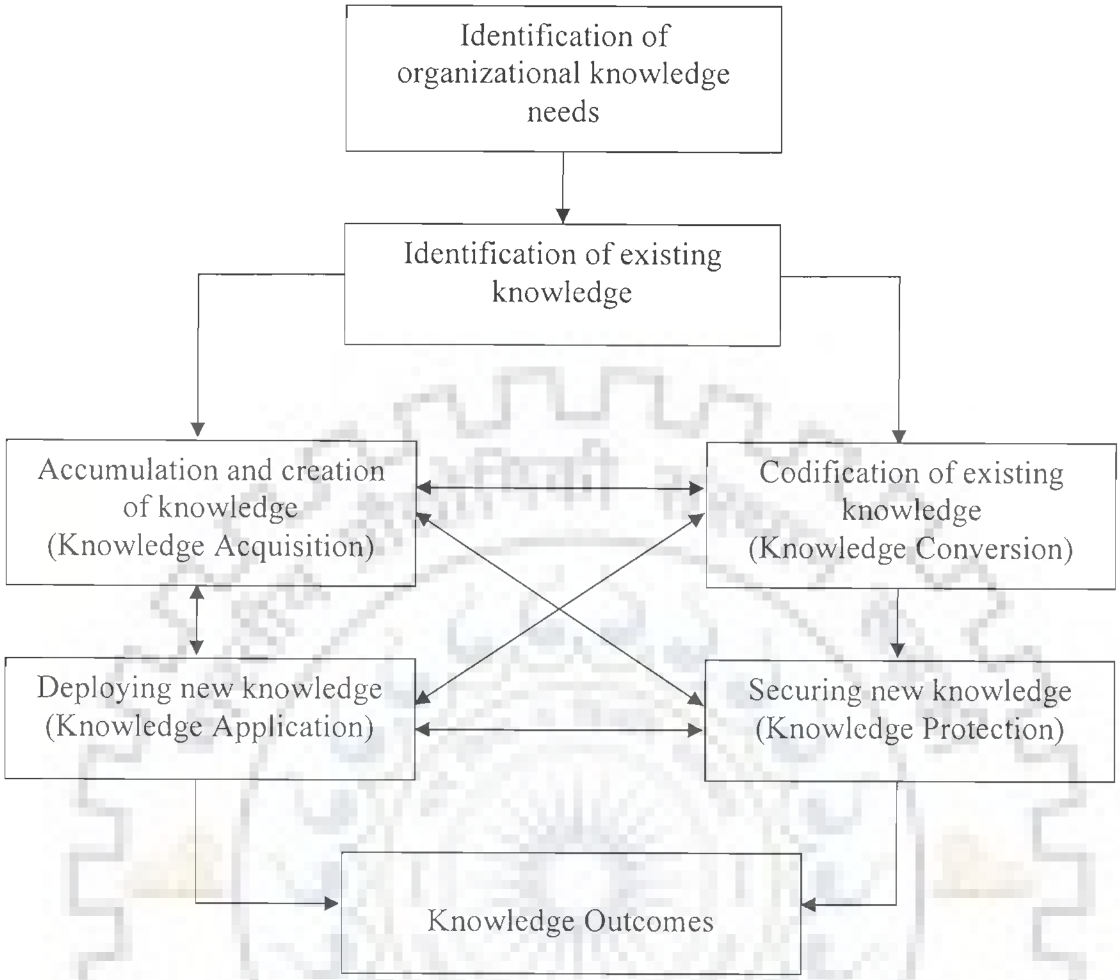

Figure 2.2: Conceptual framework for KM Processes

2.3.1 Knowledge Acquisition:

Holsapple and Singh (2001) define Knowledge acquisition as 'the activity of identifying knowledge in the organization's external environment and transforming it into a representation that can be internalized, and/or used for knowledge generation or externalization' (p. 81). Similarly, Davenport and Prusak (1998) described knowledge acquisition as the business process involving the accumulation of knowledge and the creation of new knowledge from existing knowledge. It 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. Joshi (1998) and Holsapple and Singh (2001) further elaborated the process of knowledge acquisition as Identifying appropriate knowledge from external sources by locating, accessing, valuing, and/or filtering; capturing the identified knowledge from external sources by extracting and collecting relevant knowledge; organizing the captured knowledge by refining, orienting, interpreting, combining and transforming it into usable representations; transferring the organized knowledge to a repository that immediately uses it or internalizes it for subsequent use.

Many terms have been used to describe acquisition processes: acquire, seek, get, generate, create, capture and collaborate. All of these terms have a common theme- the accumulation of knowledge. Inkpen and Dinur (1998) also argued that improved use of existing knowledge and more effective acquisition of new knowledge are crucial to knowledge acquisition. Important examples of knowledge acquisition are: searching and organizational learning (Lee and Yang 2000, Huber 1991), benchmarking and collaboration (O'Dell and Grayson, 1999). Alternatively, knowledge could also be acquired from relationships between the firm and its suppliers and customers (Darroch, 2003). Moreover, Johnson *et al.* (1996) highlighted that perceived learning within a business simulation framework helps the participants to acquire knowledge and skills during the simulation process.

Some more examples of knowledge acquisition include, conducting an extensive survey, acquiring or collaborating with knowledge-rich company, providing external training to employees, hiring employees qualified for future needs (thereby bringing in advanced level of knowledge into the organization), purchasing relevant data sets, monitoring the technological advances, purchasing a patented process, and gathering knowledge via competitive intelligence. Knowledge acquisition depends on the nature of the employee acquiring the knowledge, the nature of knowledge resources and their characteristics, the way knowledge is represented in those sources, and various constraints such as time, cost, and quality (Holsapple and Singh, 2001).

Mykytyn *et al.* (1994) define knowledge acquisition as "acquiring information directly from domain experts" (p. 98). New knowledge is typically acquired by reading, listening to experts, observing, experiencing events or thinking. But where should the organization begin? A review of the literature reveals that the background skills training and traits of knowledge workers are primary enablers for successful knowledge acquisition. Organizations should enhance knowledge environment which is conducive to effective knowledge creation and acquisition. (McGraw and Harbison-Briggs, 1998; McGraw and Seale, 1987; Mykytyn *et al.*, 1994; and Rolandi, 1986).

2.3.2 Knowledge Conversion: It represents the business processes oriented towards making existing knowledge useful. Firms need to organize and structure knowledge to make it easier for employees to access (Nonaka and Takeuchi, 1995; O'Dell and Grayson, 1998). More specifically, knowledge conversion is the process of coordinating data format, location of knowledge storage, knowledge ownership and governing mechanism. Further, Smith (2001) describes 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 stage. 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, knowledge storage is the inter-firm efforts to unit and leverage multiple knowledge repositories or retention bins for efficient knowledge acquisition and preservation (Levitt and March, 1988; Starbuck, 1992).

The ultimate objective of such 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. Storing knowledge in properly indexed and inter-linked knowledge repositories can then increase knowledge exploitation by making knowledge easily accessible (Gold *et al.*, 1991). Moreover, combining and integrating knowledge can reduce redundancy, improve representational consistency, and enhance efficiency by eliminating excess volume (Davenport and Klahr, 1998).

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 resides and the associated mechanisms about how stored knowledge to be accessed, leveraged or transferred for use. 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.

To address the knowledge conversion dilemma, there is a need for a better, broader taxonomy of both tacit and explicit knowledge (Chaudhary, 2005). Recognizing that firms' distinctive knowledge consists mostly of tacit, difficult to imitate knowledge, Spender (1996) developed a more comprehensive typology of organizational knowledge. He emphasized that explicit knowledge is referred to as objectified knowledge. Tacit knowledge is separated into three subtypes: conscious, automatic, and collective.

Individual tacit knowledge can be either conscious or automatic. Automatic knowledge is implicit knowledge that "happens by itself" and is often taken for granted. Conscious knowledge may be codified, perhaps as a set of notes. Collective knowledge is tacit knowledge of a social nature.

2.3.3 Knowledge Application: It is the process of making knowledge active and relevant for the firm in creating value. More specifically, it 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. Bose (2001) highlighted that knowledge application involves retrieving and using knowledge in support of decisions, actions, problem solving and thus generates and sustains organizational competitiveness. Using knowledge involves interaction between tacit and explicit knowledge, leading to adjusted strategic direction, problem solving, and improved efficiency (Gold *et al.*, 1991). Davenport and Klahr (1998) also noted that the effective application of knowledge has helped firms improve their innovation performance and reduce costs.

Nonaka and Takeuchi (1995) suggested that knowledge must be shared and distributed throughout an organization before it can be exploited at the organizational level. The extent to which a firm succeeds in distributing knowledge depends on effective knowledge application and the quantity of useful knowledge available in the firm. 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. 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 regarding locating and retrieving it. The value of knowledge is realized only when stored knowledge is disseminated for its application to occasions where it can make an impact.

2.3.4 Knowledge Protection: This process refers to the ability to protect organizational knowledge from illegal or inappropriate use or theft. Protecting the organizational knowledge is necessary to preserve its competitive advantage (Proter-Liebskind, 1996). From a legal perspective, firms can protect their knowledge through intellectual property rights such as copyrights, trademarks, and patents. Moreover, firms can develop a sophisticated information technology system that restricts or tacks access to vital knowledge. Besides legal and technology protection, firms should enforce contract with employees regarding the protection of confidential information, and should also establish employee rules of conduct and design jobs so as to incorporate security-oriented KM processes. Heiman and Nickerson (2004) posit that technological collaboration along the business network often involves the knowledge sharing to solve complex problems, which requires the adoption of practices that promote the sharing of knowledge. Yet, such practices make regulation of the intensity and scope of shared knowledge difficult. Although some knowledge may be legally protected, for example, by patents, much knowledge remains unguarded and thus is subject to potential by collaborators. Consequently, the value created by the collaboration from knowledge sharing may be eclipsed by the value of the knowledge expropriated - a loss in competitive advantage may result, if this problem is not managed properly.

2.4 Supply Chain Management Practices

In the face of a competitive global market, organizations have downsized, focused on core competencies, and attempted to achieve competitive advantage by more effectively managing purchasing activities and relationships with suppliers. SCM refers to how firms utilize their suppliers' processes, technologies, and capabilities to enhance competitive advantage (Farley, 1997), and how the manufacturing, logistics, materials, distribution and transportation functions are coordinated within organizations (Lee and Billington, 1992). Mohanty and Deshmukh (2005) described SCM as a loop that starts with customer and ends with customer. All kinds of materials, finished goods, information, and transactions flow through this loop. It requires looking at business as one continuous, seamless process that absorbs distinct business functions such as forecasting, purchasing, manufacturing, distribution, sales, and marketing into a continuous business transaction. Many firms have reduced their supply base so they can more effectively manage relationships with strategic suppliers (Tully, 1995). Supply chain management, analysis, and improvement is becoming increasingly important. The literature includes approaches to supply chain management (see Bytheway, 1995a; Lamming 1996; New, 1996; Waters-Fuller, 1995), in addition to supply chain models. The performance measures utilized in these models directly affects their real-world applicability. This section describes and evaluates the various types of performance measures that have been used in modeling of supply chain, and discusses the applicability of these measures. Supply chain management has received attention since the early 1980s, yet conceptually the management of supply chains is not particularly well-understood, and many authors have highlighted the necessity of clear definitional constructs and conceptual frameworks on supply chain management (Saunders, 1997; New, 1996; Cooper *et al.*, 1997; Babbar and Prasad, 1998; *Croom et al.*, 2000). As described in the previous chapter a detailed framework to show the definitions and key ideas behind SCM practices is shown in Table 2.3.

Buying firms are developing cooperative, mutually beneficial relationships with suppliers and viewing suppliers as virtual extensions of their firm (Mason, 1996; Copacino, 1996). In doing so, they have significantly increased their reliance on suppliers. Companies encountering problems due to increased reliance on suppliers use a variety of approaches to address the problems. They may reverse their downsizing emphasis and bring outsourced products and services back in-house, secure alternative sources of supply, or work with existing suppliers to increase their performance and capabilities (Watts and Hahn, 1993). Supplier development efforts vary in terms of the effort expended by the buying firm and in the variety of tools used. However, Krause (1997) found that firms often use performance measurement to identify specific supplier deficiencies and to develop plans to address them. Such efforts may involve the measurement of suppliers' delivery, quality, and cost performance, site visits, certification of suppliers' products and processes, and the setting of performance goals.

SCM practices have been defined as a set of activities undertaken in an organization to promote effective management of its supply chain. Donlon (1996) describes the latest evolution of SCM practices, which include supplier partnership, outsourcing, cycle time compression, continuous process flow, and information technology sharing. Tan *et al.* (1998) use purchasing, quality, and customer relations to represent SCM practices, in their empirical study. Kotzab and Alvarado (2001) include in their list of SCM practices concentration on core competencies, use of inter-organizational systems such as EDI, and elimination of excess inventory levels by postponing customization toward the end of the supply chain. Tan *et al.* (2002) identify six aspects of SCM practice through factor analysis: supply chain integration, information sharing, supply chain characteristics, customer service management, geographical proximity and JIT capability. Chen and Paulraj (2004b) use supplier base reduction, long-term relationship, communication, cross-functional teams and supplier involvement to measure buyer–supplier relationships. Min and Mentzer (2004) identify the concept SCM as including agreed vision and goals, information sharing, risk and award sharing, cooperation, process integration, long-term relationship and agreed supply chain leadership. Thus, the literature portrays SCM practices from a variety of perspectives with a common goal of eventually improving the effectiveness of supply chain leading towards achievement of organizational performance.

Table 2.3: Definitions and Key Ideas of SCM

Authors	Definition of SCM	Key ideas
Scott and Brook, (1991)	The chain linking each element of the manufacturing and supply process from raw materials to the end user, encompassing several organizational boundaries.	Highlights the significance of coordination among constituent members.
Ellaram, (1991)	The integration of the processes, systems, and organizations that control the movement of goods from the supplier to a satisfied customer without waste.	Highlights the necessity of integration among the organizations, physical movement and the waste reduction principal of JIT.
Lee and Billington, (1992)	Networks of manufacturing and distribution sites that procure raw materials, transform them into intermediate and finished products, and distribute them to customers.	Attempts to show conventional functions of supply chain.
Christopher, (1992,1998)	The management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole.	Signifies the importance of relationships, customer focus and cost reduction
Ellrarn Cooper, (1993)	An integrating philosophy to manage the total flow of a distribution channel from supplier to ultimate customer.	Identifies the importance of integration within supply chain.
Berry *et al.*, (1994)	SCM aims at building trust, exchanging information on market needs, developing new products, and reducing the supplier base to particular original equipment manufacturer so as to release management resources for developing meaningful, long term relationship.	Highlights the importance of supplier relationships in achieving supply chain objectives.

Table 2.3: Definitions and Key Ideas of SCM (contd.)

Cox *et al.*, (1995)	The functions within and outside a company that enable value chain to make and provide products to the customer.	Attempts to identify strategic partners within supply chain.
Saunders, (1997)	Supply Chain is the total chain of exchange from original source of raw material, through various firms involved in extracting and processing raw materials, manufacturing, assembling, distributing, and retailing to end customers.	Network of firms interacting to deliver product or service to the end customer, linking flows from raw material supply to final delivery.
Patricia *et al.*, (1996)	The physical network that begins with the supplier and ends with the customer.	Traces all the organizations with within a supply chain including all tiers of suppliers and distribution.
Monczka and Morgan, (1997)	Integrated SCM is about going from the external customer and then managing all the processes that are needed to provide the customer with value in a horizontal way.	Highlights the necessity of flat organizational structure and customer focus.
Tan *et al.*, (1998)	It is management philosophy that extends traditional intra-enterprise activities by bringing trading partners together with the common goal of optimization and efficiency.	Focuses on how firms utilize their suppliers' processes, technology and capability to enhance competitive advantage.
Houlihan and Houlihan, (1999)	The integration of various functional areas within an organization to enhance the flow of goods from immediate strategic suppliers through manufacturing and distribution chain to the end user.	Considers strategically important suppliers and integration among constituent members

In reviewing and consolidating the literature, five distinctive dimensions, including strategic supplier partnership, customer relationship, level of information sharing, quality of information sharing and postponement, are selected for measuring SCM practice. The five constructs cover upstream (strategic supplier partnership) and downstream (customer relationship) sides of a supply chain, information flow across a supply chain (level of information sharing and quality of information sharing), and internal supply chain process (postponement). It should be pointed out that even though the above dimensions capture the major aspects of SCM practice, they cannot be considered complete. Other factors, such as geographical proximity, JIT/lean capability, cross-functional teams, logistics integration, commonly agreed organizational vision and goals, and established supply chain leadership are also identified in the literature. Though, many of these factors are of great interest, they are not included due to the concerns regarding the length of the survey and the parsimony of measurement instruments. In an empirical survey, Tan et al. (1998) identified 10 SCM practices, and concluded that some of the practices positively affect firms' performance. However, while many SCM models have been proposed, there has been a lack of knowledge on actual industry practices for implementing effective SCM in the context of Indian manufacturing industries, and their relationship to supply chain performance (Sahay *et al.*, 2003).

For the purpose of this research study, 25 commonly cited SCM practices from the literature (Tan, 2002) have been identified. These included practices related to supply chain integration characteristics (SCI), supply chain information sharing (IS), Just-In-Time (JIT), and customer support management (CSM).

2.4.1 Supply Chain Integration

The most successful manufacturers seem to be those that have carefully linked their internal processes to external suppliers and customers in unique supply chains. In today's dynamic era, e-business and supply chains are integrated and play a vital role towards an organization's competitive advantage and sustenance. Manufacturing organizations orientation towards customer satisfaction has brought the realization of potential benefits and importance of strategic and cooperative buyer-supplier relationships. Over the past decade there has been a growing consensus concerning the strategic importance of integrating suppliers, manufacturers, and customers (Ragatz *et al.* 1997; Bowersox *et al.*, 1996; Freeman and Cavinato, 1990; Lummus *et al.*, 2001; Van Hoek *et al.*, 2001; Lowson, 2003; Barratt, 2004). Ragatz *et al.* (1997) noted that the "effective integration of suppliers into product value supply chains will be a key factor for manufacturers in achieving the improvements necessary to remain competitive". For professionals, the strategic importance of integration is similarly reflected in the Supply Chain Council's popular supply chain operations reference (SCOR) model that assumes all businesses include sourcing, making, and delivering processes strategically linking suppliers and customers to manufacturers. Many of the theoretical arguments for closely integrating operations among manufacturers, suppliers and customers come from the business process reengineering literature (Hammer and Champy, 1993). Typically the goal is to create and coordinate manufacturing processes seamlessly across the supply chain in such a way that most competitors cannot very easily match the best practices (Anderson and Katz, 1998). As Birou *et al.* (1998) pointed out that the opportunity to use process integration across functional boundaries is now considered a key to competitive success. Similarly, Davis (1993) and Dyer and Ouchi (1993) also highlighted the importance of integrating suppliers and customers across the supply chains for developing new products and processes. Following the importance of supply chain integration, Tan *et al.* (1999) also referred supply chain management as simultaneous integration of customer requirements, internal processes and upstream supplier performance.

A number of researchers suggest that better performance can be achieved by consolidating customer and supplier bases, removing unnecessary steps in the chain, speeding up information and material flows, and creating long-term partnerships with major customers and suppliers to leverage the capabilities of several companies in the chain. (e.g. Handfield and Nichols, 1999, Towill, 1997; William, 2002, Lambert *et al.*, 2000; Lee, 2000,).

2.4.2 Supply Chain Information Sharing

Wisdom in a supply chain resides in the people, the quality of the relationships that are formed across the chain and the application of shared knowledge. The chain is a sum of all the parts and co-operative exchanges of information and knowledge across it ensures strategies and knowledge are aligned to its goals (Furlong, 2001). Stakeholders within the chain are expected to have increased commitment to the strategic goals when they are knowledgeable about their contribution and when the culture encourages their contribution to knowledge growth. "The broader access members get to the vital knowledge activities of the organization, the better are their chances of increasing systemic wisdom" (Por, 2000).

Further, it is in the differentiation between information management and knowledge management that the value lies for business. Information management uses information technology to organize and deliver information about knowledge assets. KM uses the tacit and explicit knowledge of the people across the network to develop new ideas, new ways of thinking leading to greater innovation and value creation. If the supply chain only focuses on information technology, i.e., the use of technology to manage information "without consideration for how knowledge is applied, growth may be limited as the exploitation of collective knowledge to innovate and grow the business is unlikely" (Davenport and Marchand, 2000; Furlong, 2001).

Value is added to the supply chain's capability to sustain business with the identification of relevant information and the application of knowledge to the strategic future planning. While productivity and product quality are components of the ultimate drivers of innovation - profitability, there are other dimensions where knowledge contributes towards a chain's sustainability. A growing number of organizations are realizing that sustainability involves meeting the environmental and social aspects of the triple bottom line as well as financial goals. KM system across this complexity ensures that time is invested wisely in meeting the growing client demand for products to be developed in a sustainable manner (Hart, 2004).

Lee *et al.* (1998) and Bythway (1995) emphasize that Information sharing in a supply chain faces several hurdles. The first and foremost challenge is that of aligning incentives of different partners. It would be unsophisticated for a partner to think that information and knowledge sharing and cooperation will automatically increase his profit. In fact, each partner is cautious of the possibility of other partners abusing information and reaping all the benefits from information sharing. For example, supply chain partners seldom share information that relates to sensitive cost data, e.g., production yield data or purchase price of parts. Irrespective of the fact that each partner is guaranteed a positive gain in return for information sharing; any of the partner can bargain and play a non-cooperative game. This may potentially lead to a failure to share information. Thus, trust and cooperation become critical ingredients in a supply chain partnership. Firms may overlook this aspect and may remain complacent in starting efforts for the resolution of the problem, but reality is much more complicated with many additional factors and special considerations.

Another concern associated with supply chain information sharing is the confidentiality of information shared. Suppose, for example, that a supplier supplies a critical part to two manufacturers who compete in the final product market. Either manufacturer would not share information (like sales data) with the supplier unless it is guaranteed that the information is not leaked to the other manufacturer. But the situation becomes tricky if the supplier and one of the two manufacturers are the same company. Technology is another constraint in information sharing. Implementation of a cross-organizational information system is costly, time-consuming and risky. Partners may not agree on the specifications of the technical system, e.g., standards for EDI or ERP system, or how to split the cost of investing in the system.

2.4.3 Just-In-Time Capabilities

JIT is a set of practices for reducing manufacturing lead time and inventory levels. Its name derives from the Japanese practice of receiving or producing each raw material or component just in time for it to be used in the next step of production. Some of the most important JIT practices include small lot sizes, set-up time reduction, zero defect, single minute exchange of dies, product simplification through parts reduction, factory layout by product families, frequent deliveries from a limited number of suppliers, and consistent preventive maintenance (see Monden, 1983; Sakakibara *et al.*, 1990; Schonberger, 1986). Thus, efficient customer response and just-in-time (JIT) systems are just two management concepts that have placed pressure on inventory turns, improving in the warehouse activity in a supply chain (Lummus *et al.*, 2003).

JIT eliminates inventory buffers between production stages as well as any step that does not add value, such as materials handling. The laying out of plants by product families characterize that JIT virtually eliminates the physical distance between successive stages. JIT is often characterized by a "kanban" system, in which inventory is replenished only when existing inventory has been depleted. (A kanban is a ticket/token from a container of parts used to reinitiate production once the container is empty.) There is no reason, however, why JIT must operate with such a "pull" system; "push" systems, in which production is generated by a preset schedule, may also be compatible with its objectives (Huang *et al.*, 1983; Karmarkar, 1989). Focus of JIT system on lead time reduction in a supply chain forces supply chain managers to make changes that also improve quality and cost along the whole chain (Schmenner, 1988).

Manufacturing firms using integrated manufacturing practices such as JIT, in which more advanced or specialized skills are required, since low-ability or new employees take more time and efforts than high-ability experienced employees to be productive (Griliches and Mason, 1972; Flamholtz and Lacey, 1981), rely on the KM system helps new employees through knowledge sharing to acquire and create new knowledge essential for better performance. Eventually, firms will be able to recover the initial investment through higher productivity and less training efforts.

2.4.4 Customer Service Management

A company's customer oriented supply chain practices can have an effect on its success in managing the supply chain and hence its performance (Scott and Westbrook, 1991; Ellram, 1991; and Turner, 1993). A key element of successful supply chain management involves downstream integration of customers as well as the management of upstream suppliers. Each entity in the supply chain is a supplier as well as a customer. When a customer driven corporate vision is implemented simultaneously with effective TQM and supply chain management practices, it can produce a competitive edge in a number of different ways. These include improvements in productivity levels, reductions in inventory levels and cycle time, on-time deliveries, increased customer satisfaction, market share and profits. However, there is little empirical evidence in the literature linking customer support practices and supply chain performance to support the conceptual foundation of customer driven corporate policy.

To operationalize these customer related practices, Tan *et al.* (1999) identified significant elements of customer service. These include the evaluation of customer complaints and the measurement of customer satisfaction. A company's performance on these dimensions is an indicator of whether it is aware of the importance of customer satisfaction and of the company's roles as buyer and supplier in the supply chain. Tan *et al.* (1998) and Claycomb (1999) elaborated that customer relationship comprises the entire array of practices that are employed for the purpose of managing customer complaints, building long-term relationships with customers, and improving customer satisfaction. Noble (1997) and Tan *et al.* (1998) consider customer relationship management as an important component of SCM practices. As pointed out by the experts, committed relationships are the most sustainable advantage because of their inherent barriers to competition. The growth of mass customization and personalized service is leading to an era in which relationship management with customers is becoming crucial for corporate survival (Wines, 1996). Good relationships with supply chain members, including customers, are needed for successful implementation of SCM programs (Moberg *et al.*, 2002). Close customer relationship allows an organization to differentiate its product from competitors, sustain customer loyalty, and dramatically extend the value it provides to its customers (Magretta, 1998).

2.5 Supply Chain Performance Measures

Based on the extant literature, numerous processes have been developed that organizations can follow in order to design and implement performance evaluation and measurement systems (Bourne *et al.*, 2000). Many frameworks supporting these processes have been proposed to help organizations define a set of measures that reflect their objectives and assess their performance appropriately. These include the balanced scorecard (Kaplan and Norton, 1992), the performance prism (Kennerley and Neely, 2000), the performance measurement matrix (Keegan *et al.*, 1989), the SMART pyramid (Cross and Lynch, 1989), and the results and determinants framework (Fitzgerald *et al.*, 1991). Some of these frameworks are multidimensional, explicitly balancing financial and non-financial measures. Furthermore, a wide range of criteria has also been developed, indicating the traits of effective performance measures and measurement systems. These include the need for measures to relate to the organization's mission and objectives, to reflect the company's external competitive environment, customer requirements and internal objectives (Wisner and Fawcett, 1991; Kaplan and Norton, 1993). Wisner and Fawcett (1991) acknowledge the need to review and update the performance measures to ensure that measures remain relevant. Bititci *et al.* (2005) identify the need for performance measurement systems to be dynamic to reflect changes in current competitive environment, review and prioritize objectives, and ensure gains achieved through improvement programmes are maintained. Significant contributions for supply chain performance measures are shown in Table 2.4.

Table 2.4: Significant Contributions for Supply Chain Performance Measures

Experts	**Performance Measures**
Neely *et al.* (1995), Beamon (1999), Cohen and Lee (1989), Cohen and Moon (1990), Pyke and Cohen (1993, 1994)	Cost
Davis (1993), Newhart *et al.* (1993), Towill *et al.* (1992), Wikner *et al.* (1991), Lee and Bellington, (1993)	Customer responsiveness
Voudouris, (1996)	Flexibility
Christopher, (1994)	Customer satisfaction
Davis, (1993)	Supplier performance
Johnson and Randolph, (1995)	Risk management
Nicoll, (1994)	Information flow

Economists disagree about the use of accounting data to measure firm performance because it ignores opportunity costs and the time value of money (Chen and Lee, 1995). Business performance, the argument goes, should be measured by financial data, such as the internal rate of return (IRR). Financial data provides a measurement of a firm's performance via the market's valuation of the firm's securities. However, since future cash flows of the business entity cannot be observed, measures of business performance are typically based on accounting data such as return on investment (ROI) or return on assets. Jahera and Lloyd (1992) observed that ROI was a valid performance measure for midsize firms. However, the validity of ROI as a performance measure has been challenged by Tobin and Brainard, (1968) who concluded that a firm's financial leverage can affect its ROI to such a degree that it renders comparisons between firms meaningless. ROI also ignores opportunity costs and the time value of investments.

Tobin (1969) developed an alternate measure of performance, Tobin's q ratio, which evaluates the ratio of the market value of a firm to the replacement cost of its assets. However, Tan *et al.* (1998) suggested that the prospect of obtaining accurate measures of each firm's market value and the replacement cost of its assets to calculate Tobin's q was deemed impractical for their research. Given the lack of consensus regarding a valid cross-industry measure of corporate performance, performance in the study was operationalized by senior management's perceptions of a firm's performance in comparison to that of major competitors (Tan *et al.*, 1998). Nine dimensions of performance were considered including market share, return on assets, and overall competitive position. They validated performance measures by comparing performance for a subset of firms to actual financial performance. Moreover, the use of managers' perceptual measures as a proxy for actual performance was supported by significant correlations.

With study on 1469 employees of US companies, Tan *et al.* (1999) concluded that participating firms take advantage of their supplier's expertise in integrating their supplier's knowledge and capabilities into the design and development of new products and processes. They also reported that setting supplier performance is the least preferred practice in this survey. Further, Tan *et al.* (1999) highlighted that with regard to customer relations; firms rate themselves most highly on their ability to evaluate customer complaints, follow-up with customers' feedback for quality/service that helps them building and sustaining customer relationships. Tan *et al.* (1999) also found that firms were least confident of their abilities in the areas of interaction with customers to set performance standards and in the evaluation of customer satisfaction factors.

However, Skinner (1974) argues that firms cannot excel in all aspects of performance, highlighting the need for explicit decisions about significant trade-offs. The extent of trade-offs again needs to be identified and acceptable to all the members in the supply chain, which is a very difficult task. In line with this, Neely *et al.* (2000) highlight that despite the recognized importance of explicitly dealing with priorities and the relationships between performance measures, very little work has been done to establish the nature of the trade-offs among these measures. On the other hand, due to the limited information processing capabilities, decision-makers lack the ability to process effectively all the information necessary to develop and implement more coherent and better-informed action plans. This also hinders the implementation of a performance measurement system. Table 2.5 shows the excerpts from extant literature for evaluation criterion of supply chain performance.

The literature reviewed so far highlights the importance of managing the design and development of performance measurement systems to ensure that they continue to reflect the environment and objectives of the organization. The literature also suggests that there are many complex factors affecting evolutionary change within organizations, and hence the evolution of performance measures.

2.5.1 Resource Performance

Resource measures include levels of inventory held, manpower requirements, equipment utilization, energy consumption, and cost incurred. Resources are generally measured in terms of the minimum quantity requirements or a composite form of efficiency measure. Efficiency measures the utilization of the resources that are used to meet the organization's objectives to fulfill customers' requirements. Resource measurement is an important part of the measurement system. Limited availability of resources can negatively affect the output as well as the flexibility of the organization, while the deployment of too many resources synthetically increases the organization's requirements in terms of costs. One general goal of supply chain management is resource minimization. Although a minimum level of output is often specified, the effect of accordingly reducing resources may have adverse effect on the flexibility of the supply chain, which is not often considered properly in many manufacturing firms in India. A supply chain may be redesigned with reduced levels of resources while meeting the demands on hand, but such short-term focus eventually ignores the dynamic nature of demand existing in the future periods. In this way, resources are directly related to the supply chain output and flexibility performance. According to Beamon (1999) supply chain resource performance includes following measures:

(1) Total cost: Total cost of resources used.

(2) Distribution costs: Total cost of distribution, including transportation and material handling costs.

(3) Manufacturing cost: Total cost of manufacturing, including labor, maintenance, and re-work, and scrap costs.

(4) Inventory. Costs associated with held inventory, which includes costs of held inventory, costs associated with obsolete inventory and spoilage, costs associated with work-in-process inventories, costs associated with held finished goods inventories.

(5) Return on investment (ROI): Measures the profitability of an organization. The return on investment is generally given by the ratio of net profit to total assets.

2.5.2 Flexibility Performance

Suarez *et al.* (1995) highlighted that highly volatile markets, short product life cycle and highly sophisticated buyers are some of the important characteristics of today's intense competitive market environment that are leading to great levels of uncertainty. With customers requiring highly diverging products in the market, it becomes very difficult for the supply chain to accommodate the customer needs into a product design and to predict the level of demand for a particular product. These all contribute to difficulties in managing the operations of a supply chain. In addition, large product mix increases the costs associated with production and delivery of products to the customers. Flexibility, which is infrequently used in supply chain analysis, can measure a system's ability to accommodate quantity and schedule fluctuations from suppliers, manufacturers, and customers. Indeed, flexibility is vital to the success of the supply chain, since the supply chain exists in an uncertain environment.

Berry and Cooper (1999) in his study has shown that productivity of a production system decreases when the product mix is increased. This suggests that in order to be competitive in the marketplace, a supply chain is required to be able to produce various different products and deliver to the market in an acceptable speed and cost. This implies that flexibility is an important competitive advantage a supply chain should pursue to win the intense competition.

Slack (1991) identifies two types of flexibility- range flexibility and response flexibility. Range flexibility is defined as to what extent the operation can be changed. Response flexibility is defined as the ease (in terms of cost, time, or both) with which the operation can be changed. Although there will be a limit to the range and response flexibility of a supply chain, the chain can be designed to adapt adequately to the uncertain environment. For example, a reduction in system resources may negatively affect the supply chain's flexibility. A supply chain may be currently utilizing its resources efficiently, and producing the desired output, but will the supply chain be able to adjust to changes in, for example: product demand, manufacturing unreliability, the introduction of new products, or supplier shortages? Thus, flexibility is an important consideration in supply chain performance.

Additionally, based on the classification of products as innovative and functional, Fisher (1997) concluded that innovative products certainly require higher supply chain flexibility than the functional products do. It is important therefore that the assessment of flexibility for a manufacturing company as well as for a supply chain should relate the ability and the requirements to be flexible. Suarez *et al.* (1995) argued that the capability to respond the need from the market in terms of quality, efficiency and flexibility determines an organization's competitiveness.

Beamon (1999) emphasized that flexible supply chain systems generally lead to the reduction in the number of backorders, and subsequently, reduced number of lost sales, reductions in the number of late orders, and increased customer satisfaction, etc. He further elaborated that flexibility in a supply chain consists of following measures.

(1) Ability to respond to and accommodate demand variations, such as seasonality.

(2) Ability to respond to and accommodate periods of poor manufacturing performance (machine breakdowns).

(3) Ability to respond to and accommodate periods of poor supplier performance.

(4) Ability to respond to and accommodate periods of poor delivery performance.

(5) Ability to respond to and accommodate new products, new markets, or new competitors.

2.5.3 Output performance

Output measures include customer responsiveness, quality, and the quantity of end product produced. Most of the output performance measures can be easily represented quantitatively, such as number of items or end products produced, total time required to produce a particular item or set of items, number of on-time deliveries (orders). However, there are also some of the measures in output performance that are sometimes difficult to express in quantitative terms, for example, customer satisfaction, product quality (Beamon, 1999). In general, a minimum level of output for a particular product or item is often specified, although the relationship between the requisite costs to achieve different levels of output is usually not considered.

It is important to answer these questions in order to realize the benefits of improvements in supply chain output performance. What is the added value or gains if the product is delivered early? Likewise, what are the losses or costs if the product is delivered late? Additionally, output measures are based on short, definite time horizons, and these measures address issues such as how many items are produced today? Not how many can be produced tomorrow? Thus, Beamon (1999) further emphasizes that resources are directly related to the output of a supply chain, and the output of the supply chain system (quality, quantity, etc.) is important in determining the flexibility of the system.

Output performance measures must not only correspond to the organization's strategic goals, but must also correspond to the customers' goals and values, since strategic goals generally focus satisfying customer needs. For example, Corbett (1992) identifies a furniture manufacturer that discovered that their customers actually valued delivery reliability more than fast delivery. For the customer, short lead times were secondary to having the product delivered on time. Although lead times may be extremely important to the manufacturer, on-time delivery was more important to the customer. In this case, both of these output performance measures should be utilized. The following is an example list of supply chain output performance measures:

(1) Sales: Total revenue.

(2) Profit: Total revenue less expenses.

(3) Order fill rate: Proportion of orders filled immediately with the available inventory. Generally, average order fill rate is indicated that is total fill rate divided by the number of items.

(4) On-time deliveries: It measures item, order, or product delivery performance in terms of product lateness (delivery date minus due date), average lateness of orders (aggregate lateness divided by the number of orders), average earliness of orders, or percent on-time deliveries (percent of orders delivered on or before the due date).

(5) Backorder/stockout: It measures item, order, or product availability performance in terms of stockout probability (instantaneous probability that a requested item is out of stock), number of backorders (number of items backordered due to stockout), number of stockouts (number of requested items that are out of stock), average backorder level (number of items backordered divided by the number of items).

(6) Customer response time: It is measured as amount of time between an order and its subsequent delivery.

(7) Manufacturing lead time: It is calculated as total amount of time required to produce a particular item or batch.

(8) Shipping errors: Total number of incorrect shipments made for a period.

(9) Customer complaints: Number of customer complaints registered.

Table 2.5: Supply Chain Performance Evaluation Criteria

Authors	**Criteria**	**Key ideas**
Chan and Qi, (2003)	Holistic approach	Performance measurement in the supply chain should take a holistic system perspective beyond the organizational boundaries. The performance of supply chains needs to be assessed across the organizations in order to encourage global optimization along the supply chain channel.
Lambert and Cooper, (2000)	Process-based	Successful SCM requires a change from managing individual functions to integrated activities within key supply chain business processes. Supply chains metrics should reflect this change and focus on supply chain processes rather than functions.
Coyle *et al.*, (2003); Keebler *et al.*, (1999)	Strategic alignment	The performance measurement system must be consistent with the overall strategy of the supply chain. For instance, if the overall supply chain objective is short delivery times, logistic strategies that emphasize low cost could be in conflict.
Kennerly and Neely, (2003); Folan and Browne, (2005)	Dynamic system	An important criterion for performance measurement system is that the system needs to be dynamic. The supply chain is a dynamic system that evolves over time, and the performance measurement system must have the ability to change over time to incorporate the changes in the supply chain and to continually remain relevant
Gunasekaran *et al.*, (2004); Chan and Qi, 2003; Lambert and Pohlen, (2001)	Balanced approach	The purpose is to distribute performance measurement on a set of parameters that is representative for the most part of the supply chain. The performance measurement systems should provide a balance between financial and non-financial measures.

Table 2.5: Supply Chain Performance Evaluation Criteria (Contd.)

Basu, (2001)	Managerial tool	The performance measurement system is supposed to be a managerial tool, and the system must be able to arrange the transition from "measurement" to "management". Therefore, the performance measurement system needs to be simple to understand and provide timely and accurate feedback.
Gunasekaran *et al.*, (2004)	Covers strategic, tactical and operational level	The performance measurement system should assess and give relevant information to the appropriate level of management. Strategic level measures influence the top level management decisions, tactical level deals with source allocation and operational level measurements and metrics assess the results of decisions of low level mangers.
Coyle *et al.*, (2003); Kennerly and Neely,(2003); Basu, (2001)	Tool for improvement	The performance measurement system should focus on improvement. New methods and concepts like TPM (Total Productive Management) emphasize continuous improvement, which should result in raising the performance expectation over time.
Lapide, (2000)	Drill-down functionality	The performance measurement system should give the managers the ability to pinpoint distinct areas for improvement.
Lambert and Pohlen, (2001)	Handling conflicting objectives	The performance measurement system should assess the different trade-offs within a supply chain and visualize the results to prevent sub-optimization.
Busi, 2005; Lapide, (2000); Neely *et al.*, (1997)	Simplicity	The performance measurement system should be easy to understand at all levels in the organizations and it should contain a limited number of relevant measures
Gunasekaran *et al.*, (2004); Coyle *et al.*, (2003)	Comparability	The performance measurement system should enable the supply chain to benchmark its performance to a set of standards

2.6 Supply Chain Knowledge Management

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 *et al.*, 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) presented similar arguments and believed that driven by global competition and continuing expansion of knowledge, firms are pushed to operate primarily with Just-In-Time (JIT) principles with their supply chain partners to address the market requirement for high levels of product customization and fast delivery. Knowledge from customers about issues such 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 success, especially between strategic and stable supply chain partners where the number and variety of product demand is large. In this scenario, supply chains 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 operated with JIT.

In this direction, this study has attempted 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.

Knowledge is the competitive advantage in a supply chain – it not only transforms the production but also the ability to foresee and manage complexity and change. The challenge is to create a value chain where people have the necessary skills to add value by developing, acquiring, exploring, sharing and applying knowledge - not just to resolve issues but to be innovative. Knowledge acquisition and application within the supply chain underpin the intellectual capital of the chain and its ability to ensure a competitive product and increased profit margin. Each component in the supply chain adds value for the client, derived from its specialist knowledge, to the final product. The quality and application of the knowledge throughout the chain has a direct impact on the quality and competitiveness of the product. It is a 'wise' supply chain that values the thinking capacity of its people.

The 'value' in a value chain resides within the flow of thinking processes throughout the chain. The power to drive innovation within the chain lies within the people rather than the technology. The degree of value placed upon the acquisition and application of knowledge underlies the chain's ability to foresee and manage complexity and change. A wise supply chain engenders a climate of knowledge growth and acquisition as part of its business strategy realizing that the decision making capacity of the people within the chain creates the value for the client.

Without a process for developing new knowledge across the chain there is a danger of 'brainstapling' where history and habit ensures the business focus remains on what has always been. History and habit ossify thinking processes and leave the chain without flexible strategies for managing the future. Rigidity reduces the value of any knowledge input to the chain.

Supply chains that develop structures for KM system across the chain are actively seeking to aggregate the total knowledge potential of stakeholders to create value that is greater than the sum of the parts. The Economic Development Institute at Georgia Tech, Atlanta defines waste as any activity that consumes resources and creates no value. The eight types of waste are overproduction, waiting, defects, excess inventory, motion, transportation, over processing, and untapped human potential. Without structured and supported KM system throughout the chain much of stakeholder knowledge is never tapped and its potential value to the organization is wasted. Human potential and any competitive advantages for the chain are subsequently never realized. A chain that is responsive to change will have found ways of removing hierarchical structures which inhibit the flow of communication vertically within organizations and horizontally across the chain. Guptara (1998) identified that communicating with "employees lower down in the hierarchy" would reveal whether an organization was "genuinely open to new ideas" (Wenger, 2003).

Value is increased in the chain when reciprocal activities occur between employees and organizations in the chain. As stakeholders synthesize their knowledge to benefit the chain, the chain invests in the development of capability in its stakeholders both formally and informally. In the long term, this investment in employees further develops the capability of the organization, and in the short term, employees solve problems and create new knowledge that builds momentum in the chain.

2.7 Building Knowledge in the Supply Chain

Information or intelligence comes into an organization in many formats - paper, internet, television, radio. Each person who uses that information will process it differently depending on their preference for receiving information, learning and communication combined with their values and previous knowledge. The information becomes personal knowledge as critical thinking processes of analysis, evaluation, review and reflection are applied. As tacit internalized knowledge it may be expressed in action but the chain may not benefit from this new insight.

When a critical mass of stakeholders comes together to participate in purposeful knowledge sharing a greater diversity of ideas is generated. It is the synergy of the interaction that creates the value in processing of information. A chain encompassing a variety of personality types, communication and cognitive styles along with different operational knowledge, has a catalyst for innovation. Socialization is the vehicle for externalizing tacit knowledge, processing and then re-internalizing new knowledge leading to action. A result of this process may also be that some knowledge is regarded as redundant at this point and put aside – another step in developing wisdom.

Redundant knowledge also includes "questioning the relevance of past experiences and its appropriateness in current and future situations" to produce "radical behaviour changes in the value chain, resulting in innovative actions and processes that increase competitiveness" (Furlong, 2001). Reviewing current practice in light of new knowledge is essential if the chain is to ensure that 'best practice' remains just that, that core competencies remain relevant and that threats and opportunities are recognized and realistically analyzed (Malhotra, 1998 and Furlong, 2001). Rangeland enterprises need to have processes for identifying current knowledge and to ensure that people have the ability to evaluate situations in light of new and old knowledge.

2.8 Critical Success Factors

Several factors contribute to the development of wisdom across the supply chain. Furlong (2001) identified business strategy, leadership, culture, context, organizational structure, technology and innovation as enablers of knowledge management. A value chain is a strategic network working co-operatively towards a common goal; therefore knowledge creation must be aligned to the business strategy and the output of quality products. Identifying the knowledge gaps in the chain that are aligned to the business strategy and processes to overcome these deficiencies ensures that the chain remains both competitive and sustainable. Processes to overcome gaps include education, training, mentoring or building a 'community of practice' around a particular interest area and aligned to the strategic goals. The alternative is to engage consultants and buy in the knowledge.

Leadership is essential in creating and supporting a positive learning environment. The leader is also a learner and a role model, developing a culture of that is committed to sharing knowledge and creating new ideas to meet customer demand. At the core of knowledge sharing is the quality of the relationships throughout the chain. Emotionally intelligent leaders with both personal and social competence (self-awareness, self-management/social awareness and relationship management) will be able to anticipate needs and develop appropriate processes to meet those needs (Goldman *et al.*, 2002). This may be in the form of organizing appropriate resources, e.g., technology to facilitate the knowledge flow across the chain, leading communities of practice, and being open to new ideas from all levels of the chain.

The quality and relevance of the initial information that flows into an organization has a direct impact on the knowledge developed from its use. Information needs to be both timely and relevant to the context of the business. A toolbox of information and communication skills is used when accessing, using, evaluating and applying information. People working together with contextual information develop competence in knowing how and when to use these skills which impact on the way in which knowledge is developed. An organization's learning community develops when learning is acknowledged as an integral part of the organization's business function – that knowledge is shared, employees are open to new ideas and have the necessary skills to apply knowledge to the organization.

Developing wisdom in the supply chain is a participative process for no one person in a climate of discontinuity can have all the solutions. Hierarchical structures tend to silo knowledge and discourage sharing. Opposite to this are bottom-up groups of interest or communities of practice established around a common interest and coordinated across the chain. These groups bring together implicit and explicit knowledge from a range of perspectives (Wenger, 2003). They are a means of mentoring new members in a supportive learning culture with regard to the business strategy and how they can contribute. Lave and Wenger (1991) identified that learning is an integral part of social practice and that this type of learning involves the whole person rather than being just a cognitive activity. The social nature of the 'community of practice' is an ideal forum for members to integrate the knowledge gained from formal learning into the chain, increasing the value of that learning both for the participant and the chain.

Networking core business activities throughout the chain builds the knowledge and skills in each of these areas and increases the opportunity for innovation throughout the chain. Positive attitudes and commitment underlie a person's motivation to participate in the flow of information within in an organization. Preventing the knowledge flow has implications for the whole chain in the quality of its products. Equally so, if a producer is unaware that their non-participation in a chain in the region affects the success of the chain, the chain will falter. Communities of practice could be centered on areas that involve people at all levels of the enterprise, e.g., technical aspects, environmental management, food safety and biosecurity, animal welfare, human resource management.

Furlong (2001) further suggests that this gives a competitive advantage to the chain as increased knowledge, skills and experience in core business areas become an entry barrier to competitors. New entries would not have developed that degree of knowledge and skill but could obtain it by takeovers or head hunting.

Communities of practice as collectives of diverse stakeholders are subject to all the issues that impact on participative processes. Development of stakeholder's participation skills such as group cohesion, power sharing, communication and learning styles, conflict resolution, negotiation, active listening etc. ensures that these groups can contribute greater value to the chain.

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.

Chapter 3

METHODOLOGY

3.1 Introduction

The previous chapters of this study described the importance of KM processes and supply chain practices in supply chain performance. Chapter 2 exhibited the need for an integrated model showing the relationships between KM process factors, supply chain practices factors and the dimensions of supply chain performance that leads to achieving competitive advantage. In order to identify the variables to be studied, the systematic literature review has greatly supported the study. This literature review identified the existing practices and factors for KM processes, SCM practices, and supply chain performance measures in manufacturing organizations in India. This chapter describes the objectives of the current study and the research methodology adopted for accomplishing these objectives.

3.2 Objectives of the Study

Following are the set of objectives in this study:

1. To study the knowledge management practices in manufacturing industries in India.
2. To study the supply chain management practices in manufacturing industries in India.
3. To study the supply chain performance in manufacturing industries in India.
4. To examine the relationship between knowledge management and supply chain performance in manufacturing industries.
5. To examine the impact of supply chain practices on supply chain performance.
6. To examine the role of knowledge management processes in the relationship between supply chain practices and supply chain performance.
7. To examine the role of supply chain practices in the relationship between knowledge management processes and supply chain performance.

8. To test the goodness of fit of the models in which knowledge management plays a moderator role and Supply chain practices play mediator role.

This chapter describes the methodological design of the research study shown in Figure 3.1 to accomplish the above stated objectives. First of all, to address the research questions and investigate the difference in characteristics of relationships across the supply chain practices and performance in manufacturing industries in India, an extensive literature review is carried out on multiple aspects of supply chain practices and performance indicators. It leads to the identification of possible set of activities related to SCM practices, KM processes and supply chain performance in the context of manufacturing firms in India. Simultaneously, these identified set of activities are to be discussed with working professionals as well as academicians. Subsequently, it is required to eliminate and reword some of the activities to develop the final structure of questionnaire. Also, the address note is included in the questionnaire to sensitize the respondents regarding the purpose of the proposed research.

Through a preliminary analysis, i.e. Pilot study, of the initial data sample of about 100 responses, reliability and consistency of the questionnaire items are ensured. Validity analysis is a process to ensure content validity, content validity and divergent and convergent validity, etc. of the measurement tool. Later, major statistical analyses such as correlation analysis, factor analysis, regression analysis, hierarchical regression analysis and confirmatory factor analysis are required to be performed on the complete data set to investigate the relationship among the study variables. Finally the findings results and discussions, conclusion, direction for future research and limitations of the study are to be specified.

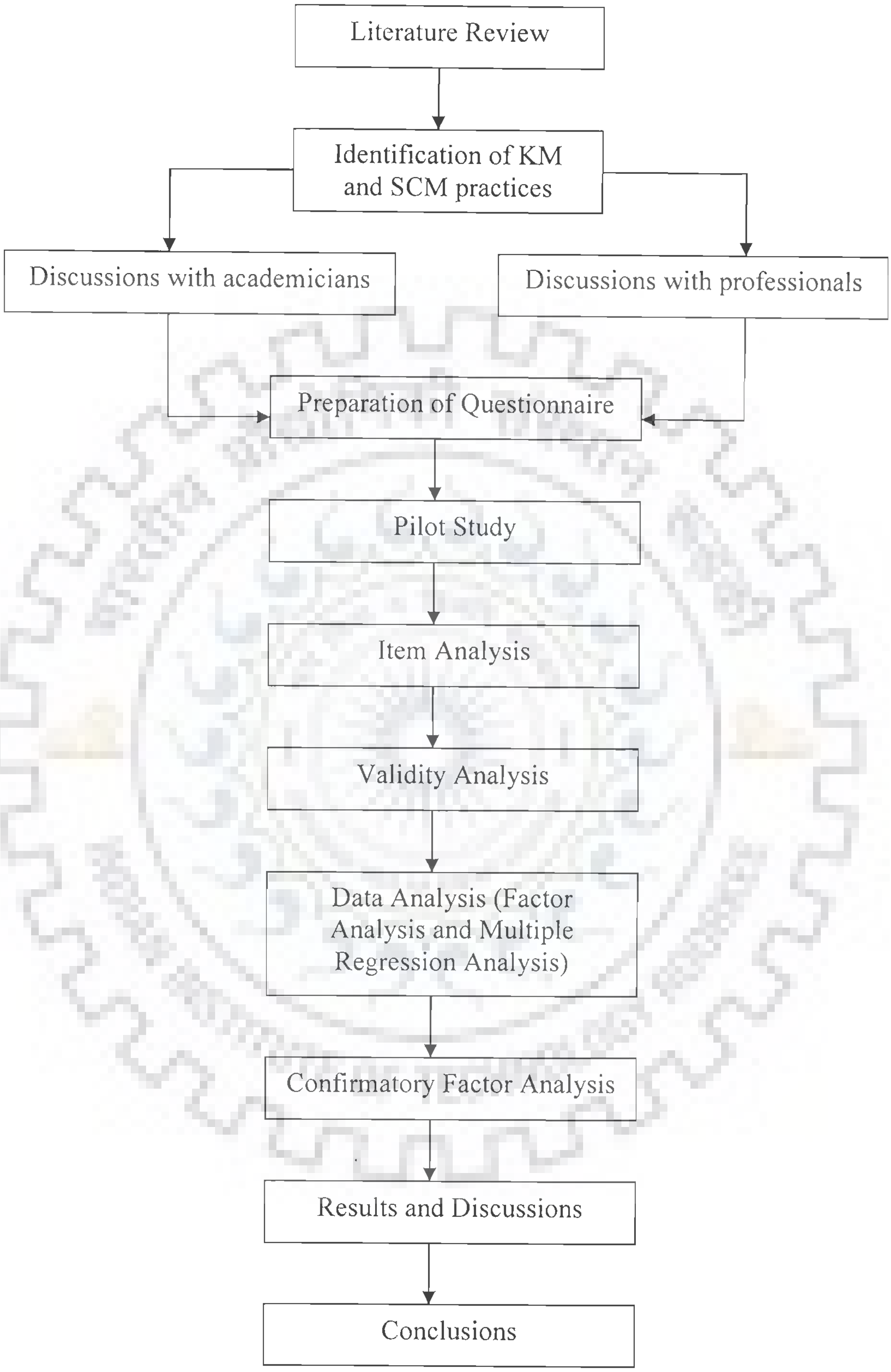

Figure 3.1 Flowchart for research methodology

3.2.1 Accomplishing Objectives 1, 2, and 3

Detailed review of extant literature of KM, SCM practices, and supply chain performance led to identification of support for the objectives 1, 2, and 3. Moreover, the descriptive statistics and correlation among these factors will help reveal the prevailing status of KM processes, SCM practices, and supply chain performance in Indian manufacturing industries.

3.2.2 Accomplishing Objective 4

Hypothesis 1: Facets of knowledge management processes (KA, KC, KAP, and KP) are positively related to Supply chain performance.

Hypothesis 1(a): Facets of KM processes are positively related to Flexibility performance.

Hypothesis 1(b): Facets of KM processes are positively related to Output performance.

Hypothesis 1(c): Facets of KM processes are positively related to Resource performance.

Hypothesis 2: The interactive effects of KM processes (KA, KC, KAP, and KP) are positively related to Supply chain performance.

Hypothesis 2(a): The interactive effects of KM processes are positively related to flexibility performance.

Hypothesis 2(b): The interactive effects of KM processes are positively related to resource performance.

Hypothesis 2(c): The interactive effects of KM processes are positively related to output performance.

3.2.3 Accomplishing Objective 5

Hypothesis 3: Facets of supply chain management practices (SCIC, SCIS, CSM, and JIT) are positively related to supply chain performance.

Hypothesis 3(a): Facets of SCM practices are positively related to flexibility performance.

Hypothesis 3(b): Facets of SCM practices are positively related to resource performance.

Hypothesis 3(c): Facets of SCM practices are positively related to output performance.

Hypothesis 4: The interactive effects of supply chain management practices (SCIC, SCIS, CSM, and JIT) are positively related to Supply chain performance.

Hypothesis 4(a): The interactive effects of SCM practices are positively related to flexibility performance.

Hypothesis 4(b): The interactive effects of SCM practices are positively related to resource performance.

Hypothesis 4(c): The interactive effects of SCM practices are positively related to output performance.

3.2.4 Accomplishing Objective 6

Hypothesis 5: The knowledge management processes moderate/mediate the relationship between supply chain management practices (SCIC, SCIS, CSM, and JIT) and Supply chain performance.

Hypothesis 5(a): The knowledge acquisition will positively moderate/mediate the relationship between SCM practices and flexibility performance.

Hypothesis 5(b): The knowledge acquisition will positively moderate/mediate the relationship between SCM practices and resource performance.

Hypothesis 5(c): The knowledge acquisition will positively moderate/mediate the relationship between SCM practices and output performance.

Hypothesis 5(d): The knowledge conversion will positively moderate/mediate the relationship between SCM practices and flexibility performance.

Hypothesis 5(e): The knowledge conversion will positively moderate/mediate the relationship between SCM practices and resource performance.

Hypothesis 5(f): The knowledge conversion will positively moderate/mediate the relationship between SCM practices and output performance.

Hypothesis 5(g): The knowledge application will positively moderate/mediate the relationship between SCM practices and flexibility performance.

Hypothesis 5(h): The knowledge application will positively moderate/mediate the relationship between SCM practices and resource performance.

Hypothesis 5(i): The knowledge application will positively moderate/mediate the relationship between SCM practices and output performance.

Hypothesis 5(j): The knowledge protection will positively moderate/mediate the relationship between SCM practices and flexibility performance.

Hypothesis 5(k): The knowledge protection will positively moderate/mediate the relationship between SCM practices and resource performance.

Hypothesis 5(l): The knowledge protection will positively moderate/mediate the relationship between SCM practices and output performance.

Based on the basis of above hypotheses, conceptual models are developed and shown in Figure 3.2 and Figure 3.3.

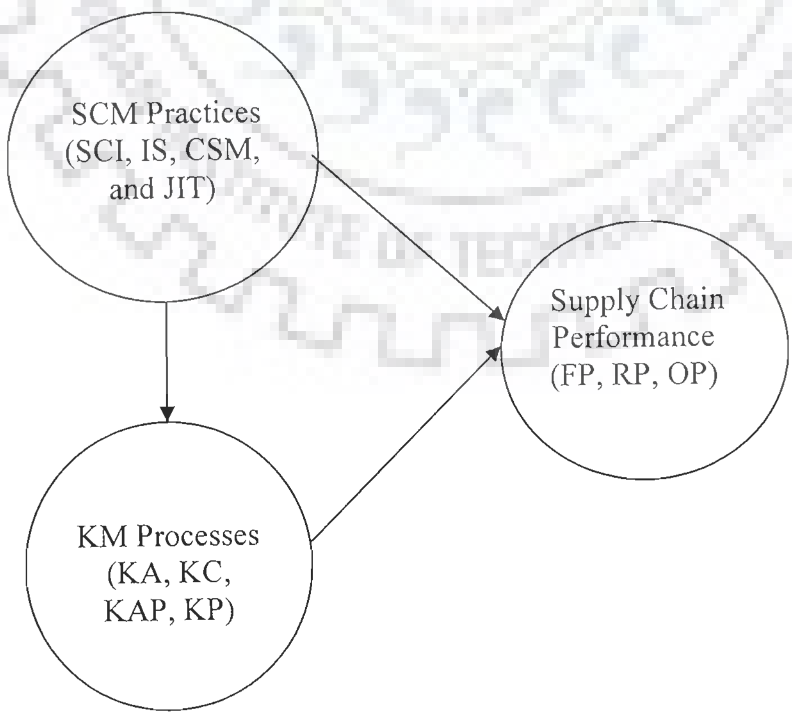

Figure 3.2: Mediator role of KM process factors

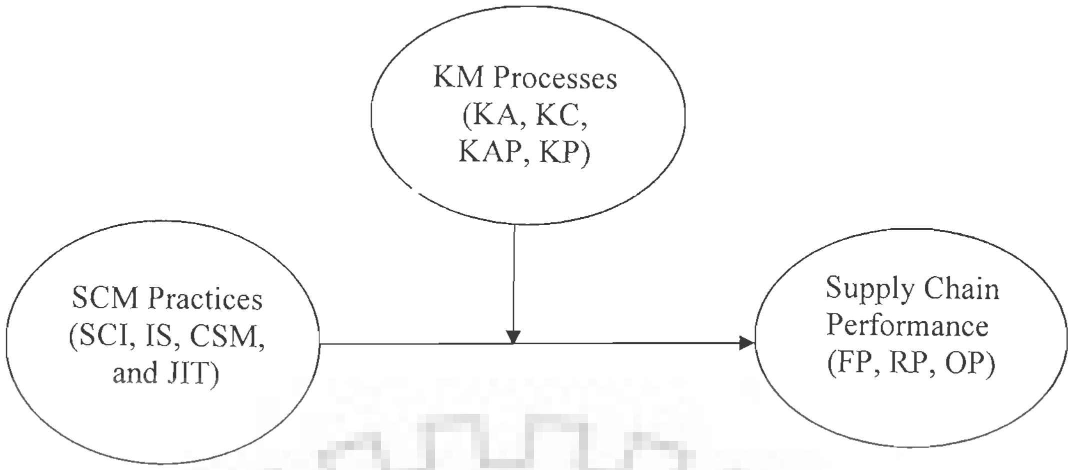

Figure 3.3: Moderator role of KM process factors

3.2.5 Accomplishing Objective 7

Hypothesis 6: The supply chain management practices (SCI, IS, CSM, and JIT) mediate/moderate the relationship between KM processes and supply chain performance.

Hypothesis 6(a): The Supply Chain Integration Characteristics (SCI) mediate/moderate the relationship between KM processes and flexibility performance.

Hypothesis 6(b): The Supply Chain Integration Characteristics (SCI) mediate/moderate the relationship between KM processes and resource performance.

Hypothesis 6(c): The Supply Chain Integration Characteristics (SCI) mediate/moderate the relationship between KM processes and output performance.

Hypothesis 6(d): The Supply Chain Information Sharing for Strategic Location (IS) mediate/moderate the relationship between KM processes and flexibility performance.

Hypothesis 6(e): The Supply Chain Information Sharing for Strategic Location (IS) mediate/moderate the relationship between KM processes and resource performance.

Hypothesis 6(f): The Supply Chain Information Sharing for Strategic Location (IS) mediate/moderate the relationship between KM processes and output performance

Hypothesis 6(i): The Customer Service Management (CSM) mediate/moderate the relationship between KM processes and flexibility performance.

Hypothesis 6(j): The Customer Service Management (CSM) mediate/moderate the relationship between KM processes and resource performance.

Hypothesis 6(k): The Customer Service Management (CSM) mediate/moderate the relationship between KM processes and output performance.

Hypothesis 6(l): The Just-In-Time Capability (JIT) mediate/moderate the relationship between KM processes and flexibility performance.

Hypothesis 6(m): The Just-In-Time Capability (JIT) mediate/moderate the relationship between KM processes and resource performance.

Hypothesis 6(n): The Just-In-Time Capability (JIT) mediate/moderate the relationship between KM processes and output performance.

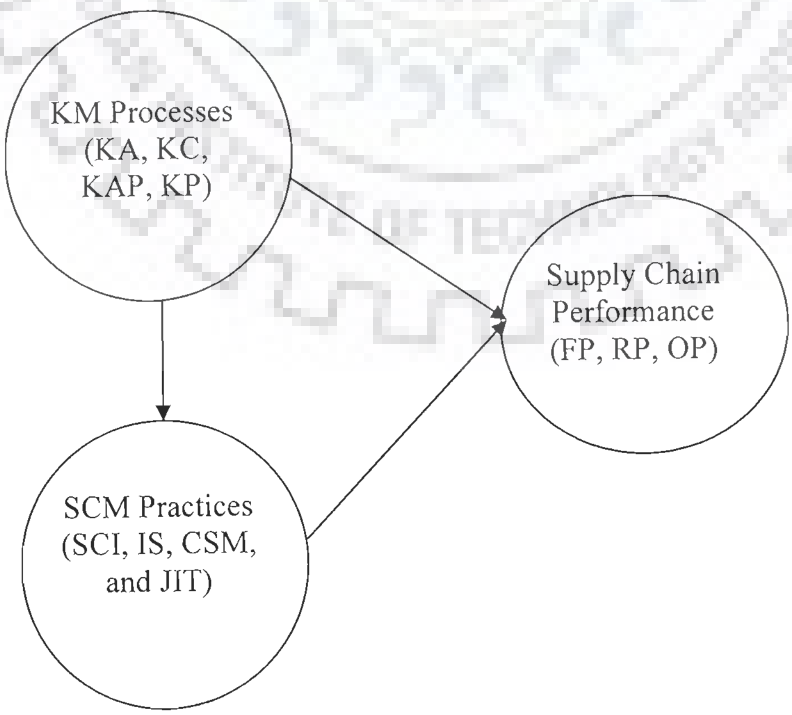

Figure 3.4: Mediator role of SCM practice factors

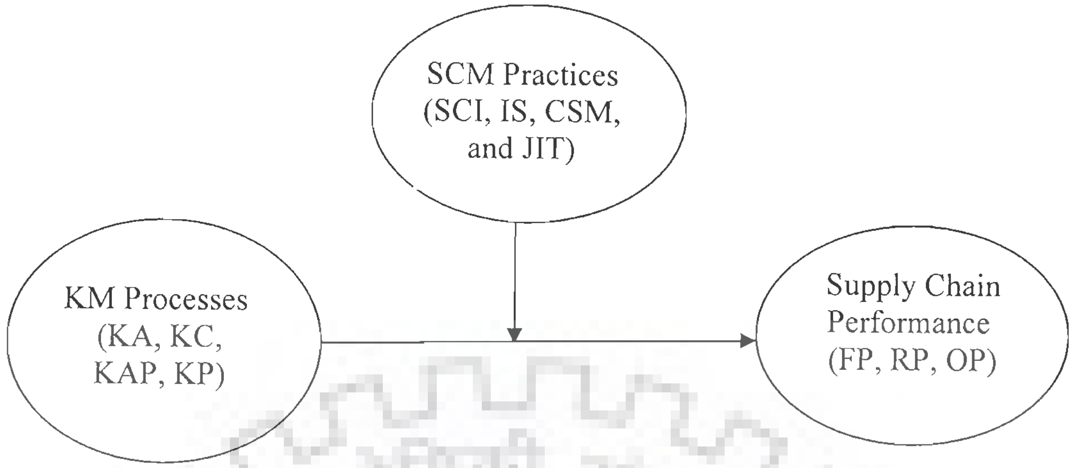

Figure 3.5: Moderator role of SCM practice factors

Figure 3.4 and Figure 3.5 show the conceptual models for hypotheses set 6.

3.2.6 Accomplishing Objective 8

After analyzing the significance of each relationship in the above models, confirmatory factor analysis (CFA) will be carried out to test the goodness-of-fit of significant research models. This procedure will help to accomplish objective 8.

3.3 Pilot Study

The questionnaire was again altered based on the responses of the preliminary study. Then, there was a need to conduct a feasibility study for being prepared into main research study. Cargan (2007) describes this study as pilot study, which provides information about whether survey can be administered and could provide accurate information. Therefore, pilot study was carried out among 100 middle and top level management executives of large, medium, and small manufacturing firms that involve in production of tyre, soya oil, electronics measurements, automobile and automotive components, and pharmaceutical products. As middle and top level management executives of manufacturing firms are the focused population for the main study, the pilot study drew sample from this population.

The responses confirmed that the administered questionnaire has included all the relevant constructs that are possessing good content validity as well as good reliability. In addition, it ensured the clarity of items. The pilot study is mainly conducted to carry out item deletion process to finalize the number of items in each construct. The following criteria were used to delete inappropriate items:

1. Item mean lying below 2.0 or above 4.0 on a 5 point scale (Stumpf *et al.*, 1983);
2. Item carrying standard deviation below 0.5 (Stumpf *et al.*, 1983);
3. Item deletion increasing internal consistency coefficient, cronbach alpha (α), to at least 0.01 (Gorsuch, 1997);
4. Item carrying missing values of more than 5 per cent (Petersen *et al.*, 2004); and
5. Corrected item scale correlation lying below 0.2 (Streiner and Norman, 2003).

As a result, total number of items of the questionnaire was reduced to 66. The following constructs are then finalized: knowledge acquisition (6 items); knowledge conversion (6 items); knowledge application (8 items); knowledge protection (6 items); supply chain integration characteristics (8 items); supply chain information sharing (6 items); just-in-time (7 items); customer support management (4 items); supply chain flexibility performance (5 items); supply chain resource performance (5 items); and supply chain output performance (5 items).

3.4 Unidimensionality of the Constructs

The validity and reliability of the constructs of the questionnaire could be assessed by analyzing unidimensionality of each construct. Principal component analysis facilitates to analyze unidimensionality, which demonstrates that all items of a single construct measure the same thing. In the principal component analysis, Eigen value 'greater than one' criteria is applied to test unidimensionality in which number of Eigen values greater than one are equal to number of factors (Netemeyer and Bearden, 2003). The rationale is each construct must have only one Eigen value of its value more than one, which enables all variables to have as much variance on the same construct. The principal component analysis of this study proved that these constructs are unidimesional as each construct has only one Eigen value of its value more than one. As a final step to assess the unidimensionality of each construct, composite reliability (see Table 3.5) of each factor of study variables is calculated as suggested by Fornell and Larcker (1981). The Eigen value, percentage of variance explained by all variables on each construct, and their factor loadings are shown in Table 3.1, Table 3.2, and Table 3.3.

3.5 Reliability of the Constructs

Hair *et al.* (2005) define reliability as "an assessment of the degree of consistency between multiple measurements of a variable" (p. 117). Thus, it refers to the systematic variance of a construct. Test-retest, internal consistency, split half, and inter-rater are some of the methods of reliability used by researchers. Among these methods, this study uses the concept of internal consistency reliability to analyze the reliability of each construct. Cronbach alpha (α) is one of a measure of internal consistency widely used by many researchers to indicate scale's reliability. The notion behind is that all items of a construct measure the same and indicate the achievement of strong inter-correlation (Cronbach, 1951). Many researchers set different lower acceptable limits for Cronbach α, but these are rules of thumb (Nunnally, 1978). Hair *et al.* (2005) set 0.60 as the acceptable limit for scales. Ko and Stewart (2002) asserted that item total correlation of at least 0.30 and Cronbach α of minimum 0.60 are the psychometric properties of a reliable scale. Table 3.4 shows the Cronbach alpha (α) value of entire measures and each construct thereby indicating the reliability of all measures and descriptive statistics.

Table 3.1 Unidimensionality of the KM Process Factors

S. No.	Construct	Items	Eigen value	% of Variance	Factor Loading
1	Knowledge Acquisition	Generating new knowledge…	2.728	45.478	0.40
2		Exchanging knowledge between employees…			0.49
3		Acquiring knowledge about new products			0.42
4		Acquiring knowledge about competitors…			0.73
5		Acquiring knowledge about customers…			0.72
6		Acquiring knowledge about suppliers…			0.68
7	Knowledge Conversion	Filtering knowledge…	2.732	45.535	0.39
8		Absorbing knowledge from employees…			0.43
9		Integrating different sources & types of knowledge…			0.52
10		Organizing knowledge…			0.52
11		Replacing outdated knowledge…			0.49
12		Converting knowledge into the design…			0.68
13	Knowledge Application	Apply knowledge learned from mistakes..	3.401	45.514	0.71
14		Apply knowledge learned from experience…			0.58
15		Using knowledge to solve new problems..			0.58
16		Makes knowledge accessible…			0.32
17		Takes advantage of new knowledge			0.61
18		Using knowledge in development of new products…			0.63
19		Uses knowledge to improve efficiency…			0.64
20		Locate and apply knowledge to changing competitive conditions…			0.46
21	Knowledge Protection	Protect knowledge from inappropriate use inside the organization…	2.975	49.591	0.66
22		Protect knowledge from inappropriate use outside the organization…			0.62
23		Protect knowledge from theft from within the organization…			0.62
24		Protect knowledge from theft from outside the organization…			0.67
25		Incentives that encourage the protection…			0.54
26		Technology that restricts access…			0.69

Table 3.2: Unidimensionality of SCM Practices Factors

S. No.	Construct	Items	Eigen value	% of Variance	Factor Loading
1	Supply Chain Integration Character-istics	Improving the integration of activities…	3.962	49.531	0.54
2		Searching for new ways to integrate…			0.48
3		Establishing more frequent contact…			0.65
4		Communicating your firm's strategic…			0.63
5		Creating a greater level of trust…			0.64
6		Communicating customers' future…			0.50
7		Involving supply chain in your pr…			0.55
8		Creating a compatible information…			0.44
9	Information Sharing for Strategic location	Participating in the sourcing decision …	3.207	45.811	0.55
10		Requiring suppliers to locate closer to…			0.48
11		Use of a third-party supply chain…			0.74
12		Use of informal information sharing…			0.61
13		Use of formal information sharing…			0.51
14		Extending supply chain beyond immediate supplier…			0.46
15	Supply Chain Characteristics for JIT Capabilities	Determining customers' future needs			0.55
16		Increasing your firm's JIT capability …			0.45
17		Aiding suppliers to increase their JIT …			0.47
18		Participating in the marketing efforts of			0.44
19		Locating closer to your customers…			0.81
20		Identifying additional supply chain…			0.39
21		Creating SCM teams to include different			0.44
22	Customer Service Management	On-time delivery directly to customers' points of use…			0.72
23		On-time delivery directly to your firm's points of use…			0.84
24		Reducing response time across..			0.43
25		Contacting the end users to get feedback…			0.46

Table 3.3: Unidimensionality of the Supply Chain Performance Factors

S. No.	Construct	Items	Eigen value	% of Variance	Factor Loading
1	Supply Chain Flexibility Performance	Periods of poor manufacturing performance…	2.745	54.909	0.80
2		Periods of poor supplier performance…			0.72
3		Periods of poor delivery performance…			0.81
4		Accommodate new products, new markets, or new competitors…			0.56
7	Supply Chain Resource Performance	Total cost of resources used	2.76	55.208	0.53
8		Costs of distribution, including transportation and handling costs			0.48
9		Costs of manufacturing, including labour, maintenance…			0.55
10		Costs associated with inventory…			0.58
11		Return on investments			0.53
13	Supply Chain Output Performance	Annual Sales (for last period)	2.294	45.881	0.81
14		Order fill rate			0.59
15		On-time deliveries			0.39
16		Customer response time			0.66
17		Manufacturing lead time			0.66

Table 3.4 Reliability and Descriptive Statistics of all measures

Standardized scale alpha for the entire measures = 0.88			
		Mean	**Variance**
1	Item means	3.60	0.16
2	Item variances	0.93	0.07

3.6 Validity of the Constructs

Validity of a questionnaire or test is very much important for research study as if reliability. Kline (1986) quoted validity as "a test is valid if it measures what it claims to measure" (p. 4). It is difficult to analyze validity of a construct, since the constructs like recruitment strategy and training are abstraction. In this direction, Groth-Marnat (1997) explained about the three broad methods of validity such as content-related validity (face and content validity), construct-related validity (convergent and discriminant validity), and criterion-related validity (predictive and concurrent validity).

3.6.1 Content-related Validity

Both face and content validity assess the representativeness and relevance of instruments of a construct, which is to be measured. Content validity is established by the judgments of experts; whereas face validity is established by test users (Groth-Marnat, 1997). Following this notion, discussions were held with professionals and researchers who were involved in KM practices and supply chain management through direct communication to seek the representativeness and relevance of the questionnaire items. Thereafter, targeted participants were met at a manufacturing firm to seek the opinions about the relevance of items. Thus, both face and content validity of the questionnaire are established.

3.6.2 Construct-related Validity

Convergent validity is established by finding high correlation between two similar operationalizations of a construct, and discriminant validity is established by finding low or negative correlation between two dissimilar operationalizations of a construct (Groth-Marnat, 1997). In this direction, Toth *et al.* (2005) established convergent validity by finding moderate correlation ($r \geq 0.40$) between an item and its own scale or construct, and assumed scaling error if high correlation value found between such item and other construct. Fornell and Larcker, (1981) also suggested that as part of a unidimensionality assessment, convergent and discriminant validity at both the item and the construct level is evaluated. For convergent validity, the standardized loading of each item must be greater than 0.5. For discriminant validity, all correlations between two constructs should be significantly less than 1, and item-level correlations between constructs are expected to be insignificant (Bagozzi, 1980). The same procedure is followed to show that the constructed questionnaire has very good convergent validity. The assessment was important because scales for KM processes and supply chain performance were adopted with some modifications for this study. Table 3.5 shows the results of the convergent validity, and values represent Pearson correlation coefficient between an item and its own construct. According to the results, items were loaded appropriately on their respective constructs, and no standardized loading was less than 0.5, which indicates an adequate level of convergent validity for each construct.

Further, divergent validity is established by finding low/negative correlation between two dissimilar operationalizations of a construct ($r < 0.50$). In which, for example, item number 8 of knowledge acquisition (KA8) has significant correlation ($r = 0.67$, $p < 0.01$) with its own construct (knowledge acquisition) and item number 30 of knowledge protection (KP30) explains significant correlation ($r = 0.62$, $p < 0.01$) with its construct (knowledge protection). Thus, it is proved that the constructed questionnaire possesses very good convergent validity. Table 3.6 summarizes the results of discriminant validity, which is found by correlating an item that is not included in any scales and the total score of any construct. Toth *et al.*, (2005) established $r < 0.50$ as a criterion for correlation between an excluded item and its own construct. The findings of this study show that no high correlation between an excluded item and its scale is observed. Thereby, developed questionnaire also possesses discriminant validity.

Table 3.5 Results of Convergent Validity

Item No.	Item	KA	KC	KAP	KP	JIT	IS	SCI	CSM	FP	RP	OP
KA8	Acquiring knowledge about suppliers.	0.67*	0.39	0.36	0.35	0.34	0.32	0.39	0.35	0.30	0.36	0.40
KC15	Converting knowledge into design…	0.42	0.64*	0.50	0.29	0.33	0.24	0.32	0.26	0.30	0.25	0.27
KAP24	Locate and apply knowledge…	0.48	0.48	0.65*	0.41	0.45	0.34	0.40	0.35	0.37	0.38	0.33
KP30	Technology that restricts access	0.33	0.34	0.27	0.62*	0.39	0.45	0.33	0.31	0.32	0.27	0.22
JIT20	Creating SCM teams to include …	0.29	0.26	0.24	0.38	0.70*	0.50	0.53	0.41	0.42	0.44	0.34
IS23	Extending supply chain beyond …	0.41	0.39	0.44	0.45	0.65	0.71*	0.60	0.51	0.51	0.46	0.40
SCI24	Creating compatible information…	0.36	0.34	0.38	0.39	0.52	0.48	0.68*	0.46	0.42	0.41	0.45
CSM25	Contacting the end users to get …	0.38	0.38	0.44	0.37	0.45	0.37	0.53	0.71*	0.45	0.48	0.46
FP5	Accommodate new products…	0.32	0.29	0.33	0.32	0.39	0.24	0.37	0.34	0.66*	0.43	0.35
RP10	Return on investments…	0.25	0.24	0.33	0.25	0.48	0.40	0.43	0.35	0.38	0.69*	0.51
OP16	Manufacturing lead time…	0.28	0.23	0.25	0.17	0.32	0.26	0.27	0.20	0.14	0.40	0.58*

Notes: * All values are significant at $p<0.01$.

KA- Knowledge Acquisition; KC- Knowledge Conversion; KAP- Knowledge Application; KP- Knowledge Protection; JIT- Just In Time; IS- Information Sharing; SCI- Supply Chain Integration; CSM- Customer Service Management; FP- Flexibility Performance; RP- Resource Performance; OP- Output Performance

Table 3.6 Results of Divergent Validity

Item No.	Item	KA	KC	KAP	KP	JIT	IS	SCI	CSM	FP	RP	OP
KA8	Acquiring knowledge…	0.48*	0.34	0.27	0.35	0.32	0.28	0.36	0.31	0.27	0.34	0.37
KC15	Converting knowledge…	0.39	0.45*	0.44	0.31	0.31	0.21	0.26	0.22	0.21	0.22	0.26
KAP24	Locate and apply …	0.44	0.43	0.39*	0.39	0.45	0.31	0.36	0.26	0.35	0.29	0.30
KP30	Technology that…	0.26	0.36	0.18	0.42*	0.34	0.43	0.27	0.31	0.31	0.31	0.17
JIT20	Creating SCM ..	0.27	0.22	0.20	0.31	0.44*	0.46	0.46	0.38	0.39	0.39	0.30
IS23	Extending supply…	0.37	0.35	0.38	0.41	0.62	0.45*	0.54	0.45	0.46	0.39	0.39
SCI24	Creating compatible…	0.32	0.30	0.33	0.37	0.50	0.44	0.34*	0.40	0.36	0.38	0.39
CSM25	Contacting the end…	0.34	0.33	0.37	0.36	0.45	0.33	0.51	0.42*	0.35	0.44	0.46
FP5	Accommodate new…	0.31	0.25	0.27	0.30	0.38	0.20	0.34	0.25	0.41*	0.34	0.30
RP10	Return on investments…	0.22	0.18	0.24	0.28	0.45	0.36	0.38	0.30	0.28	0.43*	0.46
OP16	Manufacturing lead …	0.23	0.22	0.19	0.12	0.30	0.25	0.22	0.18	0.07	0.38	0.27*

Notes: * All values are significant at $p < 0.01$.
KA- Knowledge Acquisition; KC- Knowledge Conversion; KAP- Knowledge Application; KP- Knowledge Protection;
JIT- Just In Time; IS- Information Sharing; SCI- Supply Chain Integration; CSM- Customer Service Management;
FP- Flexibility Performance; RP- Resource Performance; OP- Output Performance.

3.7 Main Research Study

This section describes the selection of participants, who are working in manufacturing firms, for the study and demographic characteristics of both participants and their manufacturing organizations.

3.7.1 Data Collection

Both random and non random sampling (convenience, and judgment or purposeful) procedures are used to collect data from employees. The top and middle level management employees are chosen in this study, since they are expected to possess relevant knowledge and experience in the subject area. In convenience sampling, industrial areas near Roorkee town in the state of Uttarakhand is selected as it is more convenient to meet employees at their firms officially and to collect their responses. In judgment sampling, Indore city in the state of Madhya Pradesh is chosen to collect data because of author's familiarity and experience about manufacturing companies that are to be included in the study, and also confident that this sample is truly representative of the population. In addition, responses were collected from employees in the conferences, workshops, and seminars. Some of the responses were collected through email from the respondents working in the remote places. Importantly, social network websites, Orkut.com and LinkedIn are also used to administer data collection processes. In which, Indian manufacturing companies' communities were randomly chosen, and the concerned employees were requested to participate in this study by leaving a message of the purpose of the study and web link to download the questionnaire at their scrap books. It is important to note that the confidentiality of all participants' responses is maintained throughout the study. To ensure confidentiality, reported data are compiled into summaries. These sampling procedures enable to collect responses from as much as 11 Indian states.

3.7.2 Survey Respondents

The selection of respondents is considered very critical for obtaining sufficient and good quality data in survey studies. The respondents in different manufacturing industries are expected to have appropriate knowledge on the subject areas of the survey. We were interested in KM processes and supply chain practices and performance in this study. Thus the respondents must have experience in KM practices, as well as possess general understanding to supply chain management and supply chain performance indicators in their respective firms as well as industry. 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 targeted respondents of the study were supply chain professionals, and high-level corporate executives. It is expected that their job function enables them to have a working knowledge about their own organization as well as the partner organizations in their supply chains. They are the most appropriate personnel to answer questions related to organizational infrastructures, KM practices, SCM practices, and supply chain performance. Responses are finally collected from 357 top and middle level managers working in various manufacturing industries in India. Their participation is confirmed only by receiving the completely filled-out questionnaire.

3.7.3 Organisations

Figure 3.6 shows that majority of responding employees (46 per cent) are belonging to manufacturing firms operating in automobile and automotive components industry, followed by precision tools (7 per cent), electrical equipments (5 per cent), and others (12 per cent).

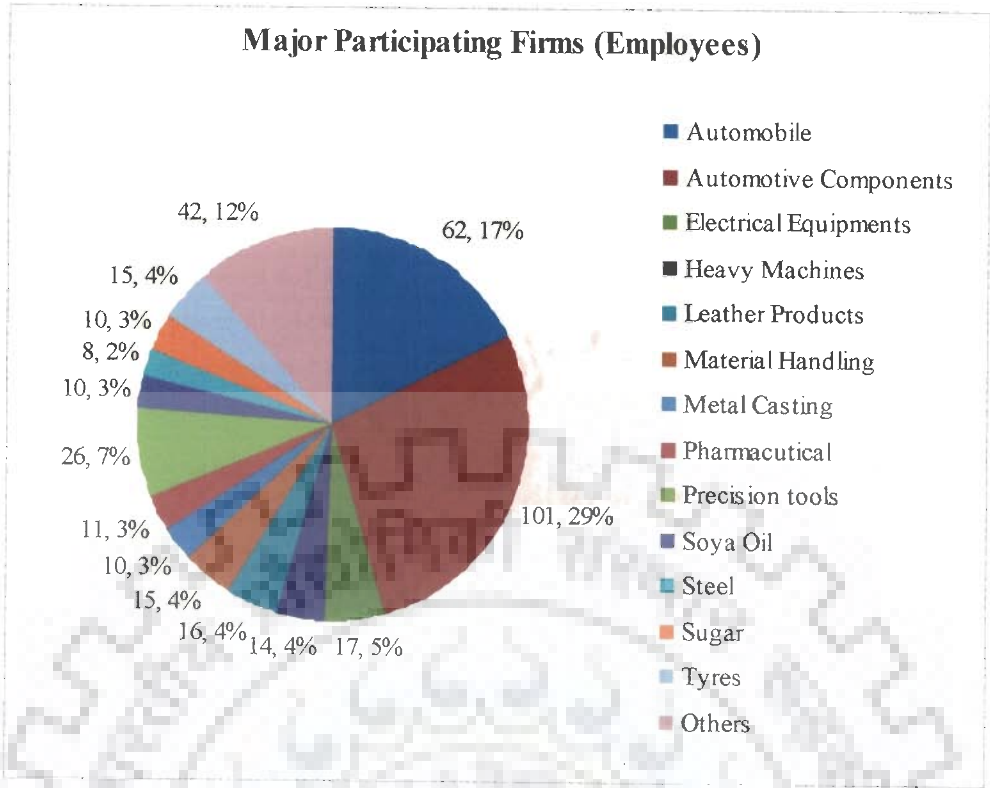

Figure 3.6: Major participating firms in terms of employee respondents

It can be seen from Figure 3.7 that responding employees are having hierarchical positions of top-level executives (31 per cent) and middle-level executives (31 percent) and lower level (38 per cent). It has been found that most of the engineer-rank employees of production and operations, materials, production planning and control divisions are responsible for SCM issues at the front end. Therefore, significant numbers of respondents are from this group at lower level management.

Figure 3.8 shows the kinds of manufacturing organization that participated in this research study. It can be seen that about 31% of the firms are from public limited organizations. Majority (58%) of the responding firms are from private limited organizations. Total 10 (11% of the responding firms) government undertaking companies participated in this study.

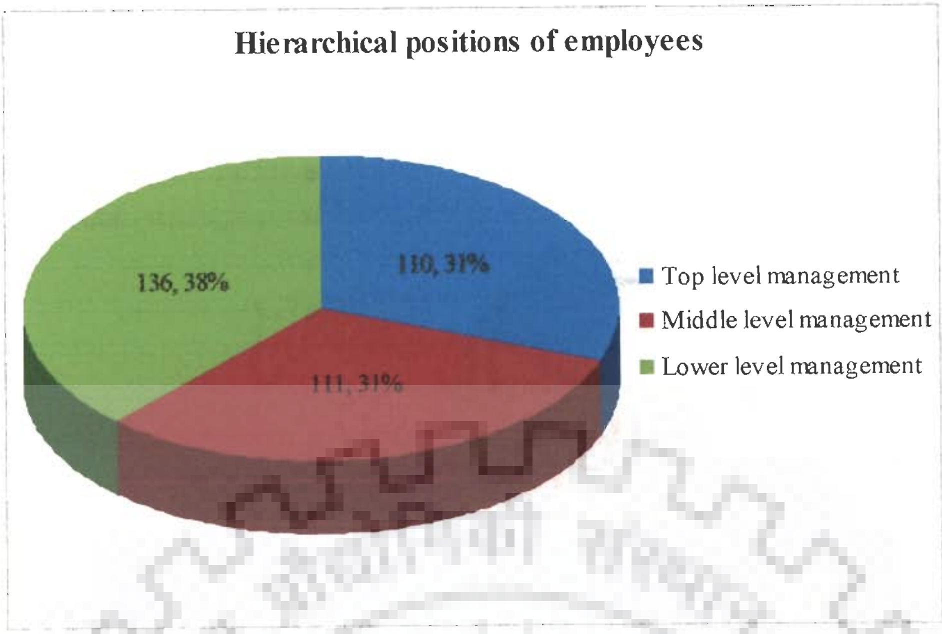

Figure 3.7: Hierarchical positions of respondents

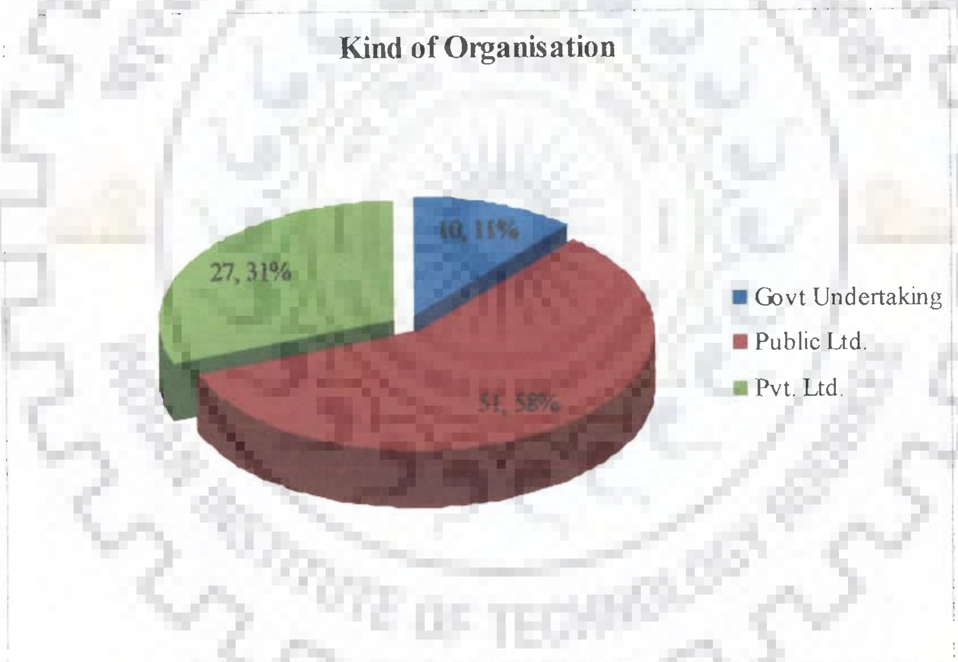

Figure 3.8: Kinds of organization

Figure 3.9 presents the composition of major participating firms in this research that includes 12 firms from automobile industry, 19 firms from automotive component industry, 9 firms from electrical equipments and 4 firms each from precision tools, power, steel, and logistics providers. 15 firms are from other manufacturing industries that include bags & luggage, food products, metal casting, paint, pump, refinery products, refrigerator, textile, security products, fertilizer etc.

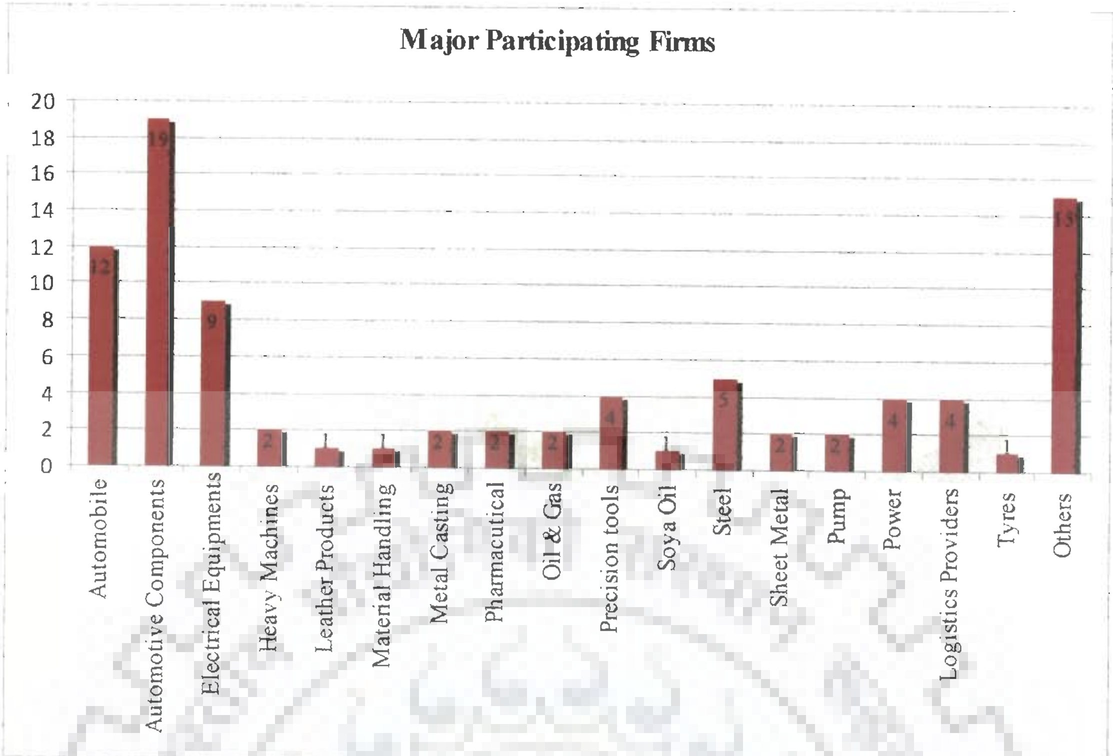

Figure 3.9: Major participating firms

Firm's size is indicated in terms of number of employees in the firm, as shown in Figure 3.10. Majority (51%) of the responding firms belong to the category of large size organizations with having employee strength more than 1000 employees. The second group is of medium sized organizations that amount to be about 40%, rest of the organizations (10%) are of small size as these have employee strength less than100 employees.

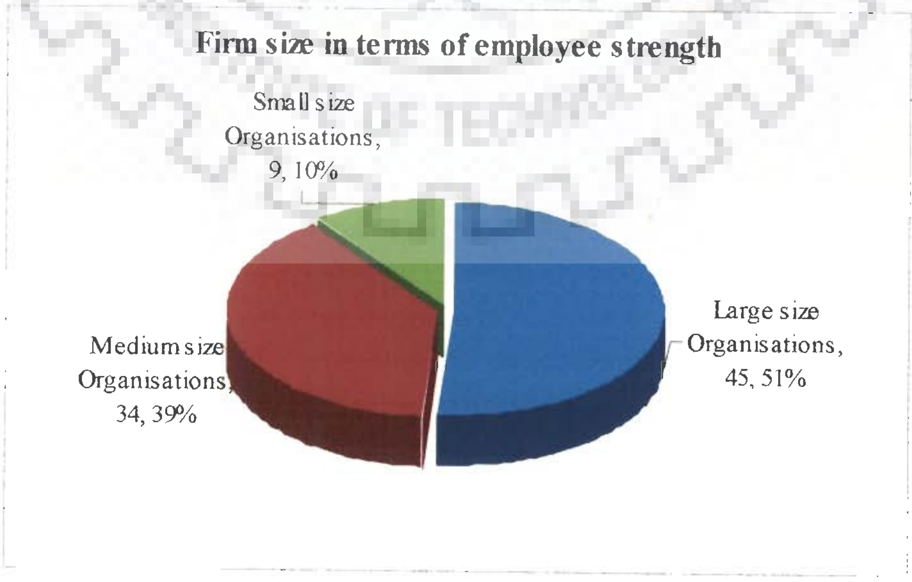

Figure 3.10: Firms' size in terms of employee strength

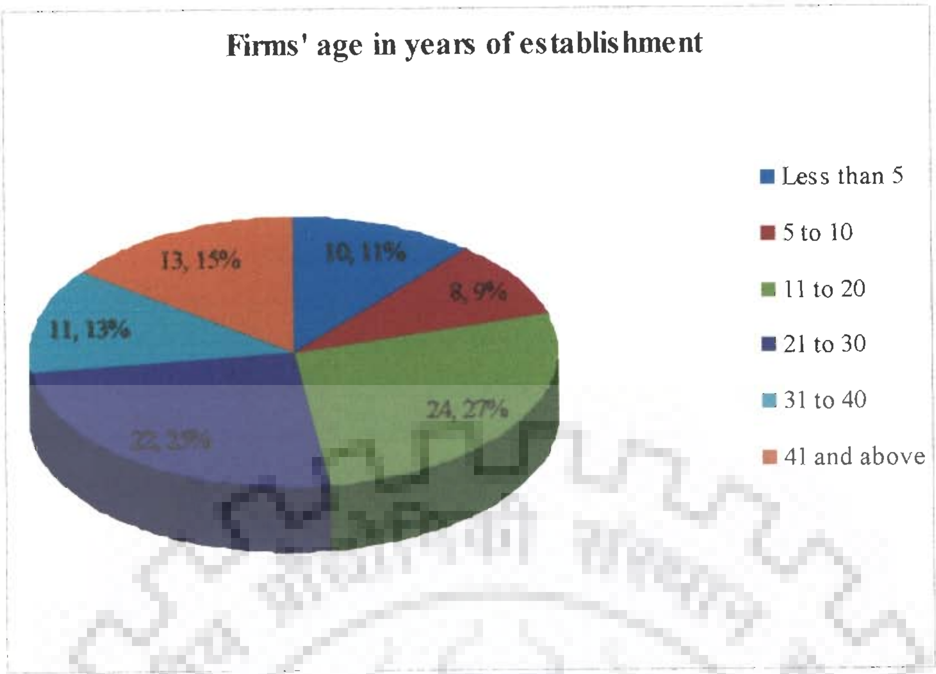

Figure 3.11: Firms' age in years of establishment

Firm's age is indicated in terms of its establishment and as obvious from Figure 3.11 about half of the firms are of the age in the range of 11 to 30 years of establishment.

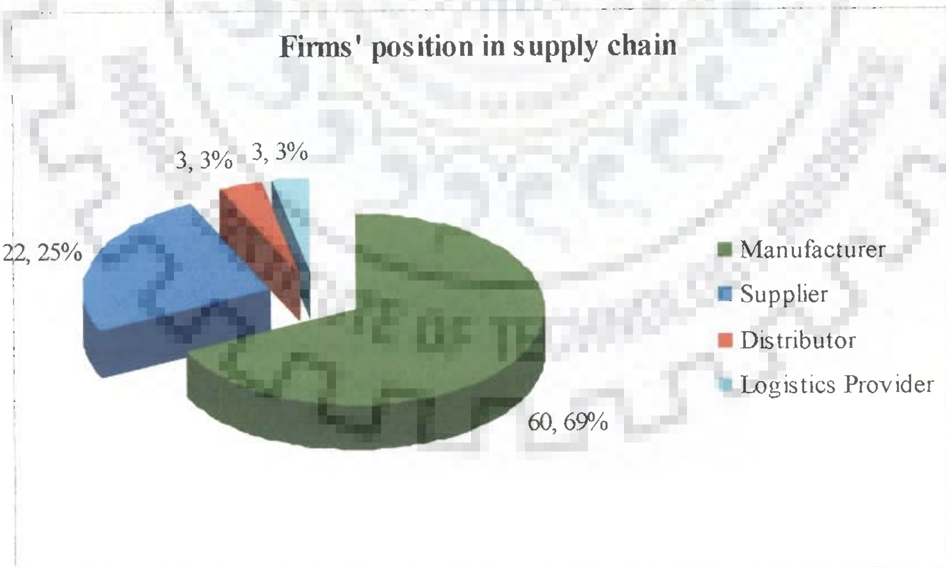

Figure 3.12: Firms' position in supply chain

Figure 3.12 shows the proportion of the firms according to their positions in the supply chain. About 69% of the firms are belonging to the major player in the supply chain, i.e. the manufacturer, while about 25% are belonging to the position of supplier to other major players in the supply chain.

Chapter 4

RESULTS

4.1 Introduction

This chapter presents the details of the analyses carried out to examine the relationships of the variables represented in the theoretical models. The first section of this chapter examines the zero order correlation coefficients between all pairs of variables represented in all models. The second section explains internal factor structure of KM process measures, SCM practices measures, and supply chain performance measures through exploratory factor analysis as well as confirmatory factor analysis. The third section analyses the impact of determinants of KM process measures on SCM practices measures and supply chain performance measures through simple regression analysis and hierarchical regression analysis (HRA) after controlling for firm's demographic characteristics. The next section explains further, the role of KM process factors in the relationship between factors of SCM practices and supply chain performance. Similarly, the role of SCM practice factors in the relationship of KM process factors and supply chain performance factors is also examined. Finally, confirmatory factor analysis is performed to the statistically significant models to examine the goodness-of-fit with data. The statistical packages SPSS 15 and LISREL 8.7 are used to carry out all the above mentioned analyses. Table 4.1, 4.2, 4.3, and 4.4 represent the responses on KM process, SCM practices, and supply chain performance in manufacturing firms in India.

Table 4.1 : Descriptive Statistics for KM Process Measures

S. No.	Items	Response counts					Mean	SD
		1	2	3	4	5		
1	Generating new knowledge…	10	21	84	187	55	3.72	0.89
2	Exchanging knowledge between employees	3	11	79	183	81	3.92	0.80
3	Acquiring knowledge about new products...	4	25	92	159	77	3.78	0.90
4	Acquiring knowledge about competitors…	18	52	84	143	60	3.49	1.09
5	Acquiring knowledge about our customers..	5	30	75	175	72	3.78	0.91
6	Acquiring knowledge about our suppliers…	4	32	94	155	72	3.73	0.92
7	Filtering knowledge…	12	55	97	162	31	3.41	0.96
8	Absorbing knowledge from employees…	5	32	79	181	60	3.73	0.89
9	Integrating different sources & types of knowledge…	3	45	112	135	62	3.58	0.95
10	Organizing knowledge…	5	31	93	174	54	3.68	0.88
11	Replacing outdated knowledge…	6	42	110	151	48	3.54	0.93
12	Converting knowledge into the design…	2	33	86	173	63	3.73	0.88
13	Apply knowledge learned from mistakes…	21	25	60	170	81	3.74	1.07
14	Apply knowledge learned from experience..	2	13	96	172	74	3.85	0.81
15	Using knowledge to solve new problems…	4	13	71	193	76	3.91	0.81
16	Makes knowledge accessible…	4	29	93	167	64	3.72	0.89
17	Takes advantage of new knowledge…	3	26	79	180	69	3.80	0.86
18	Using knowledge in developing new product	5	19	100	171	62	3.75	0.85
19	Uses knowledge to improve efficiency…	4	17	69	186	81	3.90	0.84
20	Locate and apply knowledge to changing…	5	23	106	170	53	3.68	0.85
21	Protect knowledge from inappropriate use inside the organization…	18	49	92	151	47	3.45	1.04
22	Protect knowledge from inappropriate use outside the organization…	8	55	86	152	56	3.54	1.00
23	Protect knowledge from theft from within...	6	57	95	133	66	3.55	1.02
24	Protect knowledge from theft from outside..	8	35	118	131	65	3.59	0.97
25	Incentives that encourage the protection…	14	72	120	116	35	3.24	1.01
26	Technology that restricts access…	17	34	115	141	50	3.48	1.00

Note: SD – Standard Deviation

Table 4.2 : Descriptive statistics for SCM practice measures

S. No.	Items	Response counts					Mean	SD
		1	2	3	4	5		
27	Improving the integration of activities…	16	12	92	175	62	3.71	0.94
28	Searching for new ways to integrate…	8	33	125	147	44	3.52	0.90
29	Establishing more frequent contact…	11	51	112	136	47	3.44	0.99
30	Communicating your firm's strategic needs	7	53	108	136	53	3.49	0.98
31	Creating a greater level of trust…	11	49	106	145	46	3.46	0.98
32	Communicating customers' future strategic	8	40	117	148	44	3.50	0.93
33	Involving supply chain in your product…	16	67	122	120	32	3.24	1.00
34	Creating a compatible information system…	10	40	103	161	43	3.52	0.94
35	Participating in the sourcing decisions of suppliers …	22	42	106	137	50	3.42	1.06
36	Requiring suppliers to locate closer to firm	37	49	115	119	37	3.20	1.12
37	Use of a third-party supply chain..	15	45	142	115	40	3.34	0.98
38	Use of informal information sharing…	7	42	120	156	32	3.46	0.88
39	Use of formal information sharing..	10	37	140	127	43	3.44	0.93
40	Extending supply chain beyond immediate supplier…	7	33	117	160	40	3.54	0.88
41	Determining customers' future needs…	11	36	112	148	50	3.53	0.96
42	Increasing your firm's JIT capability …	7	27	103	164	56	3.66	0.90
43	Aiding suppliers to increase their JIT capability...	8	22	110	159	58	3.66	0.90
44	Participating in the marketing efforts of…	3	26	109	141	78	3.74	0.91
45	Locating closer to your customers…	3	23	109	150	72	3.74	0.88
46	Identifying alternate supply chain…	8	40	113	142	54	3.54	0.95
47	Creating SCM teams to include different…	5	36	121	158	37	3.52	0.86
48	On-time delivery directly to customers' points of use…	6	26	110	146	69	3.69	0.92
49	On-time delivery to firm's points of use…	4	29	113	154	57	3.65	0.88
50	Reducing response time across..	13	26	109	145	64	3.62	0.98
51	Contacting the end users to get feedback…	10	30	116	131	70	3.62	0.98

Note: SD – Standard Deviation

Table 4.3 : Descriptive statistics for supply chain performance measures

S. No.	Items	Response counts 1	2	3	4	5	Mean	SD
52	Demand variations such as seasonality…	21	23	89	160	64	3.62	1.04
53	Periods of poor manufacturing performance…	7	34	92	177	47	3.62	0.90
54	Periods of poor supplier performance…	6	32	136	140	43	3.51	0.88
55	Periods of poor delivery performance…	10	32	108	157	50	3.57	0.94
56	Accommodate new products, new market...	5	35	117	135	65	3.62	0.94
57	Total cost of resources used…	5	34	123	142	53	3.57	0.90
58	Costs of distribution, including transportation...	4	36	120	149	48	3.56	0.89
59	Costs of manufacturing, including labour…	2	37	115	153	50	3.59	0.87
60	Costs associated with inventory…	3	47	120	141	46	3.50	0.91
61	Return on investments	5	40	95	148	69	3.66	0.96
62	Annual Sales (for last period)	6	17	97	160	77	3.80	0.89
63	Order fill rate	3	23	119	161	51	3.66	0.83
64	On-time deliveries	2	24	80	184	67	3.81	0.84
65	Customer response time	1	16	99	178	63	3.80	0.79
66	Manufacturing lead time	4	33	118	161	41	3.57	0.85

Note: SD – Standard Deviation

4.2 Control variables

As suggested by Bullent (2008), the control variables that have been used in this study are firm's size in terms of employee strength, firm's position in the supply chain (as manufacturer, supplier, distributer, and logistics provider), and firm's age in terms of years of its establishment. Respondent firms were belonging to a variety of sectors (including automotive, textile, machining, food, metal, chemical, and electronics/communication). Firm sizes in terms of the number of workers ranged from a few people to more than 500.

4.3 Correlation analysis

In the correlation analysis, Pearson correlation coefficient is used to express the extent to which two variables are related. In line with the research study, such analysis supports to find to what extent constructs of KM processes and SCM practices are related to supply chain performance. The results of descriptive statistics and correlation analysis are shown in Table 4.4, which shows that among the variables of firms' characteristics, firms' position in the supply chain is positively correlated with supply chain flexibility performance. In addition to this, firms' position in supply chain has substantial positive association with all factors of KM processes and SCM practices. Firms' size in terms of employee strength has significant positive correlation with overall KM processes and SCM practices. Importantly, all the studying variables show a significant positive relationship with constructs of supply chain performance ($r > 0.50$).

4.4 Exploratory Factor Analysis: Analyzing the Factor Structure

For exploring and analyzing the underlying structure of the interrelationships among the large number of variables, the procedure of exploratory factor analysis (EFA) is applied to collected responses. This analysis identifies the structure of dimensions or factors and determines the degree of the explanation of each variable on the corresponding factor (Hair *et al.*, 2005). This study performs EFA for finding the factor structure of each measure due to its interdependence approach in which all the study variables are considered simultaneously and each variable is related to all other variables. Principal component analysis is particularly chosen as it accounts for the total variance and derives factors that have small degree of unique variance in which Eigen value of at least one is set as a criterion to extract factors from the variables. However, principal component analysis generally allocates large amount of variance on the first derived factor than other following factors. Therefore, it is important to perform varimax rotation to redistribute the variance

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Table 4.4 : Descriptive Statistics and Correlation Coefficients (contd.)

No.	Variables	Mean	SD	SCMP Factors (9)	SCI (10)	IS (11)	JIT (12)	CSM (13)	SCP Factors (14)	FP (15)	RP (16)	OP (17)
1	Firms' age	21.26	14.60									
2	Firms' position in the supply chain	2.51	0.61									
3	Firms' size											
4	*KMP factors*	3.66	0.52									
5	Knowledge Acquisition (KA)	3.74	0.62									
6	Knowledge Conversion (KC)	3.61	0.61									
7	Knowledge Application (KAP)	3.81	0.57									
8	Knowledge Protection (KP)	3.48	0.71									
9	*SCMP Factors*	3.54	0.57	1.00								
10	Supply Chain Integration (SCI)	3.63	0.64	**0.90**	1.00							
11	Information Sharing (IS)	3.40	0.68	**0.85**	**0.70**	1.00						
12	Just-In-Time (JIT)	3.48	0.66	**0.87**	**0.75**	**0.69**	1.00					
13	Customer Service Management (CSM)	3.67	0.69	**0.82**	**0.69**	**0.56**	**0.58**	1.00				
14	*SC Performance Factors*	3.63	0.54	**0.76**	**0.70**	**0.58**	**0.68**	**0.66**	1.00			
15	Flexibility Performance (FP)	3.59	0.69	**0.64**	**0.61**	**0.48**	**0.59**	**0.53**	**0.81**	1.00		
16	Resource Performance (RP)	3.58	0.67	**0.66**	**0.57**	**0.53**	**0.60**	**0.58**	**0.87**	**0.52**	1.00	
17	Output Performance (OP)	3.73	0.57	**0.61**	**0.59**	**0.44**	**0.53**	**0.55**	**0.84**	**0.49**	**0.67**	1.00

Note: **p< 0.01, *p< 0.05 level; SD- Standard Deviation from earlier factors to other factors to get a simple and meaningful factor structure. Equimax is mainly considered for rotation to interpret the factors as it forms linear combinations of observed variables to interpret the factors.

To perform factor analysis, Hair *et al.*, (2005) proposed the required minimum sample size of more than 100 or at least five times as many observations as there are variables to be analyzed. Further, the authors recommended the minimum acceptable limit of factor loading, the correlation between variable and factor, of each variable in a factor as ± 0.30. Importantly, they suggested accepting a factor, which must have at least 0.60 of Cronbach alpha.

4.4.1 The Factor Structure of KM Process Measure

Table 4.5 presents the results of factor loadings from the factor analysis carried out on the employees' responses on the KM process measures. According to the findings, KM process measures can be divided into four prime factors depicting specific groupings and each binds with some relations, which together account for over 45 per cent of the total variation in the used KM process measures. These factors are:

Factor 1: This factor includes organizational processes for acquiring knowledge from competitors, suppliers, and customers about designs and need for new products and services within the industry. It also includes the processes for exchanging important knowledge among employees. Additionally, creation of new knowledge from existing knowledge is another important attribute in this factor. As it is obvious that all these variables are related to accumulation of knowledge, this factor is named as *knowledge acquisition*.

Table 4.5: Factor Structure of KM Process Variables

Fators	Factor Items	Factor Loadings			
		KA	KC	KAP	KP
Knowledge Acquisition	Generating new knowledge	0.40			
	Exchanging knowledge between employees	0.49			
	Acquiring knowledge about new products	0.42			
	Acquiring knowledge about competitors	0.73			
	Acquiring knowledge about our customers	0.72			
	Acquiring knowledge about our suppliers	0.68			
Knowledge Conversion	Filtering knowledge		0.39		
	Absorbing knowledge from employees		0.43		
	Integrating different sources & types of knowledge		0.52		
	Organizing knowledge		0.52		
	Replacing outdated knowledge		0.49		
	Converting knowledge into the design		0.68		
Knowledge Application	Apply knowledge learned from mistakes			0.71	
	Applying knowledge learned from experience			0.58	
	Using knowledge to solve new problems			0.58	
	Makes knowledge accessible			0.32	
	Takes advantage of new knowledge			0.61	
	Using knowledge in development of new products			0.63	
	Uses knowledge to improve efficiency			0.64	
	Locate and apply knowledge to changing competitive conditions			0.46	
Knowledge Protection	Protect knowledge from inappropriate use inside the organization				0.66
	Protect knowledge from inappropriate use from outside the organization				0.62
	Protect knowledge from theft from within the organization				0.62
	Protect knowledge from theft from outside the organization				0.67
	Incentives that encourage the protection				0.54
	Technology that restricts access				0.69
	KMO Test	0.812	0.827	0.856	0.800
	Eigenvalue	2.728	2.732	3.401	2.975
	% of variance	45.473	45.535	45.514	49.591
	Cronbach alpha	0.76	0.77	0.80	0.80

Factor 2: This factor includes organizational processes for integrating different sources and kinds of knowledge, filtering and organizing knowledge, replacing obsolete knowledge, and converting knowledge into the designs of new products and services. All these variables are of similar nature such as making knowledge useful; therefore, this factor is referred as *knowledge conversion*.

Factor 3: Organizational processes such as applying knowledge learned from mistakes and experience, using new knowledge to solve problems, disseminating it to employees concerned, taking advantage of new knowledge, locating and applying knowledge to changing competitive conditions, using knowledge in development of new products and services improve the efficiency, are clustered to form this factor. Thus, this factor is named *knowledge application*.

Factor 4: This factor comprises of organizational processes for protecting knowledge from inappropriate use and theft both from inside as well as outside the organization. It also includes organizational incentives for encouraging employees for securing important knowledge, and using technology for restricted access of vital knowledge. As it is obvious that all these variables are related to securing organizational knowledge, this factor is called as *knowledge protection*.

The Cronbach alpha, the Eigenvalue, and variance explained on each factor are also shown in Table 4.5. The alpha value of each factor is more than 0.70, which shows the good level of reliability of each factor.

Figure 4.1 shows the measurement model of KM process measure that has been developed using LISREL 8.7 package. In line with Gold *et al.* (2001), the parameter estimates, fit indices, and observed residuals imply that the hypothesized dimensions of KM processes provide a good fit for the observed covariance among the collection of item measures.

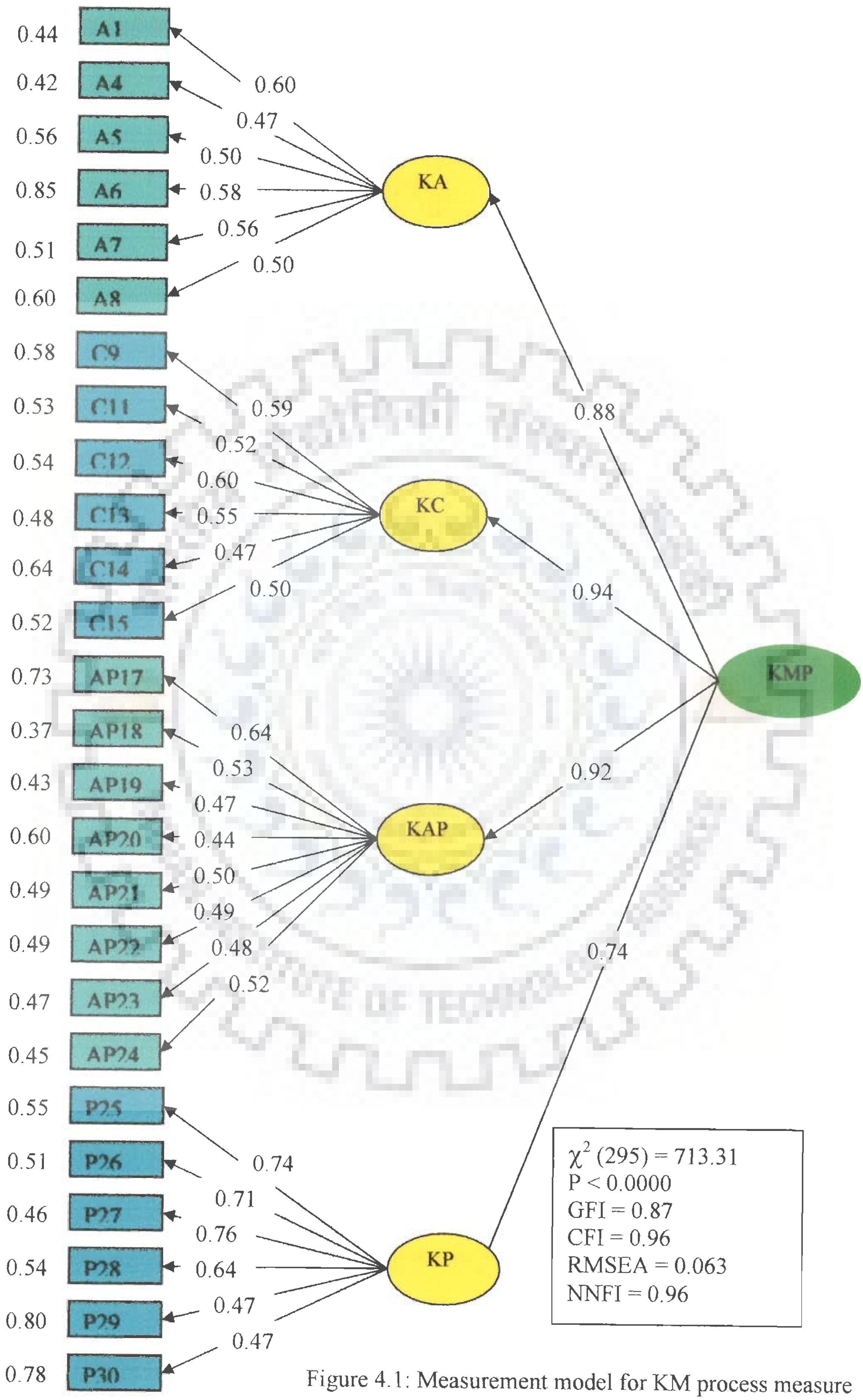

Figure 4.1: Measurement model for KM process measure

The model chi-square (χ^2) value is 713.31 with 295 degrees of freedom. Although χ^2 is not significant and rather large, the normed χ^2 (2.31) is suggesting strong fit relative to degrees of freedom. In addition, the normed and non-normed fit (NNFI) indices are very high, suggesting good model fit. All indicator variables are sufficiently high and statistically different from zero. In summery, the fit statistics seem to indicate that each scale is capturing a significant amount of variation in the latent dimensions of KM process.

4.4.2 The Factor Structure of SCM Practices Measure

Table 4.6 presents the EFA outcome for the factor structure of SCM practices measure. There are four factors extracted, which are labeled accordingly. The factors are as follows.

Factor 1: It consists of variables such as improving the integration of activities, searching for new ways to integrate, ensuring frequent contacts with suppliers, communicating firm's strategic needs, creating a greater level of trust, involving supply chain in product design. These variables have integration properties in common; therefore this factor is named as *supply chain integration.*

Factor 2: The variables, participating in the sourcing decisions of suppliers, requiring suppliers to locate closer to firm, use of third party supply chain specialist, use of informal information sharing, use of formal information sharing agreements, and extending supply chain beyond immediate suppliers/customers are indicated to form one factor. As these are related to importance of information sharing for identifying location of the firm, this factor is termed as *information sharing for strategic location.*

Factor 3: This factor includes variables determining customers' future needs, increasing your firm's JIT capability, participating in the marketing efforts of customers, aiding suppliers to increase their JIT capability, locating closer to your customers,

Table 4.6: Factor Structure of SCM Practices Variables

Factors	Factor Items	Factor Loadings			
		SCI	IS	JIT	CSM
Supply Chain Integration Characteristics	Improving the integration of activities…	0.54			
	Searching for new ways to integrate…	0.48			
	Establishing more frequent contact…	0.65			
	Communicating your firm's strategic needs	0.63			
	Creating a greater level of trust…	0.64			
	Communicating customers' future strategic…	0.50			
	Involving supply chain in your product…	0.55			
	Creating a compatible information system…	0.44			
Information Sharing for Strategic Location	Participating in the sourcing decisions of suppliers …		0.55		
	Requiring suppliers to locate closer to your firm...		0.48		
	Use of a third-party supply chain specialist…		0.74		
	Use of informal information sharing…		0.61		
	Use of formal information sharing agreements..		0.51		
	Extending supply chain beyond immediate supplier…		0.46		
Supply Chain Characteristics for JIT Capabilities	Determining customers' future needs …			0.55	
	Increasing your firm's JIT capability …			0.45	
	Aiding suppliers to increase their JIT capability...			0.47	
	Participating in the marketing efforts of customers…			0.44	
	Locating closer to your customers…			0.81	
	Identifying additional (alternate) supply chain…			0.39	
	Creating SCM teams to include different companies…			0.44	
Customer Service Management	On-time delivery directly to customers' points of use…				0.72
	On-time delivery directly to your firm's points of use…				0.84
	Reducing response time across the supply chain...				0.43
	Contacting the end users to get feedback…				0.46
	KMO Test	0.846	0.885	0.810	0.708
	Eigenvalue	2.892	3.962	2.890	2.133
	% of variance	48.197	49.531	48.169	53.334
	Cronbach alpha	0.85	0.80	0.81	0.71

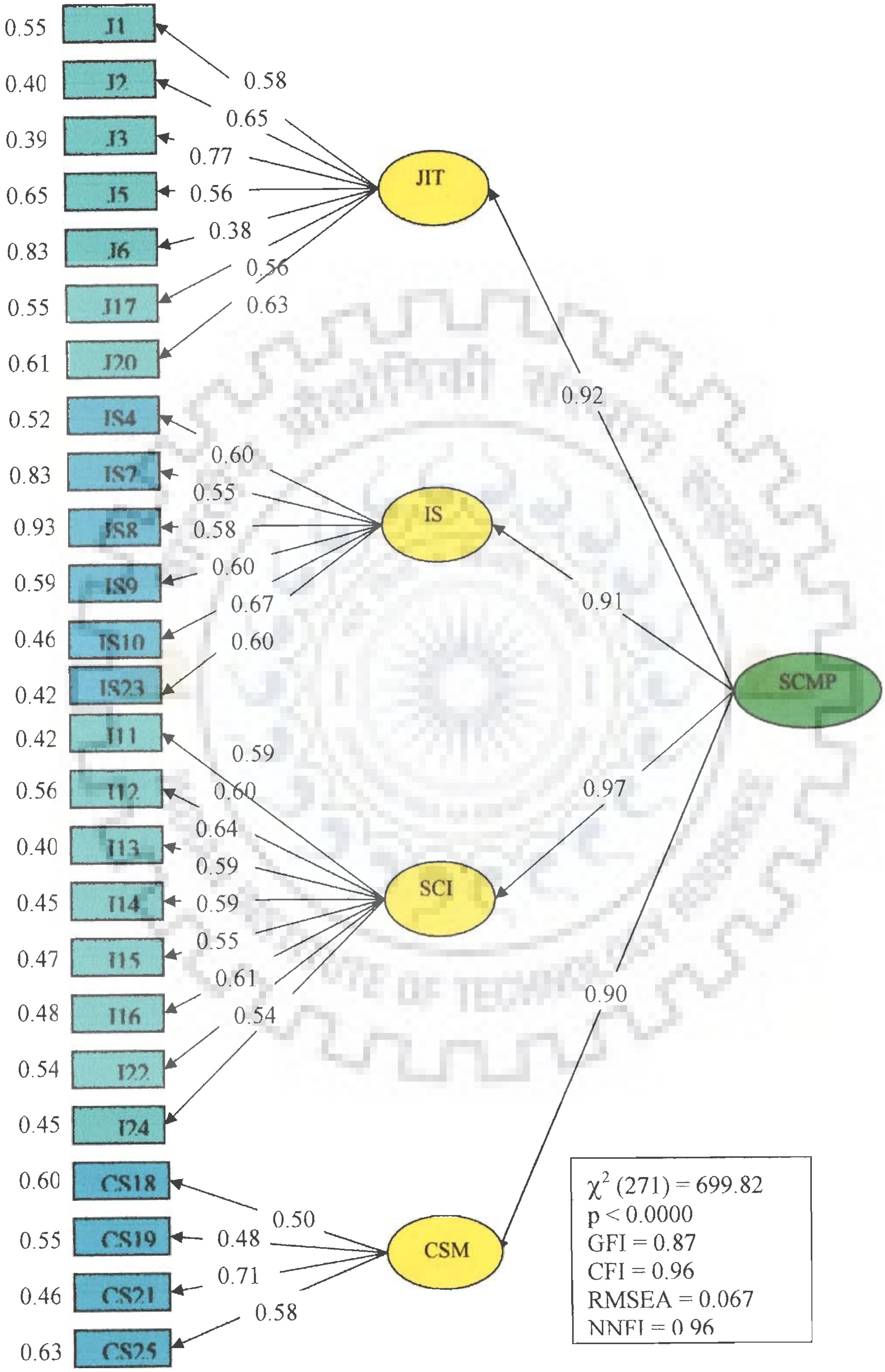

Figure 4.2: Measurement model for SCM practices measure

creating SCM teams to include different companies, and identifying additional (alternate) supply chain. These variables are related to one important dimension in the supply chain, Just-In-Time characteristics, therefore this factor is called as *supply chain characteristics for JIT capabilities*.

Factor 4: The variables, on-time delivery directly to customers' points of use, on-time delivery directly to your firm's points of use, reducing response time across the supply chain, and contacting the end users to get feedback, are included in this factor having customer focus in common, therefore, this factor is specified as *customer service management*.

The variables in factor 1, supply chain integration, together account for about 50 per cent of the total variance in the used SCM practices measure. The reliability is found to be very good at Cronbach alpha value of 0.85. The factor 2, information sharing for strategic location, amounts to 45.8 percent of total variance with reliability of 0.80. Similarly, total variance accounted for factor 3, supply chain characteristics for JIT capabilities, is 48.169 percent with Cronbach alpha value of 0.81. Factor 4, customer service management, explains a variance of 53.334 percent and indicates consistent reliability of value 0.71.

The second measurement model examines the system of relationships among measures of SCM practices. As illustrated in Figure 4.2, the parameter estimates, fit indices, and observed residuals imply that the hypothesized dimensions of SCM practices (SCI, IS, JIT, and CSM) are reasonable representations of covariance among their respective item measures. The model chi-square (χ^2) value is 699.82 with 271 degrees of freedom. Again, χ^2 is not significant and rather large, the normed χ^2 (2.58) is suggesting strong fit relative to degrees of freedom. Similar to the previous model, the normed and non-normed fit (NNFI) indices are very high, indicating good model fit (Fornell and Larcker, 1981; Anderson, 1987; Anderson and Gerbing, 1988). All indicator variables are sufficiently high and statistically different from zero. In summery, the fit statistics seem to indicate that each factor of SCM practices is found to be valid and consistent with the standards of confirmatory factor analysis.

4.4.3 The Factor Structure of Supply Chain Performance Measure

Factor 1: This factor consists of variables organization's ability to respond to and accommodate demand variations, such as seasonality, ability to respond to and accommodate periods of poor manufacturing performance (machine breakdown), ability to respond to and accommodate periods of poor supplier performance, ability to respond to and accommodate periods of poor delivery performance, and ability to respond to and accommodate new products, new markets, or new competitors.

Table 4.7: Factor Structure of Supply Chain Performance Variables

Fators	Factor Items	Factor Loadings		
		FP	RP	OP
Flexibility Performance	Demand variations, such as seasonality	0.48		
	Periods of poor manufacturing performance	0.80		
	Periods of poor supplier performance	0.72		
	Periods of poor delivery performance	0.81		
	Accommodate new products, new markets, or new competitors	0.56		
Resource Performance	Total cost of resources used		0.53	
	Costs of distribution, including transportation and handling costs		0.48	
	Costs of manufacturing, including labour, maintenance		0.55	
	Costs associated with inventory		0.58	
	Return on investments		0.53	
Output Performance	Annual Sales (for last period)			0.81
	Order fill rate			0.59
	On-time deliveries			0.39
	Customer response time			0.66
	Manufacturing lead time			0.66
	KMO Test	0.805	0.804	0.706
	Eigen value	2.745	2.760	2.294
	% of variance	54.909	55.208	45.881
	Cronbach alpha	0.79	0.79	0.70

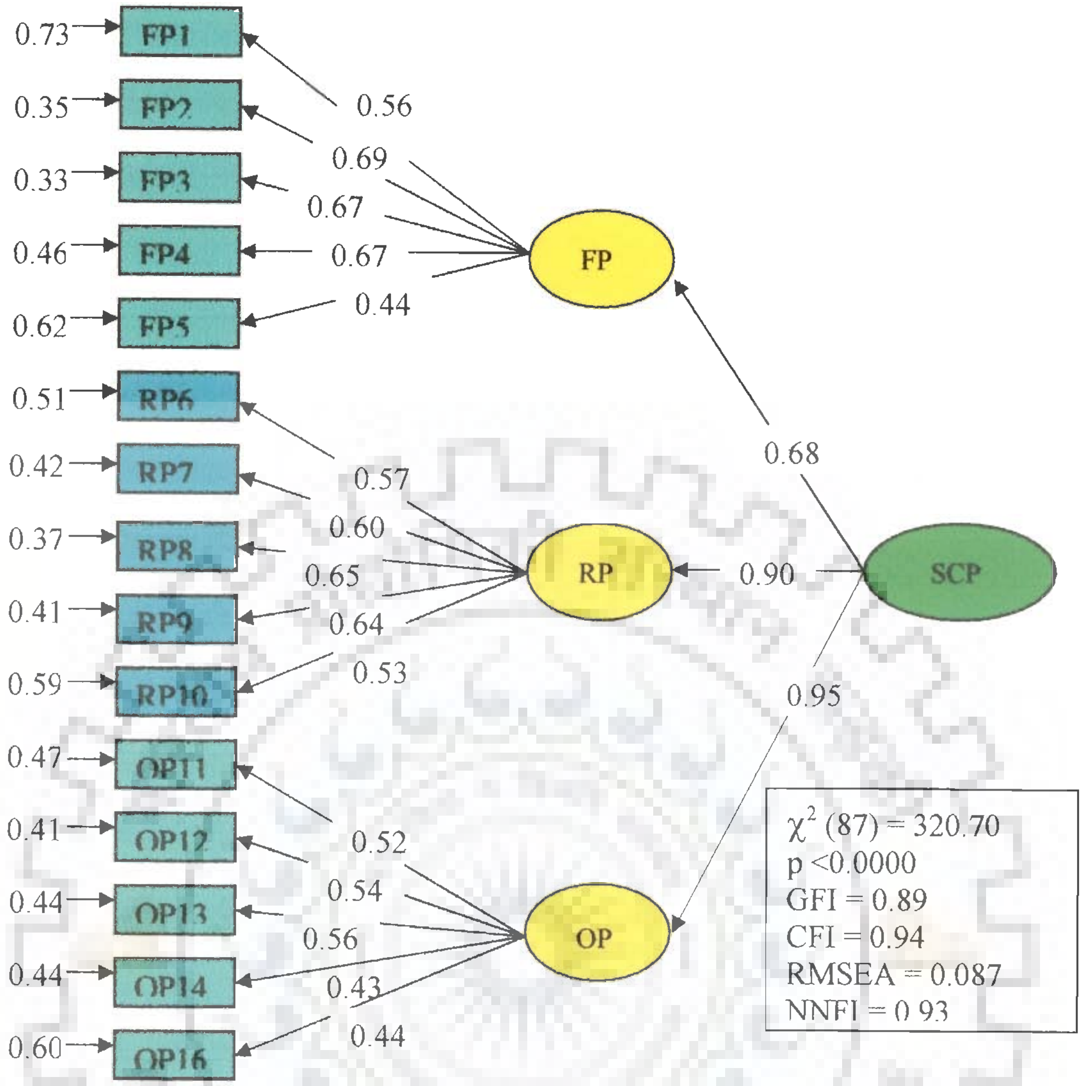

Figure 4.3: Measurement model for supply chain performance measure

As it is obvious from Table 4.7 that all the variables here in this factor are focused on organization's flexibility in its operations, this factor is called *supply chain flexibility performance*.

Factor 2: This factor comprises of total cost of resources used, Total costs of distribution, including transportation and handling costs, total costs of manufacturing, including labour, maintenance and re-work costs, costs associated with inventory, and return on investments. These variables are related to all types of costs involved in resources utilized in making product available; therefore, this factor is named *supply chain resource performance*.

Factor 3: The variables, annual sales (for last period), order fill rate, on-time deliveries, customer response time, and manufacturing lead time, are found to be grouped in this factor indicating the output related performance, thus this factor is termed as *supply chain output performance.*

The variables in the factor 1, supply chain flexibility performance explain about 55 percent of total variance in supply chain performance and have fairly good level of reliability with Cronbach alpha value 0.79. Similarly, items involved in factor 2, supply chain resource performance indicate more than 55 percent of total variance. The reliability of this factor is found to be 0.79. The factor 3, supply chain output performance, accounted for 45.8 percent of variance with fairly consistent reliability with alpha value 0.70.

Figure 4.3 shows third measurement model that examines the relationship among factors of supply chain performance measure. As it is obvious, fit measures as well as parameter estimates suggest that this model is a good fit for the observed covariances in this sample. The observed χ^2 is 320.70 (df = 87, p < 0.0000), NNFI is significantly high 0.93, RMSEA is 0.087, and all indicators are sufficiently high and statistically different from zero.

4.5 Hierarchical Regression Analysis

Due to the difficulty of eliminating the impact of control variables on dependent variable in multiple regression analysis, Hierarchical Regression Analysis (HRA) is performed to examine the antecedents of this study. HRA assesses the relative importance of independent variables (antecedents) by increase in R^2 (Coefficient of determination). This is possible when entering one independent variable into the equation, which already has other independent variables.

The resulting R^2 of the entered independent variable explains the amount of unique variance accounted for on dependent variable (supply chain performance) beyond what other variables accounted for on the dependent variable (Ho, 2006). The advantage of this analysis is that researchers can control the sequence of independent variables to be entered.

4.5.1 Knowledge Management Process Factors and Supply Chain Performance

This section describes the kinds of associations between KM process factors and supply chain performance factors to test the hypotheses H(1) and H(2). Multicollinearity was absent from the selected models where tolerance values were higher than 0.10 and variation inflation factor (VIF) values were much less than 10.0 (Hair *et al.*, 2005). Additionally, the Durbin-Watson statistic did not indicate multicollinearity as a serious problem.

To test the hypotheses, HRA was used to predict each supply chain performance variable with the set of KM process variables (Cohen and Cohen, 1975; Hair *et al.*, 2005). In the first step, we entered the set of control variables (years of establishment of the firm as firm's age, size of the firm in terms of employee strength as firm's size, and position of the firm in supply chain) into the equation. In step 2, the set of KM process variables (KA, KC, KAP, and KP) were entered. A significant incremental R^2 in this step could be interpreted as support for Hypotheses H(l) and H(1a) to H(1c). In step 3, we entered the cross products of the four KM process variables (KA * KC, KA * KAP, KA * KP, KC * KAP, KC * KP, KAP * KP) to test for two-way interactions. Significant incremental values of R^2s in steps 3 or 4 could be interpreted as support for Hypotheses H(2) and H(2a) to H(2c).

Table 4.8 shows the effects of KM process variables on supply chain performance variables as flexibility performance (FP), resource performance (RP), and output performance (OP). After controlling for firm's age, firm's size, and firm's position, in step 2, we found that KA was positively related to FP ($b=0.25$, $p<0.01$), RP ($b=0.14$, $p<0.05$) and OP ($b=0.29$, $p<0.01$). KC was positively related to RP ($b=0.12$, $p<0.10$). KAP was positively related to FP ($b=0.20$, $p<0.01$), RP ($b=0.26$, $p<0.01$), and OP ($b=0.27$, p<0.01). KP was significantly related to FP (b=0.27, p<0.01), RP (b=0.16, p<0.01), and OP (b=0.10, p<0.10). Therefore, these findings provide significant positive support for accepting hypotheses H(l) and H(1a) to H(1c).

In step 3, some of the two-way interaction terms indicated the significant incremental effect in any of the three functions. The interactive effects of KC* KP and KAP* KP have shown significant relationship with RP (b=2.18, p<0.01; b= -1.56, p<0.05 respectively) and FP (b=1.70, p<0.05) and OP (b=2.41, p<0.01). These findings partially support hypotheses H(2) and H(2a) to H(2c), stating that the interaction of parts of KM processes positively affects supply chain performance. Therefore, these findings provide support for hypothesis H(2). Overall, above results provide partial support to accept hypothesis H(1) and H(2) accomplishing objective 2 of this study.

4.5.2 Supply Chain Management Practice Factors and Supply Chain Performance

Three separate regression analyses were conducted in order to find out "which predictor variable has the highest or lowest impact on which performance measure." In each regression model, one measure of performance (flexibility, resource, and output) was the dependent variable and SCM practices namely supply chain integration, supply chain information sharing, Just-In-Time capability, and customer service management were the predictor variables. Table 4.9 shows these effects of SCM practice factors on supply chain performance factors (RP, FP, and OP). In step 2, we found that SCI is positively related with FP (b=0.28, p<0.01), and OP (b=0.30, p<0.01). Supply chain information sharing (IS) is positively related to RP (b=0.19, p<0.01); moreover, JIT is found significantly related with FP (b=0.27, p<0.01), RP (b=0.33, p<0.05), and OP (b=0.19, p<0.05).

Table 4.8: HRA Results for KM Processes and Supply Chain Performance Variables

Variables	Flexibility Performance				Resource Performance				Output Performance			
	b	ΔR^2	R^2	ΔF	b	ΔR^2	R^2	ΔF	b	ΔR^2	R^2	ΔF
		0.03	0.03	3.20		0.02	0.02	1.91		0.01	0.01	1.00
Firm's Age	0.04				0.11*				0.08			
Firm's Size	-0.07				0.05				-0.02			
Firm's position in the supply chain	0.13*				0.01				0.04			
		0.36	0.39	51.06		0.31	0.33	40.75		0.31	0.32	39.49
KA	0.25**				0.14*				0.29**			
KC	0.01				0.12†				-0.01			
KAP	0.20**				0.26**				0.27**			
KP	0.27**				0.16**				0.10†			
		0.02	0.40	1.75		0.02	0.35	2.07		0.03	0.35	2.98
KA * KC	1.70				-0.24				-0.53			
KA * KAP	-0.18				0.55				-0.18			
KA * KP	-0.69				-0.44				-0.94			
KC * KAP	-0.58				0.00				0.42			
KC * KP	0.42				2.18**				2.41**			
KAP * KP	-0.64				-1.56*				-0.74			

Note: standardized beta values are reported. * $p<0.01$; ** $p<0.05$; † $p<0.10$.

Table 4.9: HRA Results for SCM Practices and Supply Chain Performance Variables

Variables	**Flexibility Performance**				**Resource Performance**				**Output Performance**			
	b	**ΔR^2**	**R^2**	**ΔF**	**b**	**ΔR^2**	**R^2**	**ΔF**	**b**	**ΔR^2**	**R^2**	**ΔF**
		0.03**	0.03**	3.20**		0.02	0.02	1.91		0.01	0.01	1.00
Firm's Age	0.04				0.11**				0.08			
Firm's Size	-0.07				0.05				-0.02			
Firm's position in the supply chain	0.13**				0.01				0.04			
		0.41*	0.43*	62.32*		0.46*	0.47	75.43*		0.39*	0.40*	56.76*
SCI	0.28*				0.06				0.30*			
IS	-0.01				0.12**				-0.04			
JIT	0.27*				0.33*				0.19**			
CSM	0.19*				0.28*				0.26*			
		0.01	0.45	1.50		0.01	0.48	0.84		0.01**	0.41**	0.51**
SCI * IS	1.27				0.19				-0.13			
SCI * CSM	0.14				-0.72				-0.28			
SCI * JIT	-1.16				0.26				-0.68			
IS * CSM	0.25				-0.73				-0.34			
IS * JIT	0.01				0.27				0.52			
CSM * JIT	-0.29				0.75				0.88			

Note: standardized beta values are reported. * $p<0.01$; ** $p<0.05$; † $p<0.10$.

CSM is strongly related with FP (b=0.28, p<0.01), RP (b=0.28, p<0.01), and OP (b=0.26, p<0.01). These results along with significant increase in the values of R^2 (i.e. ΔR^2) provide sufficiently strong support for accepting hypotheses H(3) and H(3a) to H(3c) as well as hypotheses H(4) and H(4a) to H(4c) achieving objective 3 of this study.

4.6 The Role of Knowledge Management Processes in the Relationship between Supply Chain Management Practices and Supply Chain Performance

This section analyses the role of KM process factors (KA, KC, KAP, and KP) on the relationship between SCM practices and supply chain performance as it is important to provide answer to a question of how SCM practices and KM process factors together affect supply chain performance. Therefore, exploring the two roles of KM process factors namely mediator and moderator would answer to the above question as well to the hypotheses H(5) and H(5a) to H(5l).

4.6.1 The Mediator Role of Knowledge Management Process Factors

A. The Mediator Role of Knowledge Management Process Factors between Supply Chain Management Practices and Supply Chain Flexibility Performance

This section follows the same procedure described in section 4.5.1. Controlling for firm's characteristics, SCM practices are found to be significantly predicted. Table 4.10 shows the HRA results for predicting the role of KM process factors. From these results, it is observed that SCM practices factors, SCI ($\beta 24 = 0.28$, $p < 0.01$), JIT ($\beta 26 = 0.27$, $p < 0.01$), and CSM ($\beta 27 = 0.19$, $p < 0.01$), significantly predicted supply chain flexibility performance. When including the mediator KM process variables (knowledge acquisition, knowledge conversion, knowledge application, and knowledge protection) into the regression equation, the effect of SCM practices on supply chain flexibility performance is reduced and however, is still significant with SCI ($\beta 34 = 0.23$, $p < 0.01$), JIT ($\beta 36 = 0.17$, $p < 0.01$), and CSM ($\beta 37 = 0.11$, $p < 0.01$).

The mediators, knowledge acquisition ($\beta38 = 0.13$, $p < 0.05$), knowledge protection ($\beta311 = 0.17$, $p < 0.01$) cause for the diminishing effect of SCM practices on supply chain flexibility performance. Importantly, the standardized beta value of knowledge acquisition ($\beta38 = 0.13$, $p < 0.05$) is weaker than SCI ($\beta34 = 0.23$, $p < 0.01$), and JIT ($\beta36 = 0.17$, $p < 0.01$). Thus, these findings provide significant support for hypotheses H(5) and H(5a) to H(5l).

B. Supply Chain Management Practices and Supply Chain Resource Performance

The main effects of SCMP factors IS ($\beta25= 0.12$, $p < 0.05$), JIT ($\beta26 = 0.33$, $p < 0.01$), and CSM ($\beta27 = 0.28$, $p < 0.01$) significantly predicted supply chain resource performance. When including mediator variables into the regression equation, the effect of SCM practices on supply chain resource performance is reduced and however, is still significant IS ($\beta35 = 0.12$, $p < 0.05$), JIT ($\beta36 = 0.27$, $p < 0.01$), and CSM ($\beta37 = 0.23$, $p < 0.01$). The mediating KM process factor in this case is knowledge application ($\beta310 = 0.11$, $p < 0.10$) that cause for the diminishing effect of SCM practices on supply chain resource performance. Moreover, the standardized beta value of knowledge protection ($\beta311 = 0.11$, $p < 0.10$) is weaker than those of SCM practices factors IS ($\beta35 = 0.12$, $p < 0.05$), JIT ($\beta36 = 0.27$, $p < 0.01$), and CSM ($\beta37 = 0.23$, $p < 0.01$). Hence, these findings provide strong positive support for hypotheses for H(5k).

C. Supply Chain Management Practices and Supply Chain Output Performance

The effects of SCMP factors SCI ($\beta24= 0.30$, $p < 0.01$), JIT ($\beta26 = 0.19$, $p < 0.01$), and CSM ($\beta27 = 0.26$, $p < 0.01$) significantly predicted supply chain output performance. When including mediator variables into the equation, the effect of SCM practices on supply chain output performance is reduced but is still significant SCI ($\beta34= 0.25$, $p < 0.01$) and CSM ($\beta37 = 0.20$, $p < 0.01$).

Table 4.10 : HRA Results to Predict the Role of KM Factors on Flexibility Performance

Variables	Models			
	1	2	3	4
Control variables				
Firm's Age	0.04	0.03	0.02	0.01
Firm's Size	-0.07	-0.06	-0.03	-0.01
Firm's position in the supply chain	0.13**	0.03	0.03	0.01
SCMP Factors				
Supply Chain Integration (SCI)		0.28*	0.23*	0.33
Supply Chain Information System (IS)		-0.01	-0.04	-0.62
Just-In-Time (JIT)		0.27*	0.17*	0.71
Customer Support Management (CSM)		0.19*	0.11**	0.15
KM Process Factors				
Knowledge Acquisition (KA)			0.13	-0.62
Knowledge Conversion (KC)			-0.02	-0.30
Knowledge Application (KAP)			0.10	1.09*
Knowledge Protection (KP)			0.17*	0.16
Interaction Effects				
SCI				
SCI*KA				0.65
SCI*KC				0.28
SCI*KAP				-0.50
SCI*KP				-0.60
IS				
IS*KA				-0.33
IS*KC				0.48
IS*KAP				-0.55
IS*KP				1.67*
JIT				
JIT*KA				0.10
JIT*KC				0.20
JIT*KAP				0.40
JIT*KP				1.87*
CSM				
CSM*KA				0.94
CSM*KC				-0.40
CSM*KAP				-1.29
CSM*KP				0.81
R^2	0.03	0.43	0.49	0.53
ΔR^2	0.03	0.41	0.05	0.04
F	3.20**	37.93*	29.50*	13.66*
ΔF	3.20**	62.32*	08.80*	1.91*

Note: Coefficients are standardized beta values; and *p<0.01; ** p<.05; †p<0.1

Table 4.11: HRA Results to Predict the Role of KM factors on Resource Performance

Variables	**Models**			
	1	**2**	**3**	**4**
Control variables				
Firm's Age	0.11**	0.10**	0.09**	0.12*
Firm's Size	0.05	0.04	0.06	0.05
Firm's position in the supply chain	0.01	0.10**	0.10**	-0.11*
SCMP Factors				
Supply Chain Integration (SCI)		0.06	0.03	0.33
Supply Chain Information System (IS)		0.12**	0.12**	0.03
Just In Time (JIT)		0.33*	0.27*	0.02
Customer Support Management (CSM)		0.28*	0.23*	0.19
KM Factors				
Knowledge Acquisition (KA)			0.02	0.53
Knowledge Conversion (KC)			0.09	-0.86**
Knowledge Application (KAP)			0.11†	0.20
Knowledge Protection (KP)			0.00	0.45
Interaction Effects				
SCI				
SCI*KA				-0.99
SCI*KC				1.24
SCI*KAP				-0.78
SCI*KP				0.10
IS				
IS*KA				1.17†
IS*KC				0.41
IS*KAP				-0.94
IS*KP				-0.56
JIT				
JIT*KA				0.10
JIT*KC				-0.77
JIT*KAP				0.73
JIT*KP				0.25
CSM				
CSM*KA				-1.12
CSM*KC				0.80
CSM*KAP				0.80
CSM*KP				-0.53
R^2	0.02	0.47	0.50	0.52
ΔR^2	0.02	0.46*	0.02*	0.02
F	1.91	44.62*	30.73*	13.13*
ΔF	1.91	75.43*	3.86*	1.01

Note: Coefficients are standardized beta values; and *p<0.01; ** p<.05; †p<0.1

Table 4.12: HRA Results to Predict the Role of KM Factors on Output Performance

Variables	Models			
	1	2	3	4
Control variables				
Firm's Age	0.08	0.07†	0.06	0.08†
Firm's Size	-0.02	-0.01	0.02	0.00
Firm's position in the supply chain	0.04	-0.05	-0.06	-0.06
SCMP Factors				
Supply Chain Integration (SCI)		0.30*	0.25*	1.57*
Supply Chain Information System (IS)		-0.04	-0.02	0.89**
Just In Time (JIT)		0.19*	0.10	-1.50*
Customer Support Management (CSM)		0.26*	0.20*	-0.01
KM Factors				
Knowledge Acquisition (KA)			0.17*	0.90**
Knowledge Conversion (KC)			-0.04	-1.20*
Knowledge Application (KAP)			0.15**	1.26*
Knowledge Protection (KP)			-0.02	-0.49
Interaction Effects				
SCI				
SCI*KA				0.19
SCI*KC				0.51
SCI*KAP				3.56*
SCI*KP				0.99
IS				
IS*KA				0.98
IS*KC				0.20
IS*KAP				2.09**
IS*KP				-0.55
JIT				
JIT*KA				-1.42
JIT*KC				1.39
JIT*KAP				2.05**
JIT*KP				0.53
CSM				
CSM*KA				-1.10
CSM*KC				-0.01
CSM*KAP				1.53†
CSM*KP				-0.23
R^2	0.01	0.40	0.44	0.51
ΔR^2	0.01	0.39*	0.04*	0.07*
F	1.00	33.13*	24.51*	12.61*
ΔF	1.00	56.76*	6.05*	2.92*

Note: Coefficients are standardized beta values; and *p<0.01; ** p<.05; †p<0.1

The mediating KM process factors knowledge acquisition ($\beta38 = 0.17$, $p < 0.01$) and knowledge application ($\beta310 = 0.15$, $p < 0.05$) cause for the diminishing effect of SCM practices on supply chain output performance. Importantly, the standardized beta values of knowledge acquisition ($\beta38 = 0.11$, $p < 0.10$) and knowledge application ($\beta310 = 0.15$, $p < 0.05$) are weaker than those of SCM practices factors SCI ($\beta34= 0.25$, $p < 0.01$) and CSM ($\beta37 = 0.20$, $p < 0.01$). Thus, these positive associations provide significant support for accepting hypotheses 5c and 5i.

4.6.2 The Moderator Role of Knowledge Management Process Factors

This section follows the same procedure mentioned in section 4.5.2. The results of the interaction effects of SCM practices and KM process factors are shown under Model 4 in Table 4.10, 4.11, and 4.12. Significantly strong interactions have been found between knowledge application and SCM practice factors which affect supply chain output performance. These interactive effects are between SCI and KAP ($\beta414 = 3.56$, $p < 0.01$), IS and KAP ($\beta418 = 2.09$, $p < 0.05$), JIT and KAP ($\beta422 = 2.05$, $p < 0.05$), and CSM and KAP ($\beta426 = 1.53$, $p < 0.10$).

Noteworthy interactions between IS and KA ($\beta416 = 1.17$, $p < 0.10$) and CSM and KA ($\beta424 = -1.12$, $p < 0.10$) have been observed that affect supply chain resource performance. Similarly, some positive interactions have been found significant between IS and KP ($\beta419 = 1.67$, $p < 0.01$) and JIT and KP ($\beta423 = 1.87$, $p < 0.01$) which affect supply chain flexibility performance. Thus, in the line with these findings, interactive effects provide slightly but significant support for accepting hypothesis H(5).

4.7 The Role of Supply Chain Management Practices in the Relationship between Knowledge Management and Supply Chain Performance

This section analyses the role of SCM practices (SCI, IS, CSM, and JIT) on the relationship between KM processes (KA, KC, KAP, and KP) and supply chain performance (FP, RP, and OP). Since it is important to answer a question of how SCM practices and KM processes together affect supply chain performance, therefore, exploring the two roles of SCM practices, namely mediator and moderator, could answer to the above question as well to the hypotheses H(6) and H(6a) to H(6n).

4.7.1 The Mediator Role of Supply Chain Management Practices Factors

To test hypothesis 6, the analysis of mediator role of SCM practices factors is followed the procedure of Baron and Kenny (1986) as adopted in section 4.6.1. A variable is said to be mediated when it explains the relationship between the other variables. Precisely, mediation implies a causal hypothetical relationship in which an independent variable causes a mediator that causes a dependent variable (Baron and Kenny, 1986). Importantly, the effect of control variables should be eliminated at first.

Performing mediation analysis, the first step is to show that the independent variable (KM processes) affects the mediator SCM practices (SCI, IS, CSM, and JIT). Then, second step is to examine that independent variable affects the dependent variable i.e., supply chain performance. Third and final step is to investigate that the mediators affect dependent variable when independent variable is included in the equation. If SCM practices mediate the relationship, a significant relationship between KM processes and supply chain performance should disappear or be reduced when SCM practices are added into the regression model.

Controlling for control variables, the results of the corresponding steps are shown in Table 4.13 under Model 2 and 3.

Table 4.13: HRA Results to Predict the Role of SCM Practice Factors on Flexibility Performance

Variables	Models			
	1	2	3	4
Control variables				
Firm's Age	0.10†	0.07	0.07	0.05
Firm's Size	0.14**	0.08	0.05	0.02
Firm's position in the supply chain	0.01	-0.02	-0.02	-0.01
KMP Factors				
Knowledge Acquisition (KA)		0.23*	0.12†	-0.21
Knowledge Conversion (KC)		0.02	-0.02	-0.64
Knowledge Application (KAP)		0.17**	0.08	0.99**
Knowledge Protection (KP)		0.21*	0.12**	-0.01
SCMP Factors				
Supply Chain Integration (SCI)			0.21**	-0.13
Supply Chain Information System (IS)			-0.03	-0.53
Just In Time (JIT)			0.17**	0.43
Customer Support Management (CSM)			0.11†	0.70
Interaction Effects				
KA				
KA*SCI				0.31
KA*IS				-0.60
KA*JIT				0.11
KA*CSM				0.77
KC				
KC*SCI				1.70
KC*IS				-0.07
KC*JIT				0.74
KC*CSM				-1.25
KAP				
KAP*SCI				-0.71
KAP*IS				-0.08
KAP*JIT				0.09
KAP*CSM				-1.14
KP				
KP*SCI				-0.79
KP*IS				1.82**
KP*JIT				1.55**
KP*CSM				0.83
R^2	0.03	0.28	0.38	0.42
ΔR^2		0.25	0.10	0.04
F	3.03**	16.39*	16.51*	7.64*
ΔF		25.67*	12.38*	1.33

Note: Coefficients are standardized beta values; and *p<0.01; ** p<.05; †p<0.1

Table 4.14: HRA Results to Predict the Role of SCM Practice Factors on Resource Performance

Variables	Models			
	1	2	3	4
Control variables				
Firm's Age	0.13**	0.10**	0.09**	0.12*
Firm's Size	0.02	-0.02	0.09**	-0.08
Firm's position in the supply chain	0.08	0.04	0.03	0.02
KM Factors				
Knowledge Acquisition (KA)		0.10	-0.02	0.19
Knowledge Conversion (KC)		0.18*	0.15*	-0.39
Knowledge Application (KAP)		0.25*	0.12**	0.29
Knowledge Protection (KP)		0.10	-0.04	0.43
SCMP Factors				
Supply Chain Integration (SCI)			0.02	1.10
Supply Chain Information System (IS)			0.15**	-0.19
Just In Time (JIT)			0.26*	0.36
Customer Support Management (CSM)			0.21*	-0.55
Interaction Effects				
KA				
KA*SCI				-0.25
KA*IS				0.74
KA*JIT				0.61
KA*CSM				-1.41
KC				
KC*SCI				0.09
KC*IS				0.70
KC*JIT				-1.86
KC*CSM				2.11
KAP				
KAP*SCI				-1.35
KAP*IS				-0.63
KAP*JIT				0.76
KAP*CSM				0.88
KP				
KP*SCI				-0.12
KP*IS				-0.34
KP*JIT				0.19
KP*CSM				-0.49
R^2	0.03	0.30	0.48	0.51
ΔR^2	0.03	0.27	0.18	0.04
F	2.86**	18.02*	24.64*	10.97*
ΔF	2.86**	28.61*	25.79*	1.30

Note: Coefficients are standardized beta values; and *p<0.01; ** p<.05; †p<0.1

It is observed that KM process factors, except knowledge conversion, significantly predict the supply chain flexibility performance (KA- $\beta24 = 0.23$, $p<0.01$), (KAP- $\beta26 = 0.17$, $p<0.05$), and (KP- $\beta27 = 0.21$, $p<0.01$). When including the mediator variables from SCMP factors (SCI, IS, JIT, and CSM) into the equation, the effect of KM process factors on supply chain flexibility performance is reduced but is still significant.

The effect of SCI, CSM, and JIT on supply chain flexibility performance, as shown in Table 4.13 is found to be significant (SCI- $\beta38 = 0.21$, $p<0.05$), (JIT- $\beta310 = 0.17$, $p<0.05$), (CSM- $\beta311 = 0.11$, $p<0.10$) and it is more than that of the effect of KM process factors on supply chain flexibility performance (KA- $\beta34 = 0.12$, $p<0.10$), (KAP- $\beta36 = 0.12$, $p<0.10$), and (KP- $\beta37 = 0.12$, $p<0.05$). Therefore, the hypotheses H(6a), H(6i), and H(6l) are supported.

The effect of SCM practice factors, IS, CSM, and JIT on supply chain resource performance as shown in Table 4.14 is found to be significant (IS- $\beta38 = 0.15$, $p<0.05$), (JIT- $\beta310 = 0.26$, $p<0.01$), (CSM- $\beta311 = 0.21$, $p<0.01$) and it is more than that of the effect of KM process factors on supply chain resource performance (KC- $\beta35 = 0.15$, $p<0.01$), (KAP- $\beta36 = 0.12$, $p<0.05$). Therefore, the hypotheses H(6e), H(6j), and H(6m) are significantly supported.

The effect of SCM practice factors, SCI and CSM on supply chain output performance, as shown in Table 4.15, is found to be significant (SCI- $\beta38 = 0.23$, $p<0.01$), (CSM- $\beta311 = 0.22$, $p<0.01$) and it is more than that of the effect of KM process factors on supply chain resource performance (KA- $\beta34 = 0.10$, $p<0.10$), (KAP- $\beta36 = 0.17$, $p<0.01$). Therefore, the hypotheses H(6c) and H(6k) are supported.

4.7.2 The Moderator Role of Supply Chain Management Practices Factors

A variable is said to be moderated when it affects the direction and/or strength of the relation between an independent variable and a dependent variable (Baron and Kenny, 1986). In line with Cohen *et al.* (2003), the two-step HRA is used to test the hypothesis regarding the moderating or interacting effect of SCM practice factors on the relationship between KM processes and supply chain performance. In the first step, dependent variable (supply chain performance) is regressed by both the independent variable (KM processes) and moderating variables (SCM practice factors). In the second step, interaction terms, obtained by the multiplication of the scores of the independent variable and moderator variables are added to the regression model. The moderating effect is supported when the regression coefficients associated with the interaction terms are significant. The findings of the effect of these interactions are shown in Table 4.13, 4.14, and 4.15 under Model 4.

The interactive terms such as KP*IS and KP*JIT on supply chain flexibility performance have been found significant (KP*IS- $\beta 422 = 1.82$, $p<0.05$), (KP*JIT- $\beta 423 = 1.55$, $p<0.05$). The interactive effects of KC*CSM on supply chain resource performance have been found significant (KC*CSM- $\beta 416 = 2.11$, $p<0.01$). Similarly, the main interactive effects of KA*CSM, KC*SCI, and KAP*JIT on supply chain output performance have been found significant (KA*CSM- $\beta 415 = 2.06$, $p<0.01$), (KC*SCI- $\beta 416 = -0.94$, $p<0.10$), and (KAP*JIT- $\beta 419 = 2.38$, $p<0.01$).

So, in the light of above, it can be said that SCM practices partially exhibits moderator role in the relation between KM processes and supply chain performance.

Table 4.15: HRA Results to Predict the Role of SCM Practice Factors on Output Performance

Variables	Models			
	1	2	3	4
Control variables				
Firm's Age	0.15*	0.12	0.10	0.12
Firm's Size	0.09†	0.04	0.01	0.00
Firm's position in the supply chain	-0.01	-0.05	-0.05	-0.04
KM Factors				
Knowledge Acquisition (KA)		0.21*	0.10†	0.14
Knowledge Conversion (KC)		0.09	0.05	-0.61
Knowledge Application (KAP)		0.26	0.17*	1.18*
Knowledge Protection (KP)		0.08	-0.01	-0.16
SCMP Factors				
Supply Chain Integration (SCI)			0.23*	2.57*
Supply Chain Information System (IS)			-0.05	0.09
Just In Time (JIT)			0.09	-1.55*
Customer Support Management (CSM)			0.22*	-0.23
Interaction Effects				
KA				
KA*SCI				2.23
KA*IS				0.08
KA*JIT				-0.42
KA*CSM				2.06*
KC				
KC*SCI				0.94†
KC*IS				1.06
KC*JIT				0.42
KC*CSM				0.70
KAP				
KAP*SCI				-5.49
KAP*IS				-1.06
KAP*JIT				2.38*
KAP*CSM				2.32
KP				
KP*SCI				1.07
KP*IS				-0.35
KP*JIT				0.03
KP*CSM				-0.56
R^2	0.03	0.31	0.43	0.50
ΔR^2	0.03	0.28*	0.12*	0.07*
F	2.92	19.18*	20.27*	10.40*
ΔF	2.92	30.52*	15.63*	2.49*

Note: Coefficients are standardized beta values; and *p<0.01; ** p<.05; †p<0.1

4.8 Confirmatory Factor Analysis

In order to deal with causal relationships, confirmatory factor analysis (CFA) plays an important role in this study. This carries a confirmatory role as researchers completely control over specifying indicators for each construct. Further, it estimates goodness-of-fit for the proposed theoretical models (Hair *et al.*, 2005). The first step of confirmatory factor analysis is the specification of structural model and measurement model. Structural model concerts path diagram into various structural equations to explain endogenous variables.

Measurement model defines the relationship between measured variables or items and the theoretical constructs or latent variables (e.g. KM process). This analysis is performed by LISREL 8.7 statistical software developed by Joreskog and Sorbom (1989) and variance-covariance matrix is used as input data. Importantly, the studying sample is more than sufficient to carry out this analysis (Hair *et al.*, 2005). After specifying the structural and measurement models and selecting the input data type, structural model estimation is performed with weighted least squares in which multivariate normal is assumed for the observed variables. Then, examination is done to identify the degree to which the specified model is fitting with the sample data. The following are the measures used to estimate goodness-of-fit of the model:

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 (χ^2) Fit Index is one of the most common fit tests. 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 larger the sample size, the more likely the rejection of the model. The chi-square fit index is also very sensitive to violations of the assumption of multivariate normality. Therefore, Joreskog (1993) 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 in (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 (GFI) indicates 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 0.80-0.89 as representing reasonable fit; scores of .90 or higher are considered as evidence of good fit (Hair *et al.*, 2005; Joreskog, 1993). 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 index sensitive to the number of estimated parameters in the model. Values below 0.05 signify good fit and the most acceptable value is .08 (Browne and Cudeck, 1993).

Figure 4.1, 4.2 and 4.3 indicate good fit to models. Figure 4.4 shows the measurement model for the mediating relationships of KM process measure with SCM practices measure and supply chain performance. In line with Gold *et al.* (2001), the parameter estimates, fit indices, and observed residuals imply that the measures of KM process provide a good fit for the observed covariance among the collection of item measures. The model chi-square (χ^2) value is 4316.83 with 2033 degrees of freedom. Although χ^2 is not significant and rather large, the normed χ^2 (2.12) is suggesting strong fit relative to degrees of freedom. In addition, the normed and non-normed fit (NNFI) indices are very high, suggesting good model fit. RMSEA value (0.056) is significant at p = 0.0000, CFI = 0.96, NFI = 0.93, NNFI = 0.96, RMR = 0.051, GFI = 0.73, and AGFI = 0.71; all indicator variables are sufficiently high and statistically different from zero. In summery, the fit statistics seem to indicate that KM process measure is mediating in the relationship between SCM practices and supply chain performance. Table 4.16 illustrates the CFA results on the model of moderating role of KM process factors and indicates that the moderating model does not exhibit satisfactory level of goodness-of-fit with the data as GFI, RMSEA statistics are not significant. Similar results for the moderating role of KM factors as well as SCM practice factors are also indicated by the HRA as shown in Tables 4.10 to 4.15.

Table 4.16 CFA Results on the Model of Moderating Role of KM Process Factors

No.	MODEL	χ^2	df	χ^2/df	CFI	NFI	RMSR	RMSEA	AGFI	GFI
1	KA	269508	18877	14.27	0.87	0.86	2.64	0.19	0.095	0.11
2	KC	264555	18298	14.45	0.87	0.86	2.86	0.19	0.094	0.11
3	KAP	365645	28165	12.98	0.87	0.86	2.74	0.18	0.088	0.10
4	KP	313757	18683	16.79	0.88	0.87	2.49	0.21	0.079	0.09

Note: χ^2- Normal theory weighted least squares chi-square, df- Degrees of freedom, CFI- Comparative fit index, NFI- Normed fit index, RMSR- Root mean square residual, RMSEA- Root mean square error of approximation, GFI- Goodness of fit index, AGFI- Adjusted goodness of fit index

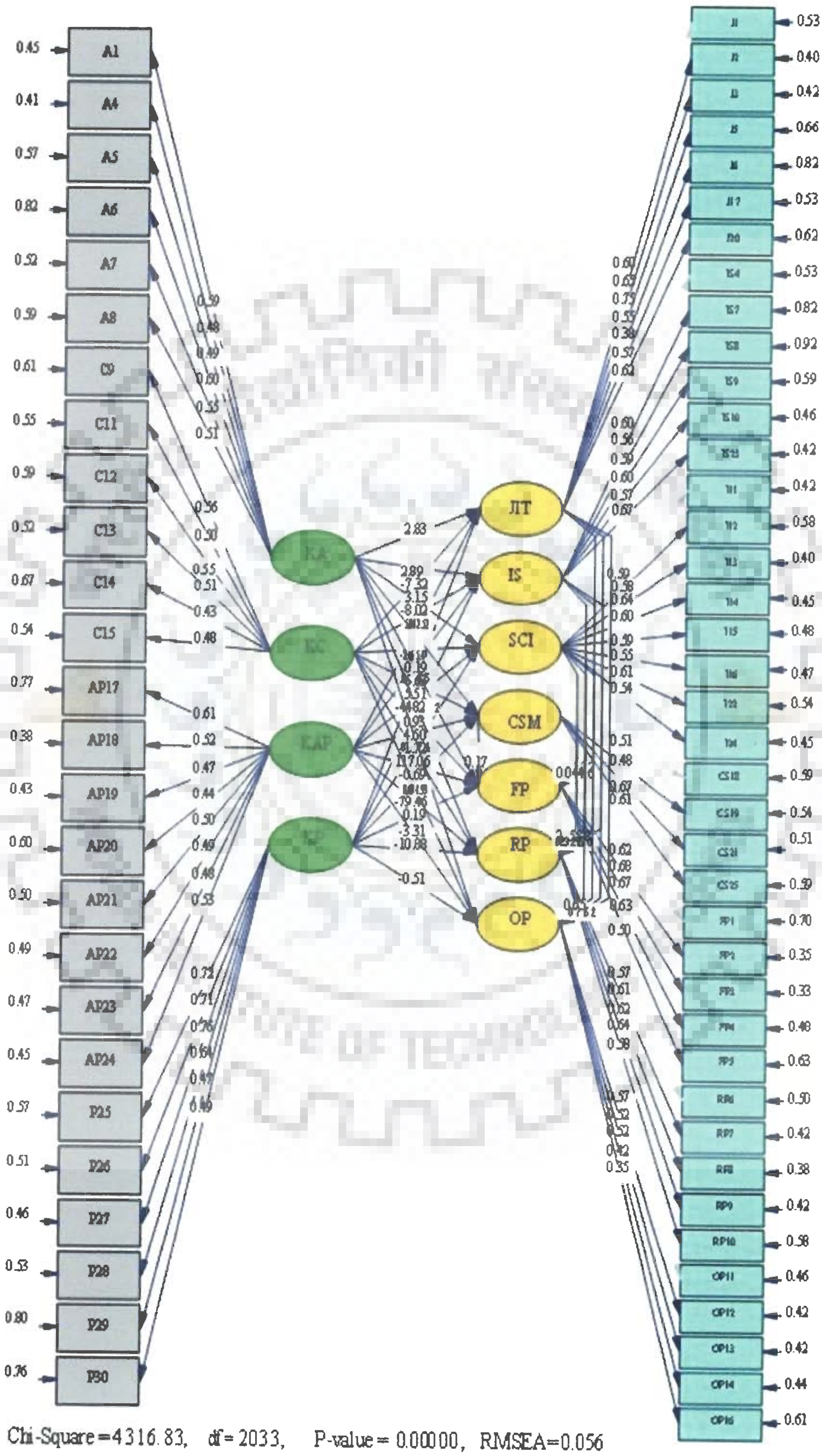

Figure 4.4: Model for mediator role of KM and SCM factors

DISCUSSIONS

5.1 Introduction

This chapter discusses the rationale for the relationships found in the previous chapter. Importantly, this research thoroughly represents a theory driven examination of how KM process factors and SCM practice factors are associated with supply chain performance factors in the context of manufacturing industries in India.

5.2 Factor Structure of KM Processes

This study found that knowledge acquisition, knowledge conversion, knowledge application, and knowledge protection are the factors of KM processes. It also showed that these factors have certain relationships with firms' characteristics. For example, knowledge acquisition, knowledge application and knowledge protection are significantly related to firm's size as well as firm's position in the supply chain. However, knowledge conversion is not found to be in such significant association with the firms' characteristics. Pillania (2008) in his study on KM practices in Indian small and medium enterprises (SMEs) reported that although the importance and relevance of stored knowledge is acknowledged but at the same time he also indicate that knowledge is not updated regularly as it is considered as a part of unimportant formalities. However, through proper integration of updated knowledge, redundancy is reduced to its minimum and hence, the performance can be improved (Davenport and Klahr, 1998; Grant, 1996). Pillania (2008) further emphasizes that generally it takes a lot of time for an employee to get the pertinent knowledge in the organization. Experts have emphasized that appropriate organization and structuring of organizational knowledge is essential for easy access and distribution of knowledge within the organization (Nonaka and Tekuchi, 1995; O'Dell and Grayson, 1998). However, Collier (2006) and Edwards *et al.* (2003; 2005) recently report that the organizational emphasis is on knowledge acquisition rather than preserving, integrating and utilizing that knowledge.

5.3 Factor Structure of SCM Practices

Tan (2002) studied the relationship between SCM practices and supply chain performance in the manufacturing firms in USA. Our research study, as focused on Indian manufacturing firms, needed factor analysis to reveal the factors inherent in the scale developed by Tan (2002). In our study, EFA identified four major factors of SCM practices. The first factor, supply chain integration characteristics, is composed of strategic practices that address improving the integration of activities across the supply chain through creating a greater level of trust among the supply chain members by communicating firm's strategic needs as well as customers' future needs, establishing more frequent contacts with supply chain members, and involving supply chain in product, service and marketing plans. This factor accounts for 49.53 percent of the variance in the data. Second factor, information sharing for strategic location, consists of the items related to the use of information sharing across the supply chain. This factor includes use of formal information sharing agreements as well as use of informal information sharing, use of third party supply chain specialist, participating in the sourcing decisions of suppliers, and extending supply chain beyond immediate supplier. Third factor, supply chain characteristics for JIT capability, relates directly to improving firm's JIT capability through aiding suppliers to increase their capabilities, identifying additional supply chain, participating in the marketing efforts, determining customers' future needs, and creating SCM teams to include different teams. Fourth factor customer service management includes firm's capabilities to satisfy the customers' needs by reducing response time across the supply chain to enable on-time delivery directly to customers' points of use, and contacting the end users to get important feedback that can help in achieving firms' objectives. This factor structure is in line with the study of Tan (2002) that addresses similar aspects of supply chain and materials management issues, ranging from the broad based supply chain integration to the more specific JIT capability.

5.4 Factor Structure of Supply Chain Performance

The factor analysis conducted on supply chain performance measures resulted in three factors namely resource performance, flexibility performance and output performance. Flexibility performance of the supply chain is found to be in positive and significant association with the firm's size and the firm's position in the supply chain. White *et al.*, (2005) have also concluded that supply chain flexibility performance significantly depends on the firm's ability to coordinate and facilitation of knowledge sharing among the members of the supply chain. He further emphasized that larger firms have better orientation towards establishing and adopting supply chain practices thereby striving at superior supply chain performance. Tan *et al.* (1998) elaborated that customer relationship comprises the entire array of practices that are employed for the purpose of managing customer complaints, building long-term relationships with customers, and improving customer satisfaction.

5.5 Impact of KM Processes on Supply Chain Performance

All four KM processes in this study, namely knowledge acquisition, knowledge conversion, knowledge application, and knowledge protection, are found to be strongly and significantly associated with all the facets of supply chain performance. Bulent (2008) concluded that sharing of knowledge and information among the members of the supply chain has positive effect on supply chain flexibility performance. He further emphasized that the more knowledge shared within a supply chain, the less time it takes to make the changes under uncertain environment, and therefore, the more flexible the operations, products, and deliveries. Hierarchical regression analysis in this study has also shown that KM processes have strong positive relationship with all three measures of supply chain performance. Srivastava *et al.* (2006) examined the relationship between knowledge sharing and team performance with the help of 102 management teams. In their study structural equation modeling resulted in that knowledge sharing had positive relationships with team performance. Their study suggested that empowering leadership benefited their members to have better opportunities for knowledge sharing in their problem solving and decision making. It also indicated that knowledge sharing is strategically important factor that scale up organizational performance. Dyer and Nobeoka (2000) highlighted that leading Japanese automakers (notably, Toyota and Honda) have developed multidimensional knowledge sharing routines with their suppliers that lead to higher levels of organizational learning among the supply chain members. Information and knowledge can be used as a source of competitive advantage by taking the data available and sharing it with members in the supply chain (Jones, 1998 and Novack *et al.*, 1995). Lalonde (1998) considers sharing of information as one of five building blocks that characterize a solid supply chain relationship. According to Stein and Sweat (1998), supply chain members who exchange information regularly are able to work as a single entity. Together, they can understand the needs of the end customer better and hence can respond to market change quicker.

5.6 Impact of SCM Practices on Supply Chain Performance

The findings of the correlation analysis conducted in this study indicate that SCM practice factors, i.e. supply chain integration, supply chain information sharing, Just-In-Time capability, as well as customer service management are in strong positive association with flexibility performance, resource performance, and output performance. Such positive relations indicate greater impact of SCM practices on supply chain performance. Moreover, the individual regression models with the predictor variables (flexibility performance, resource performance, and output performance) illustrate that Just-In-Time and customer service management have significant impact on all three measures of supply chain performance. Bulent (2008) reports that integration of supply chain capabilities helps in higher levels of supply chain performance. Supporting this view, this study also exhibits the impact of supply chain integration on flexibility performance and resource performance. Also, supply chain information sharing has positive effects on resource performance. However, Lin *et al.* (2002) demonstrate higher level of information sharing across the supply chain is associated with flexibility performance leading to lower cost and shorter order cycle time. In addition to this some researchers (for example, Byrne and Heavey, 2006; Li and Lin, 2006) noted that while timely sharing of information is crucial, its impact on the supply chain performance depends on the kind of information shared, how it is shared, and with whom it is shared.

SCM practices impact not only overall organizational performance, but also competitive advantage of an organization. They are expected to improve an organization's competitive advantage through price/cost, quality, delivery effectiveness, time to market, and product innovation. Prior studies have indicated that the various components of SCM practices have an impact on various aspects of competitive advantage (such as price/cost). For example, strategic supplier partnership can improve supplier performance, reduce time to market (Ragatz *et al.*, 1997), and increase the level of customer responsiveness and satisfaction (Power *et al.*, 2001). Information sharing leads to high levels of supply chain integration by enabling organizations to make dependable delivery and introduce products to the market quickly. Information sharing and information quality contribute positively to customer satisfaction (Spekman *et al.*, 1998). Customer oriented practices have also been shown to lead to significant improvement in organizational performance (Tan *et al.*, 1998).

5.7 The Role of KM Processes in the Relationship between SCM Practices and Supply Chain Performance Measures

From the findings, it is shown that KM system factors play a dominating mediator role than moderator role in the relationship between SCM practices and supply chain performance measures. Particularly, knowledge acquisition and knowledge protection play mediating role in between that relationship. As stated earlier, mediation implies a causal hypothetical relationship in which an independent variable causes a mediator that causes a dependent variable. Explicitly, SCM practices influence knowledge acquisition and knowledge protection that causes supply chain flexibility performance, and also SCM practices has direct relation with the measures of supply chain performance (see Fig. 3.2). Similarly, Supply chain information sharing, Just-In-time, and customer service management significantly predicted supply chain resource performance. In this relationship KM process variable, knowledge application, is in mediating role. Supply chain output performance is significantly predicted by supply chain integration, Just-In-time, and customer service management. Here, knowledge acquisition and knowledge application cause for the diminishing effect of SCM practices on supply chain output performance. In the moderator role, KM process factors did not show much significance in the relationship between SCM practices and supply chain performance. Importantly, knowledge application is found to be in moderating role in this relationship. Desouza *et al.* (2003) emphasizes applying knowledge in such a way that allows all members in a supply chain to make business decisions that optimize customer value while reducing costs and cycle times. He further highlights that effective real-time use of KM processes enables supply chains to adjust to marketplace changes that may have a significant impact on optimizing order fulfillment and lead time, leading to timely deliveries and hence better satisfaction level for the customers.

5.8 The Role of SCM Practices in the Relationship between KM Processes and Supply Chain Performance Measures

The findings of this study indicate that SCM practices are in mediating role in the relationship between KM processes and supply chain performance measures. KM processes, knowledge acquisition, knowledge application, and knowledge protection, significantly predict the supply chain flexibility performance. This relationship is found to be mediated by SCM practice factors and SCI, JIT, and CSM in particular, play the role of mediator in this relationship. Similarly, IS, JIT, and CSM are the mediators in the relationship between KM processes and supply chain resource performance. In the relationship between KM processes and supply chain output performance, SCM practice factors, SCI and CSM, are the major factors that play the role of mediator.

In line with Cohen *et al.* (2003), the two-step HRA is used to test the hypothesis regarding the moderating effect of SCM practice factors on the relationship between KM processes and supply chain performance. In the first step, dependent variable (supply chain performance) is regressed by both the independent variable (KM processes) and moderating variables (SCM practice factors). In the second step, interaction terms, obtained by the multiplication of the scores of the independent variable and moderator variables are added to the regression model. The moderating effect is supported when the regression coefficients associated with the interaction terms are found significant. This study has not shown major interactive effects of SCM practices in the relationship between KM processes and supply chain performance. However, among the few such findings only supply chain information sharing and Just-In-Time play the role of moderator in the relationship between KM processes and supply chain flexibility performance. Similar moderating effects are found with SCM practice factors (SCI, JIT and CSM) in the relationship between KM processes and supply chain output performance. In summary, it can be concluded that SCM practices play the role of moderator partially in the relationship between KM processes and supply chain performance.

5.9 Testing the Goodness-Of-Fit of the Mediation and Moderation Models

For testing the developed theoretical models, assessing the model fit and comparing the proposed model with nested models are essential. Following Anderson (1987) and Joreskog (1993) the confirmatory factor analysis is performed to analyze the goodness-of-fit of the proposed models such as-

1. The predictors of KM processes, SCM practices and supply chain performance
2. The model of SCM practices and supply chain performance in which KM processes factors play a dominating mediator role, and
3. The model of KM processes and supply chain performance in which SCM practice factors play a mediator role.

The results of this analysis on each model for factors of KM processes, SCM practices and supply chain performance were shown in Table 4.1, 4.2, and 4.3 respectively. The results of confirmatory factor analyses shown in Table 4.1 recommend that the theoretical predictors of KM processes as a valid model in terms of goodness-of-fit indices (χ^2 = 713.31, df = 295, P<0.0000, GFI = 0.87, CFI = 0.96, RMSEA = 0.063, NNFI = 0.96). Similar results for goodness-of-fit are also found with the models of SCM practices (χ^2 = 699.82, df = 271, P<0.0000, GFI = 0.87, CFI = 0.96, RMSEA = 0.067, NNFI = 0.96) and for the model of supply chain performance (χ^2 = 320.70, df = 87, P<0.0000, GFI = 0.89, CFI = 0.94, RMSEA = 0.087, NNFI = 0.93). Therefore, the results of confirmatory factor analysis support the antecedents of KM processes, SCM practices and supply chain performance. The results of confirmatory factor analyses on the model of mediating role of KM process factors shown in Table 4.4 recommend the theoretical KM process factors mediating model as a good data fitting model in terms of goodness-of-fit indices (χ^2 = 4316.83, df = 2033, P<0.0000, GFI = 0.90, CFI = 0.93, RMSEA = 0.056, NNFI = 0.92). Both KM processes as well as SCM practices are found in the dominating role of mediator in their respective relationship with supply chain performance in the manufacturing firms in India.

In order to exploit complementarities in knowledge and capabilities, in today's knowledge economy, collaboration among organizations leading to the creation of supply chains is increasingly becoming a necessary and important factor in organizational decision making (Teece, 1998). Bulent (2008) emphasized that supply chain performance is related with knowledge sharing. Zhao *et al.* (2002) also indicated that knowledge-sharing influences supply chain performance. Singh *et al.* (2008) highlighted the importance of IT tools and skills that help salespeople and consultants in managing knowledge through a centralized database. By taking the information available and sharing it with members of the supply chain, an organization can speed up the knowledge flow in the supply chain, improve the efficiency and effectiveness of the supply chain, and respond quickly to changing customer needs quicker. Moreover, Distortion in the flow of information among the members of supply chain leads to a critical problem of bullwhip effect that adversely affects the supply chain effectiveness (Balan *et al.*, 2007). Therefore, knowledge sharing will bring the organization a competitive advantage in the long run and impact the supply chain performance in terms of both total cost and service level. Heiman and Nickerson (2004) argued that the aggregate knowledge potential of all members 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. Von Hippel (1988) recognizes that primary sources of innovative ideas are firm's customers and suppliers. He argues that a production network with superior knowledge transfer mechanisms among the members of supply chain will be able to 'out-innovate' networks with less effective knowledge-sharing routines. Hill and Scudder (2002) regarded KM practices as a system that can synchronize the information that resides in both formal and informal KM system of different organizations, facilitate new knowledge creation, transferring and application, thus increase market response rate, reduced cycle time for product and services, and deliver greater value to both its internal and external customers to give the entire supply chain a competitive advantage. Shankar *et al.* (2003) emphasized that top management must focus their attention to build up strong knowledge resources through better technological infrastructure to encourage knowledge acquisition and creation. They have further asserted on the inevitable need of employees of Indian engineering industry to actively share their knowledge and provide assistance to top management in their strategic planning to achieve organizational goals. Moreover, Mintzberg (1973) has reported that managers get involved in frequent communication with followers, subordinates, and other members of the organization and in this process they spend about 75 percent of their working time in a working day in the organization (Cho *et al.*, 2008). In support to this, Birasnav and Rangnekar (2010) reported that Indian firms encourage brainstorming sessions for their managers and engineers for improving the level of creativity and innovation. They also support flexibility in the form of autonomy, participation in decision making, and freedom to experiment. Highlighting the importance of research, Wong *et al.* (2009) emphasize that research is essential for identifying supportive conditions to stimulate innovation in organizations. Moreover, Shankar *et al.* (2006) emphasized that large and medium scale manufacturing organizations, in particular automobile and machine tool industries in India, are extensively practicing KM to achieve the competitive priorities of better product quality, significant cost reduction, and improvements in efficiency, delivery, flexibility and innovation. Although business organizations need to invest in technological infrastructure initially that may seem to be an expensive exercise, it will not take them long to realize the benefit of having good information management system. In the manufacturing sector, automobile and automotive component industries in India have taken many initiatives in KM implementation. Such extensive KM system is helping them to achieve their performance goals (Momaya, 2002). For example, Dwivedi *et al.* (2005) reported that manufacturing firms, particularly large size firms like Reliance Industries, Maruti Udyog Ltd, TVS Motors, and Asian Paints make high investment on SCM and knowledge portals for knowledge creation. McAdam and Reid (2001) reported that both SMEs and larger firms need to put emphasis on KM system as a prominent source of cost efficiencies. However, it has also been shown that inter-firm collaboration in the form of supply chain is not without problems. Barringer and Harrison (2000) reported that owing to failure rates of 50-70% of business alliances, it can be pointed out that such collaborations are difficult to manage and a number of potential risks have been identified, for example, the risk of loosing proprietary information due to the partner's opportunistic behavior. Recently, Nunes *et al.* (2006) elaborated that even though KM processes are of complex nature in terms of both direct and indirect costs, the consequences for manufacturing organizations of not maintaining those processes can potentially make these organizations vulnerable to knowledge expropriation and consequent losses in efficiency, productivity and competitiveness.

In summery, the results of this research study are well supported by the previous researchers in the relevant subject area. It can be said that KM processes as well as SCM practices have been implemented significantly in manufacturing organizations in India and impacted well on their supply chain performance.

CONCLUSIONS, LIMITATIONS, AND FUTURE RESEARCH

6.1 Conclusions

Knowledge has emerged as the key resource in the post-industrial society. Creation of knowledge is a costly affair, and the life span of knowledge is getting increasingly shorter, owing to fast changes and newer developments. It is critical for organizations to acquire and accumulate vital organizational knowledge, and provide appropriate access to it, in a professional and efficient manner throughout the organization for leveraging it to achieve sustainable competitiveness. Researchers have rightly concluded that more conscious and systematic approach to KM helps manufacturing organizations enhance their performance and competitive advantage (Salojarvi *et al.*, 2005; Matlay, 2000). It is widely acknowledged in academia that all organizations, both large and small, require continuous creation, sharing and implementation of knowledge in order to maximize their competitiveness and survival chances in the modern knowledge society (Grant, 1996; Nelson, 1991; Nunes *et al.*, 2006; Pillania, 2008). Pillania (2008) studied knowledge creation and categorization in SMEs in Indian automotive components manufacturers taking into account both macro and micro perspectives. Taking the inputs from McAdam and Reid (2001), Nunes *et al.* (2006), and Sparrow (2000) he highlighted that KM processes such as knowledge acquisition, storing, retrieving and sharing processes should be seen as crucial and core by knowledge intensive companies, notably by manufacturing organizations. However, in practice, manufacturing organizations in India, particularly SMEs, are still reluctant to take KM practices into their strategic view and operational routines.

Limited research studies exist in the literature of SCM practices and supply chain performance, which focused through KM processes. Therefore, a need arises to study the impact of KM processes and SCM practices on supply chain performance in manufacturing organizations in India. As discussed in the chapter of literature review, much of the research contributions on supply chain performance are mainly focused on quantitative parameters such as cost efficiency and productivity. It is identified through review of literature that knowledge acquisition, knowledge conversion, knowledge application, and knowledge protection are the factors of KM processes. Similarly, SCM practice factors are found in supply chain integration, supply chain information sharing, Just-In-Time capability, and customer support management. The relationship among the factors of KM processes, SCM practices, and supply chain performance required to be empirically examined further. In this direction, research methodology was designed to achieve the objectives as stated in the chapter of methodology. The detailed systematic literature review and discussions held with professionals and academicians supported to decide the study variables. Following this, the scales were developed to find the antecedents through pilot study conducted among 100 responses. After establishing valid scales, data were collected from 357 middle and top level executives having experience in the area of supply chain management and knowledge management in manufacturing firms in India. From the collected data, correlation analysis, exploratory factor analysis, simple regression analysis, hierarchical regression analysis, and confirmatory factor analysis were carried out to accomplish the stated objectives of this study.

Exploratory factor analyses were conducted to find the valid structure of KM processes, SCM practices, and supply chain performance. KM processes comprised of valid factors namely knowledge acquisition, knowledge conversion, knowledge application, and knowledge protection. Similarly, factor analyses revealed that supply chain integration, supply chain information sharing, Just-In-Time capability, and customer support management are the constituent factors in the measure of SCM practices. Supply chain performance comprised of valid factors namely flexibility performance, resource performance and output performance. The reliability and unidimensionality is ensured with exploratory factor analyses as well as confirmatory factor analyses performed with the help of statistical software packages SPSS 15 and LISREL 8.7 respectively.

Further, to examine the association among the identified factors and the control variables i.e. participating firm's characteristics, correlation analysis was conducted that shows that among the variables of firm's characteristics, firm's position in the supply chain is positively correlated with supply chain flexibility performance. In addition to this, firm's position in supply chain has substantial positive association with all factors of KM process and SCM practices. Firm's size in terms of employee strength has significant positive correlation with overall KM processes and SCM practices. Importantly, all the studying variables show a significant positive relationship with constructs of supply chain performance.

The findings of hierarchical regression analysis supported hypotheses related with objective 7. In general, the mediation implies a causal hypothetical relationship in which an independent variable causes a mediator that causes a dependent variable. The HRA results observed that SCMP factors SCI, JIT, and CSM significantly predicted supply chain flexibility performance. The mediators, knowledge acquisition, and knowledge protection cause for the diminishing effect of supply chain practices on supply chain flexibility performance. The main effects of SCMP factors IS, JIT, and CSM significantly predicted supply chain resource performance while KAP and KP are found to mediate between supply chain practices and supply chain resource performance. The effects of SCMP factors SCI, JIT, and CSM significantly predicted supply chain output performance while KM processes, KA and KAP, act as mediators in the relationship between supply chain practices and output performance. Thus, these findings provide strong support for concerned hypotheses.

Further, HRA has shown that KM process factors, except knowledge conversion, significantly predict the supply chain flexibility performance. The effects of

SCI, IS, CSM, and JIT on supply chain flexibility performance as well as resource performance are found to be significant while the effect of SCI * CSM on supply chain output performance is found to be significant. The interactive terms such as KP * IS and KP * JIT on supply chain flexibility performance have been found significant. The interactive effects of KC * CSM on supply chain resource performance have been found significant. Similarly the main interactive effects of KA * CSM, KC * SCI, and KAP * JIT on supply chain output performance have been found significant. So, in the light of above it can be said that supply chain practices partially exhibits moderator role in the relation between KM processes and supply chain performance. Knowledge acquisition and application within the supply chain underpin the intellectual capital of the chain and its ability to ensure a competitive product and increased profit margin. Each component in the supply chain adds value for the client, derived from its specialist knowledge, to the final product. The quality and application of the knowledge throughout the chain has a direct impact on the quality and competitiveness of the product (Yu *et al.*, 2001).

Confirmatory factor analysis is conducted with the help of LISREL 8.7 to assess the model fit with collected data and prove the developed models as best models. This analysis is carried out for the model of (1) predictors of KM processes, supply chain practices and supply chain performance (2) mediating and moderating role of KM process factors in between SCM practices and supply chain performance, and (3) mediating role of SCM practices factors in between KM processes and supply chain performance. In line with Hair *et al.* (1998) and Joreskog and Sorbom (1993) the goodness-of-fit statistics of the analyses showed that each model is well confirmed with the data.

6.2 Managerial Implications

More importantly, while KM seems to be successfully applied in large companies, it is largely disregarded by manufacturing organizations in India, particularly SMEs. This has been attributed primarily to the lack of a formal approach to the processes of acquiring, accumulating, sharing, recording, auditing and exploiting organizational knowledge, together with a lack of utilization of available information and communication technologies (Nunes *et al.* 2006, Pillania, 2007). However, this informality within SMEs and on projects can also be viewed as a strong motivation for the adoption of KM, since it will affect the dissemination and transfer of experiences and relevant knowledge to future projects and organizational development (Egbu *et al.*, 2004).

Consequently, even though KM processes are of complex nature in terms of both direct and indirect costs, the consequences for manufacturing organizations of not maintaining those processes can potentially make these organizations vulnerable to knowledge expropriation and consequent losses in efficiency, productivity and competitiveness (Nunes *et al.* 2006). In fact, KM in manufacturing organizations in India tends to happen in an informal way, rarely supported by deliberately designed ICT systems. Classifications, hierarchies and ontologies need to be established and corresponding documents classified, indexed and uploaded (Nunes *et al.* 2006). Specifically, though, as in any global corporation, manufacturing organizations in India need appropriate and up-to-date knowledge in order to compete as they tend to be more susceptible to problems of knowledge retention mainly due to high staff turnover. Thus, this knowledge must be appropriately managed, disseminated and retained in the organizations.

The empirical findings reported herein reveal strong positive relationship between the facets of KM processes and supply chain performance measures in the context of manufacturing organizations in India. These findings explicitly suggest that the capabilities of manufacturing organizations to adopt and apply KM process measures help them to achieve higher level of supply chain performance. However, explicit need has been triggered by this research study that manufacturing firms are required to take serious initiatives on the issue of knowledge conversion, as it is observed from the results of this study that absorbing knowledge from the employees, filtering and organizing the acquired knowledge, integrating different sources of knowledge as well as replacing obsolete knowledge are not been performed substantially. It is suggested therefore that manufacturing firms in India should improve on the ICT capabilities (such as ontology, knowledge repository etc.) that facilitate effective knowledge conversion.

The challenges of integrating and deploying a robust KM system with supply chains to create competitive advantage have become more critical as the marketplace is immensely competitive nowadays and the pace of innovation is speeding than ever before. Also, organizations have taken up the goal of creating customer value on priority, staff functions are being reduced and management structures are flattening, in the light of these significant changes in the business environment in the manufacturing organizations in India, there is a need to replace the informal KM of the staff function with a formal well-structured KM system. This need is also being felt due to the reducing workforce size, new trend of early retirement and subsequent mobility, leading to loss of vital knowledge to the manufacturing organizations. It is equally important to note that it takes time to experience and acquire right set of information and knowledge relevant to the strategic as well as operational functions in the organization. Most important, organizations firms must create regular awareness programs on use of KM system among employees. To support their involvement in KM, creating a supportive culture or environment, provision of appropriate incentive and reward structure for practicing KM within the organization as well as among the members of supply chain is a must because these are the enablers of KM system. Importantly, manufacturing organizations, particularly SMEs, shall involve in modernizing communication practices like fostering email, internet, and intranet communication because employees use such communication practices, which help generate unique and new ideas.

Many large manufacturing firms in India have already begun to establish KM systems for demonstrating to value their employees. With higher level of knowledge sharing, organizations are more likely to create better innovative practices to manage the whole supply chain which can lead to improved performance. Therefore, it can be concluded that to facilitate effective knowledge sharing across supply chains, an understanding of the factors influencing KM processes is needed so that a strategy may be developed to overcome the barriers preventing knowledge sharing and encourage seamless information and knowledge flow in supply chains. KM systems in the supply chain need to facilitate and support a common supply chain wide vocabulary to ensure that the knowledge is correctly shared for its effective implementation. It is imperative that each member in the supply chain should identify, model and represent explicitly their respective knowledge capabilities. It is also essential that supply chain members share and apply their expert knowledge in various different applications in consultation with other members of the supply chain.

6.3 Limitations of the Study

The first limitation of this research study is the reach to abtain the data set required to elaborate the findings to all Indian manufacturing firms. Sincere attempt has been made in data collection through mails (both postal and emails) and personal visits to the concerned manufacturing firms in the nearby industrial areas, despite this it is felt that more firms could have been included in this study. However, the sample size used is comparatively adequate to represent the study variables in this study in wide variety of manufacturing industries in India, because of the poor response rate of manufacturing employees. Also, the authentic respondents working in the area of study variables particularly knowledge management are very limited in the manufacturing sector. This has affected the volume and quality of responses to some extent. Secondly, the time frame during which the data collection for this study is conducted was the period of market recession and has subequent effect on the responses collected. Thirdly, the scope for applying statistical tests for this study is an attempt based on the similar researches in the subject area focussing on differing variables. It is to be noted here that research related to the variables in this study is very limited in the context of manufacturing firms in India. At last, the variation among the sizes of manufacturing firms is the concern for these findings.

6.4 Future Research

Further research can be made to investigate the implications of KM system taking into account other relevant parameters such as KM outputs, KM benefits, KM enablers and obstacles, etc. Similarly, research should be carried out for a specific sector (e.g. automobile, pharmaceutical sector) in manufacturing industries and other industries as well. Doing this, complexities of implementing KM system and variation among these industries could be realized.

Research can also be extended in the area of supply chain management including variables such as problems in SCM practice, supply chain design, logistics aspects etc. to explore their significance in improving the overall performance of the supply chain. Some more variables such as for the evaluation of supply chain performance could also be taken into account for further research. Examination of the proposed research model under different supply chains is another avenue for future work. For example, impact of KM processes on supply chain performance may be higher retail supply chain than that of automobile supply chain. Therefore, the research model presented here can be further investigated by collecting data from a specific supply chain.

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Appendix I

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

DEPARTMENT OF MANAGEMENT STUDIES

Dear Participant,

Knowledge is now being seen as the most important strategic resource in organizations, and the management of this knowledge is considered critical to organizational success. If organizations have to capitalize on the knowledge they possess, they have to understand how knowledge is created, shared, and used within the organization. On the other hand the philosophy of Supply chain management focuses on how firms utilize their suppliers' processes, technology, and capability to enhance competitive advantage, and the coordination of the manufacturing, logistics, materials, distribution, and transportation functions among the members of its supply chain.

In this direction, the attached questionnaire is a tool to help us understand your perceptions on the above said factors as you have work experience in the organization. This tool is the outcome of past thorough literature and discussions with supply chain and knowledge management professionals. Your responses will add value to our research as well as to the literature of the KM and SCM practices. So, **please indicate your views by circle the appropriate number provided against each statement**. Confidentiality will surely be maintained and the aggregate responses shall only be used for academic purposes.

Thanking you.

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PERSONAL INFORMATION

Name:__________	Age:____ years	Gender:Male/Female
Name of Organisation:__________	Kind of Organisation:__________	
Job Position:__________	Experience:____ Years	
Total number of employees working:________		
Position in Supply Chain: Manufacturer/Supplier/Distributer/Logistics Provider		

A. Knowledge Management Practices measurement items

Likert Scale: (1=Strongly disagree), (2=Disagree), (3=Neither agree nor disagree), (4=Agree), (5=Strongly agree)

Knowledge Acquisition:

My Organization…..

1.	has processes for generating new knowledge from existing knowledge.	1	2	3	4	5
2.	has processes for exchanging knowledge among employees.	1	2	3	4	5
3.	has processes for acquiring knowledge about new products/services within our industry.	1	2	3	4	5
4.	has processes for acquiring knowledge about competitors within our industry.	1	2	3	4	5
5.	has processes for acquiring knowledge about our customers.	1	2	3	4	5
6.	has processes for acquiring knowledge about our suppliers.	1	2	3	4	5

Knowledge Conversion:

My Organization….

7.	has processes for filtering knowledge.	1	2	3	4	5
8.	has processes for absorbing knowledge from employees into the organization.	1	2	3	4	5
9.	has processes for integrating different sources and types of knowledge.	1	2	3	4	5
10.	has processes for organizing knowledge.	1	2	3	4	5
11.	has processes for replacing outdated knowledge.	1	2	3	4	5
12.	has processes for converting knowledge into the design of new products/services.	1	2	3	4	5

Knowledge Application:

My Organization….

13.	has processes to apply knowledge learned from mistakes.	1	2	3	4	5
14.	has processes for applying knowledge learned from experience.	1	2	3	4	5
15.	has processes for using knowledge to solve new problems.	1	2	3	4	5
16.	makes knowledge accessible to those who need it.	1	2	3	4	5
17.	takes advantage of new knowledge.	1	2	3	4	5
18.	has processes for using knowledge in development of new products/services.	1	2	3	4	5
19.	uses knowledge to improve efficiency.	1	2	3	4	5
20.	is able to locate and apply knowledge to changing competitive conditions.	1	2	3	4	5

Knowledge Protection:

My Organization….

21.	has processes to protect knowledge from inappropriate use inside the organization.	1	2	3	4	5
22.	has processes to protect knowledge from inappropriate use outside the organization.	1	2	3	4	5
23.	has processes to protect knowledge from theft from within the organization.	1	2	3	4	5
24.	has processes to protect knowledge from theft from outside the organization.	1	2	3	4	5
25.	has incentives that encourage the protection of knowledge.	1	2	3	4	5
26.	has technology that restricts access to some sources of knowledge.	1	2	3	4	5

B. Supply Chain Management Practices measurement items

Likert Scale: 1(Low), 2(Poor), 3(OK), 4(Good), 5(High)

1.	Determining customers' future needs	1	2	3	4	5
2.	Increasing your firm's JIT capability	1	2	3	4	5
3.	Aiding suppliers to increase their JIT capability	1	2	3	4	5
4.	Participating in the sourcing decisions of suppliers	1	2	3	4	5
5.	Participating in the marketing efforts of customers	1	2	3	4	5
6.	Locating closer to your customers	1	2	3	4	5
7.	Requiring suppliers to locate closer to your firm	1	2	3	4	5
8.	Use of a third-party supply chain specialist	1	2	3	4	5
9.	Use of informal information sharing	1	2	3	4	5
10.	Use of formal information sharing agreements	1	2	3	4	5
11.	Improving the integration of activities across your supply chain	1	2	3	4	5
12.	Searching for new ways to integrate SCM activities	1	2	3	4	5
13.	Establishing more frequent contact with supply chain members	1	2	3	4	5
14.	Communicating your firm's strategic needs	1	2	3	4	5
15.	Creating a greater level of trust among supply chain members	1	2	3	4	5
16.	Communicating customers' future strategic needs	1	2	3	4	5
17.	Identifying additional (alternate) supply chain	1	2	3	4	5
18.	On-time delivery directly to customers' points of use	1	2	3	4	5
19.	On-time delivery directly to your firm's points of use	1	2	3	4	5
20.	Creating SCM teams to include different companies	1	2	3	4	5
21.	Reducing response time across the supply chain	1	2	3	4	5
22.	Involving supply chain in your product/service/marketing plans	1	2	3	4	5
23.	Extending supply chain beyond immediate suppliers/customers	1	2	3	4	5
24.	Creating a compatible information system	1	2	3	4	5
25.	Contacting the end users to get feedback	1	2	3	4	5

JIT: Just in Time
SCM: Supply Chain Management

C. Supply Chain Performance measurement items:

Likert Scale: 1(Low), 2(Poor), 3(OK), 4(Good), 5(High)

Flexibility Performance:

1	Ability to respond to and accommodate demand variations, such as seasonality	1	2	3	4	5
2	Ability to respond to and accommodate periods of poor manufacturing performance (machine breakdown)	1	2	3	4	5
3	Ability to respond to and accommodate periods of poor supplier performance	1	2	3	4	5
4	Ability to respond to and accommodate periods of poor delivery performance	1	2	3	4	5
5	Ability to respond to and accommodate new products, new markets, or new competitors	1	2	3	4	5

Resource Performance:

6	Total cost of resources used	1	2	3	4	5
7	Total costs of distribution, including transportation and handling costs	1	2	3	4	5
8	Total costs of manufacturing, including labour, maintenance and re-work costs	1	2	3	4	5
9	Costs associated with inventory	1	2	3	4	5
10	Return on investments	1	2	3	4	5

Output Performance:

11	Annual Sales (for last period)	1	2	3	4	5
12	Order fill rate (number of orders that are filled from available inventory)	1	2	3	4	5
13	On-time deliveries	1	2	3	4	5
14	Customer response time	1	2	3	4	5
16	Manufacturing lead time	1	2	3	4	5

Thanks for your contribution and valuable time.