# AN EMPIRICAL STUDY OF THE RELATIONSHIP BETWEEN KNOWLEDGE MANAGEMENT AND INFORMATION TECHNOLOGY INFRASTRUCTURE CAPABILITY IN THE MANAGEMENT CONSULTING INDUSTRY

by

Sung-kwan Kim

A DISSERTATION

Presented to the Faculty of

The Graduate College at the University of Nebraska

In Partial Fulfillment of Requirements

For the Degree of Doctor of Philosophy

Major: Interdepartmental Area of Business

(Management)

Under the Supervision of Professor Sang M. Lee

Lincoln, Nebraska

December, 2001

DISSERTATION TITLE

An Empirical Study of the Relationship Between Knowledge Management and Information Technology Infrastructure Capability in the Management Consulting Industry

BY

Sung-Kwan Kim

SUPERVISORY COMMITTEE:

| APPROVED | DATE |
| --- | --- |
| Signature | 11-14-01 |
| Dr. Sang M. Lee<br>Typed Name | |
| Signature | 11/14/01 |
| Dr. Marc Schniederjans<br>Typed Name | |
| Signature | 11/14/01 |
| Dr. Keng Siau<br>Typed Name | |
| Signature | 11-14-01 |
| Dr. Alvin Surkan<br>Typed Name | |
| Signature | |
| Typed Name | |
| Signature | |
| Typed Name | |

GRADUATE COLLEGE
UNIVERSITY OF NEBRASKA

# AN EMPIRICAL STUDY OF THE RELATIONSHIP BETWEEN KNOWLEDGE MANAGEMENT AND INFORMATION TECHNOLOGY INFRASTRUCTURE CAPABILITY IN THE MANAGEMENT CONSULTING INDUSTRY

Sung-kwan Kim, Ph. D.

University of Nebraska, 2001

Advisor: Sang M. Lee

Since knowledge has become a critical corporate asset, organizations began managing knowledge aggressively and thus knowledge management (KM) has become a critical concern for creating and sustaining competitive advantage. To manage knowledge effectively, organizations extensively utilize information technology (IT). IT and its underlying components, IT infrastructure, have been reported as critical success factors.

The main purpose of this study is to develop a better understanding of the relationship between KM and IT infrastructure capability, especially in the management consulting industry. To achieve this objective, a field survey of management consulting companies was conducted. Several research methods were employed to interpret data and test hypotheses.

Through the statistical tests, no critical relationships were found between KM and IT infrastructure capability in small and medium size consulting companies. This finding highlights a gap between previous studies and actual practices in the industry.

This study also provided several important ideas and observations on the topic. First, this study proposed an extended KM classification model. Previously proposed KM classification schemes were based mainly on the knowledge type used. The extended

model in this study matched the business nature and knowledge types used in organizations. This KM classification scheme should provide a foundation for building a more comprehensive KM model. Second, this study provided several meaningful observations on the current status of IT applications to KM. This will provide managers with new opportunities of using IT for KM in a more aggressive way. Third, this study highlights the role of human skills. Human skills combine, integrate and coordinate IT infrastructure components. In shaping IT infrastructure capability for competitive advantage, the most important factor is the human skill, not the IT infrastructure itself.

## ACKNOWLEDGEMENTS

I wish to express my profound appreciation to my dissertation advisor, Dr. Sang M. Lee. I truly can not imagine myself accomplishing this work without his guidance and encouragement. I also wish to thank the other members of my dissertation committee, Dr. Marc Schniederjans, Dr. Keng Siau, and Dr. Alvin Surkan for their advice and support.

Special thanks go to my father, Chong-Ryon Kim and my mother, In-Pa Lee. Their love and support have been the source of this scholarly undertaking. I extend special thanks to my wife, Sung-Hye Kil for being so understanding throughout this endeavor. Without her love and sacrifice, I never would have achieved this goal. I also wish to thank my adorable children, Ye-Rim and Kun-Hee for their patience and understanding.

Finally, I must acknowledge two persons who helped me to achieve this goal. I would like to express my sincere appreciation to Sang-Won Lee, former CEO of Ssangyong Shipping Company and Ssangyong Heavy Industries, and Mu-in Park, CEO of Ssangyong Shipping Company.

# TABLE OF CONTENTS

## LIST OF FIGURES

# LIST OF TABLES

# CHAPTER ONE

# INTRODUCTION

## 1.1 OVERVIEW

The environment surrounding business organizations has changed drastically during the past decade. Organizations are looking for new ways to compete effectively. One of the key factors of corporate success is the ability to quickly adapt to changing conditions in the environment, innovate continuously, and achieve goals. Organizational knowledge provides this capability. More specifically, organizational knowledge provides the capability to understand the market, assess the customer's needs, and translate them into products and services by integrating various organizational resources. As we move from the industrial age into the intelligence age, knowledge has become a central force behind the competitive success of firms. In an economy where everything is uncertain, the one sure source of sustaining competitive advantage is knowledge (Nonaka and Tageuchi, 1995). Thus, knowledge management (KM) is a critical concern for creating and sustaining the organization's core competencies.

KM includes the entire process of discovery, creation, dissemination, and utilization of knowledge. For successful KM, managers need to understand the various organizational aspects including organizational structure, culture, leadership, and technology. Especially, information technology (IT) became one of the critical factors for effective KM (Junnarkar and Brown, 1997; Trussler, 1997; Ruggles, 1998; Syed, 1998; Skyrme, 1999; Sarvary, 1999; Zack, 1999; Choi, 2000). During the management process, IT is extensively utilized. As the importance of organizational knowledge and the role of IT in KM increase, choosing the right IT for different KM strategies, is critical.

Both practitioners and researchers have addressed the important issue of applying IT to KM. To date, the studies have focused on individual IT applications. However, to truly understand the impact of IT support on KM, it is important for organizations to examine the underlying components of IT applications. IT applications do not exist in vacuum. It is difficult to separate the IT applications from their infrastructure components. So far, no empirical study has been carried out on this topic. This study investigates the relationship between KM and IT infrastructure capability in the management consulting industry.

## 1.2 RESEARCH OBJECTIVE

The overall objective of this study is to examine the relationship between KM and IT infrastructure capability in the management consulting industry. In the consulting industry, knowledge and its management are primary service products. The consultants sell their expertise and get paid for the solutions they provide to their customers. The expertise and solutions are nothing more than knowledge. If a consultant leaves the firm or retires, then the company may lose a huge amount of money because the person's knowledge goes with him or her.

Managing knowledge is one of the key business processes in the consulting industry (Galagan, 1997; Zack, 1999; Sarvary, 1999; Hansen et al., 1999). The industry is also "among the first to aggressively explore the use of IT to capture and disseminate knowledge" (Hansen et al., 1999). With the growing importance of KM and the role of IT in KM projects in this industry, identification of these relationships help companies acquire appropriate IT support, plan and prioritize IT investment for KM more effectively.

Toward this end, this research involves three steps: (1) Development of a conceptual framework for the assessment of KM approaches in the management consulting industry; (2) Presentation of the research model on the relationship between KM and IT infrastructure capability leading to formulating hypotheses; and (3) Based on the field survey, the relationship between KM and IT infrastruture capability is measured and tested. The overview of this research is shown in Figure 1.1.

## 1.3 RESEARCH QUESTION

Recent studies show that organizations take specific approaches to KM (March, 1991; Jordan and Jones, 1997; Hansen et al., 1999; Zack, 1999; Sarvary, 1999). Also, it has been repeatedly reported that information technology (IT) and its underlying infrastructure are critical components of successful KM (Junnarkar, 1997; Syed, 1998; Skyrme, 1999; Choi, 2000).

According to the studies, in one KM approach, organizations focus on utilizing what they already know. In another KM approach, organizations focus on creating what they do not know. Of the two, organizations may choose one dominant approach to KM. The role of IT in the first KM approach is to help organizations efficiently capture, structure, organize and reuse the existing knowledge. The role of IT in the second KM approach is to help organizations effectively generate new knowledge through collaboration with a group of experts.

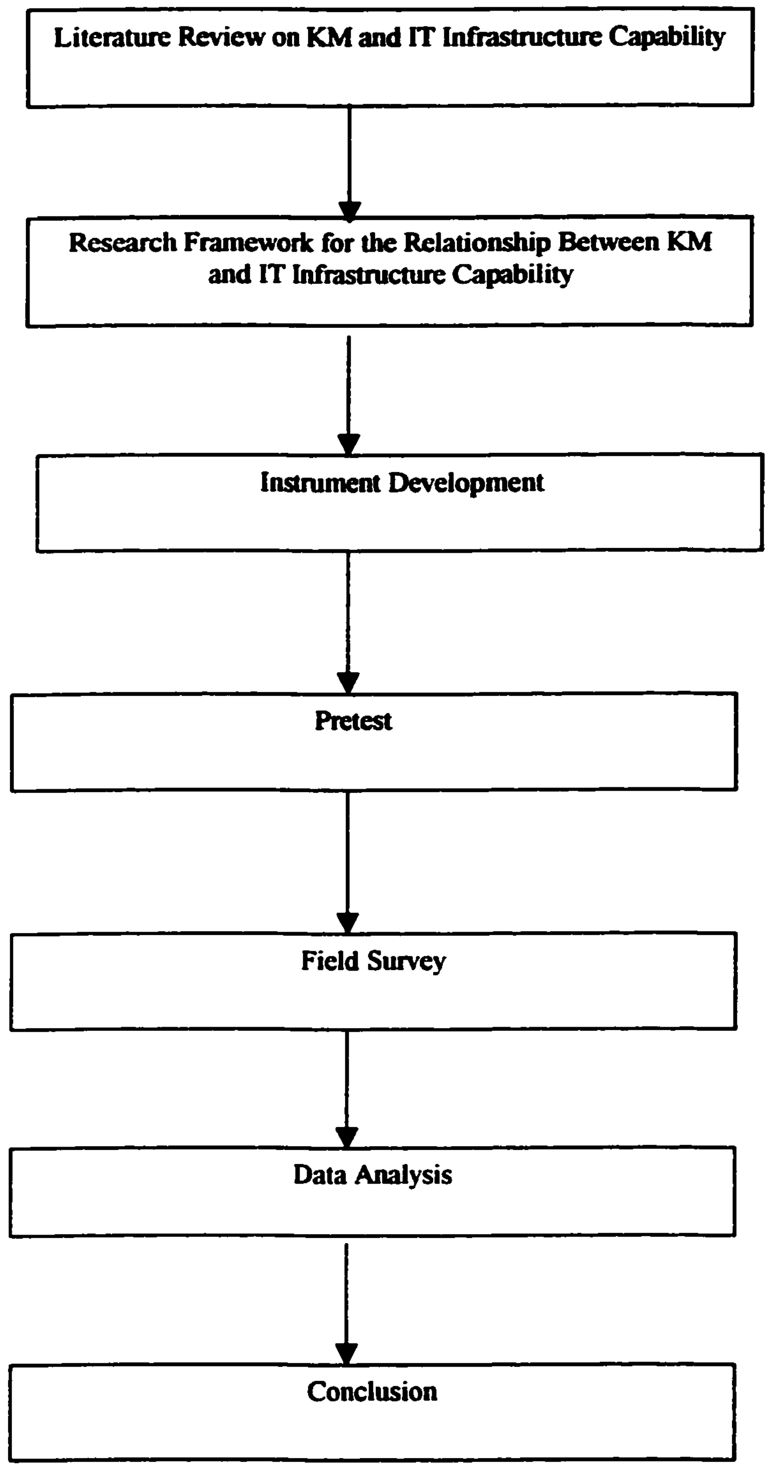


Figure 1.1 Overview of the Research

There have been numerous studies about KM and IT. However, there have been only a small number of studies about KM and the underlying IT components. Furthermore those studies are not empirically based. In order to truly understand the IT capability, it is indispensable to investigate the underlying components of IT because no individual IT application can exist without its infrastructure support.

To maximize the benefits of IT for KM, the relationship between KM and IT infrastructure capability must be established and empirically tested. The purpose of this study is to identify the relationship between KM and IT infrastructure capability. The questions such as "Do different KM approaches need different IT infrastructure capability?" and "Is there a specific IT infrastructure capability needed by a specific type of KM approach?," have critical implications for managers to more effectively plan and implement IT applications for KM projects because answering such questions will allow managers to select right tools for KM. Different KM approaches may require different approaches to leveraging IT. Then, the research question can be stated as follows: What are critical relationships between KM and IT infrastructure capability, especially in the management consulting industry?

## 1.4 RESEARCH METHODOLOGY

The following research methods are employed for this study. First, based on a literature review on KM and IT infrastructure capability, a research framework is developed to analyze the relationship between KM and IT infrastructure capability in the management consulting industry. Management consulting companies are grouped into one of the four distinct KM models depending on the type of their service and knowledge employed. Then, IT infrastructure capabilities of the four groups are compared.

Second, a two-by-two factorial model is set forth to test the relationship between KM models and IT infrastructure capability. The main method to collect data was a field survey. The sample uses the list of "The Directory of Management Consultant 2000, 9th Edition" published by Kennedy Information in 1999. The data for analysis were collected through mail questionnaires. Mail questionnaires were sent to the chief information officers (CIO) or highest ranking IT officers of the 1500 consulting companies listed in the directory. To analyze the data, Analysis of Variance (ANOVA) was employed.

## 1.5 ORGANIZATION OF DISSERTATION

This dissertation consists of five chapters; Introduction, Literature Review, Research Design and Methodology, Analysis and Discussions, and Summary and Conclusion.

Chapter One has provided a general introduction and brief overview of the research objective, research questions, and the research methodology to be employed.

Chapter Two outlines a literature review on KM and IT infrstructure capability. The first part of this chapter presents a review of KM literature, including various definitions associated with the subject, concepts, and KM approaches in the management consulting industry. The second part provides a review of literature on the IT infrastructure capability to establish a conceptual framework for this study. The third part introduces the concepts of IT infrastructure services that are used to measure IT infrastructure capability.

Chapter Three presents the reseach design and methodology employed in this study. It describes a research framework developed through literature review. Hypotheses are introdcued. All variables used in the research are presented and defiend. This chapter also includes discussions on research design, samples, and the survey instruments for measuring variables and testing hypotheses. All variables defined are operationalized for proper measurement.

Chapter Four presents the results of the analysis and discussion of the results. This chapter describes the survey procedure employed, including the data collection procedure, sampling, and unit of analysis of the study. It includes a discussion on two important analyses of the measure: reliability and construct validity tests on the instrument employed. Next it presents the results of the analysis. It drscribes demographic charateristics of the repspondents and their companies and also presents a discussion on the results and implications of the results.

Chapter Five concludes the study. It presents the summary, limitations and contributions of the study, and the future research needs.

# CHAPTER TWO

# LITERATURE REVIEW

This chapter presents the literature review on KM and IT infrastructure capability. It consists of three sections. The first section presents a literature review on KM. The second section presents a literature review on IT infrastructure capability. The concepts of IT infrastructure services that are used to measure IT infrastructure capability are introduced in the third section. This chapter includes discussions on the findings of the literature review and their implications.

## 2.1 KNOWLEDGE MANAGEMENT

### 2.1.1 Knowledge Defined

Francis Bacon once said that knowledge is power. As we move from the industrial age to the intelligence age, knowledge has become a central force behind the success of firms. Especially, with the fast developing IT, the speed of processing information and knowledge has been accelerated. Moor's law states that every 18 month, processing power doubles where costs holds constant. Today even a small desktop computer has more powerful processing capability than that of a mainframe computer decades ago. His law has been true through the years and it appears that it will remain there for the foreseeable future.

With the faster and greater capability to process information, the amount of knowledge has been exponentially utilized by organization. Organizations try to recognize assets they have that are not being fully utilized (Quintas et al., 1997). Such assets are employees and their knowledge. The assets include human skills, experience, know-how, best practices, databases etc. These assets provide opportunities to cut costs, save design time, and reduce the time to market (Quintas et al., 1997). Knowledge has become a critical corporate asset (Drucker, 1995).

However, knowledge is not a clear concept. It is helpful to distinguish the following terms: data, information, and knowledge for clarification. Data are raw facts that are recorded and stored. Data do not have much meaning. Data must be sorted, grouped, analyzed, and summarized to have meaning. When data are organized and processed, they become information. Information has meaning and value to the receiver. Knowledge consists of data or information that has been organized and processed to give understanding, experience, and expertise in a specific context.

Leonard and Sensiper (1998) define knowledge as "information that is relevant, actionable and based at least partially on experience." Turban, McLean and Wetherbe (1999) characterize knowledge as "consisting of data or information that have been organized and processed to convey understanding, experience, accumulated learning, and expertise as they apply to a current problem or activity." O'Dell and Grayson (1998) define knowledge as "what people in organization know about their customers, products, process, mistakes, and success." Davenport and Prusak (1998) provide more comprehensive view of knowledge: "Knowledge is a fluid mix of framed experience, values, contextual information and expert insight that provides a framework for evaluating and incorporating new experiences and information" and "it originates and is applied in the mind of the knower."

Based on various views of knowledge, it is clear that information becomes knowledge when it is combined with context and experience. Due to this context-dependent aspect of knowledge, it is hard to share and transfer knowledge, compared with data and information. For example, when knowledge is transferred, it is interpreted according to the receiver's capacity. Without an appropriate background, receivers can not interpret the knowledge correctly and the knowledge will have little value. In this study, knowledge is defined as the combination of information, context, and experience, and is viewed as a core competence of an organization that can be captured, shared, and utilized for various aspects of business problems.

It should be pointed out that there are two dimensions of knowledge: tacit and explicit. The first researcher who made a distinction between the two was Polanyi (1962). However, it was Nonaka and Takeuchi (1995) who brought its importance to organizational attention. Tacit knowledge is embedded in the expertise and experience of individuals and groups, not yet explicated (Leonard and Sensiper, 1998). Explicit knowledge is codified in organizational rules, routines, and procedures.

Boisot (1995) used the taxonomy of codified knowledge and uncodified knowledge. Codified knowledge can be captured, codified and shared in organizations, while uncodified knowledge can not be captured, codified and shared. Baker et al. (1997) described explicit knowledge as formal, systematic, and objective. Explicit knowledge is generally stored in the form of texts (i.e., manual, policy book, database, or even in databases). Tacit knowledge is more intangible. It is difficult to codify and transfer tacit knowledge because it is stored in an individual's head (i.e., expertise, experience, insights, or know-how). Explicit knowledge is shared through a combination process and becomes tacit through internalization. Tacit knowledge is shared through a socialization process and becomes explicit through externalization (Nonaka and Takeuchi, 1995).

### 2.1.2 Knowledge Management Defined

Knowledge is a core competence of organizations and needs to be managed as such. KM is defined in broad terms and includes all these concepts: knowledge of customers, knowledge of products and services, knowledge of people, knowledge of processes, organizational memory, knowledge of relationships, and knowledge assets (Skyrme, 1999). According to Metcalfe's law, the usefulness of a network equals the square of the number of users. A knowledge hidden in one single person's head will be useful. However, if it is networked to others and shared with them, the usefulness of the knowledge will be exponentially increased. The effective KM will identify knowledge in one place and allows it to be networked and shared with others, thereby increasing exponentially the usefulness of the knowledge.

Defining KM is difficult because it has multiple interpretations (Choi, 2000). The following definitions are a few examples of the multiple views on KM.

"KM is the management of the organization towards the continuous renewal of the organizational knowledge base - e.g., creation of supportive organizational structures, facilitation of organizational members, putting IT instruments with emphasis on teamwork and diffusion of knowledge (e.g., groupware) into place" (Bertels, 1998).

"KM is the collection of processes that govern the creation, dissemination, and utilization of knowledge" (Newman, 1997).

"KM is the mechanism for building the institutional memory of the firm to better apply, share, and manage knowledge across various components in the organization" (Choo, 1998).

"KM is a strategy that turns an organization's intellectual assets- both recorded information and the talents of its members- into greater productivity, new value and increased competitiveness; it teaches corporation from managers to employees, how to produce and optimize skills as a collective entity" (Murray, 1998).

"KM is the explicit and systematic management of vital knowledge and its associated process of creating, gathering, organizing, diffusion, use and exploitation. It requires turning personal knowledge into corporate knowledge that can be widely shared throughout an organizational and appropriately applied" (Skyrme, 1997).

Ruggles (1998) proposed eight major categories of KM activities: "generating new knowledge, accessing valuable knowledge from outside sources, using accessible knowledge in decision making, embedding knowledge in processes, products, and/or services, representing knowledge in documents, databases, and software, facilitating knowledge growth through culture and incentive, transferring existing knowledge into other parts of the organization, measuring the values of knowledge assets and/or impact of KM."

Based on the various definitions, there are five key processes associated with KM: creation, location, organization, distribution, and sharing of knowledge. KM includes a broad process of creating, organizing, locating, distributing and sharing knowledge to achieve the organizations' goals. This is used as the working definition of KM in this study.

### 2.1.3 Resource Based View of the Firm

The global competitive environment surrounding business organizations has changed drastically during the past decade. The competition has become fierce and relentless. One of the key requirements for corporate success in this competitive environment is knowing how to sustain competitive advantage. Until the late 1980s, organizations focused on their external environments such as industry competition (Kim and Mauborgne, 1999). Competition had been a key factor in organizational strategy. Most companies focused on how they could build competitive advantage over their competitors. As Kim and Mauborgne (1999) pointed out, this predominant focus on competition has some negative aspects: "strategy driven by competition usually has latent, unintended effects. They are imitative, not innovative, approaches to the market. Companies often accept what competitors are doing and simply strive to do it better. Companies act reactively. Time and talent are unconsciously absorbed in responding to competitive moves, rather than creating growth opportunities." Additionally, "industry boundaries have become fluid and the traditional notion of industry is getting obsolete."

From the late 1980s, a new perspective of strategic advantage emerged. This perspective was called a resource-based view of the firm. Researchers and practitioners of this idea suggested that competitive advantage is not gained only through the combination of product and market based on competition in a given industry, but it was mostly due to differences in organizational resources of different kinds (Prahalad and Hamel, 1990). Because resources can not always be transferred or imitated, organizations must look inside the firm to find the real sources (Wernerfelt, 1984; Barney, 1986 and 1991; Prahalad and Hamel, 1990; Mahoney and Pandian, 1992; Collis and Montgomery, 1995; Post, 1997; Markides, 1997).

As Wernerfelt (1984) pointed out, "resources are tangible or intangible assets that are tied semi-permanently to the firm." Core competence is one such resource. It constitutes competitive advantage for a firm (Prahalad and Hamel, 1990; Collis and Montgomery, 1995; Post, 1997; Markides, 1997; Bogner, 1999). Such advantage is built up over time and can not easily be imitated. "Core competencies are the collective learning in the organization, especially how to coordinate diverse production skill and integrate multiple streams of technologies" (Prahalad and Hamel, 1990). Barney (1991) developed four criteria for assessing what kinds of resources would provide sustainable competitive advantage: first, value creation for the customers; second, rarity compared to the competition; third, inimitability; and fourth, substitutability. Knowledge is the resource that meets such requirements. Knowledge is one competitive advantage that is difficult and time taking to imitate. Knowledge has become a core competency.

Knowledge as a core competency does not diminish with use. Physical assets diminish as they are used. Contrarily, competencies such as knowledge increase their values as they are used and shared. Knowledge fades if it is not used. It is a driving force for new product and new business development. The strategies of a company are the result of knowledge about customers, markets, competitors, and its internal capabilities. The strategies of organizations need to be guided by knowledge and not just by the attractiveness of the market because the strategies beyond their capability would not work. In order to sustain competitive advantage, firms need to possess resources which are unique and difficult for competitors to imitate; the organization's ability to build, integrate and utilize knowledge is the ultimate source of competitive advantage (Huber, 1991; Nonaka, 1995; Newman, 1997; Teece, 1998; Matusik and Hill, 1998).

### 2.1.4 Knowledge Management as a Value Creator

The resource-based approach to organizational strategy has highlighted the key role that organizational knowledge plays in creating and sustaining competitive advantage. However, the resource-based view limits the organization's opportunity for growth and strategic innovation because its focus is on internal resource. The opportunity for growth and innovation is possible by understanding true needs of customers (who are outside of a firm) and by delivering values to them. The resource-based view does not take customers into a critical consideration as it should. This can be misleading. "Today's business challenges include understanding and satisfying customers' needs; monitoring and staying ahead of competition; determining industry trends and adapting to the challenges; increasing market share; and entering new markets" (Hu et al., 1998).

The ultimate goal of business organizations is to offer products and services that can provide values to customers. Companies of sustained high growth and profit pursue value innovation, and the emphasis on value places the customer at the center of their strategic thinking (Kim and Mauborgne, 1999). Kim and Mauborgne (1999) also pointed out that "value innovation makes the competition irrelevant by offering fundamentally new and superior customer value in existing markets and by enabling a quantum leap in buyer value to create new markets."

Prahalad and Hamel (1990) gave an analogy of a tree to explain core competence, which is a key resource of organizations. Core competence works as the roots of a tree. Every trunk, branch, leaf, flower and fruit flourishes from the roots. However, when the roots can't get sunshine or air from the markets or customers, then the trunk and even the roots can wither away and dry up. Organizations work both ways: from roots to leaves (for water and nourishment) and vice versa (for air and sunshine).

Organizational knowledge provides the capability to understand markets and customers' needs, translate them into products and services. Organizational knowledge can link a market and customers with the resources of the firm. Even though KM has roots in the resource-based view, it can overcome some problems that the view's perspective has. KM integrates a competition-based view and a resource-based view into the more extended and balanced view of the firm.

### 2.1.5 Knowledge Management Approaches

KM is concerned with the entire process of creating, organizing, locating, distributing, and sharing knowledge. While managing organizational knowledge, a firm takes a specific approach. Researchers found that there are two major approaches to knowledge management: exploitive vs. explorative (March, 1991; Jordan and Jones, 1997; Hansen et al., 1999; Sarvary, 1999; Skyrme, 1999; Zack, 1999). Exploitive approach focuses on reusing exiting knowledge. Explorative approach focuses on creating new knowledge. Of course, companies can take both approaches simultaneously. However, successful companies do not use them to an equal degree. They tend to employ one dominant knowledge management approach (Hansen et al., 1999).

Jordan and Jones (1997) described two dominant knowledge modes within an organization. Even though they did not term the modes, the two modes represent exploitive approach and explorative approach as summarized in Table 2.1. The framework by Jordan and Jones consists of five broad subordinate categories of knowledge modes: knowledge acquisition, problem solving, dissemination, ownership and memory.

As Jordan and Jones did, Zack (1999) classified two KM applications: interactive applications and integrative applications. In the integrative applications, knowledge flows from people to computers (i.e., knowledge repository or data warehouse), and vice versa. The repository is the hub for people to place, retrieve and exchange their knowledge. Here the focus is on capturing and storing knowledge for reuse. Explicit knowledge flows into and out of a knowledge repository. "The primary focus tends to be on the repository and explicit knowledge it contains, rather than on the contributors, users, or the tacit knowledge they may hold" (Zack, 1999). In the interactive applications, the primary focus is on supporting interaction among people. The knowledge repository can be utilized, but it is a "by-product of interaction and collaboration" (Jack, 1999). The knowledge used tends to be tacit. Knowledge flows from people to people.

| | | |
|---|---|---|
| Knowledge Acquisition | | |
| Focus | Internal | External |
| Search | Opportunistic | Focused |
| Problem solving | | |
| Location | Individual | Team |
| Procedure | Trial and error | Heuristic |
| Activity | Experiential | Abstract |
| Scope | Incremental | Radical |
| Dissemination | | |
| Processes | Informal | Formal |
| Breadth | Narrow | Wide |
| Ownership | | |
| Identity | Personal | Collective |
| Resource | Specialist | Generalist |
| Storage/Memory | | |
| Representation | Tacit | Explicit |

Table 2.1 Knowledge Management Modes

(Adopted from Jordan and Jones, 1997)

March (1991) called these exploration and exploitation. "Exploration includes things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, and innovation. Exploitation includes such things as refinement, choice, production, efficiency, selection, implementation, and execution" (March, 1991). The exploitation approach is concerned about capturing existing knowledge, codifying it and utilizing it. Knowledge is put into a form that makes it accessible to people so that it can be exploited by people. Knowledge is codified so that it can be accessible and applied. By nature, the exploitation approach tends to focus on explicit knowledge. The exploration approach is to explore and generate new knowledge for new challenges. New knowledge is needed to solve new problems and new challenges. Most of the time, there is no knowledge available for these kinds of problems. Collaboration among a group of people, or even with other organizations, is encouraged. The exploration approach tends to focus on implicit knowledge.

### 2.1.6 Knowledge Management in the Management Consulting Industry

From the perspective of KM, the management consulting industry is a very exciting one. Management consulting is an industry whose core product is knowledge itself. Managing knowledge is the most critical process in the consulting industry (Sarvary, 1999). Consulting firms' core product is knowledge itself. They sell their expertise and experience to customers. The experience and expertise are nothing more than knowledge. Consulting firms get paid for the knowledge that they are providing to the customers. Producing and selling knowledge constitute their core activities. KM is the basic production technology for consulting firms. Recent studies on KM strategies in the management consulting industry also found that there are some specific approaches in the practice of KM as in other industries. There are basically two types of KM approaches: centralized and decentralized. (Sarvary, 1999; Hansen, Nohria and Tierney, 1999).

Decentralized (bottom up approach) KM systems can be observed in generalist strategy firms such as McKinsey, Bain, or Boston Consulting (Savary, 1999; Hansen et al., 1999). Such companies are known for their strategy consultancy. Their customers' problems tend to be unique and their recommendations are highly customized and context dependent. Since such knowledge is difficult to codify and standardize, the generalist strategy firms typically put more emphasis on connecting people and collaborating them than on capturing and reusing the available problems and solutions with information technology.

Centralized KM systems (top down approach) can be observed in larger IT consulting firms (i.e., Andersen for its IT consultancy) and the former Big 6 consulting firms (Savary, 1999; Hansen et al., 1999). Their customers' problems are operational. Their service often includes highly standardized solutions to the client. Since operational problems have low context dependence, their solutions can be relatively easier to codify and transfer with methods such as manuals, databases, or knowledge repositories. Centralized systems are heavily dependent on information technology. Information technology has played a critical role in this approach.

Hansen, Nohria and Tierney (1999) developed a model for mapping strategy to KM approach. According to their study, companies do not take a uniform approach to managing knowledge. There are two very different KM approaches, depending on business strategies, as shown in Table 2.2. In some companies, knowledge is codified and stored in databases/knowledge bases. Then the stored knowledge can be accessed and reused easily by anyone in the company. They call this "codification" strategy. The other KM strategy is "personalization" strategy. This strategy focuses on communicating knowledge among people, not storing knowledge. The choice of KM strategy depends on the way the company serves its clients, the economies of its business, and the people it hires. Through the case studies of consulting companies, computer manufacturing companies and medical centers, Hansen et al. (1999) found that emphasizing a wrong strategy or trying to pursue both at the same time could quickly undermine a business. They suggest that effective firms need to focus on one of the strategies and use the other in a supporting role (roughly an 80-20 split).

| | Codification | Personalization |
|---|---|---|
| Competitive Strategy | Provide high quality, reliable, and fast information-system implementation by reusing codified knowledge | Provide creative, analytically rigorous advice on high level strategic problems by channeling individual expertise |
| Economic Model | Reuse Economics Invest once in a knowledge asset; reuse it many items | Expert economics Charge high fees for highly customized solutions to unique problems. |
| Knowledge Management Strategy | People to documents Develop electronic document system that codifies, stores, disseminates, and allows reuse of knowledge | Person to person Develop networks for linking people so that tacit knowledge can be shared |
| Information Technology | Invest heavily in IT; the goal is to connect people with reusable codified knowledge | Invest moderately in IT; the goal is to facilitate conversions and the exchange of tacit knowledge |
| Human Resources | Hire new college graduates who are well suited to the reuse of knowledge and the implementation of solutions. Train people in groups and through computer-based distance learning. Reward people for using and contributing to document databases | Hire MBAs who like problem solving and tolerate ambiguity. Train people through one to one mentoring. Reward people for directly sharing knowledge with others |

Table 2.2 Knowledge Management Strategies of Consulting Companies

(Adopted from Hansen et al., 1999)

### 2.1.7 Summary of the Findings

Based on the literature review, it is clear that there are two basic approaches to KM. The findings are summarized in Table 2.3.

| | Approaches | Characteristics |
|---|---|---|
| A | - Centralized KM systems<br>- Integrated Applications<br>- Codification strategy<br>- Exploitation | - Provides standardized service<br>- Procedure oriented<br>- Reuse of knowledge<br>- Focus on capturing and utilizing knowledge<br>- Use explicit knowledge<br>- Heavy use of IT<br>- Pursue operational excellence |
| B | - Decentralized KM systems<br>- Interactive Applications<br>- Personalization strategy<br>- Exploration | - Provides customized service<br>- Product/service oriented<br>- Create new knowledge<br>- Focus on exploring new knowledge by collaboration of people<br>- Use tacit knowledge<br>- Less use of IT<br>- Pursue innovative product/service |

Table 2.3 Summary of Knowledge Management Approaches

Since one KM approach has different characteristics from the other, organizations need to identify their KM style first before they commit to implementation of the KM projects. Different KM approach will require different methods and different tools.

## 2.2 IT INFRASTRUCTURE CAPABILIY

In this section, a literature review on IT infrastructure capability is presented. First, IT as an enabler of KM is discussed. Second, the existing studies on IT infrastructure capability are introduced. Then the concept of IT infrastructure services is presented. IT infrastructure services are used to measure the IT infrastructure capability.

### 2.2.1 IT as an Enabler of KM

As discussed in the previous section, KM is the entire process of creating, organizing, locating, distributing and sharing knowledge to achieve organizational goals. During the process, information technology is extensively utilized for knowledge input, processing, repository, flows, and outputs. Information technology has been cited as one of the key enablers of the successful KM (O'Dell and Grayson, 1998; Weil and Broadbent, 1998; Skyrme, 1999; Choi, 2000). In a survey of 431 U.S. and European companies, Ruggles (1998) found that the four most popular KM projects are related to IT (i.e., Intranet, data warehouse and knowledge repository, decision support tool, and groupware). There is a powerful synergistic relationship between KM and IT; that relationship drives increasing returns and increasing sophistication on both fronts (O'Dell and Grayson, 1998).

For example, understanding customers' needs is the critical issue. Companies rank knowledge about the customer as most important (Skyrme, 1999). Organizations want to know about customers to develop new products and to enhance their services. However, in many cases, companies know much less about their customers. Traditional approaches such as customer surveys do not tell much about customers' underlying needs because sometimes customers do not know what they really need. By developing more effective market scanning systems, companies can get good customer knowledge. By analyzing customers' buying patterns and trends, organizations can understand customers' underlying needs and real wishes. All of these can be helped with information technology. Business intelligence systems, customer relationship management (CRM), and data mining are just a few examples of applications of IT to KM to enhance knowledge about a target market customers.

In the KM context, IT includes a broad range of applications. Especially new technologies such as the Internet and groupware have had critical implications for KM. They have reduced the cost and sped up knowledge processing (O'Dell and Grayson, 1998). For example, a Web browser provides an easy to use interface that can access many different types of information. Web pages are easily developed using Web development tools (i.e., Hypertext Markup Language) to store organizational information and knowledge. TCP (Transmission Control Protocol)/ IP (Internet Protocol) provides a common way of communication between different types of platforms. Group supporting software (i.e., groupware) can provide collaboration support among groups. Information technology is the knowledge enhancer. There is a wide variety of IT applications used for KM.

### 2.2.2. Information Technologies for Knowledge Management

A data warehouse is a data management technology that integrates information from multiple data pools and makes it easier to explore hidden meaning of data (Chase, 1997; Skyrme, 1999). With a data warehouse, people can access to large amounts of information that can be analyzed from different perspectives. This can enhance decision-making quality. When used with appropriate analysis tools (i.e., data mining) or multidimensional data analysis tools (i.e., OLAP: On-Line Analytical Processing), valuable knowledge can be extracted.

Document management systems can allow people to share knowledge in many applications (Junnarkar, 1997). Document management systems are a "repository of important corporate documents and are therefore important stores of explicit knowledge" (Offsey, 1997). Documents give the users knowledge with more context and details. It can include manuals, best practices, policy books and even drawings.

Another popular technology is a knowledge creation system. This technology can assist thinking and creativity in individuals or in groups. One example is an idea generation tool (i.e., group decision support system or electronic meeting systems). It can help for different creativity activities (i.e., concurrent product development) by allowing groups freely exchange their ideas (Skyrme, 1999).

Data mining technology is an emerging technology to extract meaningful information from a large pool of data to support business decisions (Mitchell, 1999). Data mining technology finds patterns, trends or relationships in large pools of data and predicts future behaviors from them. These patterns and rules can be used to extract hidden knowledge about customer behavior. Data mining can be used to locate the specific needs of a market or customers.

Knowledge mining is a newer form of data mining. Knowledge mining is a process of extracting previously unknown knowledge from a variety of information sources (Hu et al., 1998). Knowledge mining can drastically improve the power of knowledge search by integrating various information sources. For example, related data and information on the Web can be collected using software agent technology such as Web Crawler or Web Spider. With knowledge mining, information stored outside of the traditional technology (i.e., relational database) can now be utilized.

Search engines play a key role in making knowledge workers more productive by giving them the information they need in organized way. By using key words or by using directories, users can retrieve matching information. The information can be ranked or sorted according to certain criteria. By using key words, users can retrieve a great amount of matching results in an efficient way.

Intelligent agents (software agents) are "a class of software that operates autonomously, intelligently, and knowledgeably" (Skyrme, 1999). They are technologies that use "a built-in or learned knowledge base to carry out specific, repetitive, and predictable tasks on the behalf of users" (Syed, 1998). For example, intelligent agent software can travel over the Internet and capture the most appropriate information to the users' preference. They may monitor incoming e-mails and filter out messages that users would not be interested in.

AI (Artificial Intelligence) technologies such as Case-Based Reasoning Systems and Expert Systems are used to manage narrow domains of knowledge (Davenport and Prusak, 1998). Organizational knowledge can be captured and stored using case-based reasoning systems. In case-based reasoning systems, descriptions of past experiences of human specialists are represented as cases and stored in a case database for a later retrieval. With the technology, users can input characteristics of the problem that they have. Then the system searches for stored past cases with similar characteristics and provides a solution. Unsuccessful solutions are solved by human experts and added to the case database with explanations and human solved solutions. In an Expert System, human expert knowledge can be placed in a machine. An Expert System is a knowledge intensive computer program that captures the expertise of an expert. It uses a production rule (i.e., If - Then) to represent human knowledge.

Groupware is a technology that can overcome space and time barriers for group interaction. Its focus is to help knowledge workers share their expertise, particularly in a physically dispersed environment. The purpose of groupware is to support the collaborative works of a group of people. It includes software for information sharing, electronic meetings, scheduling, workflow management, and e-mail network to connect the members of the group.

In the last few years, intranets have emerged as an important KM tool (Ruggles, 1998). They provide several benefits compared with other types of IT applications. It is easy to use (i.e., World Wide Web). It provides a universal access to different platforms by using TCP/IP protocol. At the same time, it allows person-to-person interaction. It can lower the communication cost. Additionally, it prevents outsiders from accessing sensitive information of a company, while linking employees to the outside world. It is widely used to expand an organization's access to information and knowledge.

IT alone can not do anything for KM. However, an effective KM project can not be successful without the support of IT. Sveiby (1997) described IT as hygiene factors: "IT is for KM like a bathroom is for a house buyer. IT is essential because without it, the house is not even considered by buyers. But the bathroom is generally not the vital differentiating factor for the buyer." IT facilitates the rapid dissemination of knowledge and improves communication and collaboration among employees at all levels, all locations, and even with those in other organizations (Weil and Broadbent, 1998).

### 2.2.3 IT and Knowledge Value Chain

As discussed in the previous section, there are a variety of information technologies used for KM. An interesting aspect is illustrated in the IT and knowledge value chain (Skyrme, 1999). As shown in Figure 2.1, the entire process of KM can be supported by information technology. For example, data mining technology can be used to identify existing knowledge. Intelligent technology can be used to collect knowledge. Data warehouse technology can be used to store and structure knowledge. No matter what technology organizations are using, the individual technologies interact with the underlying infrastructure. There are some common underlying categories and technologies that organizations can focus on.

This indicates that organizational KM influences IT. This also suggests that organizational knowledge influences IT infrastructure. Organizational KM can be shaped by IT infrastructure capability. The relationships between KM and IT should be examined from an infrastructure view. A KM system itself is the infrastructure necessary for the organization to implement the KM process. It includes - and for large companies critically depends on - a good IT infrastructure (Sarvary, 1999). In spite of the strong indication of the influence of KM on IT infrastructure there has been no substantial research in this area because knowledge management itself is a new phenomenon and IT infrastructure has started to draw attention only recently (Sveyby, 1997: Junnarkar and Brown, 1997; O'Dell and Garyson, 1998: Weil and and Broadbent, 1998: Sarvary,1999; Davenport et al., 1998; Syed, 1998: Hansen, Nohria and Tierney, 1999),.

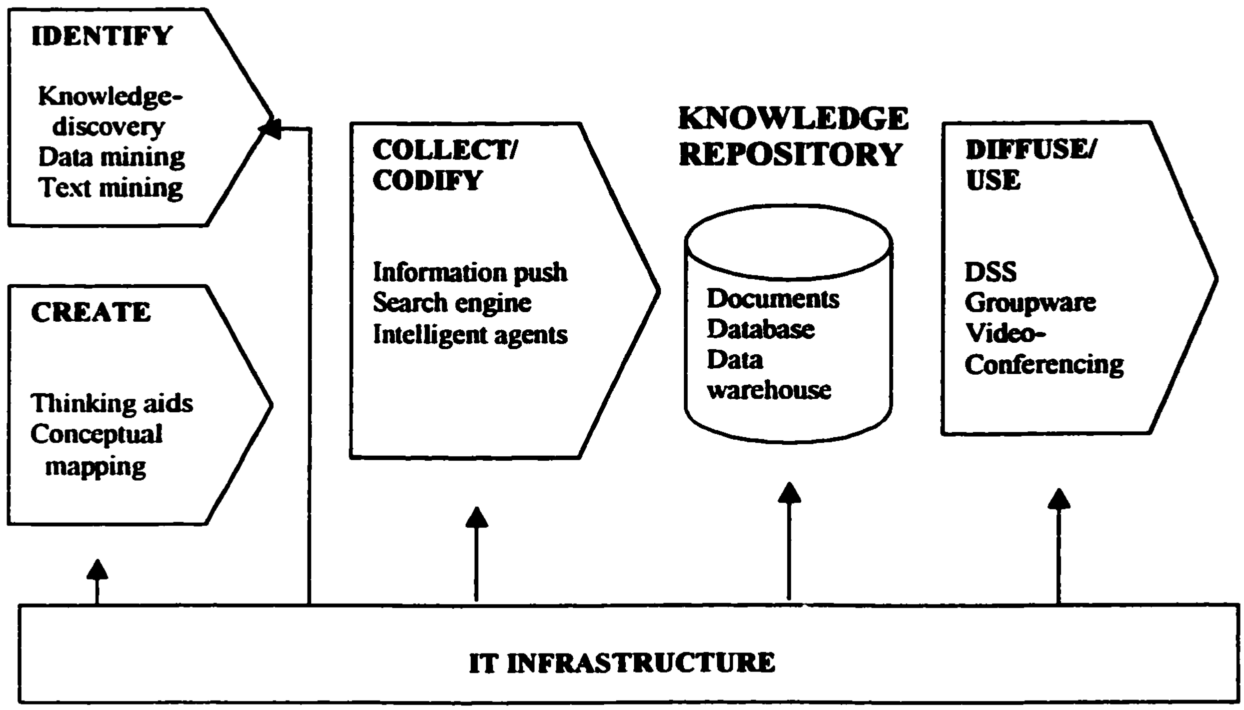


Figure 2.1 IT and Knowledge Value Chain

(Adopted from Skyrme, 1999)

### 2.2.4 IT Infrastructure Capability

KM interacts with and is supported by IT infrastructure capabilities involving a communication network and shared groupware applications (Weil and Broadbent, 1998). KM involves the access, sharing, dissemination, communication and collaboration of knowledge. It is important to understand a firm's information flow so that they can be shared. To manage a firm's knowledge requires a specific set of IT infrastructure capability. Information and knowledge should be easily transferred through a communications network. A well-defined architecture and standard of data and applications ensures enterprise-wide compatibility of systems (Weil and Broadbent, 1998).

IT infrastructure is explained in terms of the technology components. For example, Earl (1989) and Niederman (1991) explain IT infrastructure as "a platform technology consisting of the processing hardware and operating system, networking and communication technologies, data, and core data processing applications." However, today's view on IT infrastructure includes IT managerial aspects such as IT planning and control that may affect the design and implementation of technology components (McKay and Bockway, 1989; Dunkan, 1995; Weil and Broadbent, 1998). IT infrastructure "generally describes a set of shared and tangible IT resources that provide a foundation to enable present and future business application" (Dunkan, 1995). IT infrastructure is "the enabling foundation of shared information technology capabilities upon which business depends" (McKay and Brockway, 1989).

IT infrastructure includes IT software and hardware components and combines them into a shared set of capabilities. These capabilities directly support business processes. It is "generally believed to add value to the community in a way that could not be achieved through individual private investment" (McKay and Brockway, 1989).

There are key concepts in IT infrastructure capability to be mentioned. The first concept is integration. Integration refers to "the linking of individual IT components and services for the purpose of sharing software, communications, and data resources" (Keen, 1991). The goal of integration is to ensure that technology components such as hardware, software, information, and telecommunications work together seamlessly enterprise wide. Keen (1991) explains this concept with Range: "the degree to which information can be directly and automatically shared across systems and services". This represents compatibility. "Incompatibility is diametrically opposed to integration" (Keen, 1991). Architecture and enterprise wide management of information technologies assures the compatibility of IT applications.

The second concept that needs to be mentioned is collaboration. Collaboration refers to mutual efforts by two or more individuals in order to perform certain tasks. People work together on tasks from designing products and to teaching each other. Collaboration capability improves group working and knowledge sharing. Collaboration capability allows for groups of people to work together. Keen (1991) and Evans and Wurtman (2000) explained this concept with Reach. Reach determines the location of people. This capability of IT infrastructure links people and allows collaboration between them beyond space barriers.

Another concept is data management capability. Data has become an organizational resource. It is the resource shared by multiple users at different levels of management and across various functions. Data is also shared by multiple IT applications. Data resource itself is an integral part of IT infrastructure. The capability to manage the data is an important measure of IT infrastructure capability. The value of an IS is directly related to the quality of the data. Garbage-in-garbage-out is a popular cliché in IS field. The capability to manage the data is an important measure of IT infrastructure capability. Ensuring quality for the data resource has been a continuing concern (Orr, 1998; Tayi and Ballou, 1998; Wang, 1998; Redman, 1998). The popular knowledge management technologies such as data warehousing, data mining, and knowledge mining can be possible without data captured.

Security is another key concept in IT infrastructure capability. Security refers to the policies, procedures, and technical measures used to prevent unauthorized access, alteration, theft, or physical damage to information systems. Especially, this became a critical issue in IT capability with the advent of the Internet. In a broader sense, security includes disaster management and recovery planning management (Weil and Broadbent, 1998).

Another aspect of IT infrastructure capability is that there are some basic services needed (Weil and Broadbent, 1998). No matter what industry a firm is in, no matter what business a firm is engaged in, no matter what knowledge management approach a firm takes, there are some IT capabilities the firm needs. For example, some capabilities such as IT planning or IT education and training to end-users are needed regardless of their business type or which knowledge management model they are using. Put together, these capabilities can be considered a utility. It works like common public services, such as water and electricity in the public sector.

There are some IT infrastructure capabilities that are difficult to categorize into a specific concept. These capabilities are put in the category of other services in this study. Therefore, IT infrastructure capability consists of the following constructs: integration capability, collaboration capability, data management capability, security capability, utility, and other capabilities.

Finally, all these capabilities are combined by IT human skills to provide unique services to organizational processes and IT applications. The human skills are the glue that binds all of them. These capabilities are hard to imitate by competitors. This framework is summarized in Figure 2.2.

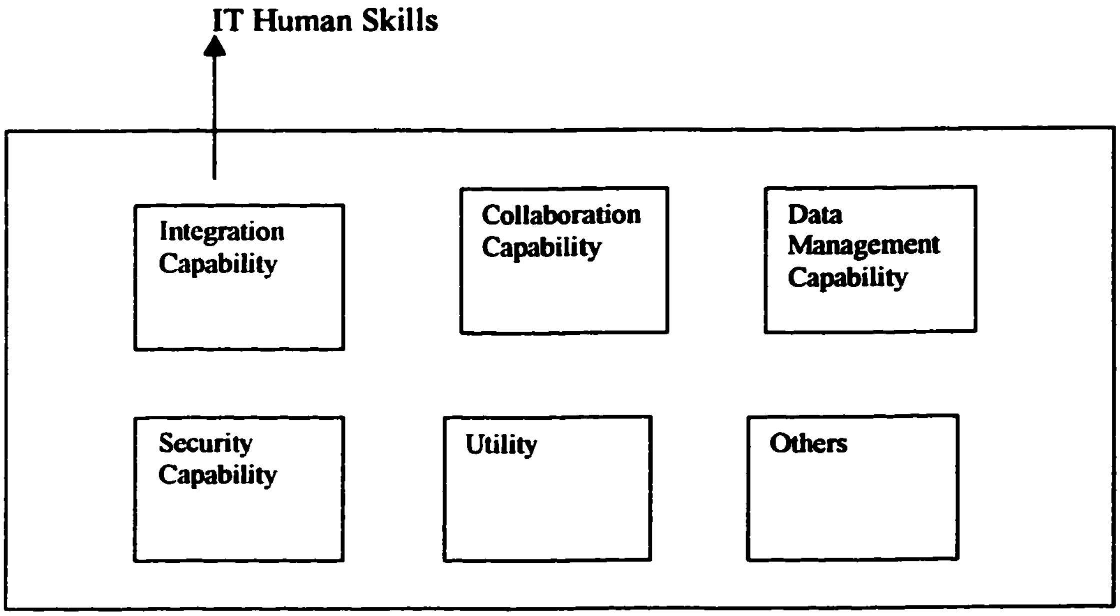


Figure 2.2 IT Infrastructure Capability Concepts

**2.2.5 IT Infrastructure Services: A Measurement of IT Infrastructure Capability**

IT infrastructure is the foundation of the IT applications. IT infrastructure is shared throughout the firm in the form of reliable services, and is usually coordinated by the IS group (Broadbent, Weill, and St.Clair, 1999). The IT infrastructure capability includes both technical and managerial aspects. One of the measures to assess IT infrastructure capability is the extent of the firm's IT infrastructure services. Broadbent, Weill, and Neo (1996) proposed IT infrastructure services to measure IT infrastructure capability.

To understand IT infrastructure services, it should be mentioned that IT infrastructure consists of four layers (McKay and Brockway, 1989; Weil and Broadbent, 1998). As shown in Figure 2.4, there are technology components (i.e., computers, databases, operating systems, and telecommunication software and hardware) at the bottom layer. At the top of the IT infrastructure there is a set of shared information technology services. The technology components are transformed into useful shared services by a human IT component. This human IT component is shown in the middle layer of Figure 2.3. The services transformed by this layer define the capability of IT infrastructure. This is why organizations can buy the same hardware and software and still provide different IT capability.

The infrastructure services "include telecommunications network management and provision of large scale computing (such as Mainframe), the management of shared customer databases, and research and development expertise aimed at identifying the usefulness of emerging technology to the business" (Weil and Broadbent, 1998). These shared IT infrastructure services support shared IT applications. Then these IT applications directly support functional business of organizations.

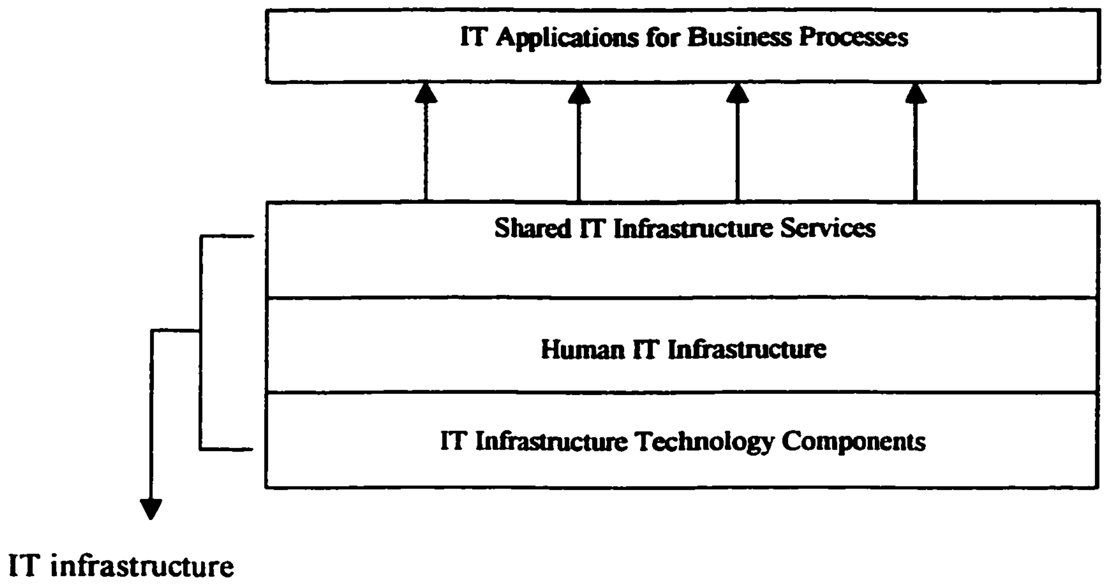


Figure 2.3 Elements of IT Infrastructure

(Adopted form McKay and Brockway, 1989; Broadbent and Weill, 1999)

"The nature of IT infrastructure can be described from a business perspective using a concept of IT infrastructure services" (Broadbent et al., 1996; Weil and Broadbent, 1998). Weill, Broadbednt and Neo originally identified 23 IT infrastructure services. Later, Weil and Broadbent extended them and suggested 25 services. These 25 services are listed in Table 2.4.

| | IT Infrastructure Services |
|---|---|
| 1 | Manage firm-wide communication network services |
| 2 | Manage group-wide or firm-wide messaging service |
| 3 | Recommend standards for at least one component of IT architecture (i.e., hardware, operating systems, data, communications) |
| 4 | Provide security, disaster planning, and business recovery services for firm-wide installations and applications |
| 5 | Provide technology advice and support services |
| 6 | Manage, maintain, support large scale data processing facilities (i.e., mainframe operations) |
| 7 | Manage firm-wide or business unit applications and databases |
| 8 | Perform IS project management |
| 9 | Provide data management advice and consultancy services |
| 10 | Perform IS planning for business units |
| 11 | Enforce IT architecture and standards |
| 12 | Manage and negotiate with suppliers and outsourcers |
| 13 | Identify and test new technologies for business purposes |
| 14 | Develop business-unit-specific applications |
| 15 | Manage firm-wide or business unit work station networks (i.e., LAN/ POS) |
| 16 | Implement security, disaster planning, and recovery for business units |
| 17 | Provide management information electronically (i.e., EIS) |
| 18 | Manage business specific applications |
| 19 | Manage firm-wide or business-unit data, including standards |
| 20 | Develop and manage electronic linkages to suppliers or customers |
| 21 | Develop a common systems development environment |
| 22 | Provide technology education services (i.e., training) |
| 23 | Provide multimedia operations and development (i.e., videoconferencing) |
| 24 | Provide firm-wide intranet capability (i.e., information access, multiple system access) |
| 25 | Provide firm-wide electronic support for groups (Lotus Notes) |

Table 2.4 IT Infrastructure Services

More IT infrastructure services mean more IT infrastructure capability. For example, the more services an organization can provide out of the 25 services, the more capable its IT infrastructure is.

# CHAPTER THREE

# RESEARCH DESIGN AND METHODOLOGY

In this chapter, the research framework and methodology employed are presented. This chapter consists of three sections. In the first section, an extended KM model is proposed and research framework is presented. The second section discusses research variables and hypotheses development. All research variables are introduced and defined. Based on the literature review and the research framework, six hypotheses are developed. Finally, the third section describes the research methodology. This includes a discussion of the research design, unit of analysis, survey instruments, samples, data collection, and statistical techniques employed in the research.

## 3.1 RESERCH FRAMEWORK

### 3.1.1 Knowledge Management Model

As discussed in Chapter Two, consulting firms with different knowledge requirements adopt different KM approaches. Hansen, Nohria and Tierney (1999) recommended a company to ask three questions for its KM assessment: "Do you offer standardized or customized products? Do you have a mature or innovative product? Do your people rely on explicit or tacit knowledge to solve problems?" These three questions can be summarized into two concepts: service type and knowledge type used.

The approaches that the firms adopt depend on their service type and knowledge type to serve their customers.

The service type has two dimensions: unique or standardized. Service type is "unique" when a firm provides highly customized, context-dependent, and expertise-oriented service to a customer's unique problem (i.e., strategic consultancy). Service type can be "standardized" when a firm provides a relatively low context-dependent and procedure-oriented services (i.e., IT consultancy). The knowledge type has two dimensions: exploitive or explorative. Knowledge type is "exploitive" when a firm's key concern is to capture explicit knowledge and utilize it by codification. Knowledge type is "explorative" when a firm's key concern is to generate new knowledge, mostly tacit knowledge by collaborative works between people.

Together two dimensions form four different types of KM models: unique service with exploitive knowledge, unique service with explorative knowledge, standardized service with exploitive knowledge, and standardized service with explorative knowledge. These four distinct models are termed as Type I, Type II, Type II, and Type IV in this study. The classification is reproduced in Figure 3.1.

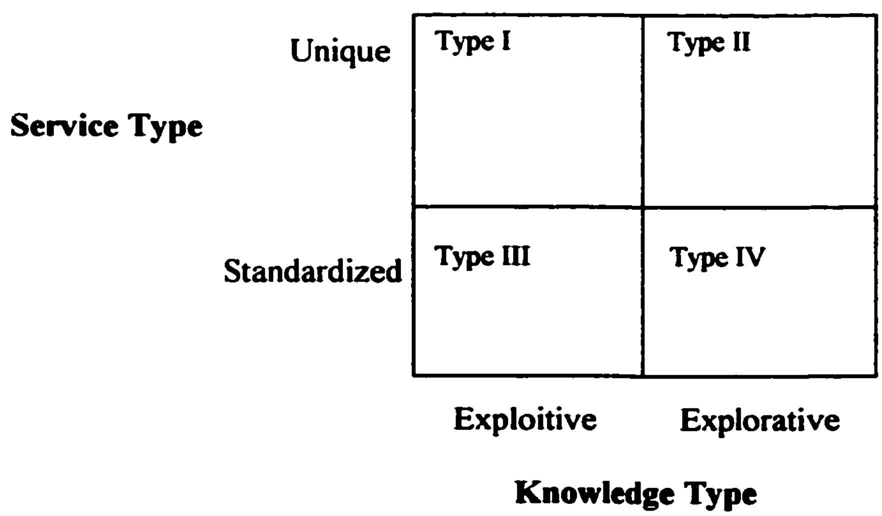


Figure 3.1 Knowledge Management Model

The vertical axis describes a firm's service type. The horizontal axis describes the knowledge type that a firm mainly uses to deliver the service. For the firms positioned in the top half (Type I and Type II), services are characterized as highly customized. The requirements of their customers tend to be unique. Their customers' problems are highly context dependent. Such problems are usually unstructured. A firm should provide highly customized solutions to customers' unique problems. The key here is on providing creative, innovative and totally new types of services. Their consultancy focuses on service itself: **WHAT** service is provided.

For the firms positioned in the bottom half (Type III and Type IV), services are characterized as highly standardized. The problems of their customers are low context dependent compared with Type I and Type II models. Such problems tend to be less structured or structured. Here the key is on providing highly reliable and quality services. Their consultancy focuses on the operational side of the solutions: **HOW** the service is delivered.

For the firms positioned in the left half (Type I and Type III), the knowledge type used is characterized as exploitive. The knowledge used is explicit and procedure oriented. This type of knowledge is easy to codify in the database, manuals, or knowledge repository. The knowledge initiative is to know what the firm already knows. The firm may already have the knowledge required for service somewhere in the organization. However, the firm may not know that it knows. Or even though the firm knows that it knows, it may not know where it is located. Therefore, the knowledge is recreated again and again. Organizations need to know how to share the existing knowledge. Many firms underutilize much of their existing knowledge because its existence is unknown to those who need it. The focus is to capture and store knowledge in the knowledge repository and utilize the stored knowledge repeatedly. This achieves the economies of scale for knowledge reuse.

For the firms positioned in the right half (Type II and Type IV), the knowledge type used is characterized as explorative. The knowledge used tends to be tacit and expertise oriented. Most of the time such knowledge exists in the people's brain. The KM focus is to know what a firm does not know because it is hidden in people's head or it does not have it. This can be achieved through encouraging creative thinking and free exchange of ideas. Throughout the process, ideas continually flow between people. Locating source of knowledge, connecting them, and collaborating them are critical. Such collaborative work encourages creativity and idea generation. These eventually will be translated into new knowledge.

### 3.1.2 KM Model and IT Infrastructure Capability

IT infrastructure should support KM activities. The ideal IT infrastructure is one that provides the capability to link anyone to any application at anytime, anyplace. However, the organizational resource is scarce (i.e., financial or human resources). IT infrastructure investment needs huge financial and human capital. If a firm understands the relationship between IT infrastructure capability and organizational KM, then it can prioritize IT infrastructure investments and distribute resources more effectively and efficiently. Also, this will help managers plan and implement KM projects more effectively with appropriate IT support.

As discussed in Chapter Two, IT infrastructure capability includes integration capability, collaboration capability, utility, security capability, data management capability, and other capabilities. Even though all of these are important, different knowledge management models will need different capabilities in different degrees. A specific knowledge management model will need some capabilities more than others.

For example, one type of knowledge management model may be more concerned about utilizing the pre-existing knowledge and require IT capabilities that can support structuring, organizing and storing, and sharing and using knowledge. In this type of model, a great amount of existing knowledge will be stored in a database, knowledge base/repository, document database, or data warehouse. Since then, employees or applications across the entire organization are allowed to access them. To allow such access, the applications must be compatible so that they can be shared among multiple sources. Then, integrating the capabilities of the IT infrastructure will be critical. A firm-wide management of IT including architecture, standard, centralized management, and policy will be critical issues.

Another KM model may be more concerned about locating the source of knowledge and creating new knowledge. This type of knowledge can be acquired through more communicative and collaborative efforts. This process needs free information flow, idea exchange, and collaboration between team members. This type of KM model will need more collaborative IT applications such as group decision support system, groupware, video conferencing, work flow management, electronic brainstorming, etc. The capabilities can be acquired with the support of the collaborating components of IT infrastructure capabilities. In this KM model, collaborating capabilities will be critical. This research framework is summarized in Figure 3.2.

If a firm understands the relationship between IT infrastructure and organizational knowledge management models, then it can get proper IT support. In this framework, a firm needs to assess its KM model first before committing to IT implementation. Rather than simply adopting popular IT applications in the market, a firm now has the exact understanding of what IT capabilities its KM needs. Then it can invest in IT according to its identified IT capability needs. This way, a firm can set priorities on IT planning and control, including financial investments. It will help managers plan and implement their knowledge management projects more effectively and efficiently.

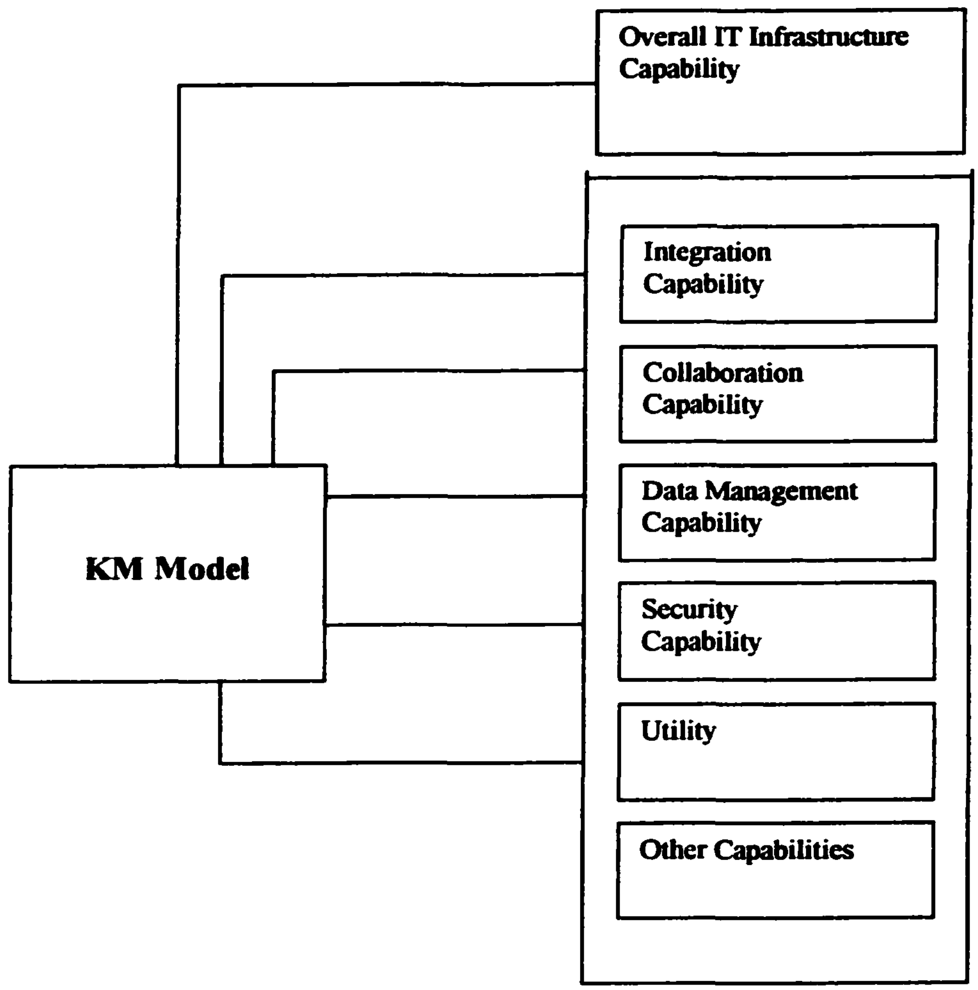


Figure 3.2 Research Framework

### 3.2 INDEPENDENT VARIABLES

In this research, there are two independent variables. One is the service type provided by management consulting companies. The other is the knowledge type used. These variables are used to categorize the sample consulting companies into one of four different KM models. Each variable has two dimensions, making four cells altogether. Each cell represents one of the four distinct KM models.

### 3.2.1 Service Type

Service type defines what service a management consulting company is providing to its customers. The service type can be unique or standardized. The level of customization is one of the factors in classifying service type (Davis, 1999). The factor determines how customized service a firm is providing. If their customers have unique problems, then firms need to provide highly customized services. The maturity of their services will determine their service type (Hansen et al., 1999). Highly mature service processes are well-understood, while highly innovative services are not. The highly mature service can be provided in more standardized way. The problem structures a consulting deals with will also determine the service type (Hansen et al., 1999). For example, the unique service tends to deal with the unstructured customer's problem. These are summarized in Table 3.1.

| Variables | Items | Standardized | Unique |
|---|---|---|---|
| Service Type | Service Concept | How to develop and deliver services | What services to provide |
| | Maturity | Mature | Innovative |
| | Focus | Highly reliable/quality/ fast delivery service | Creative/ totally new type of service delivery |
| | Customer Problem | Structured | Unstructured |
| | Standardization | Standardized | Customized |

Table 3.1 Service Type

### 3.2.2 Knowledge Type

The knowledge type can be exploitive or explorative. The knowledge type determines how explicit the knowledge is. By nature, explicit knowledge is exploitive. Exploitive knowledge can be precisely articulated and codified. It may be in the form of mathematical formulas, databases, manuals, or documents. Therefore exploitive knowledge can be easily transferable to other people. Declarative knowledge (which describes something) and procedural knowledge (which explains how something occurs or is performed) are two examples of exploitive knowledge (Zack, 1999).

On the contrary, explorative knowledge is tacit in nature. Such knowledge is difficult to understand. It is difficult to articulate and codify. Tacit knowledge can be developed from direct experience and interactive conversation. The expert's real expertise tends to be explorative. This type of knowledge is not easily transferred and also very useful to explore and handle new problems and situations. Causal knowledge is an example of explorative knowledge and explains why something occurs (Zack, 1999). If people understand the cause and effect of the something, people can predict what will happen based on the relationship. In another world, this will help us bring new knowledge.

As Jordans and Jones (1997) pointed out, exploitive knowledge can be acquired through a manual or database, but explorative knowledge can be acquired through mostly trial and error. Exploitive knowledge can be transferred easily (i.e., through classroom lectures or presentations), but explorative knowledge is hard to transfer and can be transferred mostly through coaching or apprenticeship. Exploitive knowledge can be disseminated in the formal and structured ways, but explorative knowledge can be disseminated through more informal ways such as role modeling or daily interaction. In the learning focus, exploitive knowledge tends to be incremental and explorative knowledge tends to be transformative or radical. These are summarized in the Table 3.2.

| Variable | Item | Exploitive | Explorative |
|---|---|---|---|
| Knowledge Type | Orientation | Procedure oriented | Expertise oriented |
| | Application Process | Table look up | Trial and error |
| | Training Method | Class room | Apprenticeship/ coaching |
| | Ease of Transfer | Difficult | Easy |
| | Dissemination Process | Formal/ prescribed/ structured | Informal/ role modeling/ daily interaction |
| | Scope | Incremental | Transformative |

Table 3.2 Knowledge Type

## 3.3 DEPENDENT VARIABLES

### 3.3.1 Overall IT Infrastructure Capability

IT infrastructure is the enabling foundation of shared information technology capabilities upon which business depends (McKay and Brockway, 1989). It includes software and hardware components. These technological components are transformed into a set of capabilities that support businesses. IT infrastructure capability is the combination of the technology components, human skills and management. It supports IT applications and business operations. IT infrastructure capability is a resource that is difficult to imitate because it is created through the fusion of technology and human assets (Duncan, 1995). The overall IT infrastructure capability is the composite capability of integration, collaboration, utility, security, data management and other capabilities.

### 3.3.2 Integrating Capability

Integrating capability refers to the ability of "linking individual IT components and services for the purpose of sharing software, communications, and data resources" (Keen, 1991). The goal of IT integration is to allow physical IT components (such as hardware, software, data, and telecommunications) working together as a integrated resource. Integrating capability of IT infrastructure can assure enterprise wide compatibility among IT components so that IT applications can be accessed and used by employees across the firm.

### 3.3.3 Collaborating Capability

Collaborating capability refers to the capability of allowing mutual efforts by two or more individuals in order to perform a specific task. The goal of collaborating capability of IT infrastructure is to provide support for linking people so that they can work together. Collaborating capability allows ideas and opinions to flow freely and new knowledge to be created. To allow collaborative work, people should be connected regardless of their physical locations.

### 3.3.4 Data Management Capability

Today's view of IT infrastructure includes data as a part of it. Data itself has become a part of IT infrastructure. It is the resource shared by multiple applications and users at different levels of management. The value of an IS is directly related to the quality of the data. Data management capability is the capability to manage data. Data management includes collecting, structuring, storing, transforming and retrieving data. This capability also includes data architecture, database management systems, and database applications.

### 3.3.5 Security Capability

Security is the capability to minimize IT vulnerability and abuse. Security refers to the policies, procedures, and technical measures used to prevent unauthorized access, alteration, theft, or physical damage to information systems. Backup, disaster management, and recovery planning are important components of this capability.

### 3.3.6 Utility

Utility is the basic and common services that every type of IT infrastructure has. No matter what industry a firm is in and no matter what business a firm is engaged in, these capabilities are required. For example, IT planning, training, education, and providing support to users are included in the capability.

## 3.4 HYPOTHESES

In this section, six hypotheses on knowledge management and IT infrastructure capability are developed and presented. Different KM models need different IT infrastructure capabilities. Basically, the hypotheses state that different KM models have differences in the five key IT infrastructure capabilities: overall capability, integrating capability, collaborating capability, data management capability, and security capability. No difference in utility services is expected between the groups.

### 3.4.1 Hypothesis 1: KM Model and Overall IT Infrastructure Capability

The more standardized service a company provides and the more exploitive knowledge a company applies to the service they provide, the more they need IT infrastructure capability. A firm's knowledge initiative is to know what they know. Its major concern is how to structure, organize, store, transfer, and utilize existing knowledge. In a sense, these are the ones that information technology can do best. These KM models are extensively utilizing IT and heavily dependent on IT. The focus is to codify existing knowledge and utilizing it with information technology. This KM will require more IT infrastructure capability overall than others.

H1: The more standardized service a company provides and the more exploitive knowledge it applies to the service, the more IT infrastructure capability is required overall.

### 3.4.2 Hypothesis 2: KM Model and Integrating Capability

The more standardized a service a company provides and the more exploitive knowledge a company applies to the service they provide, this type of KM model is based on the reuse economics. Once existing knowledge is captured, then this captured knowledge is accessed and utilized by entire employees and other applications of the firm. The firms get knowledge from the stored source.

An employee in one part of the company needs to freely access the knowledge stored in another part of the company. Therefore, the compatibility of applications is critical. This KM model will require more integrating capabilities of IT infrastructure. Firm-wide management of IT is the key issue. In terms of resource management, effective and efficient control is a critical issue. Effective and efficient control can be implemented through the enterprise wide management, IT architecture, policies or standards, which are key components of integrating capability.

H2: The more standardized service a company provides and the more exploitive knowledge it applies to the service, the more integrating capability of its IT infrastructure is required.

### 3.4.3 Hypothesis 3: KM Model and Collaborating Capability

Collaboration is joint effort working toward a goal. The quality of collaboration is directly related to the quality of interactions, communications, and coordination among people. According to Liedtka et al. (1997), "when collaboration facilitates learning at organizational and individual level, the solution tends to be more innovative; shared problem solving leads to greater creativity." The more innovative and customized a service a firm provides and the more tacit knowledge a company applies to the service it provides, the more the company needs collaboration between people. The more a company provides a unique service, the more explorative knowledge it needs. That means the firm needs more collaboration support from IT infrastructure capability.

In this KM model, the major concern is not to utilize existing knowledge because there is no such knowledge available. The customers' problems are so unique that the solutions to them are highly customized and creative. Locating the source of knowledge and generating new knowledge are critical. Connecting people, making them work together, or generating new ideas through interaction is important. Therefore, the firm will need more support from the collaborating capabilities from IT infrastructures. During the process, many experts get involved. Therefore, linking people regardless where they are is critical.

H3: The more unique service a firm provides and the more explorative knowledge it applies to the service provided, then the more collaborating capability of IT infrastructure is required.

### 3.4.4 Hypothesis 4: KM Model and Data Management Capability

For the firm that provides more standardized services and more explicit knowledge, its economics is based on the reuse of knowledge. In reuse economics, the key aspect is to capture and store knowledge for later utilization. This KM model inevitably uses key data management technologies such as relational databases, data warehousing, data mining, document management systems, knowledge bases, expert systems, case based reasoning systems, and more recently, customer relationship management (CRM).

At the core of these technologies is data. Therefore, this KM model will require more data management capability of IT infrastructure than other types of models. Here, knowledge flows people to computer or computer to people or computer to computer.

H4: The more standardized service a company provides and the more exploitive knowledge it applies to the service, the more data management capability of IT infrastructure is required.

### 3.4.5 Hypothesis 5: KM Model and Security Capability

This hypothesis is related to Hypothesis 1 and 4. The more standardized a service they provide and the more reusable knowledge they use, the more they need powerful IT technologies and tend to invest much in IT technology. As discussed in Hypothesis 1 and 4, this model will require a large amount of data, storage equipment, and powerful database applications. To protect this great amount of data resources is extremely critical.

When there is something wrong with the technology investment, the impact will be critical and pervasive. A firm may lose a great amount of customer data, which may take years to recover. Probably, some of it may be not recovered at all. Therefore, the security capability of IT infrastructure, including security policy and procedures, disaster planning, and recovery planning, will be much more important than other models.

H5: The more standardized service a company provides and the more exploitive knowledge it applies to the service, the more security capability of IT infrastructure is required.

### 3.4.6 Hypothesis 6: KM Model and Utility

As defined in the previous section, utility is the basic and common services that any KM model needs. Therefore, this component of IT infrastructure will be pretty much the same regardless of the KM model.

H6: There are differences in the utility of IT infrastructure capability in the different KM models.

### 3.4.7 Summary of Research Model

The research model is summarized in Figure 3.3. This research will examine the relationships between the KM model and IT infrastructure capability. The model will be measured by IT infrastructure services. In Chapter Four, the operationalization of the variables is presented.

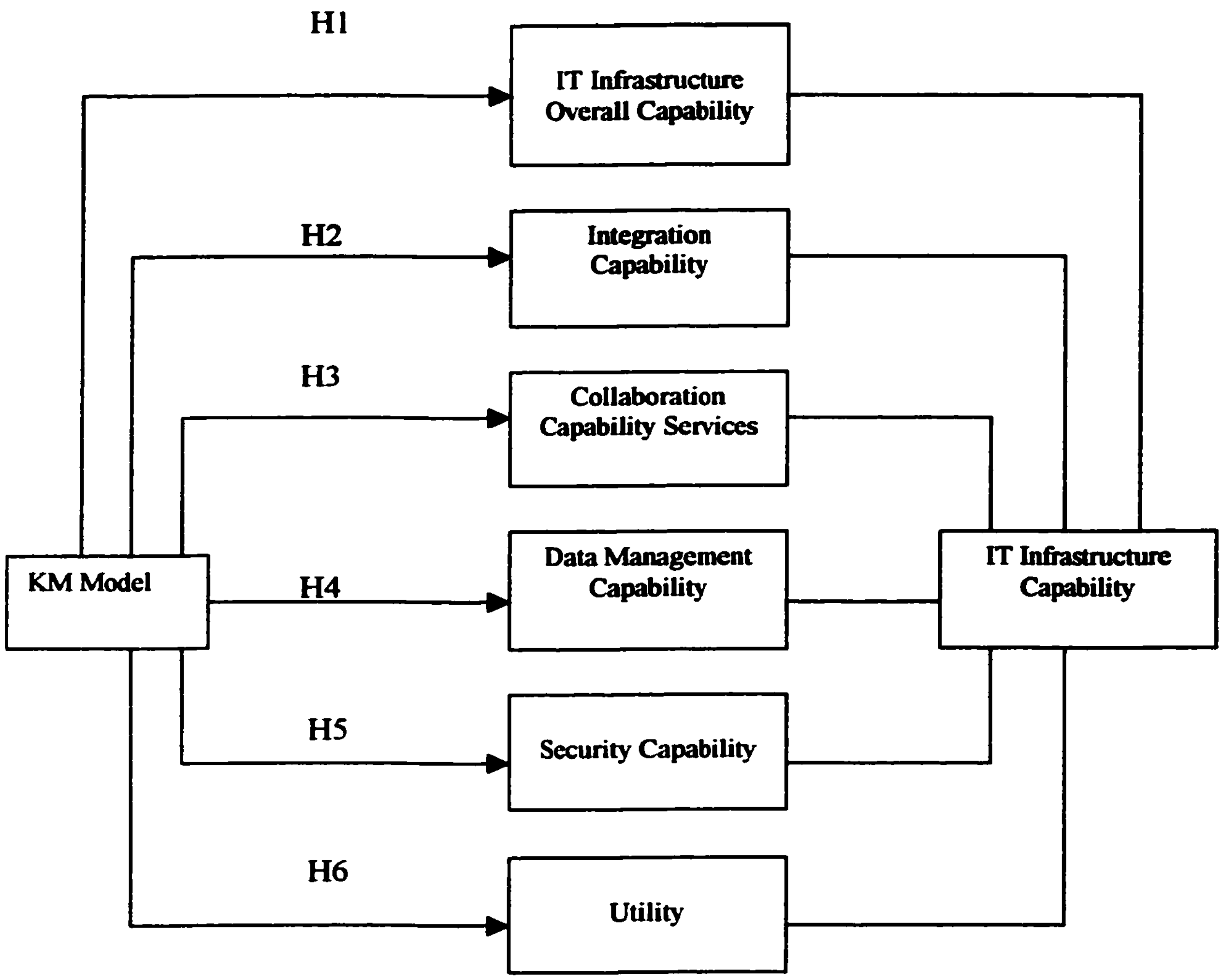


Figure 3.3 Research Model

## 3.5 RESEARCH METHODOLGOY

### 3.5.1 Research Design

Research design is a blueprint for collecting, measuring, and analyzing data. In this research, the survey method was employed. "Survey research is prominent as a methodology that has been used to study unstructured organizational problems in the IS area" (Grover, 1997). It is good for covering dispersed geographic locations; it is also good when a large number of variables are studied (Cooper and Schindler, 1998). It asks people to gather information using a structured format. The quantitative measure can be used to explain relationships between variables. This study utilizes the mail questionnaire survey.

This research basically takes the explanatory approach and investigates relationships between knowledge management models and IT infrastructure. The approach is used to find causal relationships among variables. It attempts to explain relationships between variables in the phenomenon observed (Cooper and Schindler, 1998).

In a time frame perspective, this research takes a cross sectional design. The approach collects information at one point of time from a sample. It takes a snapshot analysis of the phenomenon. This design is appropriate to find differences in subsets of population in a specific point of time.

### 3.5.2 Unit of Analysis

In the survey approach, asking questions to right person is critical. The respondents should be knowledgeable about the topic to answer the question. "This is especially true when the unit of analysis is organization. It is important that the unit of analysis be clearly defined and identified no matter which design strategy is employed. The person who is most knowledgeable about the subject should be chosen" (Grover, 1997).

In this research, the unit of analysis is the organization. To answer the questionnaire, the respondents need to be knowledgeable about their business nature, organizational knowledge management, and have a general understanding of IT. The chief information officer (CIO) was chosen. The CIO is the highest-ranking officer who is responsible for organizational IT resources. His or her job includes linking IT to the organizational strategy.

### 3.5.3 Instrument Design

The instrument used in the research basically consists of three parts. The first part collects basic demographic data on respondents and their companies. The second part is designed to identify the KM model of the responding firms. Two factors (service type and knowledge type, each with two dimensions) are used in this part. The question items were developed based on the concepts identified through the KM literature review. (Zack, 1997; Sarvary, 1999; Hansen et al., 1999).

The third part is designed to measure IT infrastructure capability. IT infrastructure services are used to measure IT infrastructure capability. The portfolio of IT infrastructure services was originally developed and proposed by Broadbent, Weil, and Neo (1996). It consisted of 23 services. Later, Weil and Broadbent (1998) extended them into 25 services. The 25 infrastructure services are used in this research. In spite of the importance of IT infrastructure issues, there are not many measures developed for measuring IT infrastructures. This is probably one of the very few measures designed and applied to several empirical studies of IT infrastructure capability.

### 3.5.4. Data Collection

To collect data, mail questionnaires were used. Mail questionnaires are one of the most widely used methods of survey design. The sample used was obtained from "The Directory of Management Consultant 2000, 9th Edition," published by Kennedy Information in 1999. The mail questionnaires were sent to the chief information officers or highest ranking IT officers of the 1500 consulting companies listed in the directory.

### 3.5.5 Statistical Technique

In this research, a two way Analysis of Variance (ANOVA) was used. The two factors (i.e., two independent variables: service type and knowledge type) will classify the consulting companies into one of the four KM models. Then, using an ANOVA, the hypotheses were tested to see if there were any differences between these four distinct KM models. For the analysis, SPSS for Windows was utilized.

# CHAPTER FOUR

# ANALYSIS AND DISCUSSION

Chapter Four presents the results of statistical analysis performed on the data collected from the questionnaires. The analysis measures the relationship between KM models and IT infrastructure services. This chapter is organized in four sections: (1) Fundamental analysis of data; (2) Analysis of measure: reliability and construct validity test; (3) The results of hypotheses tests; and 4) Discussion on the results.

## 4.1 Fundamental Analysis of Data

In this section, the basic features of data are presented. First, survey procedures performed are described. This includes discussions on the samples and response rates. Then, the demographic characteristics of the data are presented.

### 4.1.1 Survey Procedure

This research is intended to investigate the relationships between the KM model and IT infrastructure capability in the consulting industry. Due to the knowledge-intensive nature of the consulting industry, knowledge has been heavily utilized by consulting firms.

A total of 1500 consulting companies were selected for the survey. The companies are listed in the "The Directory of Management Consultant 2000, 9$^{th}$ Edition," published by Kennedy Information in 1999. The sample firms are located throughout the United States and Canada. The questionnaires were sent to the chief information officer or the highest-ranking officer responsible for information systems. To answer the questionnaire, the respondents should have an overall understanding of their company's service characteristics and IT technology. The people who can answer the questions are chief information officers. Since a detailed knowledge of IT technology is not required, some other officers, such as the chief executive officer (CEO) or chief operating officer (COO) are obviously qualified to answer the questions, too.

First, a review of the literature on KM and IT infrastructure capability was conducted to identify constructs or concepts. Based on the review, a preliminary questionnaire was developed. Prior to the administration of a nation-wide survey, the initial questionnaire was reviewed by Ph.D. students in the Management Department at the University of Nebraska-Lincoln.

A final version of the questionnaire was prepared after the dissertation advisor's review and suggestions. The questionnaires were sent with a cover letter and a postage-paid return envelope. To encourage participation, a copy of the summary of results was offered.

#### 4.1.2 Response Rate

Of the 1500 questionnaires mailed, 142 (a 9.5 % response rate) were returned. There were 89 questionnaires returned because the address was incorrect, the company had moved, or the company was out of business. Considering those returned questionnaires due to incorrect addresses, the response rate is a little higher (142 / (1500-89) = 10.1%). This response rate is still low. Generally, a 20% response rate is desirable (Yu and Cooper, 1983). However, it is not unusual to have a 10% response rate in a social science setting. A number of companies sent e-mail or letters stating that it is their policy not to respond to outside questionnaires. Some companies even had a quota. For example, some firms stated that it was their policy to answer the 10 most appropriate questionnaires a year. Out of the 142 returned by mail, 27 were unusable because they were not answered completely. For the analysis, 115 questionnaires were used (7.7%).

### 4.1.3 Demographic Characteristics of Respondents and Companies

Even though the questionnaires were sent to the chief information officers, the respondents held various job titles such as CIO, MIS manager, CEO, and others. Table 4.1 presents information about the job titles of the respondents. Most respondents were CIOs or CEOs. CIOs totaled 36.5 % of the respondents. This title category includes Chief Information Officer, Vice President of MIS, MIS director, and Chief Technology Officer who report to the CEO. MIS managers, who report to someone below the CEO, totaled 3.5%. CEOs occupied 43.5%, and other titles totaled 16.5%. The Other Titles category included senior consultants, system analysts, chief operating officers, general office managers and librarians.

| Years | Frequency | Percent |
|---|---|---|
| Chief Information Officer | 42 | 36.5 |
| MIS Manager | 4 | 3.5 |
| CEO | 50 | 43.5 |
| Others | 19 | 16.5 |
| Total | 115 | 100.0 |

Table 4.1 Job Title

Table 4.2 summarizes the number of years that the respondents have worked in the position. The idea behind this question was to ensure that the respondents had enough experience on the job to answer the questions. Only 4.3% of them were new on their jobs (less than a year). Approximately twenty-six percent held the title between 1 and less than 5 years. About 70% of the respondents have worked in the job more than for 5 years. Most of the respondents have worked in the position more than 5 years. This indicates that the respondents have enough knowledge and experience to answer the questionnaire.

| Years | Frequency | Percent |
|---|---|---|
| Less than 1 year | 5 | 4.3 |
| Less than 5 years | 30 | 26.1 |
| Less than 10 years | 22 | 19.1 |
| 10 years and more | 58 | 50.5 |
| Total | 115 | 100.0 |

Table 4.2 Number of Years in the Position

Table 4.3 summarizes the respondents' educational background. The largest category (59%) was Graduate School Degree (including Master, MBA or Ph. D). The second largest category was College Degree with 35.7%. These two together took up 94.7%. This indicates the knowledge-intensive nature of management consultancy.

| Educational Level | Frequency | Percent |
|---|---|---|
| High School Degree | 5 | 4.3 |
| College Degree | 41 | 35.7 |
| Graduate School Degree | 69 | 59.0 |
| Total | 115 | 100.0 |

Table 4.3 Educational Background

Tables 4.4 and 4.5 provide information about the size of the responding companies. Key indicators of company size are the number of employees and revenues. Table 4.4 summarizes the number of employees in the responding companies. Most companies have less than 100 employees (84.4%). Only 6.9% of the responding companies employ more than 500 people. In terms of revenues, the companies with revenues of less than $100 million occupied 94.8%. Only 5.2% make more than $100 million a year. Both the number of employees and the revenues indicate that the responding companies are relatively small or medium-sized companies.

| Employees | Frequency | Percent |
|---|---|---|
| 49 or less | 92 | 80.0 |
| 50 - 99 | 5 | 4.4 |
| 100 - 499 | 10 | 8.7 |
| 500 - 999 | 2 | 1.7 |
| 1,000 or more | 6 | 5.2 |
| Total | 115 | 100.0 |

Table 4.4 Number of Employees

| Revenues | Frequency | Percent |
|---|---|---|
| $49 millions or less | 104 | 90.4 |
| $50 - $99 millions | 5 | 4.4 |
| $100 - $499 millions | 3 | 2.6 |
| $500 - $1,000 millions | 1 | 0.9 |
| $1,000 millions or more | 2 | 1.7 |
| Total | 115 | 100.0 |

Table 4.5 Annual Revenues

## 4.2 ANALYSIS OF MEASURE

### 4.2.1 Validation of Measure

In the process of translating constructs to measurable variables, errors are introduced. Measurement error represents one of the most significant sources of error in survey research. Researchers should reduce the measurements error by carefully validating the instrument employed. There are several measurement errors reported in conducting surveys (Churchill, 1979; Straub, 1989; Schwab, 1980; Cooper and Schindler, 1998).

Sampling errors are related to the representativeness of the sample with respect to the population of interest. It is an error of selection. The question "Does the sample represents sample framework?" should be asked. Internal validity ensures that there are no other explanations for the findings. Internal validity questions "whether the observed effects could have been caused by a set of correlated, unhypothesized, and immeasurable variables" (Straub, 1989). Researchers should ask if any other explanations can explain the observed relationships. Statistical conclusion error is concerned about the statistical power of tests. Straub (1989) explains it as "an assessment of the mathematical relationship between variables and the likelihood that this mathematical assessment provides a correct picture." This error reflects the probability that the null hypothesis has been correctly rejected and the relationships do exist. Low power leads to erroneous conclusions. Two important properties of measures are reliability and construct validity.

### 4.2.2. Construct Validity

Validity refers to the extent to which differences found in a measurement reflect true differences among respondents being tested (Cooper and Schindler, 1998). In other words, in assessing validity, the researcher is concerned with determining the extent to which it measures what it is supposed to measure. Construct validity is especially important. Construct validity lies at the heart of the scientific process (Chruchill, 1979). Schwab (1980) defines construct validity as "representing the correlation coefficient between the construct and the measure." Thus, it measures "correspondence between the results obtained from a measuring instrument and the meaning attributed to those results" (Schwab, 1980). It identifies the underlying constructs being measured and determines how well the test represents them.

Factor analysis was used for construct validity. Factor analysis is commonly used for data reduction and summarization in which redundant items are combined and inappropriate items deleted (Hair et al., 1998). It is also one of the power methods to test construct validity (Kerlinger, 1986; Schwab, 1980; Cooperand Schindler, 1998). Factor analysis was performed on the measure, 25 IT infrastructure services, using SPSS for Windows. These 25 IT infrastructure services are reproduced in Table 4.6. Principal component analysis was used for the extraction method. Using the VARIMAX method for rotation, 5 factors were extracted out of 25 services. The result is summarized in Table 4.7.

| Item Name | Items |
|---|---|
| S1 | Manage firm-wide communication network services |
| S2 | Manage group-wide or firm-wide messaging service |
| S3 | Manage firm-wide or business unit work station networks (i.e., LAN/POS) |
| S4 | Manage firm-wide or business unit applications |
| S5 | Provide management information electronically (i.e., EIS) |
| S6 | Develop and manage electronic linkages to suppliers or customers |
| S7 | Develop a common systems development environment |
| S8 | Provide multimedia operations and development (i.e., videoconferencing) |
| S9 | Provide data management advice and consultancy services |
| S10 | Manage firm-wide or business-unit data, including standards |
| S11 | Manage firm-wide database |
| S12 | Recommend standards for at least one component of IT architecture (i.e., hardware, operating systems, data, communications) |
| S13 | Enforcing IT architecture |
| S14 | Provide technology advice and support services |
| S15 | Provide technology education services (i.e., training) |
| S16 | Perform IS project management |
| S17 | Manage, maintain, support large scale data processing facilities |
| S18 | Perform IS planning for business units |
| S19 | Manage and negotiate with suppliers and outsourcers |
| S20 | Provide firm-wide intranet capability for document management |
| S21 | Provide firm-wide intranet capability for collaboration |
| S22 | Provide firm-wide electronic support for groups (Lotus Notes) |
| S23 | Provide security for firm-wide installations and applications |
| S24 | Implement disaster planning and recovery for business units |
| S25 | Identify and test new technologies for business purposes |

Table 4.6 25 IT Infrastructure Services

| | Components | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| S2 | **.737** | | | | |
| S1 | **.731** | | | .304 | |
| S12 | **.729** | .423 | | | |
| S3 | **.694** | | | .408 | |
| S13 | **.692** | .475 | | | |
| S4 | **.588** | | .315 | | |
| S11 | **.464** | | .391 | .305 | .391 |
| S16 | | **.755** | | .318 | |
| S18 | | **.662** | | .442 | |
| S14 | .567 | **.601** | | | |
| S10 | | **.557** | .367 | | |
| S15 | | **.547** | | | |
| S19 | | **.546** | | | .361 |
| S25 | | **.525** | .302 | | .431 |
| S6 | | | **.848** | | |
| S5 | | | **.713** | | |
| S7 | | .366 | **.613** | .339 | |
| S9 | | .348 | **.605** | | |
| S22 | .300 | | | **.725** | |
| S17 | | | | **.707** | |
| S21 | .363 | .326 | | **.586** | .309 |
| S20 | .315 | .328 | | **.544** | .376 |
| S8 | | | .392 | **.403** | |
| S23 | .333 | | | | **.811** |
| S24 | .336 | | | | **.800** |
| Eigen Values | 4.564 | 3.728 | 3.081 | 2.984 | 2.638 |
| Variance Explained | 18.257 | 14.914 | 12.323 | 11.936 | 10.551 |

**Extraction Method: Principal Component Analysis**
**Rotation Method: VARIMAX**

**Table 4.7 Rotated Component Matrix**

The 25 items were loaded into 5 factors. Seven items (S1, S2, S3, S4, S11, S12, and S13) were loaded in factor 1. These items can be categorized into two groups. The five items (S1, S2, S3, S4, and S11) represent firm-wide (enterprise wide) management services. The second group (S12 and S13) includes architecture and standards. All these are related to the integration capability. Factor 1 is about making sure that an IT application is compatible with others in the entire firm. Factor 1 is named Integration Capability. This factor will be used to measure the integrating capability of IT infrastructure.

Another group of seven items (S10, S14, S15, S16, S18, S19 and S25) were loaded into factor 2. Factor 2 includes items about providing basic services to users (i.e., technology advice, training and education, panning IT, and IT R&D). This kind of service will be needed no matter what KM model a firm is using. This can measure the concept of utility presented in Chapter Two. One exception is S10. In a confirmatory factor analysis, when a factor is not grouped into the concepts as expected, then actual eye investigation is suggested. Even though item S10 was loaded into this factor, clearly this is more about data management capability rather than utility. Therefore, this item is excluded from the utility factor. The second factor is named Utility. This factor is used to measure the utility of IT infrastructure capability.

Four items (S5, S6, S7, and S9) were loaded into factor 3. Even though these items are grouped into one factor, it is hard to put these items into one concept. They are related to service management applications. This factor is named Other Capability of IT infrastructure in this study. It is not an interest of this research.

Five items (S8, S17, S20, S21, and S22) were loaded into the factor 4. All items except S17 are related to supporting collaborative efforts of the work groups. Even though item S17 (Manage large-scale data processing facilities) was grouped into this factor, this is clearly more about data management capability rather than collaborating capability. It is inappropriate to use the item for analyzing the collaborative nature of IT infrastructure. This item is excluded from the collaborating capability factor for the analysis. The factor 4 is named Collaborating Capability. This factor is used to measure the collaborating capability of IT infrastructure. It was excluded from the analysis.

Two items (S23 and S24) were loaded into factor 5. These two items are related to providing security and handling backup and emergencies (i.e., disaster and recovery planning). In a broad sense, factor 5 represents the security capability of IT infrastructure. Therefore, this factor is named Security Capability. This is used to measure the security capability of IT infrastructure.

There is one thing that deserves attention. As discussed in Chapter Two, IT infrastructure consists of integrating capability, collaborating capability, data management capability, security capability, utility and others. The factor analysis did not come up with a factor handling data management capability. The items related to data management capability are spread out among other factors. However, a close examination of the 25 items shows clearly that items S9, S10, and S11 are related to data management. These items are listed in Table 4.8. These three items are grouped into a data management construct and named Data Management Capability. They are used to measure the data management capability of IT infrastructure.

| Item | Service |
|---|---|
| S 9 | Provide data management advice and consultancy services |
| S 10 | Manage firm-wide or business-unit data, including standards |
| S 11 | Manage firm-wide database |

Table 4.8 Items for Data Management

The result of the factor analysis is summarized in the table 4.9.

| Construct | Factor | Items |
|---|---|---|
| Overall Capability | - | Composite of 25 Items |
| Integration Capability | 1 | S1, S2, S3, S4, S11, S12, S13 |
| Collaboration Capability | 2 | S8, S20, S21, S22 |
| Data Management Capability | - | S9, S10, S11 |
| Security Capability | 3 | S23, S24 |
| Utility | 4 | S14, S15, S16, S18, S19, S25 |

Table 4.9 Summary of Factor Analysis

### 4.2.3 Reliability

Reliability deals with error free measurement. It can be said that reliability is high "if the measurement gives the same result every time the same property is measured in the same way." (Reaves, 1992). It is concerned with the degree to which a measurement is free of random error. Thus, reliability means repeatability, consistency, stability, and accuracy. Random errors negatively affect research. More errors mean large differences between the true value and the measured value. There are several procedures used to test the reliability of measurement (i.e., test-retest, parallel forms, and internal consistency).

One of the most widely used approaches is to test the internal consistency of the measurement (Churchill, 1979; Schwab, 1980). It measures the degree to which measurement items reflect the same underlying constructs. It assesses the consistency or homogeneity among items (Cooper and Schindler, 1998). To measure the reliability of constructs used in this study, the internal consistency method was employed. An internal consistency method measures consistency and homogeneity among items that comprise the measurement. One such technique is Cronbach's Coefficient Alpha, which is commonly used in social science research. An alpha value of more than 0.7 is desirable (Nunnally, 1978). The alpha values in this study well exceed the minimum value of 0.70 suggested. Table 4.10 summarizes the result of reliability test of dependent variables. The high alpha values may have resulted from the use of validated instruments from prior research.

| Constructs | Number of Items | Alpha Value |
|---|---|---|
| Integration Capability | 7 | 0.9141 |
| Collaboration Capability | 4 | 0.8437 |
| Data Management Capability | 3 | 0.7582 |
| Security Capability | 2 | 0.8911 |
| Utility | 6 | 0.8472 |
| Overall IT Infrastructure Capability | 25 | 0.9513 |

Table 4.10 Summary of Reliability Test

**4.2.4 Classification of Knowledge Management Model**

Organizational KM models are based on two dependent variables: service type and knowledge type. To assess the service type, seven question items were used. The possible maximum score was 49. The mean total score was 29.3. The companies whose score was less than the mean score (i.e., 1- 29) were classified as "Standardized." The companies whose score was greater than the mean score (i.e., 30 - 49) were classified as "Unique."

To assess knowledge type, six question items were used. The possible maximum score was 42. The mean total score for service type was 29.2. The companies whose score was less than the mean score (i.e., 1 - 29) were classified as "Exploitive." The companies whose score was greater than the mean score (i.e., 30 - 42) were classified as "Explorative."

Out of the 115 companies that responded, a total of 22 companies were classified as a Type I model, a total of 37 companies were classified as a Type II model, a total of

35 companies were classified as a Type III model, and a total of 21 companies were classified as a Type IV model. Figure 4.1 summarizes the classification of KM models.

| Service Type | | Exploitive | Explorative |
|---|---|---|---|
| | Unique | Type I (22 Companies) | Type II (37 Companies) |
| | Standardized | Type III (33 Companies) | Type IV (23 Companies) |
| | | **Knowledge Type** | |

Figure 4.1 Knowledge Management Model

## 4.3 TESTS OF HYPOTHESES: ANALYSIS OF VARIANCE

This section examines relationships between the KM model and IT infrastructure services. A two way ANOVA was performed to examine the differences in a firm's IT infrastructure services between the four groups – type I, II, II and IV.

### 4.3.1 Overall IT Infrastructure Capability

The first hypothesis tests KM models and overall IT infrastructure capability. The hypothesis is restated from Chapter Three.

H1: The more standardized service a company provides and the more exploitive knowledge it applies to the service, the more IT infrastructure capability is required overall.

There are three assumptions for ANOVA analysis: normality, independence, and homogeneity. However, the most critical assumption is homogeneity, which means equal variance of the samples (Hair et al., 1998). To test the homogeneity, the Levene test was performed. The test showed equal variance of the samples. The null hypothesis (i.e., no difference in variance among difference among groups) was not rejected, $F(3, 111) = 1.145$, $p > .05$. There was no significant difference. This meets the equal variance assumptions for the ANOVA test.

The means and standard deviation are presented in Figure 4.2. The ANOVA results are summarized in Table 4.11. The analysis showed no significant main effect for service type, $F(3, 111) = 0.994$, $p > .05$; no significant main effect for knowledge type, $F(3, 111) = 0.079$, $p > .05$; and there were no significant interaction effects, $F(3, 111) = 0.004$, $p > .05$. It shows that there is no significant difference between the four groups. The hypothesis was not supported. In other words, there was no difference in the integrating capability of IT infrastructure between the different KM models.

| | |
|---|---|
| **Type I**<br><br>**Mean: 59.95**<br>**SD: 38.80** | **Type II**<br><br>**Mean: 57.54**<br>**SD: 38.16** |
| **Type III**<br><br>**Mean: 66.54**<br>**SD: 35.98** | **Type IV**<br><br>**Mean: 64.96**<br>**SD: 31.91** |

**Figure 4.2 Summary Statistics for Overall IT Infrastructure Capability**

| Source | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 1683.501 | 3 | 561.167 | .421 | .738 |
| Intercept | 423581.705 | 1 | 423581.705 | 317.971 | .000 |
| Service | 1324.017 | 1 | 1324.017 | .994 | .321 |
| Knowledge | 104.633 | 1 | 104.633 | .079 | .780 |
| Service * Knowledge | 5.736 | 1 | 5.736 | .004 | .948 |
| Errors | 147867.282 | 111 | 1332.138 | | |
| Total | 592231.000 | 115 | | | |
| Corrected Total | 149550.783 | 114 | | | |

**Table 4.11 ANOAVA Table for Overall IT Infrastructure Capability**

**4.3.2 Integrating Capability**

The second hypothesis tests knowledge management models and the integrating capability of IT infrastructure capability. The hypothesis is restated.

H2: The more standardized service a company provides and the more exploitive knowledge it applies to the service, the more integrating capability of its IT infrastructure is required.

To test the equal variance of the samples, the Levene test was performed. The test showed equal variance of the samples, $F(3, 111) = 0.177$, $p > .05$. The means and standard deviation are presented in Figure 4.3. ANOVA results are summarized in Table 4.12. The analysis showed no significant main effect for service type, $F(3, 111) = 1.086$, $p > .05$; no significant main effect for knowledge type, $F(3, 111) = 0.415$, $p > .05$; and there were no significant interaction effects, $F(3, 111) = 0.002$, $p > .05$. It shows that there is no significant difference between the four groups. The hypothesis was not supported. In other words, there was no difference in the integrating capability of IT infrastructure between the different KM models.

| Type I | Type II |
| --- | --- |
| Mean: 18.45<br>SD: 13.29 | Mean: 16.76<br>SD: 12.74 |
| **Type III**<br>Mean: 20.91<br>SD: 12.52 | **Type IV**<br>Mean: 19.43<br>SD: 13.21 |

Figure 4.3 Summary Statistics for Integrating Capability

| Source | Sum of Squares | Df | Mean Square | F | Sig. |
| --- | --- | --- | --- | --- | --- |
| Corrected Model | 313.147 | 3 | 104.382 | .629 | .598 |
| Intercept | 39029.624 | 1 | 39029.624 | 235.340 | .000 |
| Service | 180.109 | 1 | 180.109 | 1.086 | .300 |
| Knowledge | 68.795 | 1 | 68.795 | .415 | .521 |
| Service * Knowledge | .341 | 1 | .341 | .002 | .964 |
| Errors | 18408.645 | 111 | 165.844 | | |
| Total | 59405.000 | 115 | | | |
| Corrected Total | 18721.791 | 114 | | | |

Table 4.12 ANOAVA Table for Integrating Capability

### 4.3.3 Collaborating Capability

The third hypothesis testing the collaborating capability of the companies implementing different KM models is restated.

H3: The more innovative and customized service a firm provides, and the more explorative knowledge it applies to the service provided, then the more collaborating capability of IT infrastructure is required.

To test the equal variance of the samples, the Levene test was performed. The test showed equal variance of the samples, $F(3, 111) = 2.284$, $p > .05$. The means and standard deviation are presented in Figure 4.4. ANOVA results are summarized in Table 4.13. The analysis showed no significant main effect for service type, $F(3, 111) = 1.502$, $p > .05$; no significant main effect for knowledge type, $F(3, 111) = 0.208$, $p > .05$; and there were no significant interaction effects, $F(3, 111) = 0.166$, $p > .05$. It shows that there is no significant difference between the four groups. The hypothesis was not supported. In other words, there was no difference in the collaborating capability of IT infrastructure between the different KM models.

| Type I | Type II |
|---|---|
| Mean: 7.05<br>SD: 7.38 | Mean: 5.97<br>SD: 6.03 |
| **Type III**<br>Mean: 8.06<br>SD: 6.88 | **Type IV**<br>Mean: 8.00<br>SD: 5.67 |

Figure 4.4 Summary Statistics for Collaborating Capability

| Source | Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 95.359 | 3 | 31.786 | .755 | .522 |
| Intercept | 5781.305 | 1 | 5781.305 | 137.244 | .000 |
| Service | 63.275 | 1 | 63.275 | 1.502 | .223 |
| Knowledge | 8.778 | 1 | 8.778 | .208 | .647 |
| Service * Knowledge | 7.000 | 1 | 7.000 | .166 | .684 |
| Errors | 4675.806 | 111 | 42.124 | | |
| Total | 10704.000 | 115 | | | |
| Corrected Total | 4771.165 | 114 | | | |

Table 4.13 ANOAVA Table for Collaborating Capability

### 4.3.4 Data Management Capability

The fourth hypothesis is designed to reveal the difference in the data management capability in the different KM models and is restated.

H4: The more standardized service a company provides and the more exploitive knowledge it applies to the service, the more data management capability of IT infrastructure is required.

To test the equal variance of the samples, the Levene test was performed. The test showed equal variance of the samples, $F(3, 111) = 1.595$, $p > .05$. The means and standard deviation are presented in Figure 4.5. ANOVA results are summarized in Table 4.14. The analysis showed no significant main effect for service type, $F(3, 111) = 0.219$, $p > .05$; no significant main effect for knowledge type, $F(3, 111) = 0.001$, $p > .05$; and there were no significant interaction effects, $F(3, 111) = 0.007$, $p > .05$. It shows that there is no significant difference between the four groups. The hypothesis was not supported. In other words, there was no difference in the data management capability of IT infrastructure between the different KM models.

| Type I | Type II |
|---|---|
| Mean: 8.59<br>SD: 5.96 | Mean: 8.65<br>SD: 6.84 |
| **Type III** | **Type IV** |
| Mean: 9.21<br>SD: 5.36 | Mean: 9.09<br>SD: 4.94 |

Figure 4.5 Summary Statistics for Data Management Capability

| Source | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 8.439 | 3 | 2.813 | .080 | .971 |
| Intercept | 8635.101 | 1 | 8635.101 | 246.458 | .000 |
| Service | 7.675 | 1 | 7.675 | .219 | .641 |
| Knowledge | 3.108E-02 | 1 | 3.108E-02 | .001 | .976 |
| Service * Knowledge | 0.229 | 1 | 0.229 | .007 | .936 |
| Errors | 3889.092 | 111 | 35.037 | | |
| Total | 12980.000 | 115 | | | |
| Corrected Total | 3897.530 | 114 | | | |

Table 4.14 ANOAVA Table for Data Management Capability

**4.3.5 Security Capability**

The fifth hypothesis testing a security capability in the different KM models is restated.

H5: The more standardized service a company provides and the more exploitive knowledge it applies to the service, the more security capability of IT infrastructure is required.

To test the equal variance of the samples, the Levene test was performed. The test showed equal variance of the samples, $F(3, 111) = 2.209$, $p > .05$. The means and standard deviation are presented in Figure 4.6. ANOVA results are summarized in Table 4.15. The analysis showed no significant main effect for service type, $F(3, 111) = 0.028$, $p > .05$; no significant main effect for knowledge type, $F(3, 111) = 0.763$, $p > .05$; and there were no significant interaction effects, $F(3, 111) = 0.560$, $p > .05$. It shows that there is no significant difference between the four groups. The hypothesis was not supported. In other words, there was no difference in the security capability of IT infrastructure between the different KM models.

| Type I<br><br>Mean: 6.00<br>SD: 4.81 | Type II<br><br>Mean: 5.89<br>SD: 4.60 |
|---|---|
| Type III<br><br>Mean: 6.79<br>SD: 4.75 | Type IV<br><br>Mean: 5.39<br>SD: 3.58 |

Figure 4.6 Summary Statistics for Security Capability

| Source | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 28.882 | 3 | 9.627 | .475 | .700 |
| Intercept | 3961.475 | 1 | 3961.475 | 195.384 | .000 |
| Service | .564 | 1 | .564 | .028 | .868 |
| Knowledge | 15.479 | 1 | 15.479 | .763 | .384 |
| Service * Knowledge | 11.350 | 1 | 11.350 | .560 | .456 |
| Errors | 2250.561 | 111 | 20.275 | | |
| Total | 6516.000 | 115 | | | |
| Corrected Total | 2279.443 | 114 | | | |

Table 4.15 ANOAVA Table for Security Capability

### 4.3.6 Utility

Hypothesis 6 tests the utility of IT infrastructure in different KM models. It is restated.

H6: There are differences in the utility of IT infrastructure capability in the different KM models.

To test the equal variance of the samples, the Levene test was performed. The test showed equal variance of the samples, $F(3, 111) = 0.834$, $p > .05$. The means and standard deviation are presented in Figure 4.7. ANOA results are summarized in Table 4.16. The analysis showed no significant main effect for service type, $F(3, 111) = 01.626$, $p > .05$; no significant main effect for knowledge type, $F(3, 111) = 0.003$, $p > .05$; and there were no significant interaction effects, $F(3, 111) = 0.021$, $p > .05$. It shows that there is no significant difference between the four groups. In other words, there was no difference in the utility capability of IT infrastructure between the different KM models. The hypothesis was not supported. Utility services are the ones necessary to every firm no matter what KM model a firm adopts.

| Type I<br><br>Mean: 14.55<br>SD: 8.73 | Type II<br><br>Mean: 14.89<br>SD: 10.13 |
|---|---|
| Type III<br><br>Mean: 17.03<br>SD: 8.16 | Type IV<br><br>Mean: 16.87<br>SD: 9.22 |

Figure 4.7 Summary Statistics for Utility Service

| Source | Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 141.260 | 3 | 47.087 | .562 | .641 |
| Intercept | 27427.350 | 1 | 27427.350 | 327.478 | .000 |
| Service | 136.153 | 1 | 136.153 | 1.626 | .205 |
| Knowledge | .236 | 1 | .236 | .003 | .958 |
| Service * Knowledge | 1.759 | 1 | 1.759 | .021 | .885 |
| Errors | 9296.201 | 111 | 83.753 | | |
| Total | 38273.000 | 115 | | | |
| Corrected Total | 9437.861 | 114 | | | |

Table 4.16 ANOAVA Table for Utility Service

## 4.4 DISCUSSION

The test results were highly disappointing. The ANOVA analysis did not support the hypotheses. In this section, several possibilities for the lack of the support and implications of the analysis results are discussed.

### 4.4.1 No Relationship Between KM Model and IT Infrastructure Capability

The first possibility is that there is actually no relationship between KM and IT infrastructure capabilities. There has been a large amount of literature reports indicating the positive synergy and relationships between KM and IT infrastructure. Since there has been no empirical test performed, those claims may be based on common sense rather than proven by research. The previous research may be just propositions without evidence. If it is certain that there is no relationship between KM and IT infrastructure, then it itself is a contribution to our understanding of KM and the IT field. However, the test result only tells us that it could not find any significant difference between KM models and IT infrastructure. In relation with this discussion, there is one thing that need to be pointed out. The key in KM and IT infrastructure may be not IT infrastructure itself, but human equation: how people combine, integrate, and utilize the IT infrastructure. The follow-up study is suggested on how people creatively manage and use IT infrastructure.

### 4.4.2 Statistical Power

The second possibility is low statistical power. A statistical conclusion error is concerned about the statistical power of tests. Low power leads to erroneous conclusions. The null hypothesis is not rejected when the null is false. While a Type I error is indicated by the alpha level, the lack of power leads to a Type II error. The power of a test is directly proportional to sample size and effect size. The single most important factor is sample size (Grover, 1997). Sample size of at least 100 is desirable. Since 115 questionnaires total were used for analysis in this study, it is unlikely that low statistical power led to the lack of support.

### 4.4.3 Business Processes and Size

The internal validity issue may tell the third possibility. Internal validity ensures that there are no other explanations for the findings. In the absence of experimental design, this needs to be justified. The previous studies show that business processes and the size of a company affects IT infrastructure (Ein-Dor and Segev, 1982; Weil and Broadbent, 1998). If a firm's business process is more complex and sophisticated, then it will need more IT infrastructure capability. If a firm is large, then it tends to disperse geographically and need more IT infrastructure capability, too.

For example, a manufacturing company in general has complex business processes including order entry, inventory management, warehouse operation, billing, MRP, MRP II, scheduling, product design, supply chain management, customer relationship management systems, etc. These require complex IT applications. These processes will affect the IT infrastructure capability. The business process may determine the IT infrastructure rather than a KM model. However, in consulting companies, there are no such complex business processes existing. They do not manufacture products. They do not have to maintain inventory. They do not take orders. They do not order raw materials. Managing knowledge is their key business process. The business process is not a critical factor that confounds the results in this study.

The second factor that may affect the IT infrastructure capability is the size of the company. However, in this research, most companies involved in the research are small and medium sized companies. Since they are generally homogeneous in size, this does not affect the result. In this research, size is not a big factor. In another words, size was not a possible explanation of the results since the companies responded were homogeneous in size. Therefore, the results of this research should not be applied to large management consulting companies. It will violate the external validity. The interpretation should be limited to small and medium sized management consulting firms.

### 4.4.4 Response Bias

Another possibility is in the sampling error. Sampling error is related to the representativeness of population of interest. One source of sampling error comes from a low response rate. As discussed in the previous section, most of the companies responded were small and medium sized companies. The smaller companies will use IT technologies less. They may not use enough IT technology to show any meaningful difference in IT infrastructure. In the management consulting industry, many firms have only a handful of employees working as consultantswithout real IT infrastructure support. This could have hidden the possible relationships between the KM and IT infrastructure capability. Again, it should be emphasized that the results of this research should be interpreted only for small and medium sized firms in the management consulting industry.

### 4.4.5 Managerial Practice

The fifth possible explanation is that there should be positive relationships between the IT and KM but the companies in practice are not paying attention to the relationship. A firm first needs to assess their KM style and apply the proper IT. However, managers in practice are not doing what they should be doing. They may be simply employing some specific technologies because they are popular in the market. Mangers may adopt some technologies for KM simply because most of the companies are employing them. This practice might result in no difference in the tests. If this is the case, this managerial practice needs to be reexamined.

### 4.4.6 Supplementary Analysis

In many cases, the use of multiple analyses to cross check each other, is desirable and can enhance confidence in findings. For this purpose, additional questions were asked in the questionnaire besides the main analysis. In this part of the analysis, the most popular 18 IT technologies were identified and listed. Respondents were asked to evaluate the perceived importance of IT applications for their KM whether or not the technology is implemented in their organization. a seven-point scale was used where 1 is the least important technology and 7 is the most important technology.

The 18 most popular technologies are listed in Table 4.17. A close examination of the technologies categorizes them into four groups. The first group is related to Internet technologies (i.e., e-mail, search engines, and other Internet applications). The second group is data management technologies (i.e., relational databases, knowledge repositories, document databases, and object-oriented database management systems).

All these technologies are used for storing and retrieving the information or knowledge. The third group includes collaborating technologies (i.e., group decision support systems, knowledge maps, groupware, or videoconferencing). Finally, the fourth group is related to Artificial Intelligence technologies (i.e., expert systems, case-based reasoning systems, neural networks, or intelligent agents).

| | Applications |
|---|---|
| 1 | E-mail (EM) |
| 2 | Search Engine (SE) |
| 3 | Internet (INTNT) |
| 4 | Data Warehouse (DW) |
| 5 | Data Mining (DM) |
| 6 | Relational Database Management Systems (RDBMS) |
| 7 | Object-Oriented Database Management Systems (OODBMS) |
| 8 | Knowledge Base/ Knowledge Repository (KB/KR) |
| 9 | Document Management Systems (DMS) |
| 10 | Work Flow Management Systems (WFMS) |
| 11 | Knowledge Map/ Directory (KM/KD) |
| 12 | Videoconferencing (VC) |
| 13 | Group Decision Support Systems (GDSS) |
| 14 | Groupware (GW) |
| 15 | Expert Systems (ES) |
| 16 | Case-based Reasoning (CBR) System |
| 17 | Intelligent Agents (IA) |
| 18 | Neural Network (NN) |

Table 4.17 IT for Knowledge Management

Again, differences between groups were expected between different KM models in terms of the rank of the perceived importance. For example, in the Type III KM model, storing technologies were expected to be perceived with much more importance than in any other KM model because the issue is how to locate, organize, share, and utilize the existing knowledge. It was expected that IT able to locate, store, and reuse the existing knowledge (such as data warehouse, knowledge repositories, database management systems, expert systems, case-based reasoning systems and document management systems) would be ranked with high importance.

In the same context, the collaborating technologies would be perceived with much more importance in the Type II KM model than in Type III. Their strategy is to create new knowledge through creative thinking and the interchange of ideas by the rapid diffusion of ideas and insights through knowledge networking. The issue is how to locate the source of knowledge and to create new knowledge. It is very hard for them to employ reuse economics because there is no such existing knowledge available. Their customers' problems are supposed to be highly unique and unstructured. The services provided are supposed to be highly customized and innovative. Knowledge continually flows between people and IT should provide such support. It was expected that IT enabling people to collaborate would be ranked with much more importance. The results of this analysis are summarized in Table 4.18.

| Rank | Type I | Type II | Type III | Type IV |
|---|---|---|---|---|
| 1 | EM | EM | EM | EM |
| 2 | INTNT | INTNT | INTNT | INTNT |
| 3 | DMS | SE | SE | SE |
| 4 | DW | RD | KB/KR | KB/KR |
| 5 | DM | DMS | DM | DW |
| 6 | SE | DM | KM/KD | KM/KD |
| 7 | KB/KR | KB/KR | RDBMS | DMS |
| 8 | WFMS | KM/KD | DW | GW |
| 9 | OODBMS | WFMS | WFMS | WFMS |
| 10 | KM/KD | ES | DMS | RDBMS |
| 11 | RDBMS | OODBMS | OODBMS | DM |
| 12 | VC | DW | GW | OODBMS |
| 13 | ES | VC | GDSS | GDSS |
| 14 | GDSS | CBR | ES | ES |
| 15 | CBR | IA | NN | IA |
| 16 | GW | GDSS | IA | VC |
| 17 | IA | GW | CBR | CBR |
| 18 | NN | NN | VC | NN |

CBR (Case-based Reasoning Systems), DM (Data Mining), DMS (Document Management Systems), DW (Data Warehouse), EM (E-mail), ES (Expert Systems), GDSS (Group Decision Support Systems), GW (Groupware), IA (Intelligent Agents), INTNT (Internet), KM (Knowledge Map)/ KD (Directory), KR (Knowledge Repository)/ KB (Knowledge Base), NN (Neural Networks), OODBMS (Object-Oriented Database Management Systems), RDBMS (Relational Database Management Systems), SE (Search Engine), VC (Videoconferencing), WFMS (Work Flow Management Systems)

Table 4.18 Summary of the Perceived Importance of IT

This supplementary analysis showed the same pattern as the main analysis. The perceived importance of IT applications was similar in the different KM models. This confirms the results of the main analysis. Regardless of their KM models, the most widely used IT for their KM was the Internet technology. E-mail application was ranked first. The second one was the Internet. Search engine was sixth in the Type I model, and third in other models. Most managers think that Internet applications (including E-mail and search engines) are the most important KM tools.

The second highest group of technologies was related to the technologies for storing and structuring knowledge (exploitive technologies). The data management technologies were perceived to be important next to the Internet technologies. Document management systems, data warehouses, data mining, knowledge repositories/ knowledge bases, and database management systems are major applications of data management technologies. There was no distinct difference between different KM models.

The third highest group of technologies was related to the collaborating technologies (or explorative technologies). Collaborating technologies support joint working of the group and allow cooperative work across the physical location between groups. Videoconferencing, workflow management systems, groupware, group decision support systems, and knowledge maps are major applications of the collaboration technologies. The least important technology was AI (Artificial Intelligence).

This analysis provides some interesting aspects of IT utilization in the KM. The first one is the unpopularity of AI applications such as expert systems, case-based reasoning systems, intelligent agents, or neural networks. In the literature, AI technology has been cited as an important tool for capturing expert knowledge or utilizing the best practices or cases of the past. But to the small and medium sized companies in the consulting industry, AI technologies are perceived as the least important tools for KM. One of the reasons is that AI technologies are not widely applied to handle the complexity of human knowledge. This analysis is summarized in Table 4.19.

| Classification | IT | Type I | Type II | Type III | Type IV |
|---|---|---|---|---|---|
| Internet Technology | EM | 1 | 1 | 1 | 1 |
| | INTNT | 2 | 2 | 2 | 2 |
| | SE | 6 | 3 | 3 | 3 |
| Integrating Technology | DMS | 3 | 5 | 10 | 7 |
| | DW | 4 | 12 | 8 | 5 |
| | DM | 5 | 6 | 5 | 11 |
| | KB/KR | 7 | 7 | 4 | 4 |
| | OODBMS | 9 | 11 | 11 | 12 |
| | KM/KD | 10 | 8 | 6 | 6 |
| | RDBMS | 11 | 4 | 7 | 10 |
| Collaborating Technology | WFMS | 8 | 9 | 9 | 9 |
| | VC | 12 | 12 | 18 | 16 |
| | GDSS | 14 | 16 | 13 | 14 |
| | GW | 16 | 17 | 12 | 8 |
| AI Technology | ES | 13 | 10 | 14 | 15 |
| | CBR | 15 | 14 | 17 | 17 |
| | IA | 17 | 15 | 16 | 16 |
| | NN | 18 | 18 | 15 | 18 |

Table 4.19 Summary of the Perceived Importance of IT by Classification

A difficulty for managing implicit knowledge should be pointed out in this analysis. As discussed, there are two types of knowledge: exploitive and explorative. The importance of explorative knowledge has been emphasized in the literature. However, the analysis shows that the managers in the industry perceive the management of exploitive knowledge to be much more important. The low perceived importance of collaborating technology, which can better handle explorative knowledge, shows that it is very difficult to manage this kind of knowledge in practice, especially using IT.

IT has been repeatedly cited as one of the critical success factors for KM projects. However, at least in the management consulting industry, sophisticated and complex IT applications are not being developed and utilized for KM. It seems that there is a gap for KM between literature and actual practice.

# CHAPTER FIVE

# SUMMARY AND CONCLUSION

This chapter presents the conclusion of this research. It consists of five sections. The first section presents a brief summary of the study. The second section presents the contributions made by this study to the existing body of knowledge. The third section discusses the limitations of the study, followed by suggested future research directions in section four. Finally, section five concludes the study with comments.

## 5.1. SUMMARY

As knowledge becomes a key success factor in the knowledge economy, organizational KM began to draw attention from management. IT has been generally accepted as a critical factor for the successful KM implementation. An IT infrastructure view of the IT support was suggested in the research. This study was designed primarily to investigate the relationship between organizational KM approaches and IT infrastructure capability.

Six hypotheses on KM models and IT infrastructure capability were proposed. Based on the service type and knowledge type, consulting firms were classified into one of the four distinct KM models. To measure IT infrastructure capability, 25 IT infrastructure services were used. To test the hypotheses, survey questionnaires were sent to and answered by CIOs and CEOs of the management consulting companies. The two way ANOVA was performed to analyze the data.

The analysis of the data did not support the hypotheses proposed. In other words, KM models and IT infrastructure capability did not show significant relationship between them. Several possibilities for lack of support were discussed. A supplementary analysis was performed. It confirmed the results of the main analysis. There were no different patterns of IT applications found in different KM models adopted by consulting companies. Several implications that may be helpful to both academic researchers and practitioners were discussed.

## 5.2 CONTRIBUTIONS

Even though this study did not find major relationships between KM models and IT infrastructure capability, there are a few things that contribute to the existing body of knowledge in the field. The first contribution of the study is in its extended development of KM models. The existing KM models have been mainly categorical of knowledge or intellectual capital models (McAdam and McCreedy, 1999). These KM models reflect only one dimension of KM management, focusing on knowledge itself and ignoring the matching business characteristics of organizations.

The purpose of KM is to support organizations to achieve business goals. Therefore, organizational KM models should be analyzed with business characteristics as well as knowledge types used to solve business problems. Therefore, matching the nature of business and knowledge is important. Some studies proposed KM models that reflect and integrate business characteristics and knowledge types (Hansen et al., 1999). However, the studies classified KM models into two types. Considering the complexity of real practices, this classification may be inadequate for the industry.

In this research, the extended KM assessment model was proposed. Based on the service type and knowledge type used, each with two dimensions, this extended model can classify the organizational KM models into four distinct groups, which may provide more realistic approaches to the industry practices. The proposed KM model is not perfect yet. However, it can provide a starting point for more sophisticated organizational KM model assessment and development.

This study also provides the current status of IT applications to KM in the management consulting industry. IT applications identified in the literature were surveyed with their ranked importance. This provides some insights into the gap between literature reports and practices that may require managerial attention in applying IT for KM. The study also showed that managers are mostly interested in exploiting explicit knowledge rather than using IT to generate new knowledge. This is suggested by a managerial preference for data management technology to collaboration technology. This study revealed that the level of IT utilization is not sophisticated yet in the consulting industry. Most firms still depend on basic IT such as e-mail and search engines. Managers need to look for more opportunities to use IT more aggressively. This level of IT utilization may indicate that small and medium sized consulting firms rely more on other factors than IT for KM implementation.

IT is an important tool for KM. However, before it is applied, organizations first should identify their knowledge requirement (or model) so that they can choose the right tools. This study hints at no such efforts. It appears that managers are adopting the most popular IT. The reason may be because they are simply the most widely used technologies or that they are easy to acquire. However, to get the real benefits from IT, KM models and IT capability need to be matched.

Additionally, it must be pointed out that this study suggests the critical role of people in developing IT infrastructure capability. As discussed in Chapter Two, human skill is one of the components of IT infrastructure capability and integrates, combines, creatively use the IT infrastructure components. That is why two companies may buy same hardware and software technologies but still provide different IT Infrastructure capability. The key of the IT infrastructure capability for KM may be not the IT infrastructure itself, but the human factor

## 5.3 LIMITATIONS

As pointed out, the companies that responded consisted of mostly small and medium sized firms. The sample does not represent the entire management consulting industry. Therefore, the study results have limited application to large consulting companies. Data from larger firms could have revealed more meaningful insights into relationships between KM models and IT infrastructure capability.

Another limitation of this study is that it is based on one assumption: a firm is taking one dominant KM approach. However, some companies are engaged in multiple businesses that are heterogeneous in terms of service type and knowledge type used. When a company is taking multiple KM approaches, the proposed approach in this study may not be applied.

This is a cross-sectional study. It provides a snapshot analysis in time dimension. A longitudinal study is required. Longitudinal studies are repeated over an extended period.

Therefore, it will help to see any possible relationship. Moreover, IT changes constantly. It will be meaningful to see the relationship between KM and IT over an extended period of time, especially with the important IT changes.

The interpretation of this study results is limited to the management consulting industry in the U.S.A and Canada. Other industries and other business in different countries may show different relationship.

## 5.4 RECOMMENDATIONS FOR FUTURE RESEARCH

When relationships are found among variables, research will help explain a phenomenon and predict the future behaviors of it. On the contrary, if it finds that there are no relationships among variables, it will also contribute to the existing body of knowledge. However, the test result of this study only states that there are no supports for relationships between knowledge management and IT infrastructure capability. It does not mean that there are actually no relationships. This is worth further investigation. More in-depth analysis on this is suggested especially on the large consulting firms. A case study approach will provide proper support for this. A case study can describe the relationships, which exist in the reality of a particular environment. It can capture data in great detail than survey design in real environments. It can provide more rich data.

In the proposed KM model, Type II and III are the firms that match their service type and knowledge type. Type I and IV are the firms that mismatch the two. For example, Type I models may try to apply old knowledge to the new type of business problems. Type IV models may try to apply new knowledge to old problems, which have proven solutions already. The measurement of KM success between the companies (matching service type to knowledge type vs. mismatching them) will provide meaningful comparison. Additionally, measuring KM success itself will be a challenging future research area.

Customers have always been important in the business strategy and organizational KM initiatives. However, with the advance in the Internet and E-commerce technologies, customers' leveraging power has significantly changed. They have become more intelligent, with more information on their hands. Managing knowledge in customers in the Internet economy will be different than that of the traditional economy. Especially, KM in customer in E-commerce will be critical in future KM and IT applications.

As pointed out in the previous section, other suggested research topics are:

1) Longitudinal study on the relationship between KM and IT infrastructure capability
2) Study on the relationship in other industries
3) Study on the relationship in other countries.

## 5.5 CONCLUDING COMMENTS

This research attempted to answer an important question in KM and IT: relationships between knowledge management models and IT infrastructure capability. The identification of any relationships could provide managers with guidelines in planning and implementing IT for KM. With such guidelines, managers can better prioritize IT investments and develop effective IT infrastructure for KM.

In spite of the importance of the topic, there has been no empirical test carried out for this subject. Given the amount of literature emphasizing the importance of IT infrastructure in KM, the test result was surprising. The test could not find any evidence of relationships between KM models and IT infrastructure capability. While the research result is disappointing, it provided a foundation for the extended KM assessment model. Also, a few managerial implications were pointed out.

As organizations move into the knowledge economy, KM has become an important factor for business survival. However, KM is a relatively new subject in the business. IT infrastructure also started to receive attention only recently. More studies on the assessment techniques of KM models and the study of how IT impacts on KM needs to be followed.

**BIBLIOGRAPHY**


Ahituv, Niv., Neumann, Seev and Zviran, Moshe, "Factors affecting the policy for distributing computing resources," MIS Quarterly, Vol. 13, No. 4, December, 1989, pp. 389 ~ 401.

Baker, Marc and Baker, Mike, "Leveraging human capital," The Journal of Knowledge Management, Vol. 1, No., 1, September, 1997. pp. 61~74.

Barney, J. B., "Strategic factor markets: Expectations, luck and business strategy," Management Science, Vol. 32, 1986, pp. 1231~1241.

Barney, J. B., "Firm resources and sustained competitive advantage," Journal of Management, Vol. 17, 1991, pp. 99 ~120.

Bennett, Roser and Gabriel, Helen, "Organizational factors and knowledge management within large marketing department: an empirical study, Journal of Knowledge Management, Vol. 3, No. 3, 1999, pp. 212 ~ 225.

Bierly, Paul and Chakbrabarti, Alok, "Generic knowledge strategies in the U.S. pharmaceutical industry," Strategic Management Journal, Vol. 17. Winter Special Issue, 1996, pp. 123 ~ 135.

Bogner, William C., Thomas, Howard and McGee, John, "Competence and competitive advantage toward a dynamic model," British Academy of Management, Vol. 10, 1999, pp. 275 ~ 290.

Boisot, M., Information and organizations: the manager as anthropologist, London: Fontana Collins, 1995

Broadbent, M., Weill, P., "Management by maxim: How business and IT managers can create IT infrastructures," Sloan Management Review, Spring, 1997, pp. 77 ~ 92.

Broadbent, M., Weill, P., and St. Clair, D., "The implications of information technology infrastructure for business process redesign," MIS Quarterly, Vol. 23, No. 2, June, 1999, PP. 159 ~ 182.

Broadbent, M., Weill, P., O'Brien, T., and Neo, B. S., "Firm context and patterns of IT infrastructure capability," Proceedings of the Seventeenth International Conference on Information Systems, Cleveland, OH, December, 1996, pp. 174 ~ 194.

Carrilo, Javier, "Managing knowledge based value system," Journal of Knowledge Management, Vol. 1, No. 4, June, 1998, pp. 280 ~ 286.

Chan, Y. E., Huff, S. L., Barclay, D. W., and Copeland, D. G., "Business strategic orientation, information systems strategic orientation and strategic alignment," Information Systems Research, Vol. 8, No. 2, June, 1997, pp. 125 ~ 150.

Chase, R.I., "The knowledge based organization: An international survey," The Journal of Knowledge Management, Vol. 1, No., 1, September, 1997, pp. 38 ~ 49.

Chau, Patrick Y. K and Tam, Kar Yar, "Factors affecting the adoption of open systems: an exploratory study," MIS Quarterly, Vol. 21, No. 1, March, 1997, pp. 1 ~ 23.

Choo, C., The knowledge organization: How organizations use information to construct meaning, create knowledge, and make decisions, Oxford; UK, Oxford University Press, 1998.

Churchill, Gilbert A., "A paradigm for developing better measures of marketing constructs," Journal of Marketing Research, Vol. 16, February, 1979, pp. 64 ~ 73.

Choi, Yong Suk, An empirical study of factors affecting successful implementation of knowledge management, Doctoral Dissertation, University of Nebraska, 2000.

Collis, D. J., and Montgomery, C. A., "Competing on Resources: Strategy in the 1990s," Harvard Business Review, July-August, 1995, pp. 118 ~ 128.

Cooper, Donald. R and Schindler, Pamela S., Business Research Methods. 6th Edition, Irwin, 1998.

Davenport, T. H , "Some principles of knowledge management," 1998, URL:http://www.bus.utexas.edu/kman/kmprin.htm

Davenport, T. H., DeLong, David. W., and Beers, M. C., "Successful knowledge management projects," Sloan Management Review, Vol. 39, No. 2, Winter, 1998, pp. 43 ~ 57.

Davenport, T. H., and Prusak, L., Working knowledge: How organizations manage what they know, Harvard Business School, Boston; Massachusetts, 1998.

Davenport, T. H. and Klahr, P., "Managing customer support knowledge," California Management Review, Vol. 40, No.3, 1998, pp. 195 ~ 208.

Davis, Tim R.V., "Different service firms, different core competences," Business Horizon, September/ October, 1999, pp. 23 ~ 33.

Davis, S., and Botkin, J., "The coming of knowledge-based business," Harvard Business Review, September-October, 1994, pp. 165 ~ 170.

Drew, Stephen., "Building knowledge management into strategy: Making sense of a new perspective," Long Range Planning, Vol. 32, No.1, 1999, pp. 130 ~ 136.

Demerest, M., "Understanding knowledge management," Journal of Long Range Planning, Vol. 30, No. 3,1997, pp. 374 ~ 384.

Drucker, P. F., "The future that has already happened," Harvard Business Review, September - October, 1997, pp. 20 ~ 24.

Duncan, Nancy B., "Capturing flexibility of information technology infrastructure: A study of resource characteristics and their measures," Journal of Management Information System, Vol. 12, No. 2, 1995, pp. 37 ~ 57.

Earl, M. J., Management strategies for information technologies, London: UK, Prentice Hall, 1989.

Ein-Dor, Phillip and Segev, Eli, "Organizational context and MIS structure: Some empirical evidence," MIS Quarterly, Vol. 6, No. 3, September, 1982, pp. 55~ 68.

Fahey, L., and Prusak, L., "The eleven deadliest sins of knowledge management," California Management Review, Vol. 40, No.3, 1998, pp. 265-276.

Feenly, D. F. and Willicocks, L. P., "Core IS capabilities for exploiting information technology," Sloan Management Review, Vol. 39, No. 3, Spring, 1998, pp. 9 ~ 21.

Fried, Louis, "Advanced information technology use: A survey of multinational corporations," Information Systems Management, Spring, 1993, pp. 7 ~ 14.

Fu, Lining, "Knowledge discovery on neural networks," Communications of ACM, Vol. 42, No. 11, November, 1999, pp. 47 ~ 50.

Galagan, Patricia A., "Smart companies," Training & Development, December, 1997, pp. 20-26.

Garvin, D.A., "Building a learning organization," Harvard Business Review, July-August, 1993, pp. 78-91.

Glazer, G., "Measuring the knower: Towards theory of knowledge equity," California Management Review, Vol. 40, No. 3, 1998, pp. 175 ~ 194.

Goslar, M. D. and Grover, Varun, "Communications' place in the organization: A report from corporate IS management," Information Systems Management, Fall, 1992, pp. 22 ~27.

Grant, Robert M., "The knowledge-based view of the firm: Implications for management practice," Long Range Planning, Vol. 30, No. 3, 1997, pp. 450 ~ 454.

Gravetter, F. J. and Wallnau, L. B., Statistics for the Behavioral Science, 4th Edition, West Publishing Company, St. Paul; MN, 1996.

Grover, Varun., "A tutorial on survey research: From construct to theory," 1999, http://theweb.badm.sc.edu/grover/survey/MIS-SUVY.html)

Hair, Joseph. F., Anderson, Rolph. C., Tatham, Ronald. L., and Black, Williams. C., 5th Edition, Multivariate Data Analysis, Prentice Hall, Upper Saddle River, NJ, 1998.

Hansen, M. T., Nohria, N. and Tierney, T., "What's your strategy for managing knowledge?," Harvard Business Review, March-April, 1999, pp.106 ~ 116.

Hargadon, A.B., "Firms as knowledge brokers: Lessons in pursuing continuous innovation," California Management Review, Vol. 40, No. 3, 1998, pp. 209 ~ 228.

Henderson, J.C. and Venkarta, N., "Strategic alignment: Leveraging information technology for transforming organizations," IBM Systems Journal, Vol. 38, No. 2 & 3, 1999, pp. 472 ~ 484.

Huber, G. P., "Organizational learning: The contributing processes and the literatures," Organizational Science, Vol. 2, No. 1, 1991, pp. 88 ~ 115.

Hu, J., Huang, K., Kuse, K., Su, G., and Wang, K., "Customer information quality and knowledge management: A case study using knowledge cockpit," The Journal of Knowledge Management, Vol. 1, No. 3, March, 1998, pp. 225-236.

Hufnagel, Ellen M. and Conca, Christopher, "User response data: The potential for errors and biases," Information Systems Researches, Vol. 5, No. 1, 1994, pp. 48 ~ 73.

Inkpen, A.C., "Learning and knowledge acquisition through international strategic alliances," Academy of Management Executive, Vol.12, No. 4, 1998, pp. 69 ~ 80.

Jordan, Judith and Jones, Penelope, "Assessing your company's knowledge management style," Long Range Planning, Vol. 30, No.3, 1997, pp. 392 ~ 398.

Junnarkar, Bipin, "Leveraging collective intellect by building organizational capabilities," Expert Systems with Applications. Vol. 13, No. 1, 1997, pp. 29~40.

Junnarkar, Bipin and Brown, Carol. V., "Reassessing the enabling role of information technology in KM," Journal of Knowledge Management, Vol. 1, No. 2, December, 1997, pp. 142~148.

Keen, Peter G.W., "Shaping the future: Business design through information technology," Harvard Business School Press, Boston; Massachusetts, 1991.

Kerlinger, F., Foundation of Behavioral Research, 3ed., Holt, Rinehart and Winston, Inc., 1986.

Kim, W.C., and Mauborgne, R., "Fair process: Managing in the knowledge economy," Harvard Business Review, July-August, 1997, pp. 65-75.

Kim, W.C., and Mauborgne, R., "Strategy, value innovation, and the knowledge economy," Sloan Management Review, Vol. 40, No. 3, Spring, 1999, pp. 41-54.

Knight, Kevin, "Mining online text," Communication of ACM. Vol. 42, No. 11, November, 1999, pp. 58~61.

Krogh, G., "Care in knowledge creation," California Management Review, Vol. 40, No.3, 1998, pp. 133 ~ 153.

Leidtka, J. M., Haskins, M. E., Rosenblum, J., and Weber, J., "The generative cycle: Linking knowledge and relationships," Sloan Management Review, Fall, 1997, pp. 47-58. (1997)

Leonard, D. and Sensiper, S., "The role of tacit knowledge in group innovation," California Management Review, Vol. 40, No.3, 1998, pp. 112-132.

Luthans, F., Rubach, M.J., and Marsnik, P., "Going beyond total quality: The characteristics, techniques, and measures of learning organizations," The International Journal of Organizational Analysis , Vol. 3, No.1, 1995, pp. 24-44.

Mahoney, J. T., and Pandian, J. R., "The resource based view within the conversation of strategic management," Strategic Management Journal, Vol. 13,1992, pp. 363-380.

Malhotra, Y., "Knowledge management for the new world of business," 1998. URL: http://www.brint.com/km/whatis.htm

Malhotra, Y., "Role of information technology in managing organizational change and organizational interdependence," 1993. URL: http://www.brint.com/papaers/changes.htm

March, James G., "Exploration and exploitation in organizational learning," Organizational Science, Vol. 2, No. 1, 1991, pp. 71-87.

Markides, Constantinos, "Strategic innovation," Sloan Business Review, Spring, 1997, pp. 9-23.

Matusik, S.F. and Hill, C.W., "The utilization of contingent work, knowledge creation, and competitive advantage," Academy of Management Review, Vol. 23, No. 4, 1998, pp. 680 ~ 697.

McAdam, Rodney and McCreedy, Sandra, "A critical review of knowledge management models," The Learning Organization, Vol. 6, No. 3, 1999, pp. 91 ~ 100.

McKay, David T. and Brockway, Douglas W., "Building IT infrastructure for the 1990s," Stage by Stage (Nolan Norton and Company), Volume 9, Number 3, 1989, pp.1 ~ 11.

Mitchell, T. M., "Machine learning and data mining," Communications of the ACM, Vol. 42, No. 11, November, 1999.

Moore, K. and Birknshaw, J., "Managing knowledge in global service firms: Centers of excellence," Academy of Management Executive, Vol. 12, No. 4, 1998, pp. 81 ~ 92.

Moorman, C. and Miner, A.S., "Organizational improvisation and organizational memory," Academy of Management Review, Vol. 23, No. 4, 1998, pp. 698 ~ 723.

Newman, Victor, "Redefining knowledge management to deliver competitive advantages," The Journal of Knowledge Management, Vo. 1, No. 2, December, 1997.

Niederman, F., Brancheau, J. C., and Weatherbe, J., "Information systems management issues for the 1990s," MIS Quarterly, Vol. 15, No. 4, December, 1991, pp. 474-500.

Nonaka, Ikujiro, "The knowledge creating company," Harvard Business Review, November-December, 1991, pp. 96 ~ 104.

Nonaka, I. & Konono, N., "The concept of "Ba": Building a foundation for knowledge creation," California Management Review, Vol. 40, No.3, 1998, pp. 40 ~ 54.

Nonaka, I. & Takeuchi, H., The knowledge creating company. New York: Oxford University Press, 1995.

Nunally, J. C., Psychometric, 2nd Edition, New York: McGraw Hill, 1978.

Nurmi, R., "Knowledge-intensive firms," Business Horizons, May-June, 1998, pp. 26 ~ 32.

O'Dell, C. and Grayson, C.J., "If only we knew what we know: Identification and transfer of internal best practices," California Management Review, Vol. 40, No. 3, 1998, pp. 154 ~ 174.

Offsey, Steve, "Knowledge management: Linking people to knowledge for bottom line results," Journal of Knowledge Management, Vol. 1, No. 2, 1997.

O'Leary, Daniel E., "Enterprise knowledge management," Computer, March, 1998, pp. 54 ~ 61.

Polanyi, M., Personal knowledge towards a post-critical philosophy, Chicago: University of Chicago Press, 1966.

Porter, M. E., Competitive strategy, New York: The Free Press, 1980.

Post, H. E., "Building a strategy on competences," Long Range Planning, Vol. 30, No. 5, 1997, pp. 733 ~ 740.

Prahalad, C. K., and Hamel, G., "The core competence of the corporation," Harvard Business Review, May-June, 1990, pp. 79 ~ 91.

Quinn, J.B., Anderson, P. and Finkelstein S., "Making the most of the best," Harvard Business Review, March-April, 1996, pp. 71-80.

Quintas, P., Lefere, P. and Jones, G., "Knowledge management: A strategic agenda," Long Range Planning, Vol. 30, No. 3, 1997, pp. 385 - pp. 391.

Reaves, C., Quantitative research for the behavioral science, New York: John Wiley & Sons Inc., 1992.

Rockart, J. F., Earl, M. J., and Ross, Jeanne, "Eight imperatives for the new IT organization," Sloan Management Review, Fall, 1996, pp. 43 ~ 55.

Ross, J. J., Beath, C. M., and Goodhue, D. L., "Develop long term competitiveness through IT assets," Sloan Management Review, Fall, 1996, pp. 31 ~ 42.

Ruggles, R, "The state of the notion: Knowledge management in practice," California Management Review, Vol. 40, No.3, 1998, pp. 80 ~ 89.

Sarvary, Miklos, "Knowledge management and competition in the consulting industry," California Management Review, Vol. 41, No. 2, Winter, 1999, pp. 95 ~ 107.

Schwab, Donald P., "Construct validity in organizational behavior," Research in Organizational Behavior, Vol. 2, 1980, pp. 2 ~ 43.

Senge, P. M., "The leader's new work: Building learning organizations," Sloan Management Review, Vol. 32, No. 1, 1990, pp. 7 ~ 23.

Senge, P.M., The fifth principle: The art and practice of the learning organization, New York: Doubleday/Currency, 1990.

Skyrme, David J., "Knowledge management: Making sense of an oxymoron," 1997. http://www.skyrme.com/insights/22km.htm.

Skyrme, David J., Knowledge networking: Creating the collaborative enterprise, Massachusetts, Butterworth and Heinemann, 1999.

Star, Susan L. and Ruhler, Karen., "Steps toward an ecology of infrastructure: Design and access for large information spaces," Information Systems Research. Vol. 7, No. 1, March 1996, pp. 11 ~ 134.

Starbuck, W.H., "Learning by knowledge-intensive firms," Journal of Management Studies, Vol. 29, No. 6, 1992, pp.713 ~ 740.

Straub, Detmar W., "Validating instruments in MIS research," MIS Quarterly, Vol. 13, No. 2, June, 1989, pp. 147 ~ 169.

Sveby, K., The new organizational wealth, San Francisco: Berrett-Koehler, 1997.

Syed, Jaffler R., "An adoptive framework for knowledge work," Journal of Knowledge Management, Vol. 2, No. 2, December, 1998, pp. 59 ~ 69.

Szulanski, G., Intra-firm transfer of best practices project. New Jersey: American Productivity & Quality Center, 1994.

Telleen, S.L., The IntraNet architecture: Managing information in the new paradigm, 1996. URL: http://www.amdahl.com/doc/products/bsg/intra/infra.html

Teece, D.J., "Capturing value from knowledge assets: The new economy, markets for know-how, and intangible assets," California Management Review, Vol. 40, No. 3, 1998, pp. 55 ~ 79.

Trussler, Simon, "The rules of the game," Journal of Business Strategy. January/ February, 1997, pp. 16 ~ 19.

Turban, E., McLean, E., and Weatherbe, J., Information technology for management: Making connections for strategic advantages, Wiley: New York, 1999.

Weil, Peter and Broadbent, Marianne, Leveraging the new infrastructure: How market leaders capitalize on information technology, Boston, Massachusetts: Harvard Business School Press, 1998.

Wernerfelt, B., "A resource based view of the firm," Strategy Management Journal, Vol. 5, 1984, pp. 171 ~ 180.

Wiig, Karl M., "Knowledge management: Where did it come from and where will it go?," Expert System with Applications, Vol. 13, No. 1, 1997, pp 1 ~ 14.

Yu, J and Cooper, H , "A qualitative review of research design effects in response rate to questionnaire," Journal of Marketing Research, Vol. 36, 1983, pp. 36 ~ 44.

Zack, M. H., "Managing codified knowledge," Sloan Management Review, Summer, 1999, pp. 45 ~ 58.