KNOWLEDGE MANAGEMENT AND KNOWLEDGE MANAGEMENT SYSTEMS: CONCEPTUAL FOUNDATIONS AND RESEARCH ISSUES

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Abstract

Knowledge is a broad and abstract notion that has defined epistemological debate in western philosophy since the classical Greek era. In the past few years, however, there has been a raging interest in treating knowledge as a significant organizational resource. The heightened interest in organizational knowledge and knowledge management stems from the transition into the knowledge economy, where knowledge is viewed as the principle source of value creation and sustainable competitive advantage. Consistent with the growing interest in organizational knowledge and knowledge management (KM), recently IS researchers have been promoting a class of information systems, referred to as knowledge management systems (KMS). The objective of KMS is to support construction, sharing and application of knowledge in organizations. Knowledge and knowledge management are complex and multi-faceted concepts. Thus, effective development and implementation of KMS requires a foundation in several rich literatures.

We believe that to be credible, KMS research and development should preserve and built upon the significant literature that exists in different but related fields. We have promoted this view in this paper by providing a review and interpretation of knowledge management literatures in different fields with an eye towards identifying the important areas for future research. Next, we have presented a detailed process-view of organizational knowledge management with a focus on the potential role of IT in this process. The paper concludes with a discussion of major research questions that emerge from the review of literature as well as the process-view of KM.

It is our contention that in large and global firms information technologies (in form of KMS) will be interlaced with organizational knowledge management strategies and processes. We therefore believe that the KMS should and will receive considerable scholarly attention and will become a focal point of inquiry. It is our hope that the ideas, discussion, and the broad research issues set forth in this paper contributes to future work in the knowledge management area by IS researchers.

Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues

"In post-capitalism, power comes from transmitting information to make it productive, not from hiding it."
(Drucker, 1995)

1. INTRODUCTION

A knowledge-based perspective of the firm has recently emerged in the strategic management literature (Wilson, 1991; Nonaka and Takeuchi, 1995; Spender, 1996; Cole 1998). This perspective builds upon and extends the resource-based theory of the firm initially promoted by Penrose (1959) and expanded by others (Barney 1991; Conner, 1991; Wernerfelt, 1984). According to Penrose, it is not so much the tangible resources (e.g., capital and facilities) per se that creates the firm's competitive advantage, but the services rendered by those resources. Moreover, the resource-based view maintains that differences in external factors, such as industry conditions, do not explain long-term differences in profitability (Peteraf, 1993). In order to contribute to sustainable competitive advantage, resources must be valuable, rare, and imperfectly imitable (Barney, 1991). Inimitability stems from several potential characteristics of a resource, including social complexity (such as an organization's culture), causal ambiguity, and historical conditions (Barney, 1991). Miller and Shamsie (1996) consider resources as being property-based or knowledge-based. Legally controlled by a specific firm, property-based assets can provide competitive advantage until the market changes such that the asset is no longer valued. Knowledge-based assets, on the other hand, are protected from imitation not legally, but because they are often subtle or difficult to understand or copy by outside observers.

The knowledge-based perspective postulates that the services rendered by tangible resources depend on how they are combined and applied, which is in turn a function of the firm's know-how (i.e., knowledge). This knowledge is embedded in and carried through multiple entities including organization culture and identity, routines, policies, systems, and documents, as well as individual employees (Grant 1996; Nelson and Winter 1982; Spender, 1996). Because knowledge-based resources are usually difficult to imitate and socially complex, the knowledge-based extension of the resource-based view of the firm posits that these knowledge assets may produce long-term sustainable competitive advantage. However, it is less the knowledge existing at any given time per se, than the firm's ability to effectively apply (i.e., manipulate, store, and distribute) the existing knowledge and create new knowledge, that forms the basis for achieving competitive advantage from knowledge-based assets. It is here that information technologies have an important role to play in effectuating the knowledge-based view of the firm. Modern information technologies (e.g., the Internet, intranets, extranets, browsers, data warehouses, data mining techniques, and software agents) can be used to systematize, enhance, and expedite large-scale intra- and inter-firm knowledge management.

The concept of coding, storing, and transmitting knowledge in organizations is not new--training and employee development programs, organizational policies, routines, procedures, reports, and manuals have served this function for years (Alavi and Leidner, 1999). For example, the McDonald's restaurant's operating manual captures almost every aspect of the restaurant management, including cooking, nutrition, hygiene, marketing, food production, and accounting. By capturing, codifying, and disseminating this knowledge, the company reduces the level of required restaurant management know-how

for its managers while improving the effectiveness and efficiency of its operations (Peters, 1994).

The recent interest in knowledge management and knowledge management systems, in our view, has been fueled by the transition into the information age and the theories of knowledge as the primary source of economic rent. Parallel to research and theoretical developments, organizational and managerial practice has lately become more knowledge-focused. For example, benchmarking, knowledge audits, best practice transfer, and employee development point to the realization of the importance of organizational knowledge and intangible assets in general (Grant, 1996; Spender, 1996). The emergent patterns of literature and research as well as practice in the field imply the central role of knowledge as the essence of the firm. Already, one in ten firms surveyed in a recent study claimed that knowledge management was transforming the way their organization did business and 43% claimed to have a knowledge management initiative in place (KPMG 1998a). Given the importance of organizational knowledge, our objective is to synthesize the relevant and knowledge-centered work from multiple disciplines that in our view contribute to and shape our understanding of knowledge management and knowledge management systems in organizations.

The paper is organized as follows: Section 2 presents a review of the management literature on knowledge, knowledge management, and knowledge management systems. This section purports to provide a comprehensive summary of the existing literature with a view of identifying the important areas for future research. Section 3 adopts the process view of knowledge management, introduced in Section 2, and presents this view in detail with an eye towards identifying the potential role of information technologies in the various stages of the knowledge management process. Section 4 highlights the major

research questions that emerge from the review of the literature as well as the process-view of knowledge management. The research questions are intended to provide a basis for future research. Section 5 provides a discussion and summary of the paper.

2. KNOWLEDGE AND THE FIRM: AN OVERVIEW AND BASIC CONCEPTS

From the knowledge based perspective of the firm, the firm can be seen as a knowledge system engaged in knowledge creation, storage, transfer, and application. This perspective is consistent with the definition of organizational cognition as the ability to acquire, store, transform, and utilize knowledge. Note that in this definition, cognition is abstracted from the physical and biological system in which these abilities are supposed to be embedded (Schneider and Angleman, 1993). Therefore, cognition and knowledge can be translated to and analyzed at the individual and group as well as at the organizational level. The knowledge-based perspective of the firm leads to the following important question: what is knowledge and how can organizations effectively manage it?

2.1 What is Knowledge?

The question of defining knowledge has occupied the minds of philosophers since the classical Greek era and has led to many epistemological debates. It is unnecessary for the purposes of this paper is not to get engaged in a debate to probe, question or reframe the term knowledge, or discover the "universal truth," from the perspective of ancient or modern philosophy. This is because such an understanding of knowledge was neither a determinant factor in building the knowledge-based theory of the firm nor in triggering researcher and practitioner interest in managing organizational knowledge. It is; however, useful to consider the manifold views of knowledge as discussed in the information technology (IT), strategic management, and organizational theory literature.

This will enable us to uncover some unstated assumptions about knowledge that underlie the knowledge-based theory of the firm and the knowledge management processes. We will begin by considering definitions of knowledge.

Some authors, most notably in IT literature, address the question of defining knowledge by distinguishing among knowledge, information, and data. The assumption seems to be that if knowledge is not something that is different from data or information, then there is nothing new or interesting about knowledge management (Fahey and Prusak, 1998). For example, Vance (1997) defines information as data interpreted into a meaningful framework whereas knowledge is information that has been authenticated and thought to be true. Maglitta (1996) suggests that data is raw numbers and facts, information is processed data, and knowledge is "information made actionable." Machlup (1983) makes a distinction between information and knowledge by referring to information as a flow of messages and meaning, which may increase, or revise the knowledge of the recipient. Dreske (1981) defines information as the raw material for production of knowledge (a newly formed, or sustained belief). The Cranfield University study of knowledge management in Europe posits that the key difference between information and knowledge is that the receiver must trust the source of knowledge, although the same can really be said of information. Some EIS (executive information systems), for example, labeled the source of the information so that managers would be able to trust, or not trust, the information based upon their opinion of the source. These definitions are useful in that they all make inroads into understanding differences among data, information and knowledge and may thereby hold relevance for requirements analysis in knowledge management systems. However, these definitions fall short of providing a means to readily determine when information has become knowledge.

The problem appears to be the presumption of a hierarchy from data to information to knowledge with each varying along some dimension, such as context, usefulness, or interpretability. Such hierarchies rarely survive scrupulous evaluation. For example, Swan, Newell, and Galliers (1999) use the analogy of train schedules to explain the differences of data, information, and knowledge. They suggest that a train timetable is data; a platform announcement that the next train to the desired location leaves in 5 minutes is information; a passenger's realization that the first train to reach the destination may not be the first to leave is knowledge. Supposing an individual desires to leave on the train that will have him arrive in Brussels from Paris as soon as possible, the train timetable may very well provide information as opposed to merely data since it will enable him to deduce which train to take to meet his needs. Moreover, his awareness that the first train to leave may not be the first to arrive in Brussels is knowledge only if it is in fact accurate and moreover, this is information contained in the timetable. So, again, the apparent "data" of the timetable is in fact "knowledge" when assimilated by our Brussels passenger. What is then key to effectively distinguishing between information and knowledge is not found in the content, structure, accuracy, or utility of the supposed information or knowledge. Rather, knowledge is information possessed in the mind of individuals: it is personalized information (which may or may not be new, unique, useful, or accurate), related to facts, procedures, concepts, interpretations, ideas, observations and judgments. Using the above example, if every ten minutes our passenger must consult the timetable because he is unable to remember the time his train departs, then he has not acquired knowledge. But if, after consulting his timetable containing information, he is able to recall at what time and from what platform his train departs,

then he has acquired some knowledge. Granted, this knowledge has an ephemeral utility -- the moment he departs, it is no longer useful.

As Fahey and Prusak (1998) suggest, knowledge does not exist independently of a knower: it is shaped by one's needs as well as one's initial stock of knowledge. Knowledge is the result of cognitive processing triggered by the inflow of new stimuli. Consistent with this view, we posit that knowledge is not a radically different concept from information. Information is converted to knowledge once it is processed in the mind of individuals and knowledge becomes information once it is articulated and presented in the form of text, graphics, words, or other symbolic forms. This is also consistent with Churchman's (1971) conceptualization of knowledge and his statement that "knowledge resides in the users and not in the collection [of information]." An important implication of this definition of knowledge is that systems designed to support knowledge in organizations may not appear radically different from standard information systems, but will be geared toward enabling users to assimilate information into knowledge.

Rather than defining knowledge in relation to information and data, others define knowledge as either (1) a state of mind, (2) an object, (3) a process, (4) a condition of having access to information, or (5) a capability. Schubert (1998) suggests that knowledge is "a state or fact of knowing" with knowing being a condition of "understanding gained through experience or study; the sum or range of what has been perceived, discovered, or learned." From this perspective, knowledge is a cognitive state or state of mind. McQueen (1998) echoes this view, claiming that knowledge is "understanding". According to this perspective, it is not possible to mechanize knowledge. As such, the role of information technology in knowledge management is to

provide capabilities for searching and retrieving information so that individuals can expand their personal knowledge and apply this to the organization's needs.

Several authors adopt the view of knowledge as an object or as a process (Zack, 1998a, McQueen, 1998; Carlsson et al, 1998). Zack (1998a) suggests that knowledge can be viewed as either a thing to be stored and manipulated (i.e., an object) or as a process of simultaneously knowing and acting--applying expertise. The fourth view of knowledge is that of a condition of access to information (McQueen, 1999). According to this view, organizational knowledge must be developed and organized to facilitate access to and retrieval of content. As such, this view may be thought of as an extension of the view of knowledge as an object, with a special emphasis on the accessibility of the knowledge objects. Carlsson et al, (1998) add another view, that of knowledge as a capability. Accordingly, knowledge can be viewed as a capability with the potential for influencing future action. According to Carlsson et al (1998), the different views of knowledge lead to different perceptions of knowledge management. The view of knowledge as an object or information access suggests a perspective of knowledge management that focuses on building and managing knowledge stocks. Viewing knowledge as a process implies a focus on the knowledge flow and processes of creation, sharing, and distribution of knowledge. The view of knowledge as a capability suggests a knowledge management perspective centered on building core competencies, and understanding the strategic advantage of know-how, and creation of intellectual capital.

According to Schultz (1998), the view of knowledge adopted corresponds to a researcher's methodological stance with functionalists adopting a view of knowledge as an object, interpretivists viewing knowledge as a process, and criticalists viewing knowledge as a cognitive state and capability. The major implication of these various

conceptions of knowledge is that each perspective suggests a different strategy for managing the knowledge and a different perspective of the role of systems in support of knowledge management. Table 1 summarizes the definitions of knowledge and the implications of the various definitions for organizational knowledge management.

Table 1: Knowledge Definitions and Their Implications

Definition of Knowledge		**Implications for Knowledge Management (KM)**	**Implications for Knowledge Management Systems (KMS)**
Knowledge vis a vis Data and Information	Data is facts, raw numbers Information is processed/interpreted data Knowledge is personalized information	KM focuses on exposing individuals to potentially useful information and facilitating assimilation of information	KMS will not appear radically different from existing IS, but will be extended toward helping in user assimilation of information
State of Mind	Knowledge is the state of knowing and understanding	KM focuses on exposing individuals to potentially useful information and facilitating assimilation of information	Impossible to mechanize state of knowing. Role of IT to provide sources of knowledge rather than knowledge itself.
Object	Knowledge are objects to be stored and manipulated	Key KM issue is building and managing knowledge stocks	Role of IT involves gathering, codifying, and storing knowledge
Process	Knowledge is a process of applying expertise	KM focus is on knowledge flows and the process of creation, sharing, and distributing knowledge	Role of IT to provide link among sources of knowledge to create wider breadth and depth of knowledge flows
Access to Information	Knowledge is a condition of access to information	KM focus is organized access to and retrieval of knowledge content	Role of IT to provide effective search and retrieval mechanisms for locating relevant information
Capability	Knowledge is the potential to influence action	KM is about building core competencies and understanding strategic know-how	Role of IT is to enhance intellectual capital by supporting development of individual and organizational competencies

Considering the many views of knowledge and lack of consensus of how best to define knowledge, we have adopted a definition that in our judgment leads to a workable notion of knowledge management and knowledge management systems in organizational settings. The adopted definition, based on the work of Nonaka (1994) and Huber (1991), is: *knowledge is a justified belief that increases an entity's capacity for taking effective action.* The term entity in this definition may refer to an individual, or a collectivity (e.g., an organization). The term action may refer to physical skills (e.g., playing tennis, or carpentry), cognitive/intellectual capability (e.g., problem solving), or both (e.g., surgery which involves both manual skills as well cognitive competency in terms of knowledge of human anatomy and medicine).

Two major points emerge from this discussion: (1) Because knowledge is personalized, in order for an individual's or a group's knowledge to be useful for others, it must be expressed and communicated in such a manner as to be interpretable by the receivers. (2) Hoards of information are of little value; only that information which is actively processed in the mind of individuals through a process of reflection, enlightenment or learning can be useful. An important corollary of these two points from an information systems development and implementation perspective, as Brown and Duguid (1998) note knowledge may be "sticky" (hard to transfer) and thus will not necessarily circulate freely in the firm just because the technology to communicate and access information is made available.

Indeed, studies on such technologies as LotusNotes have not shown a change in organizational knowledge sharing and transfer. Rather, some of these studies have shown that organizational members who tended to communicate regularly and frequently without Notes communicated regularly and frequently with Notes whereas members who

communicated less regularly and frequently before the implementation of Notes continued to communicate less regularly and frequently (Vandenbosch and Ginzberg, 1997). Hence, in the absence of a knowledge management strategy, technologies that facilitate communication and information storage and retrieval, may have only a marginal effect on organizational knowledge flows. Thus, information systems designed for support and augmentation of organizational knowledge management need to complement and enhance the knowledge management activities of individuals and the collectivity. To achieve this, the design of information systems should be rooted in and guided by an understanding of the nature of knowledge and the organizational knowledge management processes. The taxonomies of knowledge are described next and the organizational knowledge management processes are discussed in Section 3.

2.2 Taxonomies of Knowledge

Drawing on the work of Polanyi (1962,1967), Nonaka (1994) has identified two dimensions of knowledge in organizations: tacit and explicit. According to Nonaka, the tacit dimension of knowledge (from here on referred to as tacit knowledge) is rooted in action, experience, and involvement in a specific context. Tacit knowledge is comprised of both cognitive and technical elements (Nonaka, 1994). The cognitive element refers to an individual's mental models consisting of mental maps, beliefs, paradigms and viewpoints. The technical component consists of concrete know-how, crafts and skills that apply to a specific context. An example given is knowledge of the best means of approaching a particular customer--using flattery, using a hard sell, using a no-nonsense approach. The explicit dimension of knowledge (from here on referred to as explicit

knowledge) is articulated, codified and communicated in symbolic form and/or natural language.

Classification of knowledge based on Nonaka's dimensions of tacit and explicit has been widely cited, yet a danger of this classification is the seeming assumption that tacit knowledge is more valuable than explicit knowledge. In essence, this is tantamount to equating an inability to articulate knowledge with its worth. Others, such as Cole (1998), further assume that tacit knowledge is more complex than explicit, simply because it has not been articulated. However, few would question the complexity of diagnosing meningitis as compared with writing a freshman English essay, yet the former has been made explicit in an expert system whereas the latter remains mostly unarticulated. Snyder (1998) even suggests that an expert is an expert to the extent that he has a "vast reservoir of tacit knowledge" in a given situation. Again, doctors are "experts" in their particular specialties, yet modern medicine is to a large extent a highly explicit science. Junnarkar and Brown (1998) suggest that "tacit knowledge is that which is implied but not actually documented" assuming that it is tacit not because one is unable to articulate it, but because it has not yet been documented. This perspective is more useful in that some tacit knowledge may be more valuable when made explicit than other. Thus, a goal of knowledge management would not be to explicate tacit knowledge per se but to first assess the existing tacit knowledge and determine that which has the most value before trying to make it explicit.

Few venture to suggest that explicit knowledge is more valuable than tacit knowledge. Organizational theory researchers in particular may prefer to ignore this possibility in that it does suggest a technology enabled knowledge management process (technology being used to aid in explicating, storing and disseminating knowledge).

Bohn (1994), however, does take the less popular path of arguing that knowledge is valuable to the extent that it is explicit. He suggests that knowledge exists on a scale of complete ignorance, to awareness (tacit), to measures, to control of the mean (written and embodied in processes), to process capability, to process characterization, to know-why (scientific formulas and algorithms), to complete knowledge.

In addition to the tacit-explicit distinction of knowledge, on a separate dimension (referred to as the ontological dimension) Nonaka (1994) has identified two other types of knowledge: individual and social knowledge. Individual knowledge is created by and exists in the individual, and social knowledge is created by and is inherent in the collective actions and interactions of individuals acting as a group. A similar classification of knowledge is provided by Spender's (1992,1996-c) matrix of knowledge types. In Spencer's matrix presentation, knowledge is classified along two dimensions of tacit-explicit and individual- social, leading to four types of knowledge. Conscious knowledge refers to explicit knowledge of an individual (e.g., knowing facts or syntax of a programming language). Automatic knowledge refers to individual's tacit knowledge and subconscious skills (e.g., riding a bicycle). Objectified knowledge is explicit and codified knowledge of a social system (e.g., a firm's operating manuals and formal rules and policies). The collective knowledge consists of tacit knowledge held in a social system and is inherent in its processes and interactions (e.g., organizational culture).

Another classification of knowledge that does not rely on the tacit-explicit nomenclature refers to knowledge as declarative (know-about), procedural (know-how), causal (know-why), conditional (know-when), and relational (know-with) (Zack, 1998c). Declarative or factual knowledge is elsewhere referred to as knowledge by acquaintance (Nolan Norton, 1998). Others take what we would label a pragmatic approach to

classifying knowledge, ignoring the recondite subtleties inherent in defining differences among data, information, and knowledge and viewing knowledge is an object rather than a condition, capability, cognitive state, or process. The pragmatic classification is interested in identifying types of knowledge that are most useful to organizations rather than distinguishing among the types of knowledge using abstruse labels. Swan et al (1998) defines knowledge as " experience, facts, rules, assertions and concepts about their subject areas that are crucial to the business (customers, markets, processes, regulations)." KPMG 1998a defines knowledge quite simply as knowledge about customers, products, processes, and competitors, which may be locked away in people's minds or filed in electronic form. Huang (1998) defines knowledge as "intellectual capital" which includes best practices, know-how and heuristic rules, patterns, software code, business processes, and models; architectures, technology, and business frameworks; project experiences (proposals, work plans, and reports); tools used to implement a process such as checklists, surveys. Im and Hars (1998) define knowledge as consisting of components, frameworks, and patterns. Components consist of objects, such as document templates and engineering drawings that are outputs of problem-solving activities and can be used in narrow problem areas. Frameworks, such as market reports and manuals, cover a wide range of problems and are also outputs of problem solving activities. Patterns consist of general internal principles such as best and worst practices, and lessons applicable to broad areas.

Taxonomies of knowledge and the corresponding examples are displayed in Table 2. The utility of classifying knowledge lies in the importance of assessing an organization's knowledge position vis a vis competitors and cataloging its existing intellectual resources (Zack 1998b). Such distinctions are useful for managing

knowledge once a knowledge strategy has been formulated (Zack 1998b) and in evaluating the role of information technology in facilitating knowledge management. In the information systems (IS) field, it has been common to primarily design systems focused on the codified knowledge (that is, explicit organizational knowledge). Management reporting systems, decision support systems, and executive support systems have all focused on collection and dissemination of this knowledge type. Knowledge management systems may provide an opportunity for extending the scope of IT-based knowledge provision to include different knowledge types shown in Table 2.

Table 2: Knowledge Taxonomies and Examples

Knowledge Types	**Definitions**	**Examples**
Tacit	Knowledge is rooted in actions, experience, and involvement in specific context	Best means of dealing with specific customer
Cognitive Tacit:	Mental Models	
Technical Tacit:	Know-how applicable to specific work	
Explicit	Articulated, generalized knowledge	Knowledge of major customers in a region
Individual	Created by and inherent in the individual	Insights gained from completed project
Social	Created by and inherent in collective actions of a group	Norms for inter-group communication
Conscious	Explicit knowledge of an individual	Syntax of a programming language
Automatic	Individual's tacit, subconscious knowledge	Riding a bike
Objectified	Codified knowledge of a social system	An operating manual
Collective	Tacit knowledge of a social system	Organization culture
Declarative	Know-about	What drug is appropriate for an illness
Procedural	Know-how	How to administer a particular drug
Causal	Know-why	Understanding how the drug works
Conditional	Know-when	Understanding when to prescribe the drug
Relational	Know-with	Understanding how the drug interacts with other drugs
Pragmatic	Useful knowledge for an organization	Best practices, business frameworks, project experiences, engineering drawings, market reports

The knowledge taxonomies described in this section illustrate the multi-faceted nature of organizational knowledge and highlight the variety of knowledge that coexists in organizational settings. It is important to also note that these knowledge taxonomies do not represent pure and mutually exclusive categories in that they are mutually constituted and highly interdependent. For example, Polanyi (1975) has stated that explicit knowledge is always grounded on a tacit component and vice versa. Nonaka and Takeuchi (1995) discuss the conversion modes between tacit and explicit knowledge (described in more detail in Section 3.1) and the "spiral" of knowledge creation in which individual knowledge is amplified by flowing through individual, group, and organizational levels. According to Spencer (1996, pp. 50), "the boundary between the explicit and tacit type of knowledge is both porous and flexible, so there is traffic between the domains."

An understanding of the concept of knowledge and knowledge taxonomies is important because theoretical developments in the knowledge management area are influenced by the distinction among the different types of knowledge. Furthermore, the knowledge taxonomies discussed here can inform the design of knowledge management systems by calling attention to the need for support of different types of knowledge and the traffic and flows among these different types.

2.3 Knowledge Management in Organizations

The recent interest in organizational knowledge has prompted the issue of managing the knowledge to the organization's benefit. Knowledge management is a process of identifying, capturing, and leveraging the collective knowledge in an organization to help the organization compete (von Krough, 1999). Knowledge

management is purported to increase innovativeness and responsiveness (Hackbarth, 1998). A recent survey of European firms by KPGM Peat Marwick (Nolan Norton, 1998a) found that almost half the companies reported to have suffered significant damage from losing key staff with 43% experiencing impaired client or supplier relations and 13% facing a loss of income because of the departure of a single employee. Forty-nine percent stated that knowledge of the best practice in a specific area of operations had been lost when an employee left the company. In another survey, the majority of organizations (61%) believed that much of the knowledge they needed existed inside the organization, but that identifying that it existed, finding it, and leveraging it remained problematic (Cranfield University, 1998). Elsewhere, respondents reported that the less critical the type of knowledge was to an organization's business, the easier it was to locate (KPMG, 1998a). With such problems identifying, locating, and applying knowledge, organizations are undertaking systematic processes to manage knowledge. The primary goals of knowledge management as reported in a sample of organizations are: better decision making (86%), faster response time to key issues (67%), increasing profitability (53%), improving productivity (67%), creating new/additional business opportunities (58%), reducing costs (70%), sharing best practice (60%), increasing market share (42%), increasing share price (23%), and better staff attraction/retention (42%). (KPMG, 1998a).

According to Davenport and Prusak (1997), most knowledge management projects have one of three aims: (1) to make knowledge visible and show the role of knowledge in an organization, mainly through maps, yellow pages, and hypertext tools; (2) to develop a knowledge-intensive culture by encouraging and aggregating behaviors such as knowledge sharing (as opposed to hoarding) and proactively seeking and offering

knowledge; (3) to build a knowledge infrastructure--not only a technical system, but a web of connections among people given space, time, tools, and encouragement to collaborate.

Although some organizations claim to have been engaged in knowledge management for more than 10 years, albeit they did not refer to it as knowledge management (Cranfield University, 1998), there is little evidence of firms systematically evaluating the outcomes (Alavi and Leidner, 1999). Some studies suggest that knowledge management enables firms to improve the quality of customer solutions, establish consistent solutions to the same types of problems, increase first-call resolution to customer problems, reduce field service calls, and become more customer oriented (Davenport and Klahr, 1999). The perceptual evidence yields marked improvements from knowledge management (KM) initiatives: KPMG reports that 86% of firms in a study reported better decision making following KM initiatives, 66% reported faster response time, 67% reported improved productivity, and 70% reported reduced costs. Over half claim to have experienced increased profit. Benefits were also perceived in such areas as creating new business opportunities and better staff retention (KPMG, 1998a). Another study found fewer firms reporting such success, with 50% perceiving cost/time reduction and productivity increase, 19% reporting process improvement; 18%, customer orientation and satisfaction; 17% better decisions and forecasts; 15%, improvement in the exchange of information; 13%, quality improvement; 8%, market leadership; and 8%, staff qualifications and satisfaction (Tan et al, 1998). In certain areas, such as software code reuse, the benefits to software development productivity and quality are readily identified (Yap and Bjorn-Andersen. 1998). Improving customer service is a primary motivation behind many KM initiatives. Yap and Bjorn-Andersen (1998) gives the

example of a firm using a knowledge management process to make the same technical product knowledge available to all of its global sales force. The idea was to make the same knowledge in terms of content and media representation available to sales people in Europe as that accessed by sales people in the remotest regions of Asia. This provided all sales people a more equalized level of competence to carry out their tasks/functions. Despite a number of firms reporting benefits from knowledge management, others suggest that the primary benefit to be obtained from knowledge management is long-term. The Cranfield university study (1998) reports that the primary function targeted by knowledge management--research and development-- and the overall reason for knowledge management--obtaining competitive advantage--was not the kind of benefit obtained rapidly.

2.3.1. Knowledge management processes

Having broadly defined knowledge management and its organizational applications and outcomes, we now consider the process of managing knowledge. While there is debate as to whether knowledge itself is a process, an object, a cognitive state etc., knowledge management is mostly considered as a process. Discrepancies in the literature appear in the delineation of the knowledge management processes. Davenport, Jarvenpaa and Beers (1996) present four key processes: finding existing knowledge, creating new knowledge, packaging knowledge created, externally using existing knowledge. KPMG (1998b) presents seven processes involved in knowledge management: creation, application within the organization (for example in problem-solving), exploitation outside the organization (for example, selling intellectual property), sharing and dissemination, encapsulation (capturing and recording experience and know-

how), sourcing (locating a person or record embodying the required knowledge), and learning. Teece (1998a) considers eight basic processes: 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 incentives, transferring existing knowledge into other parts of the organization, and measuring the value of knowledge assets and/or impact of knowledge management. And The Cranfield University study (1998) identifies ten processes: creating new knowledge, finding knowledge internally, acquiring knowledge externally, having the knowledge, processing the knowledge, re-using the knowledge, applying the knowledge to some benefit, updating knowledge, sharing knowledge internally, and sharing knowledge outside the organization. These views of knowledge management share the process perspective and tend to include four major processes into which the more detailed processes can be included. The four major processes consist of the process of creating the knowledge (including knowledge maintenance and updating), the process of storing and retrieving the knowledge, the process of transferring (sharing) the knowledge, and the process of applying the knowledge. We will return to these four processes in Section 3.

2.4 Knowledge Management Systems

While not all KM initiatives involve the implementation of IT and admonitions against an emphasis on IT at the expense of the social and cultural facets of KM are not uncommon (Davenport and Prusak, 1997; O'Dell and Grayson, 1998; Malhotra, 1998), many KM initiatives rely on IT as an important enabler. Those who posture against the application of IT to KM do so on the basis that the important organizational knowledge is

too complex to be captured electronically, that the incentives for and barriers to sharing knowledge are not really technical (O'Dell and Grayson, 1998), and that knowledge repositories ignore the critical social and interactive nature of knowledge creation (Malhotra, 1998). It is argued that meaning and knowledge can only be achieved "through dialogue in a human community."(Malhotra, 1998) Yet these views are myopic in their vision of the various ways IT can be applied to aid knowledge management. IT can support KM in sundry ways. Examples include: finding an expert or a recorded source of knowledge using online directories and searching databases; sharing knowledge and working together in virtual teams; access to information on past projects; and learning about customer needs and behavior by analyzing transaction data (KPMG, 1998b), among others. Indeed, there is no single role of IT in knowledge management just as there is no single technology comprising KMS.

There are three common applications of IT to organizational knowledge management initiatives: (1) the coding and sharing of best practices, (2) the creation of corporate knowledge directories, and (3) the creation of knowledge networks.

One of the most common applications is internal benchmarking with the aim of transferring internal best practices (O'Dell and Grayson, 1998; KPMG, 1998b). For example, an insurance company was faced with the commodization of its market and declining profits. The company found that by applying the best decision making expertise via a new underwriting process supported by a knowledge management system enabled it to move into profitable niche markets and hence, to increase income (KPMG, 1998b).

Another common application of knowledge management is the creation of corporate directories, also referred to as the mapping of internal expertise. Because much knowledge in an organization remains uncodified, mapping the internal expertise is a

potentially useful application of knowledge management (Ruggles, 1998). One survey found that 74% of respondents believed that their organization's best knowledge was inaccessible and 68% thought that mistakes were reproduced several times (Gazeau, 1998). Decision-making performance is adversely affected since the best knowledge is not available to those who need it (KPMG, 1998b). Such perceptions of the failure to apply existing knowledge is an incentive for mapping internal expertise. For example, a commercial bank needed to be able to put together its expertise from around the world on different industries, territories and financial instruments quickly and efficiently in order to compete for a corporate finance business. By developing and publishing a sophisticated directory identifying experts and their subjects, the bank estimated that the directory would increase the deal success rate by 1% with a 10% return on the investment (KPMG, 1998b).

A third common application of knowledge management systems is the creation of knowledge networks (Ruggles, 1998). For example, when Chrysler reorganized from functional to platform-based organizational units, they realized quickly that unless the suspension specialists could communicate easily with each other across platform types, expertise would deteriorate. Chrysler formed Tech Cul, bridging people together virtually and face-to-face to exchange and build their collective knowledge in each of the specialty areas. In this case, the knowledge management effort was less focused on mapping expertise or benchmarking as it was on bringing the experts together so that important knowledge was shared and amplified. Providing online forums for communication and discussion may form knowledge networks. Buckman uses an online interactive forum where user comments are threaded in conversational sequence and indexed by topic, author, and date. This has reportedly enabled Buckman to respond to

the changing basis of competition that has evolved from merely selling products to solving customers' chemical treatment problems (Zack, 1998a). In another case, Ford found that just by sharing knowledge, the development time for cars was reduced from 36 to 24 months, and through knowledge sharing with dealers, the delivery delay reduced from 50 to 15 days (Gazeau, 1998).

For those using technologies with KM in mind, the objectives are varied. For example, one firm described in Yap and Bjorn-Andersen (1998) captured essential product and marketing knowledge, linked and stored the knowledge in one multi-purpose knowledge repository, and then made it equally accessible to all sales channels worldwide. The firm achieved its goal of providing an omnipresent body of technical knowledge that fully supported its global marketing efforts. AXA Courtage used technologies to support a career management system. Online tests are available to ascertain the needed competencies of the individual and suggest appropriate training. The intent is to then link the application with partner training organizations via an extranet (Gazeau, 1998). The system enhanced organizational knowledge acquisition by facilitating development of personnel competencies by first identifying the required knowledge and then providing access to the appropriate training sources. Workflow management systems are another application of technologies to support KM (Zhao, 1998). Such systems contain several different types of knowledge, including descriptions of tasks, roles, rules and routines; descriptions of business procedures and regulations; and descriptions of relevant government regulations, industrial associations, competitors, and customers (Zhao, 1998). Other uses, such as that of Legrand, apply technologies to shorten product development cycles. Legrand uses case-based reasoning applied to

databases of product information to enable product designers to reuse the experiences of past designers on similar products and to more rapidly estimate costs (Gazeau, 1998).

3. ORGANIZATIONAL KNOWLEDGE MAMAGEMENT PROCESSES: A FRAMEWORK FOR ANALYSIS OF INFORMATION SYSTEM'S ROLE

In this section, we develop a systematic framework that will be used to further analyze and discuss the potential role of information technologies in organizational knowledge management. This framework is grounded in the sociology of knowledge (Berger and Luckman, 1967; Gurvitch, 1971; Holzner and Marx, 1979; Schutz, 1962) and is based on the view of organizations as social collectives and "knowledge systems". According to this framework, organizations as knowledge systems consist of four sets of socially enacted "knowledge processes": (1) construction, (2) storage and retrieval, (3) distribution, and (4) application (Holzner and Marx, 1979; Pentland, 1995). The view of organizations as knowledge systems represents both the cognitive and social nature of organizational knowledge and its embodiment in the individuals' cognition and practices as well as the collectives' (i.e., organizational) practices and culture. Some authors emphasize the social nature of knowledge by stating that individual knowledge exists because of social practices in which individuals engage, and that the two (individual and organizational knowledge) are mutually defined and highly interdependent (Tsoukas, 1996; Whetherel and Maybin, 1996). Carrying out each of the four processes of creation, storage and retrieval, distribution, and application entails some degree of social knowledge and interactions even if the process is completely automated and focused on codified knowledge. This is because the software logic represents the codified organizational and individuals' knowledge and the utilization of the computer system and

interpretation of its output are affected by social processes (Pentland, 1995). For example, Manning (1988) analyzed the implementation and use of similar advanced information and communication technologies in two different police departments. His work indicated that due to the differences in social influences and the interactions in the two departments, the interpretation and significance of the messages (i.e., the resulting knowledge from the information flows) varied as they crossed different organizational units. The constitutive processes of organizational knowledge management are each described below.

3.1 Knowledge Creation

Organizational knowledge creation involves adding new components or replacing existing components within the organization's tacit and explicit knowledge (Pentland, 1995). Nonaka (1994) and Nonaka and Konno (1998) articulate the most comprehensive models of organizational knowledge creation. Nonaka's model (1994) explicitly addresses the social nature of knowledge creation as well as its tacit and explicit dimensions. We have therefore adopted this model in our discussion of organizational knowledge creation. According to this model, through social and collaborative processes as well as individuals' cognitive processes (e.g., reflection), knowledge is created, shared, amplified, enlarged, and justified in organizational settings. This model views organizational knowledge creation as involving a continual interplay between tacit and explicit dimensions of knowledge and a growing spiral flow as knowledge moves through individual, group and organizational levels. Four modes of knowledge creation are identified (Nonaka, 1994): socialization, externalization, internalization, and combination The socialization mode refers to conversion of tacit knowledge to new tacit knowledge

through social interactions and shared experience among organizational members (e.g., apprenticeship, or internship). The combination mode refers to the creation of new explicit knowledge by merging, categorizing, reclassifying and synthesizing existing explicit knowledge (e.g., literature survey reports). The other two modes involve interactions and conversion between tacit and explicit knowledge. Externalization refers to converting tacit knowledge to new explicit knowledge (e.g., articulation of best practices or lessons learned). Internalization refers to creation of new tacit knowledge from explicit knowledge (e.g., learning and understanding that results from reading or discussion).

In considering these four modes, it appears that the modes are as much about transferring existing knowledge from one source (individual, group, document) and state (tacit, explicit) to another as they are about creating new knowledge. The socialization mode is transferring existing tacit knowledge from one member to another. New knowledge per se may not be created, but only knowledge that is new to the recipient. Socialization can result in new knowledge being created when an individual obtains a new insight triggered by interaction with another. One study found that team members reported that their best ideas occurred while working with others, rather than alone (El Sawy et al, 1998); hence, individuals learned best, according to themselves, while working in groups. And Leonard and Sensiper (1998) argue that even though the moment of insight itself is individual in nature, many creative individuals are nevertheless aware of the social nature of knowledge creation. Research is needed to examine the relative benefits and forms of socialization for knowledge transfer versus new knowledge creation. The combination mode, unless performed by technology such as data warehousing and data mining, is missing an intermediate step--that of an individual

drawing insight from explicit sources (i.e., internalization) and then coding the new knowledge into an explicit form (externalization). Combination is thus a redundant label unless it can be performed without human intervention. Externalization is about coding tacit knowledge, rather than creating new knowledge. Again, a weakness in viewing knowledge on a tacit-explicit continuum is that new explicit knowledge may have been created, but from existing tacit knowledge, so although transferability of knowledge is facilitated, no truly new organizational knowledge has been created. Finally, even internalization may be the simple conversion of existing explicit knowledge to an individual's knowledge--such as the Brussels train passenger able to recall the time of his departure. New knowledge is created when the explicit source triggers a new insight. Thus, Nonaka's modes of knowledge creation are as much about transferring knowledge from one source and state to another as they are about creating new knowledge. The creation of new knowledge is thus inseparable from knowledge transfer (or conversion), learning and innovation.

Having focused on the source and state of knowledge, we now move to consider the conditions and environments that facilitate new knowledge creation. Nonaka and Takeuchi (1998) suggest that the essential question of knowledge creation is establishing an organization's "ba" (defined as a common place or space for creating knowledge). Four types of ba corresponding to the four modes of knowledge creation discussed above are identified: (1) originating ba, (2) interacting ba, (3) cyber ba, and (4) exercising ba (Nonaka and Konno, 1998). Originating ba entails the socialization mode of knowledge creation and is the ba from which the organizational knowledge creation process begins. Originating ba is a common place in which individuals share experiences primarily through face-to-face interactions and by being at the same place at the same time.

Interacting ba is associated with the externalization mode of knowledge creation and refers to a space where tacit knowledge is converted to explicit knowledge and shared among individuals through the process of dialogue and collaboration. Cyber ba refers to a virtual space of interaction and corresponds to the combination mode of knowledge creation. Finally, exercising ba involves the conversion of explicit to tacit knowledge through the internalization process. Thus, exercising ba entails a space for active and continuos individual learning. Understanding the characteristics of various ba and the relationship with the modes of knowledge creation is important to enhancing the organizational knowledge creation. For example, use of IT capabilities in cyber ba is advocated to enhance the efficiency of the combination mode of knowledge creation (Nonaka and Kenno, 1998). Data warehousing and data mining, documents repositories, and software agents, for example, may be great value in cyber ba.

We further suggest that considering the flexibility of modern IT, other forms of organizational ba and the corresponding modes of knowledge creation can be enhanced through use of various forms of information systems. Consider the following examples. Information systems designed for support of collaboration, coordination and communication processes, as a component of the interacting ba, can facilitate teamwork and thereby increase an individual's contact with other individuals. Electronic mail and group support systems (such as LotusNotes) have been shown to increase the number of "weak ties" (i.e., informal and causal contacts among individuals) in organizations (Pickering and King, 1995). This in turn can accelerate the growth of knowledge creation spiral described by Nonaka (1994). Intranets enable exposure to greater amounts of on-line organizational information, both horizontally and vertically, than may previously have been the case. In so doing, the breadth and depth of information to which

individuals are potentially exposed increases. As the level of information exposure increases, the internalization mode of knowledge creation, wherein individuals make observations and interpretations of information to result in new individual tacit knowledge, may increase. In this role, intranets can play a major role in support of individual learning (conversion of explicit knowledge to personal tacit knowledge) through provision of capabilities such as computer simulation (to support learning-by-doing) and smart tutors. Several studies have established the efficacy of advanced information technologies in support of individual learning (Alavi and Yoo, 1998; Alavi et al. 1995, and Alavi, 1994). Such tools, if widely available in a corporation's intranet, can allow individuals to learn more efficiently on an as needed basis.

Computer-mediated communication may increase the quality of knowledge creation by enabling a forum for constructing and sharing beliefs, for confirming consensual interpretation, and for allowing expression of new ideas (Henderson and Sussman, 1997). By providing a extended field for interaction among organizational members for sharing ideas and perspectives, and for establishing dialog (i.e., augmenting the originating ba), information systems may enable individuals to arrive at new insights and/or more accurate interpretations than if left to decipher information on their own. Boland et al. (1994) provides a specific example and case of an information system called Spider that creates an environment for organizational knowledge creation in the context of a planning task. Spider provides an environment for representing, and exchanging and debating different individual perspectives. The system actualizes an extended field in which, "assumptions are surfaced and questioned, new constructs emerge and dialog among different perspectives is supported" (Boland et al. 1994, pp. 467). As such, the quality and frequency of the knowledge creation is improved.

3.2 Knowledge Storage and retrieval

One aspect of knowledge management is the management of the organization's memory, rather than leaving the re-utilization of memory to the chance of whom one organizational member happens to know or come in contact with. Empirical studies have shown that while organizations create knowledge and learn, they also forget (i.e., do not remember or loose track of the acquired knowledge) (Argote, Beckman, and Epple, 1990; Darr, Argote and Epple, 1993). Thus, storage, organization, and retrieval of organizational knowledge also referred to as organizational memory by Walsh and Ungson (1991), and Stein and Zwass (1995); constitute an important aspect of effective organizational knowledge management. Organizational memory includes knowledge residing in various component forms, including written documentation, structured information stored in electronic databases, codified human knowledge stored in expert systems, documented organizational procedures and processes and tacit knowledge acquired by individuals and networks of individuals. (Tan et al, 1999). Much of an organization's explicit knowledge reside in unstructured documents in the form of memos, design blueprints, notes, meeting minutes, etc. (Dworman, 1998). Managing organizational memory involves organizing, storing and retrieving knowledge.

Similar to the knowledge creation process described in the previous section, a distinction between individual and organizational memory has been made in the literature. Individuals in organizations acquire, retain and remember knowledge primarily through their brains and cognitive capabilities. Individual memory is developed based on a person's observations, experiences and actions (Argyris and Shon, 1978; Nystrom and Starbuck, 1984; Sanderland and Stablein, 1987). Some researchers have argued that

memory can reside in supraindividual collectives (e.g., groups and organizations). Collective or organizational memory is defined as "the means by which knowledge from the past, experience, and events influence present organizational activities" (Stein and Zwass, 1995, p. 85). In this context, organizational activities have been defined in terms of decision-making, problem solving, coordinating, controlling, planning, producing goods and services and so on. Thus, while individual memory is primarily embodied in organizational members and reflects their past and specific individual experiences, collective memory includes individual memory as well as shared knowledge and interpretations resulting from social interactions in organizations. According to Walsh and Ungson (1991), organizational memory extends beyond individuals' memory to include other components including: organizational culture, transformations (production processes and work procedures), structure (formal organizational roles), ecology (physical work setting) and information archives (both internal and external to the organization).

Two categories of organizational memory are: semantic memory and episodic memory (El Sawy et al., 1986; Stein and Zwass, 1995). Semantic memory refers to general, explicit and articulated knowledge (e.g., organizational archives of annual reports). Episodic memory refers to context-specific and situated knowledge (e.g., specific circumstances of organizational decisions and their outcomes, place, and time). For a detailed discussion of the structure and contents of organizational memory, see Walsh and Ungson (1991). It is widely believed that memory, i.e., storage and retrieval of knowledge (in both tacit and explicit forms) from retention repositories influence subsequent behavior and performance at both individual and organizational levels. Both positive and negative potential influences of memory on behavior and performance have

been identified. On the positive side, memory is viewed as a required component of cognition and adaptation at both individual and organizational levels and a necessary ingredient for effective and efficient learning, problem solving, and decision making. Some authors have highlighted the value of organizational memory by pointing out that basing and relating organizational change in past experience facilitates implementation of the change (Kantrow, 1987; Wilkins and Bristrow, 1987). Walsh and Dewar (1987) state that organizational memory helps in storing and reapplying workable solutions in the form of standards, and procedures which in turn reduce organizational transaction costs. By keeping track of solutions and organizational responses to recurring problems, organizational memory can avoid waste of organizational resources and re-inventing the wheel.

On the other hand, some authors have viewed memory as having a potentially negative influence on individual and organizational performance. For example, the negative impacts of individuals' memory (in terms of biases in recall, belief systems and blind spots) on decision-making have been discussed by several authors (e.g., Larwood and Whitaker, 1977; Starbuck and Hedberg, 1977, and Walsh, 1988). Potential negative effects of memory at the organizational level have been of concern to several authors. March (1972) was concerned about "encased" learning, stating that memory is the enemy of organizations. Similarly, Argyris and Schon (1978) stated that organizational memory may lead to maintaining the status quo by reinforcing single loop learning (defined as a process of detecting and correcting errors). This could in turn lead to stable, consistent organizational cultures that are resistant to change (Denison, 1995). Leonard-Barton (1995) eloquently presents the potential positive and negative effects of organizational memory on a firm's performance in terms of concepts of core capabilities and core

rigidities. Core capabilities refer to organizational know how and competencies that lead to a competitive advantage for a firm. They are developed over time and cannot be easily imitated (Leonard-Barton, 1995, pp. 4). As such, core capabilities represent the positive aspects of organizational memory. Core capabilities, however, can turn into organizational liabilities (core rigidities) in the face of major change in an organizational competitive environment requiring rapid adaptation by the firm. Thus, core rigidities constitute the negative aspects of organizational memory.

Despite the concerns about the potential constraining role of organizational memory, there is a positive perspective on the influence of IT-enabled organizational memory on behavior and performance of individuals and organizations. Considering the enormous and cost-effective capacity and variety of computer technologies for information storage and retrieval, we believe that IT can play a major role in developing and accessing organizational memory.

Advanced computer storage technology and sophisticated retrieval techniques such as data warehousing and data mining, multimedia databases and database management systems, and powerful search engines have proven to be effective tools in enhancing organizational memory. These tools increase the speed at which organizational memory can be accessed. Weiser and Morrison (1998) give the example of AI-STARS, a project memory system at DEC that combines such information as bulletin board postings, product release statements, service manuals, and email messages to enable rapid access to product information for assisting customer problems. Also, with corporate intranets, changes in codified knowledge, such as changes in customers, products, services, employees, or corporate policies, can be reflected in organizational memory more rapidly. For example, instead of printing thousands of brochures for sales

personnel, companies can put product and sales information for their sales personnel on corporate intranets. When changes occur, they can be immediately noted in the system instead of having brochures reprinted. This in turn avoids the lag time resulting from the time a change occurs to when the sales personnel become aware of the change (Leidner, 1998a).

Groupware also enables organizations to create intra-organizational memory in the form of both structured and unstructured information and to share this memory across time and space (Vandenbosch and Ginzberg, 1996). For example, McKinnsey's Practice Development Network places core project documentation online for the purposes of promoting memory and learning organization-wide (Stein and Zwass, 1995). IT can play an important role in the enhancement and expansion of both semantic and episodic organizational memory. Document management technology allows knowledge of an organization's past, often dispersed among a variety of retention facilities, to be effectively stored and made accessible (Stein and Zwass, 1995). Drawing on these technologies, most consulting firms have created semantic memories by developing vast repositories of knowledge about customers, projects, competition and the industries they serve (Alavi, 1997). In addition to enabling greater context of the knowledge to be stored, information technology can improve the quality of organizational memory by classifying knowledge using intuitive taxonomies (Offsey, 1998). Thus, IT can increase the breadth, depth, speed, and quality of knowledge storage and retrieval.

3.3 Knowledge Distribution

Considering the distributed nature of organizational cognition, an important process of knowledge management in organizational settings is the transfer of knowledge

to locations where it is needed and can be used. However, this is not a simple process in that, according to Huber (1991), organizations do not know what they know and have weak systems for locating and retrieving knowledge that resides in them and in general, the knowledge distribution process is under-studied. Communication processes and information flows fundamentally drive knowledge distribution in organizations As such, we postulate that the knowledge distribution processes are subject to the same influences as the organizational communication process. In their review of communication theories, Krone, Jablin, and Putname (1987) observed that regardless of the specific theoretical perspective, all communication systems consist of the following components: a sender (source), a message, a receiver, a channel, and a coding/decoding scheme. Building on and extending on these elements, Gupta and Govindarajan (1996) have conceptualized knowledge distribution (knowledge flows in their terminology) in terms of five elements: (1) perceived value of the source unit's knowledge, (2) motivational disposition of the source (i.e., their willingness to share knowledge), (3) existence and richness of transmission channels, (4) motivational disposition of the receiving unit (i.e., their willingness to acquire knowledge from the source), and (5) the absorptive capacity of the receiving unit (defined by Cohen and Levinthal (1990) as its ability not only to acquire and assimilate, but also to use knowledge). The least controllable element is the fifth: knowledge must go through a recreation process in the mind of the receiver (El Sawy et al., 1998). This recreation depends on the recipient's cognitive capacity to process the incoming stimuli (Vance and Eynon, 1998).

In an empirical study of knowledge flows among headquarters and subsidiaries in multinational firms, Gupta and Govindarajan (1996) established complete or partial support for the influence of four of the five elements: value of knowledge stock,

transmission channels, motivational disposition to receive knowledge, and absorptive capacity of the receiving unit. In another study Szulanski (1996) investigated the influence of characteristics of some of the communication system components on the intra-firm transfer of best practices. More specifically, the study investigated the impact of characteristics of the source (motivation, reliability), characteristics of the receiving unit (motivation and absorptive capacity), characteristic of message (tacit, or explicit knowledge), and the communication context (relationship between source and receiver and organizational context) on the transfer of best practices. This study showed that the factors that influenced knowledge transfer within the firm were: absorptive capacity of the receiver, the nature of message (causal ambiguity in knowledge), and the relationship between the source and recipient (ease of communication).

The majority of the literature focuses on the third element that of the knowledge transfer channels. Knowledge transfer channels can be informal or formal, and personal or impersonal (Holtham and Courtney, 1998). Informal mechanisms, such as unscheduled meetings, informal seminars, or coffee break conversations, may be effective in promoting socialization but may preclude wide dissemination (Holtham and Courtney, 1998). Such mechanisms may also be more effective in small organizations (Fahey and Prusak, 1998). Moreover, such mechanisms may involve certain amounts of knowledge atrophy in that, absent a formal coding of the knowledge, there is no guarantee that the knowledge will be passed accurately from one member to others. This parallels problems with the recipient's ability to process the knowledge. Learning problems can involve recipients filtering the knowledge they exchange, interpreting the knowledge from their own frame of reference, learning from only a select group of knowledge holders (Huysam, 1998). These forms of problematic knowledge transfer are

tied to limited access to knowledge (Huysam, 1998). Formal transfer mechanisms, such as training sessions, may ensure greater distribution of knowledge but may inhibit creativity. Personal channels, such as apprenticeships or personnel transfers, may be more effective for distributing highly context specific knowledge whereas impersonal channels such as knowledge repositories may be most effective for knowledge that can be readily generalized to other contexts. Personnel transfer is a formal, personal mechanism of knowledge transfer. Such transfers, common in Japan, immerse team members in the routines of other members, thereby gaining access to the partner's stock of tacit knowledge (Fahey and Prusak, 1998). A benefit is that learning takes place without the need first to convert tacit knowledge to explicit, saving time and resources and preserving the original knowledge base (Fahey and Prusak, 1998).

At the organizational level, one study found four major modes of knowledge transfer between headquarters and a subsidiary. The processes identified were: technology sharing, subsidiary-parent interaction (such as plant tours), personnel transfers, and strategic integration (Inkpen and Kinur, 1998). The study found that the most effective transfer mechanism was dependent upon the type of knowledge being transferred. Technology was used to transfer explicit knowledge such as knowledge about product designs. Social interactions were used to transfer tacit knowledge such as product quality knowledge. Personnel transfer was used to transfer tacit knowledge such as beliefs and behavioral norms, and strategic integration was used to transfer explicit knowledge as well as cultural knowledge. Much as the existence of "care" may be important to knowledge transfer between individuals (Powell, 1998), the existence of a close, tight interface is critical at the organizational level. The authors found that a

narrow and distant interface was found to be an obstacle to learning and knowledge sharing (Inkpen and Dikur, 1998).

IT can support all four forms of knowledge transfer, but has mostly been applied to informal impersonal means (through such venues as Lotus-Notes discussion databases) and formal impersonal (such as knowledge maps or corporate directories). The latter have been found to be particularly useful transfer mechanisms for many organizations. Consulting firms use such knowledge maps to connect individuals with other individuals having relevant project knowledge and manufacturing firms use such knowledge maps to connect product designers. An added innovative use of technology for transfer is using intelligent agent software to use interest profiles of organizational members to determine which members might be interested recipients of point-to-point electronic messages exchanged among other members (O'Dell and Grayson, 1998). Employing video technologies can also enhance transfer. For example, offshore drilling knowledge is made available globally at British Petroleum by desktop video conferencing. A typical screen will include not just images of the participants but windows of technical data, video clips of the physical issue under consideration, specification, contractual data, and plans (Cranfield University, 1998).

IT can increase knowledge distribution by extending individuals' reach beyond the formal communication lines. One of the challenges in organizational knowledge distribution is that individuals with a need to know may not be aware of the knowledge sources in the organization. The search for knowledge sources is usually limited to immediate coworkers in regular and routine contact with the individual. However, individuals are unlikely to encounter new knowledge through their close-knit work networks because individuals in the same clique tend to possess similar information

(Robertson, Swan, and Newell, 1996). Moreover, studies show that individuals are decidedly unaware of what their cohorts are doing (Kogut and Zander, 1996). Thus, expanding the individual's network to more extended, though perhaps weaker connections is central to the knowledge diffusion process because such networks expose individuals to more new ideas (Robertson et al, 1996). Computer networks and electronic bulletin boards and discussion groups create a forum and an electronic community of practice that facilitates contact between the person seeking knowledge and those who may have access to the knowledge. For example, this may be accomplished by posting a question in form of "does anybody know", or a "request for help" to the discussion group. These tools may expand the available knowledge both horizontally and vertically in organizations. They also speed access to knowledge. It is not surprising that one of the most popular applications on intranets is corporate directories. Such directories do not contain the knowledge themselves, but enable individuals to rapidly locate the individual who has the knowledge that might help them solve a current problem. For example, at Hewlett-Packard, the primary content of one system is a set of expert profiles containing a directory of the backgrounds, skills, and expertise of individuals who are knowledge on various topics (Davenport 1997a). These directories enable individuals to much more quickly locate the knowledge needed for problem solving. Often such metadata (knowledge about where the knowledge resides) proves to be as important as the original knowledge itself (Andreu and Ciborra, 1997).

One problem noted with lateral communication in organizations (where the traditional network would not include personal relationships with individuals laterally), is the difficulty of access to individuals with relevant knowledge (George et al, 1990). Individuals often must rely on a commonly known third party to approach what might be

termed internal organizational strangers. IT enables such lateral knowledge to be accessed more rapidly by increasing the individuals' potential network, by reducing communication delays, and by increasing the number and capacity of organizational communication channels. Moreover, providing taxonomies or organizational knowledge maps enables individuals to rapidly locate either the knowledge or the individual who has the needed knowledge, more rapidly than would be possible without such IT-based support (Offsey, 1998).

3.4 Knowledge Application

An important aspect of the knowledge-based theory of the firm is that the source of competitive advantage resides in the application of the knowledge rather than in the knowledge itself. Pentland (1995) argues that it is difficult to make an attribution of knowledge or competence to an organization that does not produce knowledgeable or competent performance. Knowledge, particularly tacit knowledge, is constructed by and is held within individuals. A major challenge in knowledge application in organizations is the absence of a collective mind and a central memory. Due to cognitive limitations, no single individual can be aware of all that is known to the organization as a whole, or can specify in advance what knowledge will be needed, when and where. Organizations are distributed knowledge systems and knowledge is continuously emerging from the organizational members' actions and interactions. Since knowledge is distributed among multiple agents and is dispersed in time and space, knowledge integration is a significant facet of knowledge application in organizational settings.

According to Grant (1996), the essence of organizational capability is the integration of individuals' specialized knowledge to create value through conversion of

inputs to outputs in the form of organizational products and services. He further identifies three primary mechanisms for the integration of knowledge to create organizational capability: directives, organizational routines, and self-contained task teams. Directives refer to the specific set of rules, standards, procedures, and instructions developed through the conversion of specialists' tacit knowledge to explicit and integrated knowledge for efficient communication to non-specialists (Demsetz, 1991). Examples include directives for hazardous waste disposal, or airplane safety checks and maintenance. Organizational routines refer to development of task performance and coordination patterns, interaction protocols, and process specifications that allow individuals to apply and integrate their specialized knowledge without the need to articulate and communicate what they know to others. Routines may be relatively simple (e.g., organizing activities based on time-patterned sequences such as an assembly line), or highly complex (e.g., a cockpit crew flying a large passenger airplane). Another example is the use of routines in surgery teams (Grant, 1996) in which each team member performs a highly specialized task in context and sequence of pre-specified operating room procedures with minimal requirements for communicating with other specialists and no need for explicating his/her specialized knowledge. The third knowledge integration mechanism is the creation of self-contained task teams. In situations in which task uncertainty and complexity prevent the specification of directives and organizational routines, teams of individuals with prerequisite knowledge and specialty are formed for problem solving. Group problem solving requires intense communication, coordination, and collaborative processes, which are actualized in the form of frequent interactions and knowledge exchanges among the team members.

Technology can support knowledge application by embedding knowledge into organizational routines. Procedures that are culture-bound can be embedded into IT so that the systems themselves become examples of organizational norms. An example is Mrs. Field's use of systems designed to assist in every decision from hiring personnel to when to put free samples out on the table to transmit the norms and beliefs held by the head of the company to organizational members through systems (Bloodgood and Salisbury, 1999). Technology enforced knowledge application raises a concern that knowledge will continue to be applied after its real usefulness has declined. And, that the dominant logic may persist after the underlying assumptions have changed (Malhotra, 1998). This may lead to perceptual insensitivity of the organization to the changing environment. Organizations may find themselves doing "more of the same" better and better, with diminishing marginal returns (Malhotra, 1998). The institutionalization of "best practices" by embedding them into IT might facilitate efficient handling of routine, 'linear', and predictable situations during stable or incrementally changing environments. However, when change is radical and discontinuous, there is a persistent need for continual renewal of the basic premises underlying the practices archived in the knowledge repositories (Malhotra, 1998). What this highlights is the need for organizational members to remain attuned to contextual factors and not to blindly apply knowledge without appropriate modification to the current environment. A second problem may be deciding what rules and routines to apply to a problem, given that over time, the organization has learned and codified a large number of rules and routines, so that choosing which rules to activate for a specific choice making scenario is itself problematic. Shared meanings and understandings about the nature and needs of a particular situation must be used to guide rule activation (Nolan Norton, 1998).

Although there are challenges with applying existing knowledge as discussed, IT can have a positive influence on knowledge application. IT can play an important role in organizational knowledge integration. For example, IT can enhance the organizational knowledge integration and application by supporting teamwork and collaboration in problem solving and decision-making groups. As previously mentioned, groupware can greatly enhance group problem solving and decision making through the support of alternative generation, analysis, prioritization and ranking as well as by the development of a group memory. By increasing the size of individuals' internal networks and by increasing the amount of organizational memory available, information technologies allow for organizational knowledge to be applied across time and space. IT can also enhance the speed of knowledge integration and application by codifying and automating organizational routines. As mentioned in Section 3.4, organizational routines are created to integrate the individual knowledge bases needed for task performance while reducing the need for communicating specialized tacit knowledge held by individuals. Workflow automation systems are examples of IT applications that reduce the need for communication and coordination and enable more efficient use of organizational routines through timely and automatic routing of work-related documents, information, rules and activities. Rule based expert systems are another means of capturing and enforcing well specified organizational procedures.

IT can enhance knowledge integration by facilitating the capture, updating and accessibility of organizational directives. For example, many organizations are enhancing the ease of access and maintenance of their directives (repair manuals, policies and standards) by making them available on corporate intranets. This increases the speed at which changes can be applied. Also, organizational units can follow a faster learning

curve by assessing the knowledge of other units having gone through similar experiences. For example, a system at the US Army transfers new learning from one site to the next so that later sites traverse a learning curve faster with fewer problems and mistakes (Henderson and Sussman, 1997). The system includes tactical and operational observations structured and then posted on bulletin boards and sent via distribution lists. Formerly, data collection entailed massive amounts of raw data being collected that overloaded the capacity to effectively use the information. The new method involves a quality control element, with analysts indexing the observations and eliminating duplications.

3.5 Summary: Organizational Knowledge Management Processes

To summarize, Section 3 has described and elaborated on a knowledge management framework based on the view of organizations as a system of knowledge creation and knowledge application. One of the important implications of this framework is that knowledge management consists of a dynamic and continuous set of processes and practices embedded in individuals, as well as in social and physical structures. At any point in time and in any part of a given organization, individuals and groups may be engaged in several different aspects and processes of knowledge management. Thus, knowledge management is not a discrete, independent, and monolithic organizational phenomenon.

Another implication of this framework is that the four knowledge processes of creation, storage and retrieval, distribution, and application are essential to effective organizational knowledge management. They can be thought of as links in a chain, if any one of them is weak, or fails, the effectiveness and integrity of the overall process will

suffer. Thus, attempts at strengthening knowledge management in organizations should consider the synergistic interdependencies among the four processes and avoid sub-optimization in relation to any specific process. For example, over-emphasis on creation of large computer systems for support of static organizational memory, with little or no consideration of requirements for creating, distributing and applying the content of the knowledge repositories would not be effective. Our contention is that the application of information technologies can create an infrastructure and environment for strengthening and accelerating organizational knowledge management by actualizing, supporting, augmenting and reinforcing knowledge processes at a deep level through enhancing their underlying dynamics, scope, timing, and overall synergy.

Another significant potential role of IT is the support of organizational knowledge management framework is through the coordination and integration of the four phases of knowledge management. Organizational knowledge management is only as strong as the weakest link in the process: the effective integration of knowledge relies on the effective implementation of tools for knowledge creation, storage, and distribution. Likewise, the effective creation of new knowledge depends on the effective storage, distribution, and use of previous knowledge. The knowledge management phases are interconnected and interdependent. Hence, it is important to focus on the entire knowledge management process. IT can play a significant role in bridging the links in the chain of knowledge management.

For example, an intranet can integrate all the phases of knowledge management in a seamless manner. Discussion databases can be used for the support of knowledge creation and collaborative discussions. By capturing group interactions, the discussion databases provide a group memory that can be preserved and later searched and accessed

by other organizational members. Group generated data can be combined by data obtained from other internal and external databases and disseminated through the organization through "push technology" based on the user specified "profiles."

While some disparage the importance of IT to knowledge management initiatives (Gill, 1995; Pentland, 1995; Malhotra, 1996), we contend that knowledge management will be undermined without the appropriate application of information technology.

4. RESEARCH ISSUES IN KNOWLEDGE MANAGEMENT

A review of the literature on knowledge, knowledge management, and knowledge management systems uncovers a broad gamut of potential research streams. Rather than expatiating upon a single research theme in great detail, we will here present sundry important research questions answers to which are needed to elucidate the role of knowledge in organizations. We will consider research needed at multiple levels of analysis, including organizational, the unit or team level of analysis, and the individual level of analysis.

(1) Organizational knowledge and firm level competitive advantage

A major assumption behind the knowledge-based theory of the firm is that firm-level competitive advantage is to be had from knowledge, more specifically, from tacit-knowledge. According to this theory, tacit knowledge is valuable, rare, and imperfectly imitable. Yet if such knowledge is imperfectly imitable, how can it be successfully reapplied by individuals from disparate units within a single firm? Moreover, how is a firm to separate valuable, rare, imperfectly imitable tacit knowledge from less valuable, mundane, imitable tacit knowledge? One necessary line of research thus considers the

question of if and if so how, knowledge does create competitive advantage to the firm. In one study, increasing market share and share price were two widely cited reasons for pursuing knowledge management (KPMG, 1998a). Hence, there is either a common belief that such initiatives will provide competitive advantage or a common practice of adopting competitive advantage jargon in an attempt to make knowledge management initiatives more visible and acceptable to senior management. If competitive advantage is to be obtained, is it from the rapid creation of new knowledge, the ability to explicate and share existing knowledge, or the astute protection of difficult to replicate knowledge? The latter question has important implications for the focus of knowledge management initiatives. The competitive advantage question is related to the larger question of the impact of knowledge, and attempts to manage knowledge, on the firm. Few firms, 35% according to one study, attempt to evaluate the success of their KM initiatives while 40% reported that a lack of understanding of the benefits of KM hindered the projects (Cranfield University, 1998). Hence, research on the outcomes of managing organizational knowledge has practical in addition to theoretical significance.

(2) Tacit knowledge and knowledge worker effectiveness

The literature review on taxonomies of knowledge revealed a widely held assumption that knowledge workers need and use a great deal of tacit knowledge. The assumption typically considers tacit knowledge to be inexplicable rather than explicit knowledge that has simply not yet been explicated. An interesting line of inquiry concerns the degree of importance of tacit knowledge to knowledge work. Research could examine individuals in various knowledge work positions, trace these individuals' use and reuse of knowledge. Examples of some research questions in this area include: what knowledge

individuals typically obtain from their tight (close) network of contacts, what knowledge do they seek from a weak (distance) network of contacts, or how do they determine what knowledge they need and where to search for the knowledge? By documenting variances in knowledge needed and available knowledge, and by determining the search behaviors of individuals in need of knowledge, the research could be useful in determining knowledge requirements and implementation success for knowledge management systems.

(3) Knowledge absorption

As discussed in section 1, what separates knowledge from information is that knowledge results from active cognitive processing in an individual triggered by the inflow of new stimuli. Providing sources of information to an individual is no guarantee that the individual will understand, process, or convert it to knowledge. As such, a major issue to examine at the individual level of analysis concerns the means by which cognitive processing is triggered. It is not sufficient to merely provide codified knowledge in a system and hope that individuals absorb it in their own minds and make beneficial use of the it. A large part of knowledge management will revolve around ensuring that the non-originators of knowledge are prompted to acquire the relevant knowledge. This suggests a need not only for swift search mechanisms to locate knowledge, but the recognition of what knowledge is needed and the ability to understand available knowledge. An important question is thus: how can KMS be built to foster active attempts to understand and modify as appropriate the existing knowledge?

(4) The knowledge management processes

Knowledge management was defined as the process of identifying, capturing, and utilizing the collective knowledge in an organization to help the organization compete. Research is needed that focuses on the processes of knowledge management.

Questions on Knowledge Creation:

Much of the existing research on knowledge creation focuses on the source and state of knowledge. Research is now needed that moves beyond the source and state to consider the conditions that facilitates knowledge creation. Descriptive studies have identified culture as a major hindrance to knowledge creation and sharing. Von Krough (1998) focused on the values guiding relationships in an organization. He suggests that cultures with a quality of "care" result in greater knowledge creation because such a quality in human relations speeds up the communication process and enables organizational members to share their personal knowledge and discuss their ideas freely. Research is needed that examines the relationships between various organizational cultures and knowledge creation. Do certain organizational cultures foster knowledge creation? If so, must cultural change occur before knowledge management initiatives can be successfully undertaken or can knowledge management initiatives facilitate cultural change?

Organizational design is also considered an important catalyst for knowledge creation. The research to date has focused on communities of practice and shared knowledge creation spaces. There are two views of the effect of communities of practice on knowledge creation. One view asserts that close ties in a community limit knowledge creation because individuals are unlikely to encounter new ideas in close-knit networks because they tend to possess similar information (Robertson, Swan, and Newell). This view upholds the need for weak ties to expose individuals to new ideas that can trigger

new knowledge creation. Distant, informal, spontaneous contact between different organizational subunits might be an important mechanism for knowledge creation (Roberston, Swan, and Newell). The alternate view argues that knowledge creation is better served by close ties in a community of practice since individuals would be more at ease discussing ideas openly and challenging the ideas of others. Moreover, such communities develop a shared understanding or a "collective knowledge base" (Brown and Duguid, 1998) from which knowledge emerges. Hayduk (1998) hypothesizes that learning processes are more effective when shared between a self-selected peer group. One research question is thus: is the usefulness of knowledge related to the extent context is shared among members? What is knowledge efficiency (defined as a ratio of the amount of knowledge created to the amount of knowledge re-used) in communities of practice relative to the organization as a whole? How does changing organizational subunit membership (i.e., turnover) affect knowledge creation and re-use?

Another area of research on enabling conditions relates to the relationship of organizational design to knowledge creation. Nonaka and Konno (1998) suggest that the essential question of knowledge creation is establishing an organization's "ba" which is a function of "spatial design." As discussed in section 3.1, as a component of various forms of ba, IT can impact knowledge creation process. Research is needed to investigate the role of IT in design of organizational ba and the corresponding knowledge creation modes. Nonaka and Konno (1998) further suggest that the essence of "ba' is the continual conversion of tacit knowledge into explicit and then back to tacit. This emphasizes the knowledge conversion and transfer processes rather than new knowledge creation. Knowledge needs to be adapted and modified before being converted from explicit to tacit in order for a new, more relevant knowledge to emerge. Others suggest that part of

organizational design can be the creation of a time and place where staff meet to discuss their ideas and experiences (KPMG, 1998b). For such a meeting to facilitate knowledge creation, it must be promoted by senior management as an investment (KPMG, 1998b). Alternatively, a formal shared knowledge creation space can be established. This involves creating a shared space or shared bonds of interest that allows the collective massaging of ideas and information in situations of ambiguity and change (El Sawy et al, 1998). Research is needed to determine how tight collaboration should be within the shared space to improve and accelerate knowledge creation and whether shared knowledge creation spaces can be designed in such a manner to tighten collaboration (El Sawy et al, 1998). Research could also consider how knowledge coming from outside the shared space is evaluated: does a lack of context prevent the effective adoption of outside knowledge? Or, are members able to adopt and modify outside knowledge to meet their needs? Answers to these questions have implications for the appropriate scale features of knowledge management systems.

Questions on Storage:

Knowledge storage involves obtaining the knowledge from organizational members and or external sources, coding the knowledge, and storing the knowledge.

Incentives are important to overcome some of the major barriers to KM success. These barriers include the lack of employee time to contribute their knowledge (KPMG, 1998a; Cranfield University, 1998) and a corporate culture that has historically not rewarded sharing of insights (Brown and Duguid, 1998; KPMG, 1998a; Cranfield University, 1998). Many organizations are so lean that people do not have time to make knowledge available, share it with others, teach and mentor others, use their expertise to

innovate and find ways of working smarter (Glazer, 1998). Instead, they are task-focused, shifting existing workloads to fight deadlines. Huang (1997) reports too that over half the respondents in a study felt that changing individuals' behaviors represents a major challenge to KM and incentives were necessary to encourage new behaviors. In another study, 39% of the respondents reported that their organizations did not reward knowledge sharing, which was seen as the third biggest barrier to KM after lack of time and wasting effort. Moreover, in many organizations, members feel that their futures with the company are dependent upon the expertise they generate and not on the extent to which they actually help others. In such situations, it is then expected that individuals will attempt to build up and defend their own hegemonies of knowledge (von Krough, 1998). People may be unaware of what they have learned; moreover, even if they realize what they have learned from a project, they be unaware of what aspects of their learning would be relevant for others. An important role of senior managers may be to provide incentives such as basing promotion decisions in part on one's knowledge contribution (O'Dell and Grayson, 1999). O'Dell and Grayson(1999) suggest that the incentive system must focus on encouraging individuals to help others, particularly younger colleagues, and encouraging the organization's tyros to make their time accessible to the novices. Hayduk, 1998) suggests that in order for KM to be effective, performance review systems and incentive systems, closely tied to compensation, should be designed to foster the development of corporate knowledge between employees. Knowledge may best be captured if individuals are prompted for it, such as at a weekly meeting or during a post-project review (Cranfield University, 1998). Without a systematic routine for capturing knowledge, a firm might not benefit from its best knowledge being captured. Research is

needed to address the issue of what types of incentives are effective in promoting organizational members with valuable knowledge to share their knowledge.

An important consideration with coding knowledge is how much context to include. When the context surrounding knowledge creation is not shared, it is questionable whether storing the knowledge without sufficient contextual detail will result in effective uses. This could lead to the essence of the knowledge being lost (Zack, 1998c). For that knowledge which is highly context-specific, the appropriate storage mode is the individual (i.e. people's minds) (KPMG, 1998a). Transferring such knowledge may be best done with personal communication (Zack, 1998a; Zack 1998c, KPMG, 1998a) so that the nuances are captured. Hence, the coding of context specific knowledge might best be pointers to the individual in whose mind the knowledge resides; this is the idea behind corporate directories. In addition to the question of how much context to capture is the question of how much knowledge to code and store. The more readily available the knowledge, the more likely its reuse. On the other hand, the more readily available, the greater the likelihood of knowledge misuse, i.e., knowledge being misapplied to a different context simply because the search costs would be too high to find a new, better solution. This would militate against creativity, innovation, and flexibility (Zack, 1998b); moreover, today's knowledge is tomorrow's ignorance in the sense that knowledge emerges and evolves over time and any system designed to store the knowledge must ensure that the knowledge is dynamic rather than static. Thus, research is needed to address several important issues regarding knowledge storage and retrieval (explication, codification, and organization).

Questions on distribution:

The notion of knowledge transfer raises several important issues: first is the question of to what degree knowledge needs to be shared internally (Leonard and Sensiper, 1998). This may depend upon the extent of interdependency among subgroups or individuals (Leonard and Sensiper, 1998). A second major issue involves location of knowledge. There are two facets to the location, or retrieval, problem. The document retrieval question is given a large collection of documents, how do we find the documents that we need? The information or knowledge retrieval question is given a large collection of documents, how do we find the knowledge that we need? Research is being done on developing technical solutions to these two questions. One system called Homer, sorts through collections of documents to find specific information relevant to a query as well as to identify patterns of information in a large collection of documents. One could envision using Homer on a corporate collection of memos and meeting notes indexed with employee and project names to identify who worked on a particular project when. Homer can also provide informal yet important information such as when an employee unofficially helps out on a crucial problem for a project. (Dworman, 1998). A problem, similar to the information overload problem, exists when individuals are aware that the relevant knowledge exists in organizational memory, but are discouraged from search for the knowledge by the sheer volume of available knowledge. For example, most developers at Hewlett-Packard, are aware that the SPaM system holds all of their past projects history, but rarely seek answers in SPaM because finding the answer would take days (Powell, 1998). In the traditional (sequential information processing) organization, the issue of information distribution follows a “need to know” approach, a style of functioning which suffers from two serious problems. First, it assumes that the uses to which information will be put are already known in advance (exactly the opposite of what

is required for learning). Second, it exacerbates the already serious tendency wherein knowers do not know what they know (Davenport and Klahr, 1998), and/or who needs the knowledge they posses. Thus, research on the development of effective organizational and technical strategies for organizing, retrieving, and transferring knowledge are needed to facilitate knowledge distribution. The third important issue on knowledge distribution concerns knowledge flows between the provider (source) and the knowledge seeker. According to Holthouse (1998) from the provider's perspective, flow is a selective pull process; and from a seeker's perspective, flow is a selective push process. Balancing the pull and push processes then is an important aspect of knowledge distribution in organizations. This may be best accomplished through study of knowledge usage and commination patterns of seekers and providers typically expressed through work practice habits at the individual and community levels (Holthouse, 1998). Research that focuses on social, cultural and technical attributes of organizational settings that encourage and facilitate knowledge flows by balancing the push and pull processes is important.

(5) IT and knowledge management processes

Our analysis of the literature suggests that IT can lead to a greater breadth and depth of knowledge creation, storage, transfer, and application in organizations, as well as to faster and higher quality knowledge creation, storing, transfer, and application. While these suppositions in general can be applied to most IT designed to provide information and could form the subject of research in themselves, an interesting line of research emerges. This line of research would consider the subsequent question of how having knowledge available from more vertical and horizontal sources in the organization in a more timely manner enhances individual and organizational performance. Does an

increase in the breadth and depth of knowledge result in greater use of a knowledge management system and greater use of finding relevant knowledge, or contrarily, does such an expanded availability discourage usage as the potential search time for needed knowledge might simultaneously increase? Does an increase in the breadth, depth, quality, and timeliness of organizational knowledge result in improved decision making, reduced product cycles, greater productivity, or better customer service? In general, what are the consequences of increasing the breadth, depth, quality, and timeliness of organizational knowledge?

There is debate as to whether information technology inhibits or facilitates knowledge creation and use. On the one hand, some argue that capturing knowledge in a KMS inhibits learning (Cole, 1998) and results in the same knowledge being applied to different situations even when it might not be appropriate. Proponents of this view maintain that IT plays a limited role in knowledge creation because they are only helpful if an individual knows what he is looking for (the search is necessary but the solution is obvious). (Powell, 1998). In this case, little new knowledge creation can occur. Moreover, some argue that the mechanistic and rigid nature of IT-based KM is incapable of keeping pace with dynamic needs of knowledge creation (Malhotra, 1998). However, this argument is not so much about information technology as about the role of explicit knowledge. Explicit knowledge, whether coded in a KMS or in a document, can be reused mindlessly. The issue is how to ensure that individuals modify explicit knowledge to meet their situation and thereby create new knowledge. Individuals must be responsible for unlearning as well as for modifying explicit knowledge to suit their specific situation. The choice to adopt existing knowledge and then to adapt it to the given situation is an important avenue of research. Once individuals modify and use

knowledge from a KMS, do they then transfer their experiences into using the modified knowledge for others to use, or is existing knowledge continually reused in various ways with no record of the modifications? Do individuals prefer knowledge obtained with a low search cost that does not precisely fit their needs to knowledge that is more precise but would take longer to obtain? What level of trust do individuals have in knowledge that resides in a system but the originator of whom they do not personally know? Does trust, or the lack thereof, inhibits individuals use of knowledge stored in a KMS?

As with most IS, the success of KMS partially depends upon the extent of use, which itself may be tied to system quality, information quality, and usefulness (Delone and McLean, 1992). System quality is influenced by attributes such as ease of use, characteristics of human-computer interface, and flexibility and effectiveness of search mechanisms. Research focusing on KMS use process, and development of intuitive search, retrieval, and display is needed to enhance KMS quality. At the level of knowledge quality, issues pertain to what kinds of knowledge can be usefully codified and at what level of detail, how to protect coded knowledge from imitation, (Wistro, 1998), and how to ensure that the knowledge is maintained (KPMG, 1998a). In terms of KMS usefulness, studies can examine the extent to which knowledge available is reused. A ratio of knowledge accessed to knowledge available and knowledge used to knowledge accessed could give an indication of system usefulness. Equally important to consider would be the degree of searches yielding no useful knowledge.

(6) Managing KM initiatives

KM implies a systematic attempt to create, share, and use knowledge. As discussed in section 2.4, many KM initiatives involve the use of information technologies dedicated to

facilitating knowledge creation, storage, and transfer. To many, the term knowledge management implies supporting systems, which we termed Knowledge Management Systems. As such, many of the themes emerging as needed research in the area of managing KM initiatives are reminiscent of research themes in the management of IS. IS research can form a theoretical basis for some of these questions.

Role of Senior Management

An assumption is often made in the literature that the "full and active commitment and sponsorship of senior management" is critical to the success of KM processes (O'Dell and Grayson, 1998). KPMG (1998a) reports that 26% of organizations surveyed rated lack of senior management commitment to KM as a major barrier to success. O'Dell and Grayson (1998) suggest that the role of senior management is to support a learning organization and to promote knowledge sharing. However, the evidence is sketchy and work remains to be done to determine whether KM projects even need to be organization-wide projects with senior management involvement. Ciborra and Hanseth (1998) find that full backing from top management is no guarantee of immediate or long-term success. They argue that there are two approaches to KM projects that may work equally well, dependent upon the situation. In one case, a top down approach with senior management push and centralized planning is successful in static, knowledge-poor environments whereas a bottom-up decentralized approach may be more appropriate in dynamic, knowledge-intensive environments. Important research questions thus concern the role of senior management in KM initiatives. For example, is there a higher success rate among KM projects initiated by and managed by senior managers? Is senior management

involvement in KM initiatives positively related to the quantity and quality of new knowledge created, shared, accessed, and applied?

Link of KM to organizational strategy

The literature cites the linking of the KM initiative to organizational strategy as an important success factor for KM projects (Zack, 1998a; O'Dell and Graywon, 1998; KPMG, 1998b). Huang (1997) suggests four parts to a KM strategy: (1) making knowledge visible--a taxonomy of expertise, corporate yellow pages, for example; (2) building knowledge intensity--competence centers, communities of practice; (3) building a knowledge infrastructure; and (4) developing a knowledge culture-- knowledge sharing values and norms. Zack (1998b) suggests that the knowledge management strategy must be developed that supports business strategy. O'Dell and Grayson (1998) suggest that organizations create and publish an integrated mission, value, and vision statement that endorses and sustains learning and transfer. Some scholars disagree that KM should be linked to business strategy (Tan et al, 1998). Knowledge management research indicates that only 33% of those companies with a KM initiative had created a strategy (KPMG, 1998a; Nolan Norton Institute, 1998). Moreover, two key indicators of a strategy -- senior management responsibility for KM and the establishment of a budget--were largely absent. The vast majority of firms were therefore undertaking KM initiatives without either developing an explicit KM strategy or tying this strategy to the organization's strategy. Research is needed that examines the role and content of KM strategy, and the means of linking the KM strategy to organizational strategy.

Organizational KM roles

Some firms have established a high-level corporate role dedicated to KM to help link the KM initiative with organizational strategy, much as the high level CIO (chief information officer) position was adopted in organizations to better link IT with business strategy. There is not yet evidence of the necessity of such roles to KM success, nor to the exact nature such roles should take. However, Dejnaronk (1998) suggests that CKOs' (chief knowledge officer) roles include understanding how people learn and share their knowledge, establishing processes, incentives, and rewards to encourage contributions to the organizational knowledge base, and transforming individual learning to organizational learning. One study reported that only 5% of organizations surveyed with KM initiatives in place had CKOs that the authors associate with a serious KM initiative. Some organizations have separate knowledge centers under the leadership of the CKO, staffed with individuals responsible for coding, classifying, and maintaining knowledge (Alavi, 1997). Among the most important of these roles may be that of subject matter expert, functioning as an editor to assure the quality of content, and as a repository manager, assuring quality of context by thoughtful abstracting and indexing (Gazeau, 1998). Some questions related to the CKO role are: Are knowledge management initiatives led by a a CKO more effectively than initiatives led by a CIO? How can a CKO gain the trust and respect of the various units whose contribution is vital to the success of the KM initiatives? How can the CKO foster a culture that is conducive to knowledge sharing?

4.1 Summary: KM Research Issues

In this section, we identified and discussed a variety of KM research issues from a business perspective. These issues can be categorized into four fundamental themes for

KM research: (1) relationship between knowledge and firm-level competitive advantage, (2) relationship between knowledge and the individuals, (3) processes of knowledge management and the potential role of IT in these processes, and (4) organizational issues of KM and KMS initiatives. We have not attempted to provide an exhaustive list of possible KM research issues. However, we believe that research progress in the areas discussed in this paper will significantly advance our understanding and contribute to practice of knowledge management in organizational settings. Our discussions reveal the multifaceted and multidisciplinary nature of knowledge management. Thus, as KM research advances, it is important that it builds upon and preserves the significant literature that exists in several different but related fields. Teece (1998) argues that there is a real danger that knowledge management research will become discredited if it proceeds in ignorance of these other related literature. In fact, knowledge management can be viewed as an effective framework for integrating relevant research in the related fields including strategic management, organizational theory, and information systems.

5. SUMMARY AND CONCLUSIONS

In this paper, we have presented a discussion of knowledge, knowledge management and knowledge management systems based on a review, interpretation, and synthesis of a broad range of relevant literature. Several general conclusions may be drawn from our work.

1. The literature review revealed the complexity and multi-faceted nature of organizational knowledge and knowledge management. Different definitions and taxonomies of knowledge were reviewed and discussed. For example, knowledge may be tacit, or explicit, it can refer to an object, a cognitive state, or a capability. It

may reside in individuals, groups (i.e., social systems), documents, processes, policies, physical settings (e.g., the physical arrangement of an assembly line), or computer repositories. Thus, no single or optimum approach to organizational knowledge management and knowledge management systems can be developed. A variety of knowledge management approaches and systems needs to be employed in organizations to effectively deal with the diversity of knowledge types and attributes.

2. Knowledge management involves distinct, but interdependent processes of knowledge creation (and maintenance), knowledge storage and retrieval, knowledge distribution, and knowledge application. At any point in time, an organization and its members can be involved in multiple knowledge management process chains. As such, knowledge management is not a monolithic, but a dynamic and continuous organizational phenomenon. Furthermore, the complexity, resource requirements, and the underlying tools and approaches of knowledge management processes vary based on the type, scope and characteristics of knowledge management processes.
3. KMS by drawing on various IT tools and capabilities can play a variety of roles in support of organizational knowledge management processes. Specific examples of IT for support of the four knowledge management processes delineated in the paper were presented in Section 3. It is important to note that KMS by drawing on various and flexible IT capabilities can lead to various forms of KM support, extending beyond the traditional storage and retrieval of coded knowledge.
4. A variety of interesting research questions regarding different aspects of organizational knowledge and knowledge management were presented. In our discussions of the KM research issues, we aimed at providing a wide representation

of issues pertaining to a variety of organizational, individual, process and technological factors.

Organizational knowledge and knowledge management are popular topics in several extent literatures including strategic management and organizational theory as well as information systems. It is thus important that IS researchers be aware, understand, and build upon the already significant work in the large extent literatures. This will provide the diversity of perspectives and approaches that study of such multi-faceted and complex phenomenon, as organizational knowledge management requires.

It is our contention that in large global firms in hypercompetitive environments, information technology will be interlaced with organizational knowledge management strategies and processes. This is based on the observation that in these firms, KM processes span across time and geographic distance. This combined with the need for very short cycle times for product/service development and innovation necessitates reliance on information and communication technologies. We therefore believe that the role of IT in organizational knowledge management ought to receive considerable scholarly attention and become a focal point of inquiry. It is our hope that the ideas, discussion, and the broad research issues set forth in this paper will stimulate interest and future work in the knowledge management area by IS researchers.

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