KNOWLEDGE MANAGEMENT AND KNOWLEDGE MANAGEMENT SYSTEMS: CONCEPTUAL FOUNDATIONS AND AN AGENDA FOR RESEARCH

by

M. ALAVI*

and

D. E. LEIDNER**

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* Orkand Professor of Information Systems, Robert H. Smith School of Business, University of Maryland, College Park, MD 20742.

** Associate Professor of Information Systems at INSEAD, Boulevard de Constance, 77305 Fontainebleau Cedex, France.

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Knowledge Management and Knowledge Management Systems: Conceptual Foundations and an Agenda for Research

By

Maryam Alavi
Orkand Professor of Information Systems
Robert H. Smith School of Business
University of Maryland
College Park, MD 20742
malavi@rhsmith.umd.edu

and

Dorothy E. Leidner
INSEAD
Boulevard de Constance
77305 Fontainebleau Cedex France
dorothy.leidner@insead.fr

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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. For example, some companies have started to produce supplemental annual reports reflecting their intellectual and knowledge assets, while others have created the organizational position of Chief Knowledge Officer. The heightened interest in organizational knowledge and knowledge management is primarily motivated by the transition into the knowledge economy, where knowledge is viewed as the principle source of organizational rent and sustainable competitive advantage.

Knowledge management systems (KMS) refer to a class of information systems that have evolved from the need to enable systematic organizational learning and memory by facilitating the coding and sharing of knowledge across organizational entities that previously may have had little occasion for interacting. As such, an understanding of the effective development and implementation of KMS require a foundation in several rich research literatures including: organizational learning, the sociology of knowledge, and the resource-based theory of the firm. This article will provide a review of these bodies of literature in relation to knowledge management with a view toward understanding the role of information and communication technology in providing not only the technical infrastructure of KMS but in effecting organizational implementation of knowledge management strategies.

In the paper, we view organizations as social collectives that generate, codify, store, distribute, and apply knowledge. This perspective, grounded in the sociology of knowledge, views organizations as knowledge systems consisting of a set of socially enacted knowledge processes. These knowledge processes, including knowledge construction, storage, distribution, and application, constitute a framework for managing organizational knowledge. For each phase of the knowledge management process, we first review and summarize the relevant literature drawn from organizational knowledge and learning, organizational memory, communication, and knowledge integration and organizational capability. Next, we develop a research agenda aimed at IS researchers by developing propositions that describe the potential role of IT in the augmentation/support of the knowledge management processes.

In summary, the purpose of the paper is threefold: 1- To identify and synthesize literature relevant to knowledge management, 2- To provide a framework for knowledge management systems planning and design, and 3- To provide a theoretically based research agenda and propositions for information system researchers with an interest in this area.
1. INTRODUCTION

Information technologies designed to assist managerial and professional workers have evolved over several decades from systems focusing on storing and providing vast amounts of information to managers organization wide (MIS), to systems focusing on providing tools for ad-hoc decision analysis to specific decision makers (DSS), to systems designed to provide updated, often real-time, relevant information to senior and later middle managers (EIS). These systems have each contributed to managerial and organizational improvements in varying degrees and continue to be important components of organizations' information technology portfolio. An emerging line of systems targets professional and managerial activities by focusing on creating, gathering, organizing, and disseminating an organization's "knowledge" as opposed to "information" or "data." These systems are referred to as Knowledge Management Systems.

The concept of coding 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. 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). What is new and exciting in the knowledge management area is the potential of using modern information technologies (e.g., the Internet, intranets, extranets, browsers, data warehouses, and data mining techniques, and
software agents) to systematize, enhance, and expedite large-scale intra- and inter-firm knowledge management.

The existing body of work on KMS consists primarily of general and conceptual principals of KMS and case descriptions of such systems in a handful of bellwether organizations (Alavi, 1997; Baird, Henderson and Watts, 1997; Bartlett, 1996; Davenport and Prusak, 1997; Henderson and Sussman, 1997; Sensiper, 1997; Watts, Thomas and Henderson, 1997). Because KMS are just beginning to appear in organizations, there exists little research and theoretically-based insight to guide the successful development and implementation of such systems, or to frame expectations of the benefits, costs and outcomes of such systems. Nor is it yet clear if KMS will experience widespread development and implementation across a variety of industries, or if KMS are destined to be highly touted systems that quickly find themselves in desuetude as a passing fad.

The recent interest in knowledge management, 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. Economic and managerial implications of knowledge have been addressed by several literature and research streams including: resource-based theory, strategic management, and organizational knowledge and learning. Knowledge-centered perspectives and approaches have become popular among economic theorists (e.g., Arrow, 1962; Penrose, 1958; Nelson and Winters, 1982), and organizational theorists (e.g., Argyris and Schon, 1978; Daft and Weick, 1984; March, 1991). Parallel to research and theoretical developments, organizational and managerial practice have lately become more knowledge-focused. For example, bench marking, 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 points to the central role of knowledge as the essence of the firm. However, providing a comprehensive review and analysis of multiple research literatures is beyond the scope of this paper. Rather, 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 the potential role of information technologies in organizational knowledge management.

2. Knowledge and the Firm: An Overview and Basic Concepts

Recently, a knowledge-based perspective of the firm has 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 create 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). Unimitability 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 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 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 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 manipulate, store, and distribute the knowledge, as well as the firm’s ability to enable employees to create new knowledge, that forms the basis for achieving competitive advantage from knowledge-based assets.

Thus, from this perspective, 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?

This question has occupied the minds of great western philosophers since the classical Greek era and has led to many epistemological debates.¹ It is unnecessary for the purposes of this paper to get engaged in a philosophical debate to probe, question or reframe the term knowledge, or discover the “universal truth.” We have therefore 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).

Some authors further make a distinction among knowledge, information, and data. 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). These definitions are useful in that they all make inroads into understanding differences among data, information and knowledge. 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.

What we consider 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. We are basically positing that knowledge is not a radically different concept from information, but rather that 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 consistent with Churchman’s (1971) conceptualization of knowledge and his statement that “knowledge resides in the users and not in the collection [of information].”

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 to them. (2) Hoards of information is 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 (1991) note, is that knowledge 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, 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 which 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

Several researchers (e.g., Mitroff, 1990; Nonaka and Takeuchi, 1995; Spender 1996) have described different types of knowledge. Mitroff (1990) has argued that the type of knowledge created in organizations depends on the nature of the inquiry systems employed by organizations. An inquiry system is a social system capable of creating knowledge about itself and its environment (Churchman, 1971). Mitroff distinguished among five types of inquiry systems that may be used alone or in combination in organizations. Drawing on the work of Polanyi (1962,1967), Nonaka (1994) has identified two types of knowledge in organizations: tacit and explicit. According to Nonaka, 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. Explicit knowledge is articulated, codified and communicated in symbolic form and/or natural language. It is documented tacit 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 presented in Spender’s (1992,1996-c) matrix of knowledge types (displayed in Figure 1). In this matrix, 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 implicit 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 implicit knowledge held in a social system and is inherent in its processes and interactions (e.g., organizational culture).

[Insert Figure 1 Here]

In the IS field, it has been common to primarily design systems focused on the objectified 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 are extending the scope of computer-based knowledge provision to include all four of the knowledge types shown in Figure 1.

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, as will be discussed in Section 3, 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.

3. Organizational Knowledge Management Processes:
A Framework for Analysis

In this section, we develop a systematic framework that will be used in analyzing and hypothesizing the potential role of information technologies on organizational knowledge management. This framework, displayed in Figure 2, is grounded in the sociology of knowledge (Berger and Luckman, 1967; Gurvitch, 1971; Holzner and Marx, 1979; Schutz, 1962). It is based on the view of organizations as social collectives and “knowledge systems” consisting of the following set of socially enacted “knowledge processes”: construction, storage, distribution, and 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 processes of Figure 2 entails some degree of social knowledge and interactions even if the process is completely automated (computerized) and focused on objective information. 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.

[Insert Figure 2 Here]

3.1 Knowledge Creation

Organizational knowledge creation involves adding new components or replacing existing components within the organization’s stock of tacit and explicit knowledge (Pentland, 1995). One of the most comprehensive models of organizational knowledge creation is articulated by Nonaka (1994). This model explicitly addresses the social nature of knowledge creation as well as its tacit and implicit 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, knowledge is created, shared, amplified, enlarged, and justified. This model views organizational knowledge creation as a social and collaborative process involving a continual conversion between tacit and explicit 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 (See Figure 3). 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 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). An important aspect of organizational knowledge creation, according to Nonaka (1994) and Nonaka and Takeuchi (1995) is the provision of organizational mechanisms and resources for support of all the four modes of knowledge creation and smooth movement and cycling among the four modes.

[Insert Figure 3 Here]

In Section 4 we will build on this discussion of knowledge creation to formulate propositions concerning the role of information technologies as an environment or "field" for support of organizational knowledge creation process as conceptualized and described in this section.

3.2 Knowledge Storage and retrieval

Empirical studies have shown that while organizations create knowledge and learn, they also forget (i.e., do not remember or lose 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 Zwas (1995) constitute an important aspect of effective organizational knowledge management.

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. 12)
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. 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 supra-individual collectives (e.g., groups and organizations). 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 roughly paralleling the two types of organizational knowledge are identified: 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. 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.

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). On the other hand, some authors have viewed memory as 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. This could lead to stable, consistent organizational cultures that are resistant to change (Denison, 1995).

Despite these concerns about the potential constraining role of organizational memory, in this work we have adopted a positive perspective on the influence of memory on behavior and performance of individuals and organizations. This is based on our adopted definition of knowledge as increasing the potential for taking effective action. Consistent with this perspective, we will therefore assume positive influences of memory on organizational performance and hence consider the application of information technology for support and augmentation of organizational memory desirable. Other researchers might wish to consider the potential negative consequences of systematic organizational memory on culture, innovation, flexibility, and creativity. We will formulate and present hypotheses on the role of IT for enhancing organizational memory in Section 4.
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. Knowledge distribution in organizations is fundamentally driven by communication processes and information flows. 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.

Furthermore, in an empirical study of knowledge flows among headquarters and subsidiaries in multinational firms, Gupta and Govindarajan 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, which can be interpreted as the degree of tacitness of knowledge) and the relationship between the source and recipient (ease of communication).

In general, the organizational process of knowledge distribution needs to be studied and strengthened in organizations. According to Huber (1991), connection between those who need to know, and those who possess the required knowledge does not occur automatically and needs to be explicitly supported in organizations. In Section 4, we will build propositions on the role of IT in enabling such connection and transfer of knowledge in organizations.

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.

3.5 Summary

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. 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, 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 (e.g., over-emphasis on creation of large computer systems for support of organizational memory, with little or no consideration of requirements for creating, distributing and applying the content of the databases). 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. 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. The Role of Information Technologies in Support of Organizational Knowledge Management Processes

In this section, the role of IT in support of organizational knowledge management will be articulated in the form of propositions. These propositions will be grounded on the knowledge management framework of Figure 2 and its underlying concepts and theories discussed in section 3.

4.1 Role of IT in Knowledge Creation

Our discussion in Section 2 indicated that several authors have made a distinction between two categories of knowledge: tacit and explicit. Nonaka and Takeuchi (1995, pp.61)
stated that in organizations, “knowledge is created and expanded through social interaction between tacit knowledge and explicit knowledge.” By building on the concept of four knowledge conversion modes between tacit to explicit knowledge (and vice-versa), Nonaka (1994) developed a model of organizational knowledge creation. According to this model, new knowledge in organizations is created through the sharing of tacit knowledge among a group of individuals. Through dialog and discussion, knowledge is amplified, validated, and made tangible (i.e., made explicit). Once distributed in the organization, explicit knowledge (possibly combined with other explicit knowledge) is converted to tacit knowledge by individuals through a process of internalization (i.e., individual learning). Nonaka (1994) further states that these modes of knowledge creation and conversion are typically induced and facilitated by some “triggers” including teamwork (for socialization), documentation (for combination), dialog and collaboration (for externalization), and experimentation or learning-by-doing, (for internalization). We postulate that IT enhances the knowledge creation process through the creation of a facilitative “field” or environment for knowledge creation triggers. More specifically, we have developed three propositions regarding the specific role of IT in organizational knowledge creation.

**Proposition 4.1.1.** Information technology expands the potential breadth and depth of knowledge creation in organizations.

Knowledge creation may be limited by the availability and accessibility of sources of knowledge. The combination and internalization modes of knowledge creation (from explicit to explicit or explicit to implicit) rely on systems or individuals to recognize patterns in existing information to create new knowledge. The greater the number of knowledge sources available, the greater should be the potential for new knowledge creation. IT in the form of computer-supported communication supports teamwork, discussion, and dialog. Known as group support systems (or groupware), IT designed for the support of collaboration, coordination and communication processes can facilitate teamwork and thereby increase an individual’s contact with other individuals. Such increased contact with the ideas of others is
a requisite for the socialization mode of knowledge creation. Moreover, group support systems are being used to support global virtual teams --electronically communicating work groups that are temporary, culturally diverse, and geographically dispersed (Jarvenpaa and Leidner, 1998). The ability to support global virtual teams means that organizations are able to assemble individuals with diverse knowledge and skills to work together. In so doing, the breadth of knowledge to which individuals are potentially exposed increases more than in previous situations where such IT-enabled global teamwork was not possible. Likewise, electronic mail and group support systems (such as LotusNotes) have been shown to increase the number of “weak ties” in organizations (Pickering and King, 1995). Intranets also enable exposure to greater amounts of organizational information, both horizontally and vertically, than may previously have been the case. As the amount of information exposure increases, the possibility for the combination and externalization modes of knowledge creation increase, wherein individuals make observations and interpretations of explicit knowledge to result in either new tacit or new explicit knowledge. As such, the potential depth of knowledge exposure in organizations is increased.

**Proposition 4.1.2.** Information technology increases the quality of knowledge creation in organizations.

IT (e.g., in form of discussion databases, and bulletin boards) can provide a field for interaction among organizational members for sharing ideas and perspectives, and for establishing dialog. By enabling a field of discussion, individuals may arrive at more accurate interpretations than if left to decipher information on their own. Boland et al. (1994) provide a specific example and case of an IT 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 a 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 of the knowledge created is improved.
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).

**Proposition 4.1.3.** Information technology accelerates the speed of knowledge creation in organizations.

By increasing the availability of sources of information and knowledge via communication tools, group support systems, and retrieval tools, IT enables the rapid development of new knowledge. Such technologies as data mining and data warehousing can identify patterns in very large databases at a much faster rate than individuals. Such tools accelerate the pace of the combination mode of knowledge creation (explicit to explicit). Another means by which IT enables rapid knowledge creation is by providing tools for “just-in-time learning”. IT can play a major role in support of individual learning through provision of capabilities such as 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, for example, can allow individuals to learn as needed.

4.2 Role of IT in the Storage of Knowledge

In section 3.2 we discussed the process of knowledge storage in organizational knowledge management and discussed the variety mechanisms for organizational knowledge storage. Files and documents constitute a significant component of organizational memory. We also identified two types of content for organizational memory: semantic and episodic. Considering the enormous and cost-effective capacity and variety of computer technologies for information storage and retrieval, we have formulated three propositions on the role of IT for support of knowledge storage (i.e., organizational memory).
Proposition 4.2.1. Information technology expands the breadth and depth of organizational memory.

Information technologies can enhance the organizational capability for capturing, storing and manipulating explicit knowledge (in the form of numbers, text, video and graphs). An example is the role that the World Wide Web plays for efficiently combining explicit knowledge from different sources through the use of the Hypertext Markup Language (HTML). Applying such tools internally, corporate intranets allow organizational entities distributed horizontally and vertically across the organization to contribute knowledge, thereby increasing the breadth and depth of organizational memory. Also, powerful storage technology increases the amount of historical information that organizations are able to keep online for retrieval, again increasing the scope of available organizational memory. 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, McKinsey's Practice Development Network places core project documentation online for the purposes of promoting memory and learning organization-wide (Stein and Zwass, 1995).

Proposition 4.2.2 Information technology increases the quality of organizational memory.

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). Multimedia files and sophisticated access and display tools provide an opportunity for capturing organizational actions and events in their context, thus facilitating the creation and
access of episodic memory and increasing the quality of memory available. For example, videotapes of simulated and actual battle fields are captured in the electronic organizational memory at the United States Army’s Center for Army Lessons Learned (Watts, Thomas, Henderson, 1997). Project memory, a subset of organizational memory, may also be improved through information technologies (Weiser and Morrison, 1998). Project memory aims to retain "hard" project data, such as documents, and "soft" data such as recollections of critical incidents and details about decision processes (Weiser and Morrison, 1998). 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).

**Proposition 4.2.3** Information technology accelerates the retrieval speed of 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 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 and then, when changes occur, these are immediately noted in the system instead of having brochures reprinted and a lag in time resulting from when the change occurs to when the sales personnel become aware of the change (Leidner, 1998a).
4.3 Role of IT in Knowledge Distribution

In section 3.3, the knowledge distribution process was discussed. We mentioned that the absence of a central and “all-knowing” organizational mind makes organizational knowledge distribution a challenging process. As primarily a process of organizational communication, knowledge distribution follows the organization communication model and knowledge flows typically follow the organizational communication patterns. Building on the discussions in this and section 3.3, we have formulated three propositions.

Proposition 4.3.1. Information technology increases the breadth and depth of knowledge distribution in organizations.

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). Among the chief problems of organizational memory is that members with information needs often are unaware of the existence of location of information possessed by other members (Huber, 1991). Thus, expanding the individual’s network to more extended, though perhaps weaker, networks is central to the knowledge diffusion process because such networks expose individuals to 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
Proposition 4.3.2 Information technology increases the quality of knowledge distribution in organizations.

One of the tradeoffs noted in decision making literature is that decision makers often must choose between quality information and accessible information (O'Reilly, 1982). Where time pressures exist, the choice is often to accept lower quality information that is more rapidly obtained (O'Reilly, 1982; Todd and Benbasat, 1991). One of the primary incentives behind knowledge management systems in organizations is to make knowledge rapidly accessible so that individuals are able to obtain quality information rapidly (Alavi, 1997; Davenport 1997, 1997b). It is not surprising that one of the most popular applications on Intranets are 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 megadata (knowledge about where the knowledge resides) proves to be as important as the original knowledge itself (Andreu and Ciborra, 1997).

Proposition 4.3.3 Information technology accelerates the speed of knowledge distribution in organizations.

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 knowledge maps of organizational information enables individuals to rapidly locate either the information or the individual housing the needed information, more rapidly than would be possible without such IT-based support (Offsey, 1998).

4.4 The Role of IT in Knowledge Application

In section 3.4 we described the organizational knowledge application process and discussed knowledge integration as a significant aspect of knowledge application. Three organizational mechanisms for knowledge integration were identified: directives, organizational routines and team problem solving. IT can play an important role in organizational knowledge integration per the following three propositions.

**Proposition 4.4.1** Information technology increases the breadth and depth of knowledge integration in organizations.

IT can enhance the knowledge integration process 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.

**Proposition 4.4.2** Information technology increases the quality of knowledge integration in organizations.
IT can enhance knowledge integration 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 and activities. Rule based expert systems are another means of capturing and enforcing well specified organizational directives.

**Proposition 4.4.3** Information technology accelerates the speed of knowledge integration in organizations.

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. Formally, 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.
4.5 The Role of IT in Bridging the Four Phases of Knowledge Management

A very significant potential role of IT is the support of organizational knowledge management 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 mutually dependent. Hence, it is important to focus on the entire knowledge management process and not just one aspect. IT can play a significant role in bridging the links in the chain of knowledge management. Our final proposition is:

**Proposition 4.5:** IT can strengthen organizational knowledge management by supporting the linkages in the chain and the process interdependencies.

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.”

4.6 Summary

This section has presented propositions concerning the role of IT in enhancing the knowledge management process. Several technologies can be important components of knowledge management initiatives, including computer-supported communication tools, groupware, data warehousing, data mining, storage media, expert systems, and intranets. Knowledge management systems are in fact many technologies combined. As such, a
knowledge management system is best thought of as the process of applying information
technologies to a knowledge management initiative rather than as a specific technology
(Alavi and Leidner, 1998). The characteristics of these information technologies which
contribute to knowledge management are that: (1) they can extend the internal network of
individuals in an organization, (2) they can enable rapid learning, (3) they can enable the
rapid storage, retrieval and updating of information, and (4) they can enable unstructured
knowledge and queries to be disseminated vertically and horizontally in an organization. In
so doing, IT can thereby increase the breadth and depth, the quality, and the speed of
knowledge creation, storage, distribution, and application in an organization. Figure 4
summarizes the proposed role the IT in the knowledge management process.

5. Summary and Discussion

It is our contention that in 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 will receive considerable scholarly attention and become a focal
point of inquiry. As the research interest in this area grows, it is important to understand and
build upon the already significant KM work in the large extant literatures. These literatures
provide significant insights into different aspects of this broad topic. Ignoring the existing
and emerging work in other related disciplines may lead to intellectual redundancy and clutter
and inefficient expenditure of intellectual capital of IS research.

In this paper we have presented a framework, based on review and interpretation of a
range of relevant literature, for understanding the process of knowledge management in
organizations and the role of information technology in this process. It is our hope that the
framework of Figure 1 and the propositions set forth in this paper serve as building blocks for
the development of a theory and the effects and outcomes of IT on organizational knowledge
management. A next step in this line of research is to develop hypotheses to be tested empirically. A major challenge in the next step involves the development of meaningful measures of KM processes and outcomes and creation of technical infrastructure. Although we have presented a technology imperative on the role of IT in knowledge management, others may wish to take an organizational imperative and develop a contingency theory of KMS effectiveness. For example, already researchers are suggesting that organizational culture is posing a significant limitation to the amount of success a knowledge management initiative may have in an organization [Skryme and Amidon, 1997]. Because knowledge management systems integrate information vertically and horizontally in organizations, information ownership problems and underlying subunit culture clashes are prone to occur. One framework for assessing the impact of organizational culture on KMS maps various subunit cultures into an information culture matrix (Leidner, 1998b). This framework suggests that certain organizational subunits are more predisposed to the effective use of knowledge management systems than are others and that such subunit cultures must be taken into account in the implementation strategy.

While our propositions suggest that IT can play an important role in the knowledge management process, we do not suggest that IT necessarily will produce the desired effects. Many factors, such as shared cognitive and social context, influence communication behavior and interpretation of information (Zack, 1993). These factors are also likely to influence receptivity to knowledge contained in a system from individuals who the recipient does not personally know. Some might question whether electronic communities will be as effective as physically present communities-of-practice in fostering learning and knowledge integration (Brown and Duguid, 1991). Research is needed to explore whether in the absence of co-presence, the extended networks enabled by information technologies lead to long-term improvements in knowledge management. Our intent was not to elucidate the factors that enable technology to be applied effectively, but to discern the role that technology could play, if effectively implemented. The implementation issues to be considered would form an important basis of other research.
NOTES

1. The epistemological debates have been expressed from a variety of perspectives and positions including the rationalist perspective (advanced by philosophers such as Descartes in the seventeenth century), the empiricist perspective (advanced by Locke and others in the eighteenth century), and the interactionist perspective (advanced by Kant and others in the nineteenth century). For a discussion of the history of knowledge and epistemology, see Polanyi (1958, 1962).

2. The term "new" is used to refer to knowledge that was previously unknown to the individual or the collective (group) under consideration. In this context, knowledge creation process does not have to lead to development of knowledge new to all humanity.

3. This assumption is consistent with Schatz (1991-1992) position that organization memory can provide "knowledge that enables the organization to continue functioning effectively."
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<td>Implicit</td>
<td>Automatic</td>
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Figure 1. Different types of organizational knowledge (Spender, 1996, p. 52)

Figure 2. Knowledge Management Framework (Adapted from Pentland, 1995)

Figure 3. Modes of Knowledge Creation (Nonaka, 1994, pp. 19)

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<tr>
<th>Phases of Knowledge Management</th>
<th>Knowledge Creation</th>
<th>Knowledge Storage</th>
<th>Knowledge Distribution</th>
<th>Knowledge Application</th>
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<th>More historical knowledge available Organization-wide</th>
<th>More extensive internal network</th>
<th>More extensive internal network - knowledge can be applied in many locations</th>
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<td>More extensive communication channels available</td>
<td>Rapid updating of information</td>
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<th>Proposition 4.3.1</th>
<th>Proposition 4.4.1</th>
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<td>Proposition 4.4.2</td>
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<td>IT increases the quality</td>
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