

Knowledge Management: A Threefold Framework

C. W. Holsapple

*School of Management, Gatton College of Business and Economics, University of Kentucky,
Lexington, Kentucky, USA*

K. D. Joshi

*School of Accounting, Information Systems, and Business Law, College of Business
and Economics, Washington State University, Pullman, Washington, USA*

It is widely claimed by a number of business and academic gurus that in order for organizations to have a lasting competitive advantage they will have to be knowledge driven. If knowledge is viewed as a resource that is critical to an organization's survival and success in the global market, then like any other resource it demands good management. However, the bulk of organizations still have not approached knowledge management (KM) activity formally or deliberately. The cause for this inattention could be that most organizations are still struggling to comprehend the KM concept. To ease the struggle, the fundamental issue of identifying salient characteristics of KM phenomena needs to be addressed. This article helps address this need by introducing a threefold descriptive framework that identifies and characterizes the main elements of KM phenomena and their relationships. The first component provides a generic description of an organization's knowledge resources. A second component introduces elemental knowledge manipulation activities an organization performs in dealing with those resources. The third component identifies major influences that impact an organization's conduct of KM. Results of a survey to assess the framework are reported. They indicate general satisfaction with the framework.

Keywords chief knowledge officer, framework, knowledge-based organization, knowledge management, knowledge resources

The world in general, and the business world in particular, is experiencing a paradigm shift: a shift toward knowledge-based organizations (Holsapple & Whinston, 1987) in a knowledge-based society (Toffler, 1990; Drucker, 1993). In such organizations, knowledge is regarded as a crucial resource, and harnessing knowledge-processing skills to maximize the value of this resource is recognized as a paramount concern. An organization's knowledge resources are complex and multifaceted, ranging from tacit components to knowledge that is explicitly represented (Nonaka, 1991), and including descriptive knowledge, procedural knowledge, and reasoning knowledge (Holsapple & Whinston, 1987). Both computer and human participants in an organization possess various skills for manipulating its knowledge resources. This portfolio of skills and how they are deployed in manipulating available knowledge resources go a long way toward determining the nature of an organization's innovations and outputs, and hence its competitiveness in a dynamic environment.

It is clear that knowledge resources need to be carefully managed rather than being left to serendipity (Amidon, 1996). Documented cases of organizations that have achieved some success in this include Chaparral Steel, Honda, Canon, Buckman Laboratories, and Skandia (Rifkin, 1997; Stewart, 1997; Leonard-Barton, 1995; Nonaka, 1991). However, as Nonaka (1991) points out, "despite all the talk about brainpower and intellectual capital, few managers grasp the true nature of the knowledge-creating company—let alone how to manage it." Zack and Serino (1996) maintain that "While the business case for knowledge management is becoming widely accepted, few organizations today are fully capable of developing and leveraging critical organizational knowledge to improve their performance."

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Address correspondence to K. D. Joshi, Todd 240B, School of Accounting, Information Systems, and Business Law, College of Business and Economics, Washington State University, Pullman, WA 99164, USA. E-mail: joshi@wsu.edu

One reason why the full potential of deliberate, systematic knowledge management (KM) efforts has yet to be widely fulfilled is that organizations are still struggling to comprehend the KM concept. Anne Stuart, senior editor of *CIO*; writes, "Many managers would be hard pressed to explain precisely and concisely, what this evolving business trend (KM) means. What they probably do know is knowledge management has been billed as a critical tool for the 21st century corporation And they know it is something they just have to get too—even if they don't know exactly what it is" (Stuart, 1996). To foster a common understanding of what it is, we need to address the fundamental issue of identifying the salient characteristics of KM phenomena in organizations. This is a prerequisite for systematic research into the nature and possibilities of KM, as well as for easing the emergence of KM into practice.

This article advances a framework that identifies key characteristics to consider in the study and implementation of KM. It is the result of synthesizing elements from existing descriptive frameworks and related KM literature to yield a relatively complete, unified perspective. The framework is comprised of three main components. The first of these provides a taxonomy that identifies the kinds of knowledge resources that an organization can have and manage. The second component identifies basic types of activities that can be used to manipulate an organization's knowledge resources. An organization's participants (human and computer-based) use their knowledge-handling skills to execute these manipulation activities, producing and consuming knowledge flows in the process. The framework's third component characterizes three classes of influences that shape the conduct of knowledge management in an organization (e.g., they influence the configuration of manipulation activities used to satisfy knowledge needs).

We begin with a brief background discussion of the nature of knowledge and the need for descriptive KM frameworks. Next, the threefold framework is described. As its elements are introduced, they are tied to the KM literature and illustrated with examples. In addition to this conceptual grounding, some external validation is then presented in results of a survey to assess the threefold framework's completeness, accuracy, clarity, and conciseness. We close with a description of future research avenues emanating from the framework.

BACKGROUND

Throughout the ages, philosophers, scientists, and others have debated the nature of knowledge. Although it is not our intent to review or add to this debate, a brief consideration of knowledge provides useful background for appreciating the framework.

According to Newell (1982), knowledge is embedded in usable representations. Simply put, representations are patterns. This includes patterns of materials, energy (e.g., sound, light electro-magnetic), actions, behaviors, and other symbolic systems. Such representations convey knowledge to the extent they are usable by some processor (i.e., a knower). That is, knowledge is relative to the knower; one processor may attain great utility from the knowledge embedded in a representation that another processor is unable to use (Holsapple & Whinston, 1996).

The KM framework advanced here is not oriented toward any particular kind of representation or processor. It admits the possibility of both explicit representations (e.g., the words displayed here) and tacit representations (e.g., mental states). It also admits the possibility of both human-based and computer-based processors. However, its focus is not on enumerating types of representations, transformations of representations, or the mechanisms for processing a particular type of representation. Its focus is on identifying classes of knowledge resources, basic activities for manipulating them, and factors influencing the conduct of KM.

Commentators on the knowledge management scene often strive to draw distinctions between the notions of data, information, and knowledge. Some of these same commentators, as well as others, proceed to use the terms *knowledge* and *information* interchangeably. Still others argue that knowledge management is simply a renaming of information management. The framework is not dependent or predicated on any of these views; nor is its purpose one of grappling with such distinctions. However, the manner in which the framework is understood and applied is dependent on one's view of knowledge.

Like much of the KM literature, the framework probably furnishes the least value to those who equate knowledge with information. For those who treat knowledge and information as mutually exclusive, the framework can be applied to whatever is regarded as being in the knowledge category. Between these two extremes is the view that regards information as a kind of knowledge. A progression of several knowledge states including data, information, and knowledge has been identified by van Lohuizen (1986); the progression proceeds from the least refined, least focused, least directly usable state of knowledge (i.e., data) through states that are increasingly refined, focused, and directly usable. A researcher applying the framework can consider knowledge to encompass all such states, or can choose to apply it to some subset of these states.

Machlup (1982) contends that all information is knowledge, but not the reverse; knowledge is more than just information. For example, one knowledge taxonomy

distinguishes among descriptive, procedural, and reasoning knowledge (Holsapple, 1995). Descriptive knowledge, commonly called information, describes the state of some world (e.g., past, current, predicted, hypothetical). In its various states from raw data to structured information, descriptive knowledge has long been the focus of information management and information systems for representing and processing it (Holsapple & Whinston, 1988). In contrast, procedural knowledge is concerned with how to do something (e.g., processes, techniques) and reasoning knowledge indicates what conclusion is valid in a particular situation (e.g., cause-and-effect principles, correlations, heuristics). Like descriptive knowledge, these exist in various gradations of refinement and usability.

An organization's descriptive, procedural, and reasoning knowledge is explicitly and/or tacitly represented and processed by human and/or computer-based participants in the organization. Although the framework does not incorporate or commit to this view, we suggest that such a view is sufficiently inclusive to be a helpful basis for understanding and applying the framework's characterizations of what an organization's knowledge resources are, what activities can be exercised in manipulating those resources, and what factors influence the organization's conduct of KM.

In the absence of a comprehensive framework, a field's "progress is but a fortunate combination of circumstances, research is fumbling in the dark, and dissemination of knowledge is a cumbersome process" (Vatter, 1947). Although a few descriptive frameworks have been posited for KM (e.g., Nonaka, 1994; Wiig, 1993), each seems to address only certain KM elements. A comparative analysis of such frameworks shows that individually, none describes the full scope of KM phenomena (nor is this the stated intent of any); collectively, it is not obvious how they might fit together and it appears that they overlook some KM issues reported elsewhere in the literature (Holsapple & Joshi, 1999a). A more comprehensive descriptive framework for characterizing KM phenomena can benefit both researchers and practitioners by furnishing an organized foundation for future progress in understanding the conduct of KM.

Here, we help address this need by introducing a descriptive framework that identifies and characterizes the main elements of KM phenomena and their relationships. A descriptive framework provides a perspective for fully understanding (as well as organizing) concepts in a unified fashion. It describes a phenomenon in the form of key factors, constructs, or variables and their relationships (Miles & Huberman, 1994). One finding from a survey evaluating the threefold framework introduced later in this paper is that respondents are unanimous in their view that a KM

framework is needed; representative respondent comments about this need are shown in Table 1.

A THREEFOLD KNOWLEDGE MANAGEMENT FRAMEWORK

For many years organizations have formally captured and managed explicit knowledge by way of computer systems such as management information systems, decision support systems, and expert systems. One premise of this article is that such technologies are just a portion of what is possible and what is necessary for effective KM. A second premise of this article is that understanding KM phenomena depends on (1) characterizing knowledge resources that need to be managed, (2) identifying and explaining activities involved in manipulating these knowledge resources, and (3) recognizing factors that influence the conduct of knowledge management. These three aspects correspond to components of the descriptive framework introduced here: a knowledge resources component, an activities component, and a KM influences component. The knowledge resources are an organization's reservoirs of knowledge; this knowledge (e.g., descriptive, procedural, reasoning) is embedded in usable representations (e.g., tacit, explicit). The knowledge manipulation activities are elementary functions an organization performs in processing its knowledge resources. The KM influences are factors that affect the conduct or manifestation of KM in an organization.

A major objective of this framework is generality. It is not geared toward the description of KM within any particular organization, but rather can be applied to the study of KM phenomena in diverse organizations. As such, its elements involve a certain level of conceptual abstraction that becomes more concrete only when applied to the study of a particular organization. As the elements of each component are introduced, we ground the descriptions in examples. These examples are included to illustrate concepts and are by no means exhaustive.

In creating the framework, pains were taken to ensure that its concepts accommodate features found in prior KM frameworks, plus ideas gleaned from the KM literature at large (Holsapple & Joshi, 1999a). This involved an iterative process of synthesis in the direction of a unifying and more complete view of KM. In keeping with the objective of generality, the framework recognizes that technology can play an important role in KM, but does not emphasize its role relative to nontechnological aspects. That is, the framework is applicable regardless of whether one wants to use it from a technological, human, or hybrid vantage point.

A survey was conducted to assess the threefold framework in terms of its completeness, accuracy, clarity, and

TABLE 1

The need for a KM framework: Survey respondents' comments about the need for a KM framework

The framework is important for the practical & theoretical structure it can provide. It can provide a context for all work in the field.

It is important to create (or begin the process of converging on) a consensual definition of the phenomenon so that we can begin to perform "normal science" and start to coordinate accumulated research.

A framework helps people understand what KM is, what knowledge activities are involved and how the knowledge activities affect organizational effectiveness. Most of the confusion about knowledge management results from the lack of a comprehensive framework.

This framework gives academicians and practitioners a common set of well-defined constructs for research and practice in KM.

A framework can help place people's efforts in a bigger perspective. It can also help both practitioners and researchers have a way to identify if they have covered all the appropriate issues pertaining to their situation.

For (a) awareness and understanding, (b) common communication, (c) scoping of initiatives and projects, (d) further development of the field. It is especially important at this early stage in the development of the practice and theory of KM to be able to discuss what it is and "is not"; what entities and activities it is concerned with (as you have done). The importance of models and frameworks in the communication of subtle issues, such as one involved in KM, can hardly be overstated.

A framework facilitates communication.

It is also extremely useful to have a common and understood vocabulary.

A beginning for purposeful research in an emerging area.

(1) Need to be able to define for students the range of activities that they will be prepared for, if they concentrate in KM. (2) Clarifies what people mean when they talk about KM and intellectual property. (3) Reveals the "culture" of KM-ers to those of us who study this "information renaissance" as a social phenomena.

You must be able to visualize it in order to manage it and continuously improve it. Managing knowledge is not new—what is new and exciting is the development of a framework and language that allows us to talk/study it.

Much confusion exists surrounding the notion of knowledge management. Most of this is based on a lack of clarity with respect to the definition and domain of KM. A framework is needed that defines the boundary of KM as well as its components.

We tend to have (create) tacit frameworks, so an explicit one helps in reflection and communication in a wider circle.

(1) Determines scope of action/management. (2) Acts as visual support to aid communications. (3) Can be a diagnosis/resource allocation tool.

To understand how big a problem is and that it is necessary to consider it in global dimension. To identify all resources, actors and influences involved in the process. Framework helps to understand all (quite all) facets of KM to make a difference between true KM and just marketing keywords.

The KM label is being applied to everything and anything by consultants and "scholars" looking to get in on the hottest issues of the day. We need to reclaim the concept and provide some influential foundation, rigor, and consistency. On the other hand, we must realize that something as basic and fundamental as knowledge cannot be captured by a single view.

It matters not what framework or architecture you use, but having one enables systematic knowledge identification and leverage.

The experience I have with my clients is that until they have a coherent vision (the perspective based on an overall framework model), they cannot focus on priorities, identify how to coordinate cross-organizational efforts, [focus] on identifying overall long-term benefits.

conciseness. Survey results indicate an appreciable degree of success for these criteria. They also suggest the possibility of future enhancements. Future investigations will determine the extent to which the threefold framework serves to unify viewpoints and ideas in the field, the degree of its descriptive power, its utility in the generation of KM theory and research hypothesis, its value as a guide to considerations that practitioners need to address, and its contribution as a stepping stone in the stimulation of future KM frameworks.

The Knowledge Resource Component

A conventional view of an organization sees it as having three main types of resources: material, human, and monetary (Miner, 1978). A knowledge-based view recognizes knowledge as another major organizational resource (Holsapple & Whinston, 1987). Indeed, Peter Drucker (1993) and others have proclaimed that knowledge is the most important of an organization’s resources. Figure 1a

portrays this knowledge-centric view of an organization. Arrows in the figure indicate that knowledge resources impact the other three resources and the external environment, and vice versa. More broadly each type of resource can affect each of the other resources as well as the external environment, and vice versa (e.g., there can be tradeoffs, exchanges, substitutions, synergies).

Figure 1a also highlights one of these impacts by recognizing the existence of knowledge management skills in the organization’s participants. The dashed lines are meant to suggest that some of these skills are human resources (e.g., a person’s cognitive skills), while others may be material resources (e.g., a computer system’s processing abilities). That is, an organization can have both human and machine-based knowledge workers each having certain capabilities for representing and processing knowledge (Holsapple et al., 1996). An organization’s knowledge resources can be exploited only as far as its participants’ knowledge manipulation skills permit. Conversely, the exercise of knowledge manipulation skills depends on what

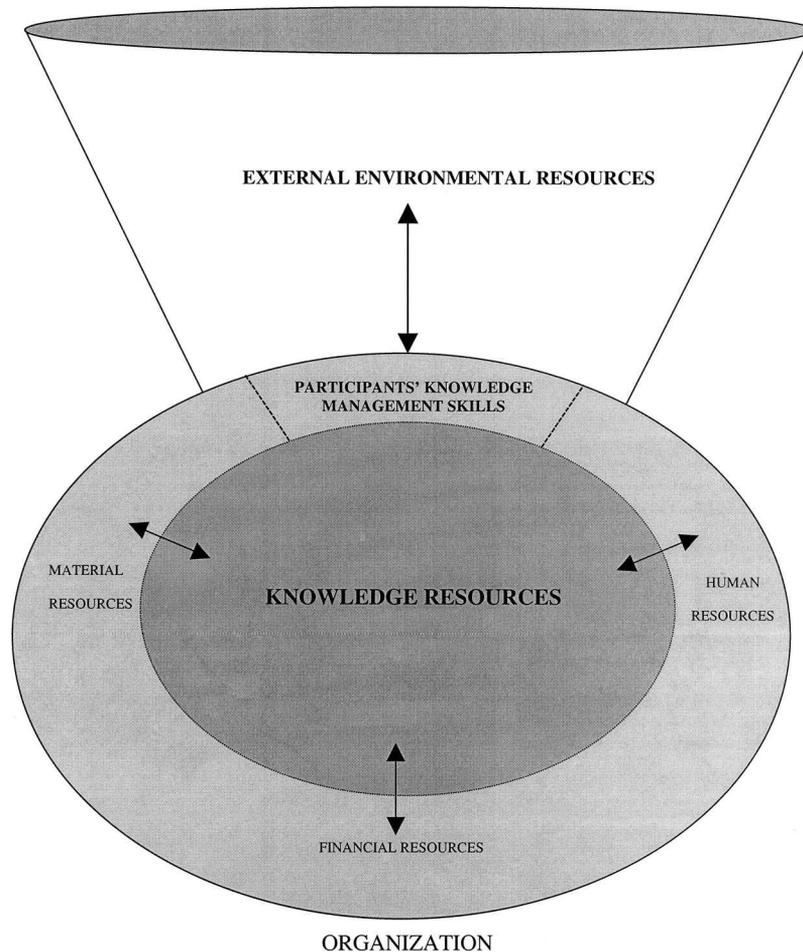


FIG. 1a. Organizational resources.

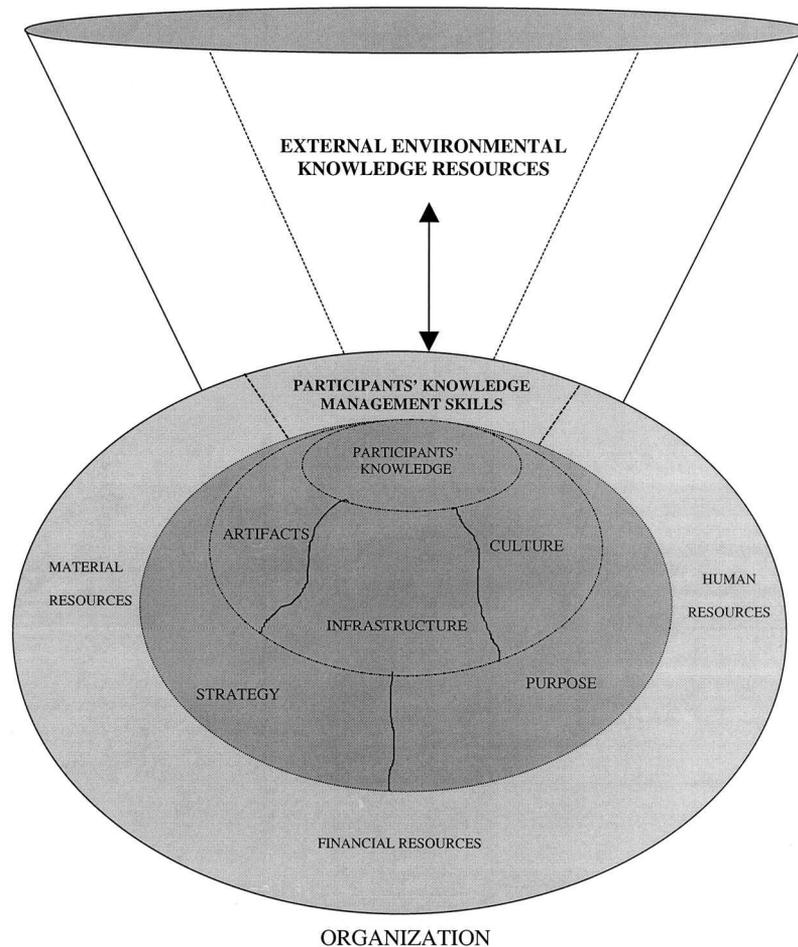


FIG. 1b. Types of knowledge resources.

knowledge resources are available in the organization and its environment.

In Figure 1b, the knowledge-centric view of an organization is further developed to identify primary types of knowledge resources. This constitutes the KM framework's resource component. The issue of how participants' knowledge manipulation skills are exercised (i.e., channeled into a set of interrelated knowledge manipulation activities) is addressed later in discussion of the framework's activities component. Knowledge can be stored, embedded, or represented in an organization as any of six distinct kinds of resources: (1) participants' knowledge, (2) culture, (3) infrastructure, (4) knowledge artifacts, (5) purpose, and (6) strategy.

A researcher investigating knowledge management in a particular organization can study any of these six resources or dependencies among them. A practitioner likely would be concerned with all six types of knowledge resources and their interdependencies. Aside from the six types of knowledge resources within its boundaries, an organization has

access to knowledge existing in its environment. Although it does not belong to an organization, it is a crucial source for replenishing and augmenting an organization's knowledge resources. Both researchers and practitioners must be cognizant of the relationships between environmental knowledge resources and the six types of organizational knowledge resources.

Participants' Knowledge. An organization's participants can be human resources (e.g., employees) and/or material resources (e.g., computer systems). Each participant has certain knowledge management skills and a storehouse of knowledge. The knowledge that a participant brings to bear in the execution of its role within an organization is a knowledge resource of that organization. Being the combination of such knowledge, an organization's participant knowledge resource is thus affected by the arrival and departure of participants, participant learning, the portion of each participant's knowledge that is brought to bear on organizational work, and the interrelationships that

participants' knowledge are allowed to have (e.g., by organization's infrastructure and culture).

The portion of an employee's knowledge that is used in accomplishing work for an organization is a part of the organization's participant knowledge. An organization's knowledge can also be stored on computer systems, for instance in a database or an expert system. For example, General Electric's answer center, USA, has collected customers' complaints in a database. This knowledge is part of a system that aids operators in handling customer complaints and concerns for 1.5 million potential problems (Sveiby, 1997).

The knowledge stored by a computer system preserves, formalizes, and consolidates knowledge from various sources. Joe Daniele, corporate manager for intellectual property at Xerox Corp., in Rochester, NY, in 1990 after identifying a retirement trend that would have created a huge knowledge deficit throughout Xerox, recognized the need to capture the valuable knowledge of key players in the organization before they left (Crowley, 1997). Similarly, the consulting firm Integral, Inc., recognized the need to create a system that captured and stored the participants' knowledge when 25% of its 40-person staff planned to go to graduate school (Crowley, 1997). Once the knowledge of the human participants is captured and formalized, it can be transferred and shared throughout the organization.

Culture. Culture is defined by Schein (1985) as the "basic assumptions and beliefs that are shared by members of an organization, that operate unconsciously, and that define in a basic taken-for-granted fashion an organization's view of itself and its environment." An organization's values, principles, norms, and unwritten rules and procedures comprise its cultural knowledge resource. This resource exists independently of the presence of any particular participants' knowledge, yet it influences each participant's use of knowledge as well as the interactions among participants' knowledge. The cultural resource is comprised of basic assumptions and beliefs that govern participants' activities. It is important for KM researchers and practitioners to appreciate this knowledge resource and the mechanisms whereby it persists and can be altered.

Historically, culture has been a storehouse of knowledge. For instance, persons involved in karate and Japanese culture point out that karate is not only a mechanism to achieve physical fitness, but also serves as a vehicle through which Japanese philosophy is transferred from generation to generation. It is an approach to preserving an organization's (i.e., a community's) cultural knowledge. This transfer is highly nonverbal in nature, communicated mainly through watching and doing. Another example of cultural knowledge persistence involves fasting. In India,

the practice of fasting has been observed for centuries. Practiced as frequently as once or twice a week, this ritual is a body-cleansing mechanism and a means to achieve self-control over eating. The cultural knowledge of body cleansing and self-control is embedded in the form of a belief in the practice of fasting. Interestingly, an activity similar to fasting is advocated by several diet programs in the Western world. Also, cultural knowledge has long been stored in the form of stories and proverbs, which are transferred from generation to generation by means of storytelling.

The perspective of culture as a knowledge resource can be recognized by observing organization's participants' behaviors. For instance, a mill superintendent "championed the ultimately disastrous installation of a \$1.5 million arc saw for cutting finished beams. He was not penalized, but promoted" (Leonard-Barton, 1995). This encouraged the values of high tolerance for risk taking and failure at Chaparral Steel. Slowly, the knowledge that a positive attitude toward risk taking is crucial to the organization's success became ingrained in its culture. This knowledge is manifested in the form of frequent experimentation performed by employees to solve problems, which allows Chaparral to be innovative and creative.

An organization's cultural knowledge resource governs participants' behaviors (e.g., knowledge sharing vs. knowledge hoarding). It affects what knowledge is acquired and internalized. Leonard-Barton (1995) points out that "Values serve as a knowledge-screening and -control mechanism." That is, the cultural knowledge resource can function as a kind of meta-knowledge. It also influences and is influenced by the other kinds of organizational knowledge resources such as infrastructure, strategy, and purpose.

Infrastructure. Infrastructure is the knowledge that is used to structure an organization's participants. It is a formal counterpart to an organization's cultural knowledge resource. Infrastructure refers to, "the roles that have been defined for participants to fill, the relationships among those roles, and regulations that govern the use of roles and relationships" (Holsapple & Luo, 1996). The roles, relationships, and regulations in force for an organization are knowledge about the formal structuring of work performed by both human and computer participants. This infrastructure knowledge resource governs not only ordinary organizational operations, but also the designing, enabling, monitoring, evaluating, enforcing, and modifying of organizational infrastructure (Holsapple & Luo, 1996).

Representing knowledge as infrastructure is a means of formalizing existing organizational knowledge that can be used to generate new knowledge (Marshall et al., 1996). Role definitions are knowledge about what needs to be

done by participants, about expectations for the participants assigned to the roles (e.g., what knowledge each is expected to handle or generate). Relationship definitions are knowledge about what interactions are available among participant-filled roles. The interactions that occur for one relationship pattern may generate different knowledge from those that occur for a different pattern (Ching et al., 1992). Regulation definitions are knowledge of formal rules and procedures that participants are expected to observe in filling their roles and in engaging in relationships. Examples include manufacturing and service processes, hiring processes, performance appraisal, and reward processes.

Knowledge Artifacts. A knowledge artifact is an object that represents knowledge. An artifact is not a participant, as it does not have any innate knowledge-processing capability. Common examples of knowledge artifacts are video training tapes, books, memos, business plans in print, manuals, patent documents, filing cabinet contents, and products (e.g., knowledge embedded in a manufactured car). An artifact belongs to an organization, but it may be under the control of or accessible to only certain participants.

Knowledge embedded in artifacts can also be represented in other knowledge resources. Representing knowledge as an artifact involves explicit embodiment of that knowledge in an object, thus positively affecting its ability to be transferred, shared, and preserved. For example, Chaparral Steel's near-net-shape casting process, in which both mold and process are patented (Leonard-Barton, 1995), is represented as two knowledge artifacts: the physical system and a document describing a patented process (thereby preserving and protecting it). It is conceivable that this process knowledge also resides with participants; however, it is the representation as a patent document that furnishes legal protection and preservation.

Organizational knowledge manifests itself in form of products (Wiig, 1993). Products are not simply a result of material, capital, and labor resources, but also of knowledge resources. Knowledge resources guide the transformation of material, labor, and capital resources into a product. In other words, products in an organization's inventory are artifacts representing the knowledge used to build them. Once a product is released into the environment it is no longer an organizational resource. But these products can be exchanged for other kinds of resources (e.g., financial). A product's exchange value is influenced by what a customer is willing to pay for that knowledge. For example, the value of a can of Coke to a consumer derives largely from the marketing, packaging, and recipe knowledge embodied in it, rather than from the costs of assembling certain ingredients and distributing them in containers. A subtle acknowledgment that knowl-

edge is represented in products can be seen in competitors' attempts at reverse engineering.

Purpose. Purpose is knowledge of the reason for which an organization exists. It is a knowledge resource that indicates an organization's mission, vision, objectives, and goals. It strongly influences the other knowledge resources that an organization does or needs to have. The purpose resource guides strategy formulation, the result of which then drives knowledge manipulation activities. If this knowledge is unclear, inadequate, and not carefully evaluated, then an organization may formulate and implement strategies that are detrimental to organizational performance. For example, Sears, whose purpose is to sell consumer goods, bought the investment firm Dean Witter. This turned out to be a failure because consumers did not consider their financial needs to be satisfiable by a "consumer product" (Drucker, 1994). In this case, the knowledge about purpose (i.e., what comprises consumer goods) was inadequate or unused.

Strategy. Strategy is knowledge about what to do in order to achieve organizational purpose in an effective manner. This knowledge resource indicates plans for using an organization's infrastructure, culture, knowledge artifacts, and participants' knowledge (as well as other organizational resources). For instance, it can be plans for promoting a product or achieving effective resource allocation. A purpose of Pepsi and Chaparral Steel is to sustain their leadership positions in their respective markets. However, strategies needed to achieve the same purpose are very different for each firm. Pepsi's strategies focus mainly on gaining competencies in the areas of marketing and sales, whereas Chaparral Steel strategies focus primarily on competencies that allow it to continually improve and innovate its production processes (Leonard-Barton, 1995). In this example, Pepsi and Chaparral Steel have very different sets of strategic knowledge on how to sustain market leadership. And thus activities for acquiring and cultivating such knowledge would be different for Pepsi and Chaparral Steel.

External Environment. An organization's environment is populated with many entities that are potential sources of knowledge. Through contact with these entities, an organization can augment and replenish its knowledge resources. Environmental knowledge may be viewed as a virtual knowledge resource for an organization. It does not actually belong to an organization, nor is it controlled by the organization, but it can be accessed or acquired from the environment. This may or may not be difficult or expensive. The World Wide Web's content is a virtual knowledge resource that is relatively easy and inexpensive to tap, albeit of variable quality. The Johns Hopkins

networked database for genetic research is an example of a virtual knowledge resource. This database is the “one and only one official record of every gene and piece of DNA that’s mapped in the world. . . . [It also] captures and reflects the ongoing wisdom” of experts from all over the world (Anthes, 1991, p. 28). Thousands of medical researchers and practitioners access this knowledge resource that is virtually their own.

Discussion. The six types of knowledge resources identified here are distinct. A given purpose does not dictate a particular strategy, although it may limit candidate strategies. Conversely, a given strategy does not imply a particular purpose. Similarly, a given culture does not dictate a particular strategy or purpose; nor is a given strategy or purpose necessarily incompatible with all but a single cultural variation. Infrastructure does not dictate culture, and vice versa. Participant knowledge is different from any of these (e.g., it is a knowledge resource that can walk out the door). Although artifacts may hold renditions of any of the other knowledge resources, they are not those other resources. Although distinct, the six types of organizational knowledge resources are also highly interrelated. They constrain, facilitate, and reinforce each other. It is outside the scope of this article, but we do note the importance of appreciating relationships among knowledge resources as a basis for bringing them into proper alignment.

An organization’s knowledge resources can be characterized in terms of various attributes. Although the resource types are nouns, the attributes are adjectives that qualify them in various ways. The literature contains a variety of attribute dimensions, including knowledge usage—practical versus intellectual versus pastime versus spiritual versus unwanted (Machlup, 1982), knowledge type—descriptive versus procedural versus reasoning (Holsapple & Whinston, 1988), knowledge mode—explicit versus tacit (Nonaka, 1994), knowledge subject—domain versus relational versus self (Holsapple et al., 1996), and knowledge quality, involving knowledge utility and validity measures (Holsapple & Whinston, 1996). For instance, usage of the latter attribute dimension can be seen in Integral Incorporated’s Knowledge Bank System, which requires that each internalized unit of knowledge pass through a value check or quality assurance procedure and be assessed for assignment into one of three quality grades (Crowley, 1997). Studying the application of attribute dimensions to each of the framework’s resource types is an interesting direction for future research.

The Knowledge Manipulation Activities Component

Having identified the generic types of knowledge resources an organization possesses, we now formulate a set of generic types of manipulation activities an organization

undertakes in working with those resources. These knowledge manipulation activities are an expression of participants’ knowledge manipulation skills. *Skill* is the ability to apply one’s knowledge effectively and readily to execution and performance (*Merriam Webster’s Collegiate Dictionary*, 10th ed., 1995). Knowledge manipulation skills are exhibited by human and/or material resources as they operate on knowledge resources.

From one organization to the next; we contend there is a set of interrelated knowledge manipulation activities that is common. These form a starting point for KM researchers investigating how knowledge is processed in particular organizations and for comparisons across time or organizations. They highlight major activities with which a chief knowledge officer needs to be concerned. Participants’ knowledge manipulation skills should be cultivated, harnessed, and organized in the performance of these activities. Thus, an organization’s knowledge resources will be used in creating value.

The second component of the framework is illustrated in Figure 2. It retains the knowledge resources from Figure 1b and further develops the participants’ knowledge manipulation skills from the figure in terms of activities performed with those skills. The framework’s four knowledge manipulation activities are acquiring knowledge, selecting knowledge, internalizing knowledge, and using knowledge. The latter refers to the activities of externalizing knowledge and generating knowledge. The arrows in Figure 2 indicate knowledge flows from one activity or resource to the another. Aside from the knowledge flows, activities interact by sending and receiving messages (e.g., requests, commands). For simplicity, these message flows are not represented in the figure. A message in the form of a request can range from procedural (specifying how the activity should be carried out) to nonprocedural (merely indicating what is needed). It can range from explicit (e.g., a command) to implicit (e.g., involving recognition of a need). It may require a fast response or tolerate performance of an activity in the background. It can range from a one-time request to a standing request that requires continual monitoring.

Each activity can be performed individually by participants in an organization or may be carried out by configurations of multiple participants. For instance, an individual’s knowledge manipulation skills can be applied to acquiring a unit of knowledge for the organization or the skills of multiple participants may jointly be brought to bear on acquiring that knowledge. An individual participant may exercise knowledge manipulation skills to engage in multiple activities. For instance, a person or a computer system may participate in both acquiring and generating knowledge. How participants’ skills are deployed with respect to accomplishing the activities identified in Figure 2 depends on an assortment of factors: resource

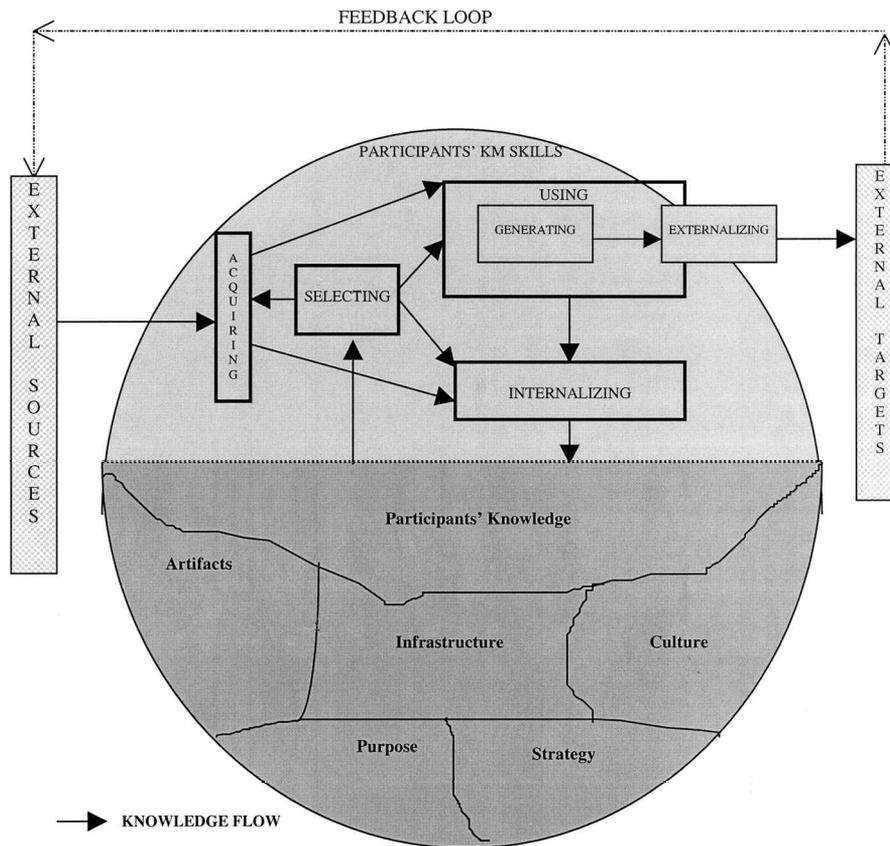


FIG. 2. Major knowledge management activities.

influences (e.g., culture, infrastructure, financial resources, participants' knowledge manipulation skills), environmental influences (e.g., dynamics of the environment), and managerial influences (e.g., leadership style, coordination approach that governs assignment of participants to roles). These influences on the conduct of KM are addressed in the framework's third component. Here the activities along with their relationships are described.

Acquiring Knowledge. Acquiring knowledge is the activity of accepting a unit of knowledge from the external environment and transforming it into a representation that can be internalized, and/or used within an organization. Subactivities involved in acquiring knowledge include:

- Extracting knowledge from external sources. This includes locating, accessing, capturing, and collecting knowledge from external sources into the organization (e.g., customers, competitors, suppliers, universities, consultants, government agencies).
- Interpreting the extracted knowledge. This involves transforming extracted knowledge into

representations that can be understood and processed by another knowledge manipulation activity.

- Transferring the interpreted knowledge. This transferal can be to an activity that immediately uses the knowledge or to one that internalizes it within an organization for subsequent use.

Acquiring knowledge from customers is illustrated by the example of Nike's innovative foot-measuring technology, called NGAGE (Levine, 1997). A customer places a foot on a screen and a personalized card detailing customer's foot length, forefoot length and width, arch length, height and heel width, as well as recommended product size is printed. This not only helps customers get right-sized shoes, but also allows Nike to update its sizing tables and later to use this information for research and development of new footwear. Acquisition of knowledge in this case involves extraction from a customer, interpretation of a foot image, and transferal of resultant foot characteristics for internalization in sizing tables.

Selecting Knowledge. Selecting knowledge is an activity of extracting a requested unit of knowledge from

internal knowledge resources and providing it in an appropriate representation to a requesting activity (i.e., to the acquiring, using, or internalizing activities). Subactivities involved in selecting knowledge include:

- Locating requested knowledge within the internal knowledge resources.
- Retrieving the located knowledge. This involves capturing and/or collecting knowledge from located organizational knowledge resources, and assembling/organizing/packaging it in a representation appropriate for the requesting activity.
- Transferring retrieved knowledge to an appropriate activity. This transferal can be used to support the acquiring, internalizing, or using activities.

An example of the selecting activity is illustrated by Buckman Labs' knowledge sharing system, K'Netix (Rifkin, 1997). For instance, a managing director of Asian facilities sent a message to all the employees in the company requesting knowledge about pitch-control strategies in their parts of the world. Within a few hours he received 11 suggestions addressing his request and enabling him to secure a \$6 million order. Here, the K'Netix participant broadcasted the message to all the human participants for the purpose of locating an appropriate unit of knowledge. Once this knowledge was located, K'Netix collected, packaged, and transferred it to the person requesting the knowledge.

Internalizing Knowledge. Internalizing is an activity that alters an organization's knowledge resources based on acquired or generated knowledge. Subactivities involved in internalizing knowledge include:

- Assessing the knowledge to be internalized. This is concerned with determining the suitability of the knowledge for internalization.
- Targeting the assessed knowledge. This identifies knowledge resources that are to be impacted by the new knowledge.
- Depositing the knowledge as targeted. This involves modifying existing knowledge resources by adding to them, deleting from them, or perhaps fundamentally restructuring them. It involves disseminating, distributing, sharing, and diffusing knowledge to targeted knowledge resources.

McKinsey and Bain & Co. has established a computer system that holds experiences from various team assignments (Sveiby, 1997). Knowledge generated from each assignment is internalized in the system's database. Later, it can be selected by employees for future assignments. In this example, suitability of knowledge to be internalized is assessed by team members, who then target a

computer system where it is to reside and take care of depositing it.

Using Knowledge. Using knowledge is the activity of applying existing knowledge to generate new knowledge and/or to produce an externalization of knowledge.

Generating Knowledge. Generating knowledge is an activity of producing a unit of knowledge by processing existing units of knowledge, where the latter are the results of selection, acquisition, and/or prior generation. The knowledge generated may be new to the organization. This is very crucial because "new knowledge provides the basis for organization renewal and sustainable competitive advantage" (Quinn, 1992). Alternatively, it may currently exist or have previously existed in the organization's knowledge resources. Generation of knowledge that is not "new" can occur for economic reasons (e.g., it is cheaper to produce than to select or acquire), for training reasons, for validity checking, due to a lack of awareness about its existence, or due to not having been internalized when previously acquired or generated. Subactivities involved in generating knowledge include:

- Monitoring the organization's knowledge resources and the external environment.
- Evaluating selected or acquired knowledge.
- Producing knowledge. This can involve creating, developing, analyzing, constructing, synthesizing, refining, and/or assembling knowledge from existing knowledge.
- Transferring the generated knowledge for externalization and/or internalization.

There are two types of generation: deriving knowledge and discovering knowledge. Deriving generates knowledge by structured use of procedures or rules that are known to the organization. Examples include calculating a forecast for product demand, deriving an optimal order quantity using the EOQ formula, or inferring a recommendation from a set of rules. Discovery generates knowledge in less structured ways. The exact path toward the generated knowledge cannot be fully preconceived or even traced. Herman Helmholtz, a German physiologist and physicist, described his scientific discoveries by saying that he went through three stages: *saturation*, finding out everything he could learn on the subject; *incubation*, reflecting on what has been absorbed, by thinking about and mulling over what he has learned through the research; and *illumination*, arriving at a sudden solution. French mathematician Henry Poincare added a fourth stage to this, which he called *verification* (Carson, 1992).

Externalizing knowledge. Externalizing knowledge is the activity of using existing knowledge to produce organizational outputs for release into the environment.

Externalization is only partially a knowledge manipulation activity because it can involve physical activities such as the act of producing a product through transformation of raw materials. However, the flow of material can be seen as secondary to the flow of knowledge that enables, facilitates, and guides it (Cook et al., 1995). The externalization box in Figure 2 is not completely subsumed within the participants' knowledge manipulation skills area as it can use other skills (e.g., manual skills) participants have. Subactivities involved in externalizing knowledge include:

- Targeting the output. This is a determination of what needs to be produced for targeted elements of the environment (e.g., certain customers).
- Producing the output. This involves applying, embodying, controlling, and leveraging existing knowledge to produce output for the target. The output is a representation of the knowledge used to produce it.
- Transferring the output. This is concerned with packaging and distributing the representations of knowledge that have been produced for targets in the environment.

Examples of externalization include manufacturing a car, providing technical support, or developing a financial portfolio. For instance, manufacturing a car involves targeting the car to a specific market (low-income group vs. high-income group). Producing a car by applying the product and process design knowledge to manufacture it and then transferring the car into the external environment. The car that is released into the market is a representation of knowledge (disassembling the car during reverse engineering would reveal at least some of the knowledge that went into manufacturing it).

Knowledge Management Influences

The conduct of KM in an organization involves the use of knowledge manipulation skills to perform knowledge manipulation activities with respect to the organization's knowledge resources. Although both knowledge and knowledge manipulation skills are crucial and necessary for the operation of a knowledge-based organization, they are not sufficient. Which of the activities in Figure 2 are executed, when, by which participants, and with respect to which knowledge resources? The third component of the framework aims to help practitioners and researchers answer such questions for specific organizations by recognizing factors that influence this conduct of KM.

Stewart (1997) describes the experience of Frank Ostroff of Perot Systems as a college student working at a tire-making factory. He and others were given the job of applying glue to rubber for tire after tire. These same people upon leaving work for the day would spend their

evenings rebuilding cars or running volunteer organizations. Although this tire-making organization had knowledgeable and skilled employees, who could rebuild a car or run a volunteer organization, it did not use its participants' expertise to create value for the organization. Little of the participants' individual knowledge was made into an organizational knowledge resource. Their knowledge manipulation skills were largely unused in the organization's execution of knowledge manipulation activities. Although some level of KM undoubtedly occurred in this organization, its conduct of KM was probably far less effective than it could have been.

The conduct of KM in an organization is influenced by a variety of factors. The third component of the KM framework identifies three classes of factors: resource influences, managerial influences, and environmental influences. In Figure 3, the solid circle represents KM conduct, its inner core represents the essential results of KM conduct (i.e., projection and learning), and each angle of the triangle represents a class of influences. Appreciating these influences is important for KM researchers in describing and prescribing how KM is or should be accomplished. Chief knowledge officers need to be cognizant of such influences as constraints on their efforts to create knowledge-based organizations as well as levers that can help them to do so.

Resource Influences. Both knowledge resources (Andersen & APQC, 1996) and other resources (Inkpen, 1996) affect the way in which KM is conducted in an organization. Financial resources could put a ceiling on the capital expended on knowledge manipulation activities. Similarly, participants' knowledge manipulation skills (e.g., human resources) both constrain and facilitate knowledge manipulation activities.

Each of the six types of knowledge resources influences the conduct of KM in an organization. That is, the knowledge an organization has influences the nature and outcome of its knowledge work. For instance, Kodak's culture has valued chemical engineering knowledge related to film design more than the mechanical engineering associated with equipment design (Leonard-Barton, 1995). Chemical engineers were assured good compensation and challenging assignments; consequently, Kodak attracted the best chemical engineers, but not top-notch mechanical engineers. This proclivity likely enhanced the organization's innovations and projections related to chemical processes rather than mechanical processes. Similarly, KM conduct is influenced by infrastructure, strategy, purpose, knowledge artifacts, and available participant knowledge.

Managerial Influences. The conduct of KM is affected not only by the existence of various resources, but also by the deployment of these resources. Here is where

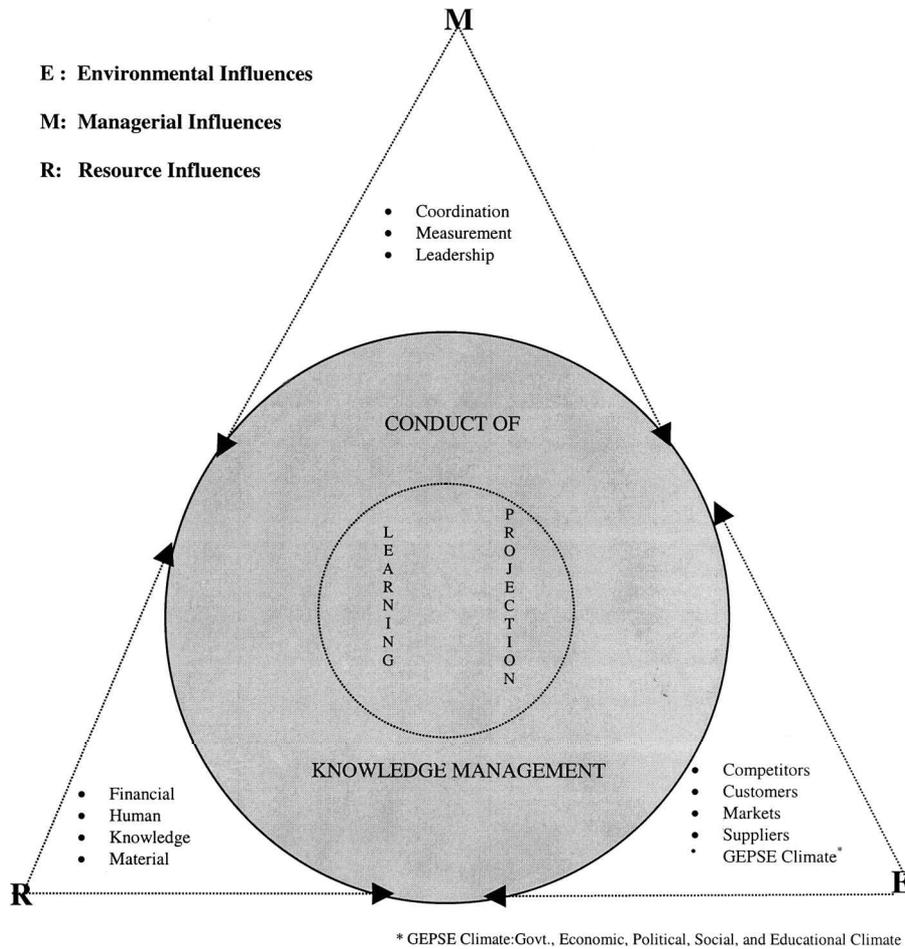


FIG. 3. Knowledge management influences.

managerial influences on KM conduct come into play. Such influences govern the state of an organization’s knowledge resources and the use of knowledge manipulation skills in performing the activities in Figure 2. As indicated in Figure 3, managerial influences on the conduct of KM include the factors of leadership, coordination, and measurement.

Leadership. Leadership has been recognized as a factor influencing the conduct of KM (Andersen & APQC, 1996; Inkpen, 1996). The characteristics of leaders range from being manipulators of culture (Schein, 1985) to architects and catalysts (Hedlund, 1994). In writing about leadership, Mort Meyerson (1997), CEO for Perot Systems, says “the way to be a leader today is different” as leaders can no longer function as sole decision makers the way they could 15 years ago at EDS when competition was stable. Meyerson states that the essence of leadership today is to make sure that an organization knows itself.

In today’s knowledge-based economy a successful leader will be one who can effectively manage both organizational knowledge resources and associated knowl-

edge manipulation skills. He or she creates conditions that allow participants to readily exercise and cultivate their knowledge manipulation skills, to contribute their own individual knowledge resources to the organization’s pool of participant knowledge, and to have easy access to relevant knowledge resources. A study conducted by Andersen and APQC revealed that one crucial reason why organizations are unable to effectively leverage knowledge is because of a “lack of commitment of top leadership to sharing organizational knowledge or there are too few role models who exhibit the desired behavior” (Hiebeler, 1996).

Coordination. Coordination refers to managing dependencies among activities (Malone & Crowston, 1994). It aims to harmonize activities in an organization by ensuring that proper resources are brought into play at appropriate times and that they adequately relate to each other during the conduct of activities (Holsapple & Whinston, 1996). In the conduct of KM, dependencies that need to be managed include those among knowledge resources (e.g., alignment of participants’ knowledge with strategy, diffusion of knowledge among participants), those among

knowledge management activities (e.g., which activities are undertaken under varying circumstances), those between knowledge resources and other resources (e.g., what financial resources are to be allocated for knowledge manipulation activities, which participants are assigned to which infrastructure roles), and those between resources and knowledge management activities (e.g., use of knowledge manipulation activities to improve knowledge resources, allocating knowledge resources among competing knowledge manipulation activities). The conduct of KM in an organization is strongly influenced by how such dependencies are managed.

How the knowledge manipulation activities of Figure 2 are coordinated defines an organization's approach to problem solving, decision making, experimentation, and organizational learning—all of which are knowledge-intensive endeavors. Coordination approaches suggested and used to manage dependencies in a knowledge-based organization include linking reward structures to sharing, establishing communications for knowledge sharing, and constructing programs to encourage learning. For example, in order to create a knowledge sharing culture at Integral, Inc., management made knowledge sharing part of the performance review (Crowley, 1995). To get good reviews (and large bonuses), participants had to share their knowledge. At one consulting firm, professionals are expected to document what they have learned about what works and what does not work, and they are partially compensated based on how often their documentation is accessed from a central knowledge repository (Marshall et al., 1996).

At Buckman Labs, incentive, evaluation, and promotion systems are designed to reward employees who share and transfer knowledge and punish those who do not (Rifkin, 1997). This knowledge sharing and transfer is facilitated by establishing open communications via trust building and the installation of the K'Netix communication support system. What makes the K'Netix system work is the culture of trust instilled by company leadership (Rifkin, 1997). This illustrates an important point about KM influences identified in the framework: Although the influences are distinct concepts, they are related to and can impact each other. The efficacy of coordination can be impacted by leadership (another managerial influence on KM). Culture (a knowledge resource influence) can affect the fashion in which coordination can be conducted and coordination, in turn, can lead to cultural change.

Measurement. Another managerial influence on the conduct of KM is the installation of mechanisms for measuring knowledge resources, knowledge manipulation skills and activities, and the results of KM in terms of organizational learning and projection. Such measurement becomes a basis for evaluation of leadership, coordination, and resources. It can indicate where adjustments in these may be needed.

Ultimately, measurement may help evaluate the impact of an organization's KM on bottom-line performance. Interestingly, this is an under-implemented area (Hiebeler, 1996). A few organizations have developed a set of indicators for KM measurement. For example, the Swedish firm Celemi published the world's first audit of its intangible assets in its 1995 Annual Report; Skandia uses nonfinancial indicators to measure its processes and published the first annual report supplement on intellectual capital (Sveiby, 1997). Chris Turner, "learning person" for Xerox, believes that anecdotal evidence is more valuable than hard data in measuring if KM is occurring or working for a company (Webber, 1997). Turner emphasizes the point that measurement indicators need not be hard and financial, but can be soft and nonfinancial. What is important is linking these indicators to the financial results.

The feasibility of measuring knowledge resources or processes and linking them to financial results is not only difficult but also controversial. There exist two schools of thought: One believes knowledge assets and processes can be measured (Lev, 1997; Malone, 1997; Stewart, 1997), and the other contends "you're a fool if you buy into this" (Rutledge, 1997). Whatever the case, the framework in Figure 3 posits that the conduct of KM is influenced by (1) whether an organization attempts to measure its knowledge resources and/or performance of its knowledge manipulation activities, (2) how it goes about measuring these, and (3) how effective the measures are.

Environmental Influences. Aside from internal factors (resource and managerial influences), entities outside an organization also affect its conduct of KM. The environment determines or constrains what knowledge resources should or can be acquired, as well as what the knowledge manipulation skills are available (via a labor pool or available technology). As Figure 3 illustrates, external influences include such factors as competition, customers, markets, suppliers, and the GEPSE (governmental, economic, political, social, and educational) climate. Examples of these are many, varied, and largely self-evident. Detailed investigations of these are warranted.

SURVEY AND RESULTS

Aside from conceptual justification for the framework, survey results provide external validation. A list was compiled of contributors to the KM literature, presenters at KM conferences, and faculty who designate KM as a major research area. Each of the 122 persons on this list received the framework description as presented in this paper, plus a questionnaire. Of the 31 respondents, 13 identified themselves as researchers, 13 as practitioners, and the rest as both researcher and practitioner.

Respondents were asked to assess each of the three framework components on four criteria: completeness, accuracy, clarity, and conciseness. Their perceptions regarding the overall framework were also captured by asking how satisfied they were with the overall framework and the extent of the framework’s success in providing a unified and comprehensive view of KM phenomena. These perceptions were gathered using Likert-scale items and clustered into three categories: low, medium, high. For instance, responses indicating no success to slight success form the low category; those in the somewhat successful to moderately successful range form the medium category; responses in the successful to extremely successful range belong to the high success category. In addition to scaled items, respondents were also asked to provide observations on the need for a KM framework (responses were shown earlier in Table 1).

Distributions of responses are presented in Figures 4 and 5. Figure 4 shows frequency distributions of responses concerning the overall framework. The respondents are nearly unanimous in their perception that it is highly important to have a KM framework. Overall satisfaction with the threefold framework was indicated to be medium or high by over 80% of the respondents. Similar results were obtained for the framework’s success in providing a

unified view and a comprehensive view of the main factors involved in KM.

Figure 5 shows frequency distributions of responses on the four criteria for each of the framework’s three components. For each of the 12 assessments, at least 70% regard the framework as in the medium to high success categories. The mode is high success for 9 of the 12 and medium success for the other three assessments. On the whole, these results are supportive of the framework, but do suggest that future modifications to the framework should focus on enhancing the accuracy and clarity of the resource component and the completeness of the activity component.

IMPLICATIONS AND CONCLUSION

In its current stage of development, the framework has several uses. It provides a language (i.e., a system of terms and concepts) for discourse about and study of KM phenomena. It can be used to generate and frame KM research issues. It identifies factors with which KM practitioners should deal. Survey results are positive, but also suggest there is room for improvement in the framework. The framework itself serves as a basis for thinking about extensions, refinements, or corrections that could yield an improved KM framework. We conclude with a brief

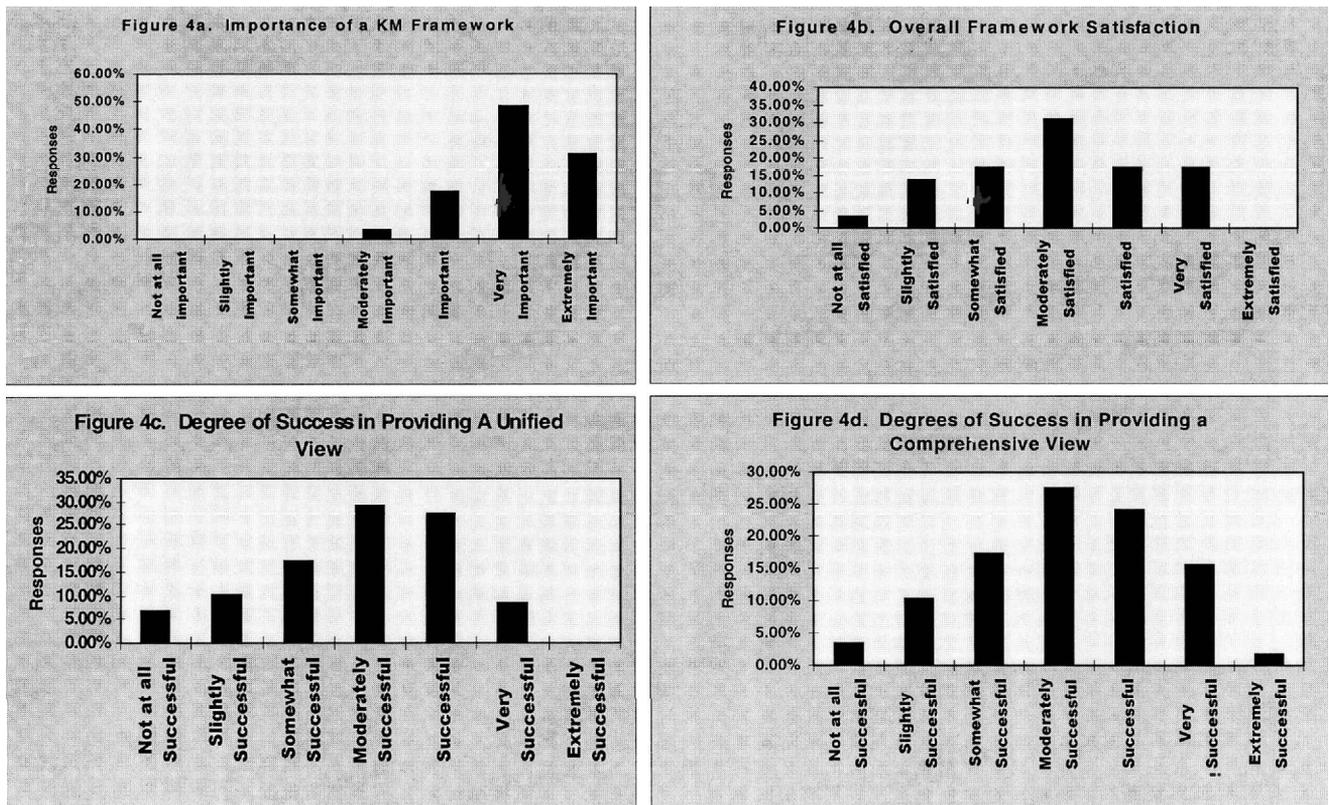


FIG. 4. Responses concerning the overall framework.

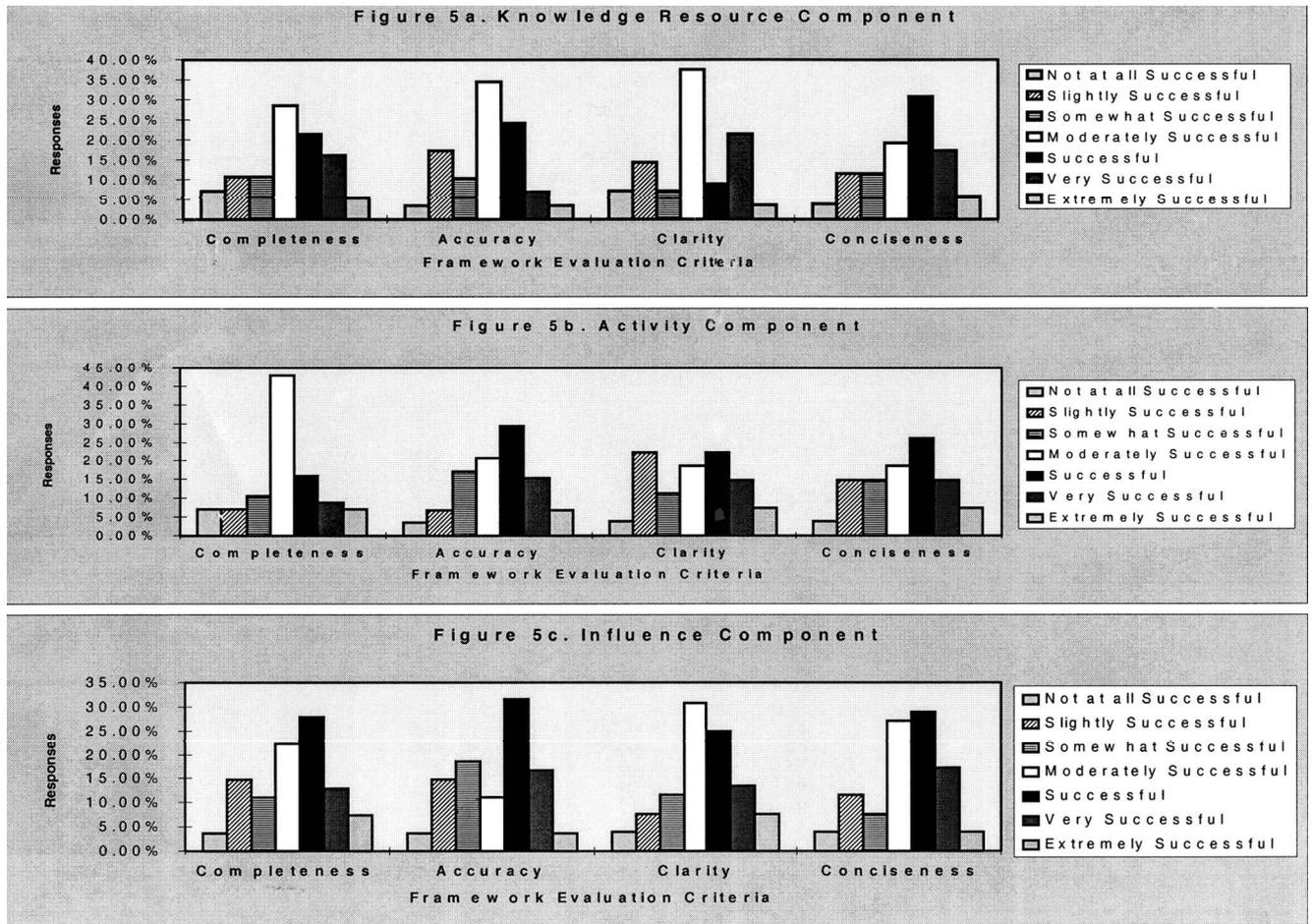


FIG. 5. Responses for each of the framework's component.

discussion that highlights a few avenues of subsequent investigation implied by the framework.

Each of the three main components and any of their subcomponents can be analyzed in greater detail. That is, the framework is a starting point for gaining a deeper understanding of any of its elements and of relationships that an element may have with other elements. For example, the knowledge selection activity has been examined in greater detail, leading to an identification of issues related to knowledge selection that deserve consideration by KM researchers and practitioners, plus a characterization of current technological offerings for performing and supporting knowledge selection (Holsapple & Joshi, 1999b). The threefold framework can be applied similarly to guide the study of other knowledge manipulation activities or of elements in the influence and resource components.

The framework provides building blocks for devising and investigating prescriptive frameworks. KM methods can be designed and developed to guide the temporal pattern of knowledge manipulation activities that should be

used to satisfy a knowledge need. Prescriptions about what knowledge resources deserve greater cultivation and how to conduct that cultivation are another possibility.

Each of the manipulation activities identified in Figure 2 can be explored from such standpoints as how to effectively perform it relative to available knowledge resources, how to employ technology in implementing the activity, and how to utilize it in the scope of more composite activities. Fulcrum, for example, has implemented software that performs the selection activity with respect to a diverse set of knowledge repositories (Fulcrum, 1997). Composite knowledge manipulation activities include problem solving, experimenting, decision making, and learning. Each can be characterized in terms of patterns of the elemental manipulation activities and each is susceptible to technological support (e.g., a knowledge-based view of decision making; Holsapple, 1995).

The threefold framework can be employed to organize an exploration of available technologies. What types of technologies can support and/or perform each of the

knowledge manipulation activities? What types of technologies facilitate KM initiatives (e.g., measuring, controlling, and coordinating knowledge manipulation activities and resources)? What types of technologies can be used for storing, representing, and embedding knowledge? How can technology affect projection and learning? Investigations to answer these questions can help clarify the role of technology in KM.

The framework suggests a need for investigating possible linkages between resource, managerial, and environmental influences on the one hand and the outcome of KM conduct (i.e., organizational learning and projections) on the other hand. For a given set of environmental and resource influences, how might we select from coordination, leadership, and measurement alternatives? Such questions appear to be amenable to empirical investigations. At a more fundamental level, there is the issue of identifying these alternatives as a prelude to assessing their efficacy.

A study of influences on the conduct of KM is also important from the standpoint of detecting deficiencies in knowledge resources and in the management of those resources. Such deficiencies, if untreated, can lead to malfunction in organizational processes and damage of overall performance. The influences identified in Figure 3, as well as the activities noted in Figure 2, need to be investigated with respect to how they can be shaped to remedy problems in the conduct of KM.

One formal way to further develop the threefold framework is by means of a Delphi-like methodology (Bacon & Fitzgerald, 1996). This involves identifying a panel of experts on KM. The experts are provided with the threefold framework and asked to comment on its accuracy, comprehensiveness, clarity, and conciseness. These comments give a basis for revising the framework. The revised framework is then submitted to the panel for a second round of comment and critique. This process continues until consensus is reached or panelists express no major reservations about the framework. In this way, the framework is beneficial in leading to its own obsolescence.

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