Chapter V
A Model of Knowledge Management Success

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ABSTRACT

This article describes a knowledge management (KM) success model that is derived from observations generated through a longitudinal study of KM in an engineering organization and KM success factors found in the literature, which were modified by the application of these observations and success factors in various projects. The DeLone and McLean (1992, 2003) IS Success Model was used as a framework for the model, since it was found to fit the observed success criteria and provided an accepted theoretical basis for the proposed model.

INTRODUCTION

Knowledge management (KM) and knowledge management system (KMS) success is an issue that needs to be explored. The Knowledge Management Foundations workshop held at the Hawaii International Conference on System Sciences in January 2006 discussed this issue and reached agreement that it is important for the credibility of the KM discipline that we be able to define KM success. Also, Turban and Aronson (2001) list three reasons for measuring the success of KM and KMS:

- To provide a basis for company valuation
- To stimulate management to focus on what is important
- To justify investments in KM activities.

All are good reasons from an organizational perspective. Additionally, from the perspective of KM academics and practitioners, identifying the factors, constructs, and variables that define KM success is crucial to understanding how these initiatives and systems should be designed and implemented. It is the purpose of this article to present a model that specifies and describes the antecedents of KM and KMS success so that researchers and practitioners can predict if a specific KM and KMS initiative will be successful. The article assumes that KM and KMS success cannot be separated, which is based on a broad, Churchman view of what constitutes KMS and a definition of success that is not reliant solely on technical effectiveness. The other basic assumption for this article is that success and effectiveness, as used in the KM literature, are synonymous terms. The remainder of the article uses the term *KM* to refer to KM and KMS and the term *success* to refer to success and effectiveness. The reasoning for these assumptions is discussed later in the article.

The proposed KM Success Model is an explication of the widely accepted DeLone and McLean (1992, 2003) IS Success Model, which was used since it was able to be modified to fit the observations and data collected in a longitudinal study of Organizational Memory, OM, and KM. It fit success factors found in the KM literature, and the resulting KM Success Model was useful in predicting success when applied to the design and implementation of a KM initiative and/or a KMS. Additionally, the stated purpose of the DeLone and McLean (1992, 2003) IS Success Model is to be a generalized framework that describes success dimensions for which researchers can adapt and define specific contexts of success (DeLone & McLean, 2003). Before presenting the KM Success Model, we will discuss the concepts of knowledge, KM, KMS, and KM/KMS success. We then will discuss briefly the DeLone and McLean (1992, 2003) IS Success Model, present the KM Success Model, and discuss the differences. We will conclude by summarizing studies that support the KM Success Model and will present operationalizations that can be used to evaluate the constructs used to define the KM Success Model dimensions.

KNOWLEDGE, OM, AND KM

Alavi and Leidner (2001) summarize and extend the significant literature relating to knowledge, knowledge management, and knowledge management systems. They view organizational knowledge and OM as synonymous labels, as do Jennex and Olfman (2002). This is useful, as it allows for the combination of research results from OM and KM. It is also born out in the literature. Huber, Davenport, and King (1998) summarize OM as the set of repositories of information and knowledge that the organization has acquired and retains. Stein and Zwass (1995) define OM as the means by which knowledge from the past is brought to bear on present activities, resulting in higher or lower levels of organizational effectiveness, and Walsh and Ungson (1991) define OM as stored information from an organization's history that can be brought to bear on present decisions.

Davenport and Prusak (1998) define knowledge as an evolving mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. Knowledge often becomes embedded in documents or repositories and in organizational routines, processes, practices, and norms. Knowledge is also about meaning in the sense that it is context-specific (Huber et al., 1998). Jennex (2006) extends the concepts of context also to include associated culture that provides frameworks for understanding and using knowledge. Ultimately, we conclude that knowledge contains information, but information is not necessarily knowledge. Also, we conclude that OM contains knowledge. However, for the sake of simplicity, we will use the term *knowledge* to refer to OM and knowledge throughout this article.

Various knowledge taxonomies exist. Alavi and Leidner (2001) and Jennex and Croasdell (2005) found that the most commonly used taxonomy is Polanyi's (1962, 1967) and Nonaka's (1994) dimensions of tacit and explicit knowledge. This article uses this taxonomy for knowledge. Tacit knowledge is that which is understood within a knower's mind. It consists of cognitive and technical components. Cognitive components are the mental models used by the knower, which cannot be expressed directly by data or knowledge representations. Technical components are concrete concepts that can be expressed readily. Explicit knowledge also consists of these technical components that can be directly expressed by knowledge representations. KM in an organization occurs when members of an organization pass tacit and explicit knowledge to each other. Information Technology (IT) assists KM by providing knowledge repositories and methods for capturing and retrieving knowledge. The extent of the dimension of the knowledge being captured limits the effectiveness of IT in assisting KM. IT works best with knowledge that is primarily in the explicit dimension. Knowledge that is primarily in the tacit dimension requires that more context be captured with the knowledge where context is the information used to explain what the knowledge means and how it is used. Managing tacit knowledge is more difficult to support using IT solutions.

Jennex (2005) looked at what KM is and found no consensus definition. However, using the review board of the *International Journal of Knowledge Management* as an expert panel and soliciting definitions of KM that were used by the board members, the following working definition is used to define KM for this article:

KM *is the practice of selectively applying knowledge from previous experiences of decision making to current and future decision making activities with the express purpose of improving the organization's effectiveness.* (Jennex, 2005, p. iv)

KM is an action discipline; knowledge needs to be used and applied in order for KM to have an impact. We also need measurable impacts from knowledge reuse in order for KM to be successful. Decision making is something that can be measured and judged. Organizations can tell if they are making the same decisions over and over and if they are using past knowledge to make these decisions better and more quickly. Also, decision making is the ultimate application of knowledge. This working definition provides this direction for KM and leads to a description of success for KM as being able to provide the appropriate knowledge for decision making when it is needed to those who need it.

KNOWLEDGE MANAGEMENT SYSTEMS

Alavi and Leidner (2001) defined KMS as "IT (Information Technology)-based systems developed to support and enhance the organizational processes of knowledge creation, storage/retrieval, transfer, and application" (p. 114). They observed that not all KM initiatives will implement an IT solution, but they support IT as an enabler of KM. Maier (2002) expanded on the IT concept for the KMS by calling it an ICT (Information and Communication Technology) system that supported the functions of knowledge creation, construction, identification, capturing, acquisition, selection, valuation, organization, linking, structuring, formalization, visualization, distribution, retention, maintenance, refinement, evolution, accessing, search, and application. Stein and Zwass (1995) define an Organizational Memory Information System (OMS) as the processes and IT components as necessary to capture, store, and apply knowledge created in the past on decisions currently being made. Jennex and Olfman (2002) expanded this definition by incorporating the

OMS into the KMS and by adding strategy and service components to the KMS. We expand the boundaries of a KMS by taking a Churchman view of a system. Churchman (1979) defines a system as "a set of parts coordinated to accomplish a set of goals" (p. 29) and that there are five basic considerations for determining the meaning of a system:

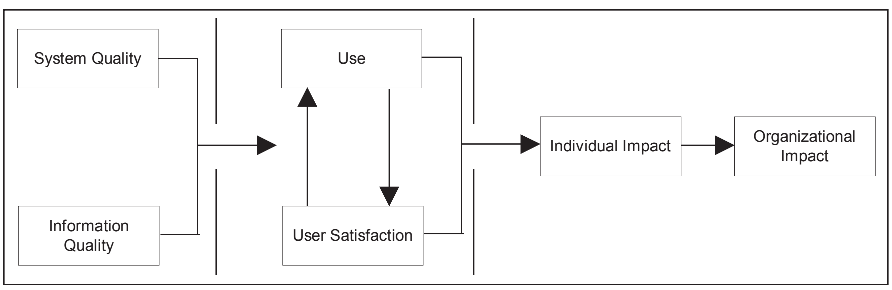
- System objectives, including performance measures
- System environment
- System resources
- System components, their activities, goals, and measures of performance
- System management

Churchman (1979) also noted that systems are always part of a larger system and that the environment surrounding the system is outside the system's control but influences how the system performs. The final view of a KMS is as a system that includes IT/ICT components, repositories, users, processes that use and/or generate knowledge, knowledge, knowledge use culture, and the KM initiative with its associated goals and measures. This final definition is important, as it makes the KMS an embodiment of the KM initiative and makes it possible to associate KM success with KMS success.

KM SUCCESS

The previous paragraphs define KM success as reusing knowledge to improve organizational effectiveness by providing the appropriate knowledge to those that need it when it is needed. KM is expected to have a positive impact on the organization that improves organizational effectiveness. DeLone and McLean (1992, 2003) use the terms *success* and *effectiveness* interchangeably. This article uses KM success and KM effectiveness interchangeably by implying that increasing decision-making effectiveness has a positive impact on the organization, resulting in successful KM. KM and KMS success also is used interchangeably. KMS success can be defined as making KMS components more effective by improving search speed, accuracy, and so forth. For example, a KMS that enhances search and retrieval functions enhances decision-making effectiveness by improving the ability of the decision maker to find and retrieve appropriate knowledge in a more timely manner. The implication is that by increasing KMS effectiveness, KMS success is enhanced, and decision-making capability is enhanced, which leads to positive impacts on the organization. This is how KM success is defined, and it is concluded that enhancing KMS effectiveness makes the KMS more successful as well as being a reflection of KM success.

Figure 1. DeLone and McLean's (1992) IS success model



DeLone and McLean IS Success Model

In 1992 DeLone and McLean published their seminal work that proposed a taxonomy and an interactive model for conceptualizing and operationalizing IS success (DeLone & McLean, 1992). The DeLone and McLean (D&M) (1992) IS Success Model is based on a review and integration of 180 research studies that used some form of system success as a dependent variable. The model identifies six interrelated dimensions of success, as shown in Figure 1. Each dimension can have measures for determining their impact on success and on each other. Jennex, Olfman, Pituma, and Yong-Tae (1998) adopted the generic framework of the D&M IS Success Model and customized the dimensions to reflect the System Quality and Use constructs needed for an organizational memory information system (OMS). Jennex and Olfman (2002) expanded this OMS Success Model to include constructs for Information Quality.

DeLone and McLean (2003) revisited the D&M IS Success Model by incorporating subsequent IS success research and by addressing criticisms of the original model. One hundred forty-four articles from refereed journals and 15 papers from the International Conference on Information Systems (ICIS) that cited the D&M IS Success Model were reviewed, with 14 of these articles reporting on studies that attempted to empirically investigate the model. The result of the article is the modified D&M IS Success Model shown in Figure 2. Major changes include the additions of a Service Quality dimension for the service provided by the IS group, the modification of the Use dimension into a Intent to Use dimension, the combination of the Individual and Organizational Impact dimensions into an overall Net Benefits dimension, and the addition of a feedback loop from Net Benefits to Intent to Use and User Satisfaction. This article modifies the Jennex and Olfman (2002) OMS Success Model into a KM Success Model by applying KM research and the modified D&M IS Success Model.

KM SUCCESS MODEL

The model developed in this article was initially proposed by Jennex, et al. (1998) after an ethnographic case study of KM in an engineering organization. The model was modified by Jennex and Olfman (2002) following a five-year longitudinal

Figure 2. DeLone and McLean's (2003) revisited IS success model

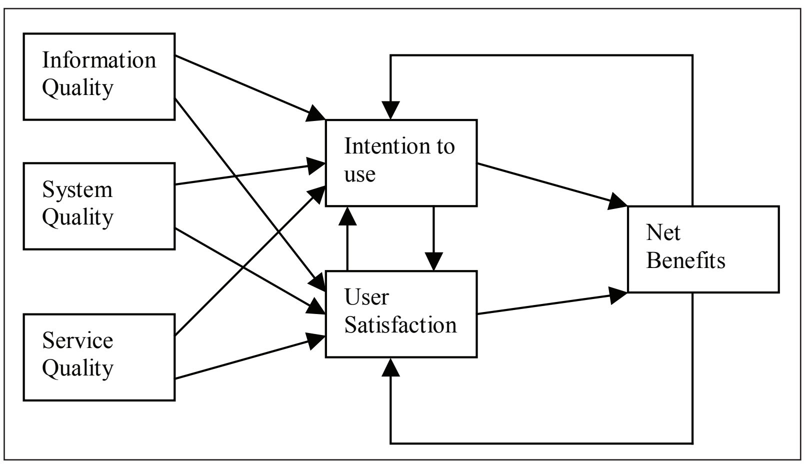
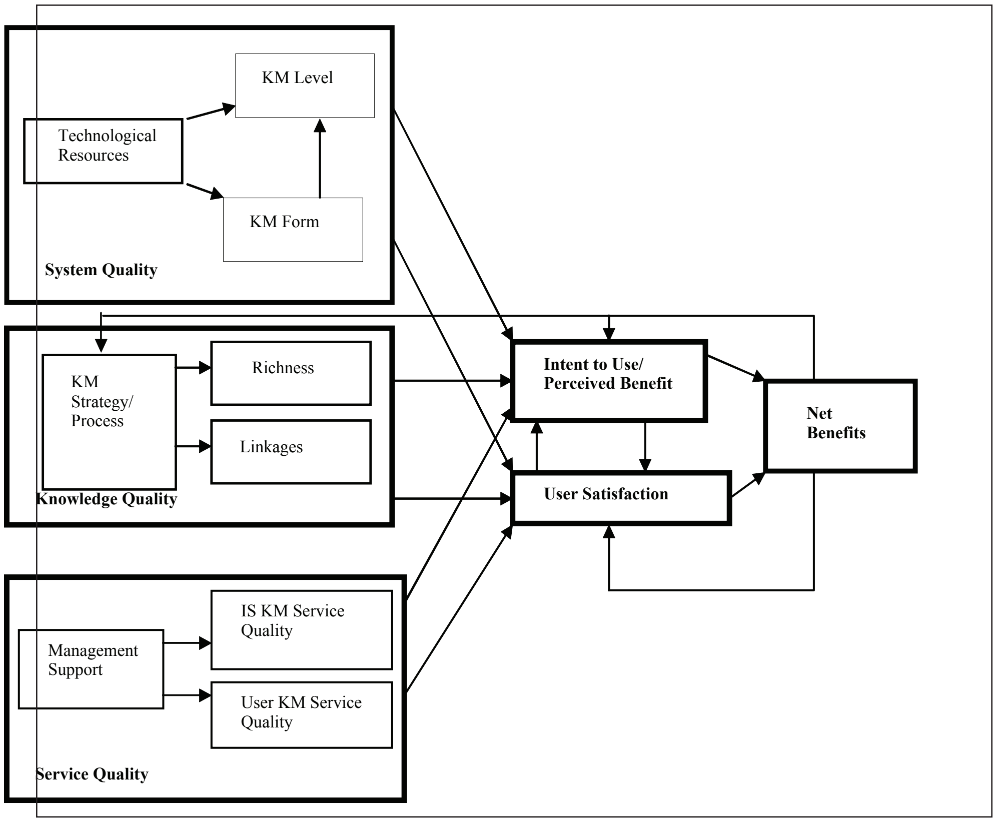


Figure 3. KM success model



study of knowledge management in an engineering organization and is based on the DeLone and McLean (2003) revised IS Success Model. This final model was developed to incorporate experience in using the model to design KMS and for incorporating other KM/KMS success factor research from the literature. Figure 3 shows the KM Success Model. The KM Success Model is based on DeLone and McLean (2003). Since the KM Success Model is assessing the use of organizational knowledge, the Information Quality dimension is renamed the Knowledge Quality dimension. Also, because use of a KMS is usually voluntary, the KM Success Model expanded the Intention to Use dimension to include a Perceived Benefit dimension based on Thompson, Higgins, and Howell's (1991) Perceived Benefit model used to predict system usage when usage is voluntary. Finally, since KM strategy/process is key to having the right knowledge, the feedback loop is extended back to this dimension. Dimension descriptions of the model follow.

SYSTEM QUALITY

Jennex and Olfman (2000, 2002) found infrastructure issues such as using a common network structure; adding KM skills to the technology support skill set; and using high-end personal computers, integrated databases; and standardizing hardware and software across the organization to be keys to building KM. The System Quality dimension incorporates these findings and defines system quality by how well KM performs the functions of knowledge creation, storage/retrieval, transfer, and application; how much of the knowledge is represented in the computerized portion of the OM; and the KM infrastructure. Three constructs—the technological resources of the organization, KM form, and KM level—are identified. Technological resources define the capability of an organization to develop, operate, and maintain KM. These include aspects such as amount of experience available for developing and maintaining KM; the type of hardware, networks, interfaces, and databases used to hold and manipulate knowledge, capacities, and speeds associated with KM infrastructure; and the competence of the users to use KM tools. Technical resources enable the KM form and KM level constructs.

KM form refers to the extent to which the knowledge and KM processes are computerized and integrated. This includes how much of the accessible knowledge is online and available through a single interface and how integrated the processes of knowledge creation, storage/retrieval, transfer, and application are automated and integrated into the routine organizational processes. This construct incorporates concerns from the integrative and adaptive effectiveness clusters proposed for KMS effectiveness used by Stein and Zwass (1995). This construct, along with the technological resources construct, influences the KM level construct.

KM level refers to the ability to bring knowledge to bear upon current activities. This refers explicitly to the KM mnemonic functions such as search, retrieval, manipulation, and abstraction, and how well they are implemented. The technological resources and form of the KMS influence this construct in that the stronger the technical resources and the more integrated and computerized knowledge is, the more important this construct is and the more effective it can be.

Additional support for these constructs comes from Alavi and Leidner (1999), who found it important to have an integrated and integrative technology architecture that supports database, communication, and search and retrieval functions. Davenport, DeLong, and Beers (1998) found technical infrastructure to be crucial to effective KM. Ginsberg and Kambil (1999) found knowledge representation, storage, search, retrieval, visualization, and quality control to be key technical issues. Mandviwalla, Eulgem, Mould, and Rao (1998) described technical issues affecting KMS design to include knowledge storage/repository considerations; how information and knowledge is organized so that it can be searched and linked to appropriate events and use; and processes for integrating the various repositories and for reintegrating information and knowledge extracted from specific events and access locations, as users rarely access the KMS from a single location (leads to network needs and security concerns). Sage and Rouse (1999) identified infrastructure for capturing, searching, retrieving, and displaying knowledge and an understood enterprise knowledge structure as important. Finally, several of the KMS classifications focus on KM support tools, architecture, or life cycle, which all require strong system quality.

Ultimately, given the effectiveness of information technology to rapidly provide search, storage, retrieval, and visualization capabilities, it is expected that a more fully computerized system that utilizes network, semantic Web, and data warehouse technologies will result in the highest levels of system quality.

KNOWLEDGE QUALITY

Jennex and Olfman (2000, 2002) identified that having a KM process and an enterprise-wide knowledge infrastructure, incorporating KM processes into regular work practices, and that knowledge needs were different for users of different levels, were key issues in order to determine and implement what is the right knowledge for KM to capture. Additionally, it was found that

KM users have formal and/or informal drivers that guide them in selecting information and knowledge to be retained by KM and formal and informal processes for reviewing and modifying stored information and knowledge. The Knowledge Quality dimension incorporates this and ensures that the right knowledge with sufficient context is captured and available for the right users at the right time. Three constructs: the KM strategy/process, knowledge richness, and linkages among knowledge components are identified. The KM strategy/process construct looks at the organizational processes for identifying knowledge users and knowledge for capture and reuse, the formality of these processes including process planning, and the format and context of the knowledge to be stored. This construct determines the contents and effectiveness of the other two constructs. Richness reflects the accuracy and timeliness of the stored knowledge as well as having sufficient knowledge context and cultural context to make the knowledge useful. Linkages reflect the knowledge and topic maps and/or listings of expertise available to identify sources of knowledge to users in the organization.

Hansen, Nohria, and Tierney (1999) describe two types of knowledge strategy: personification and codification. They warn of trying to follow both strategies equally at the same time. These strategies refer to how knowledge is captured, represented, retrieved, and used. However, KM strategy/process also needs to reflect that the knowledge needs of the users change over time, as found by the longitudinal study (Jennex & Olfman, 2002) and that new users have a hard time understanding codified tacit knowledge (Koskinen, 2001). For example, new users will follow personification until they understand the context in which knowledge is captured and used, and then they are willing to switch to a codification strategy. Personification corresponds to linkages in the model shown in Figure 3 and refers to the situation in which new users initially feel more comfortable seeking knowledge contexts from recognized human experts on a particular subject. Following this phase, these users tend to switch to codified knowledge; thus, codification corresponds to richness in the model. Additionally, Brown, Dennis, and Gant (2006) found that as the procedural complexity and teachability of knowledge increased, the tendency of users to rely on linkages (person-to-person knowledge transfer) also increased. Jennex (2006) discuses the impact of context and culture on knowledge reuse, and the conclusion is that as knowledge complexity grows, the ability to capture the context and culture information needed to ensure the knowledge is usable and, used correctly, becomes more difficult, and the richness of the stored knowledge is less able to meet this need, which results in users shifting to using linkages and personification. This model disagrees with Hansen, et al.'s (1999) finding that organizations need to select a single strategy on which to concentrate, while using the other strategy in a support role by recognizing that both strategies will exist and that they may be equal in importance.

Additional support for these constructs comes from Barna (2003), who identified creating a standard knowledge submission process, methodologies, and processes for the codification, documentation, and storage of knowledge, processes for capturing and converting individual tacit knowledge into organizational knowledge as important. Cross and Baird (2000) found that in order for KM to improve business performance, it had to increase organizational learning by supporting personal relationships between experts and knowledge users, providing distributed databases to store knowledge and pointers to knowledge, providing work processes for users to convert personal experience into organizational learning, and providing direction to what knowledge the organization needs to capture and from which to learn. Davenport, et al. (1998) identified three key success factors for KM strategy/process: clearly communicated purpose/goals, multiple channels for knowledge transfer, and a standard, flexible knowledge structure. Mandviwalla, et al. (1998) described several strategy issues affecting KM design, which include the KM focus (who are the users); the quantity of knowledge to be captured and in what formats (who filters what is captured); what reliance and/or limitations are placed on the use of individual memories; how long the knowledge is useful; and the work activities and processes that utilize KM. Sage and Rouse (1999) identified modeling processes to identify knowledge needs and sources, KM strategy for the identification of knowledge to capture and use and who will use it, an understood enterprise knowledge structure, and clear KM goals as important.

SERVICE QUALITY

The Service Quality dimension ensures that KM has adequate support in order for users to utilize KM effectively. Three constructs—management support, user KM service quality, and IS KM service quality—are identified. Management support refers to the direction and support an organization needs to provide in order to ensure that adequate resources are allocated to the creation and maintenance of KM; a knowledge sharing and using organizational culture is developed; encouragement, incentives, and direction are provided to the work force to encourage KM use; knowledge reuse; and knowledge sharing; and that sufficient control structures are created in the organization in order to monitor knowledge and KM use. This construct enables the other two constructs. User KM service quality refers to the support provided by user organizations to help their personnel to utilize KM. This support consists of providing training to their users on how to use KM, how to query KM, and guidance and support for making knowledge capture, knowledge reuse, and KM use a part of routine business processes. IS KM service quality refers to the support provided by the IS organization to KM users and to maintaining KM. This support consists of building and maintaining KM tools and infrastructure; maintaining the knowledge base; building and providing knowledge maps of the databases; and ensuring the reliability, security, and availability of KM.

Our previous KM success model versions included the previous constructs as part of the system quality and knowledge quality dimensions. These constructs were extracted from these dimensions in order to generate the constructs for the service quality dimension and to ensure that the final KM success model was consistent with DeLone and McLean (2003).

Additional support for these constructs comes from Alavi and Leidner (1999), who found organizational and cultural issues associated with user motivation to share and use knowledge to be the most significant. Barna (2003) identified the main managerial success factor as creating and promoting a culture of knowledge sharing within the organization by articulating a corporate KM vision, rewarding employees for knowledge sharing and creating communities of practice. Other managerial success factors include obtaining senior management support, creating a learning organization, providing KM training, precisely defining KM project objectives, and creating relevant and easily accessible knowledge-sharing databases and knowledge maps. Cross and Baird (2000) found that in order for KM to improve business performance, it had to increase organizational learning by supporting personal relationships between experts and knowledge users and by providing incentives to motivate users to learn from experience and to use KM. Davenport, et al. (1998) found senior management support, motivational incentives for KM users, and a knowledge-friendly culture to be critical issues. Ginsberg and Kambil (1999) found incentives to share and use knowledge to be the key organizational issues. Holsapple and Joshi (2000) found leadership and top management commitment/support to be crucial. Resource influences such as having sufficient financial support and skill level of employees were also important. Malhotra and Galletta (2003) identified the critical importance of user commitment and motivation but found that using incentives did not guarantee a successful KMS. Sage and Rouse (1999) identified incentives and motivation to use KM, clear KM goals, and measuring and evaluating the effectiveness of KM as important. Yu, Kim, and Kim (2004) determined that KM drivers such as a learning culture, knowledge-sharing intention, rewards, and KM team activity significantly affected KM performance

USER SATISFACTION

The User Satisfaction dimension is a construct that measures satisfaction with KM by users. It is considered a good complementary measure of KM use, as desire to use KM depends on users being satisfied with KM. User satisfaction is considered a better measure for this dimension than actual KM use, as KM may not be used constantly yet still may be considered effective. Jennex (2005) found that some KM repositories or knowledge processes such as e-mail may be used daily, while others may be used once a year or less. However, it also was found that the importance of the once-a-year use might be greater than that of daily use. This makes actual use a weak measure for this dimension, given that the amount of actual use may have little impact on KM success, as long as KM is used when appropriate and supports DeLone and McLean (2003) in dropping amount of use as a measurement of success.

INTENT TO USE/PERCEIVED BENEFIT

The Intent to Use/Perceived Benefit dimension is a construct that measures perceptions of the benefits of KM by users. It is good for predicting continued KM use when KM use is voluntary, and amount and/or effectiveness of KM use depend on meeting current and future user needs. Jennex and Olfman (2002) used a perceived benefit instrument adapted from Thompson, et al. (1991) to measure user satisfaction and to predict continued intent to use KM when KM use was voluntary. Thompson, et al.'s (1991) perceived benefit model utilizes Triandis' (1980) theory that perceptions on future consequences predict future actions. This construct adapts the model to measure the relationships among social factors concerning knowledge use, perceived KM complexity, perceived near-term job fit and benefits of knowledge use, perceived long-term benefits of knowledge use, and fear of job loss with respect to willingness to contribute knowledge. Malhotra and Galletta (2003) created an instrument for measuring user commitment and motivation that is similar to Thompson, et al.'s (1991) perceived benefit model but is based on self-determination theory that uses the Perceived Locus of Causality that also may be useful for predicting intent to use. Additionally, Yu, et al. (2004) found that KM drivers such as knowledge-sharing intention significantly affected KM performance.

NET IMPACT

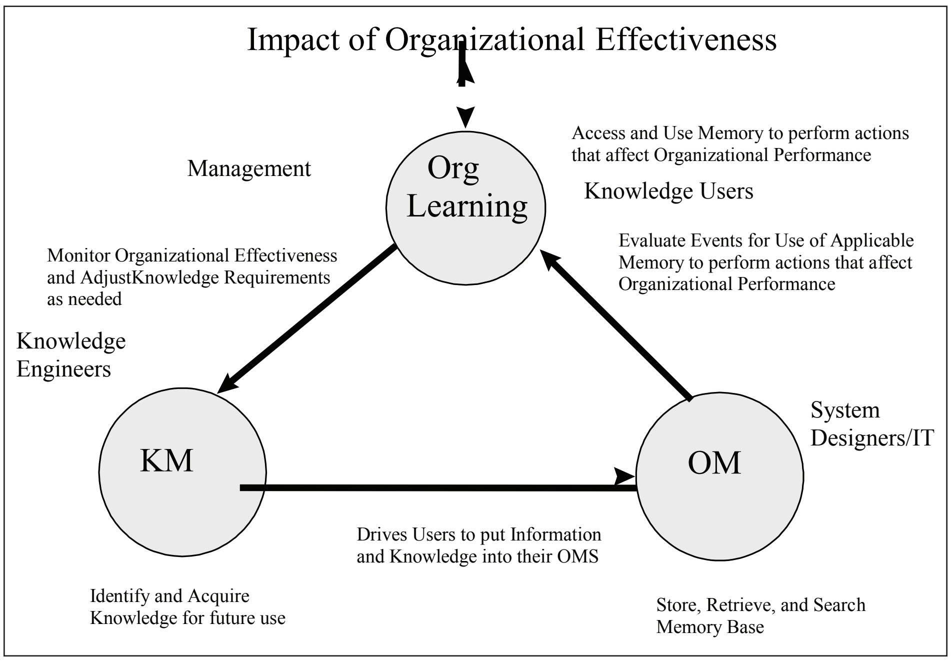
An individual's use of KM will produce an impact on that person's performance in the workplace. In addition, DeLone and McLean (1992) note that an individual impact also could be an indication that an information system has given the user a better understanding of the decision context, has improved his or her decision-making productivity, has produced a change in user activity, or has changed the decision maker's perception of the importance or usefulness of the information system. Each individual impact should have an effect on the performance of the whole organization. Organizational impacts usually are not the summation of individual impacts, so the association between individual and organizational impacts is often difficult to draw. DeLone and McLean (2003) recognized this difficulty and combined all impacts into a single dimension. Davenport, et al. (1998) overcame this by looking for the establishment of linkages to economic performance. Alavi and Leidner (1999) also found it important to measure the benefits of KM, as did Jennex and Olfman (2000).

We agree with combining all impacts into one dimension and the addition of the feedback loop to the User Satisfaction and Intent to Use/Perceived Benefit dimensions but take it a step further and extend the feedback loop to include the KM Strategy/Process construct. Jennex and Olfman (2002) showed this feedback in their model relating KM, OM, organizational learning, and effectiveness, as shown in Figure 4. This model recognizes that the use of knowledge may have good or bad benefits. It is feedback from these benefits that drives the organization either to use more of the same type of knowledge or to forget the knowledge, which also provides users with feedback on the benefit of the KMS. Alavi and Leidner (2001) also agree that KM should allow for forgetting some knowledge when it has detrimental or no benefits. To ensure that this is done, feedback on the value of stored knowledge needs to be fed into the KM Strategy/Process construct.

OPERATIONALIZATION OF THE SUCCESS MODEL

Jennex and Olfman (2002) performed a longitudinal study of KM in an engineering organization that identified a link between knowledge use and improved organizational effectiveness. Although a great deal of quantitative data were taken, it was not possible to quantify productivity gains as a function of knowledge use. KM was found to be effective and to have improved in effectiveness

Figure 4. The OM/KM model



over a five-year period. Additionally, the engineers were found to be more productive.

Jennex (2000) applied an early version of this model to the construction and implementation of a knowledge management Web site for assisting a virtual project team. It was found that applying the model to the design of the site resulted in the project going from lagging to a leading project in just a few months.

Hatami, Galliers, and Huang (2003) used the KM Success Model to analyze knowledge reuse and the effectiveness of decision making. They found the model useful in explaining the effects of culture and knowledge needs on the overall KM success.

Jennex, Olfman, and Addo (2003) investigated the need for having an organizational KM strategy to ensure that knowledge benefits gained from projects are captured for use in the organization. They found that benefits from Y2K projects were not being captured, because the parent organizations did not have a KM strategy/process. Their conclusion was that KM in projects can exist and can assist projects in utilizing knowledge during the project. However, it also led to the conclusion that the parent organization will not benefit from project-based KM unless the organization has an overall KM strategy/process.

The following discussion combines these studies to provide methods of operationalizing the constructs proposed previously. Table 1 summarizes the various measures applied in these studies.

SYSTEM QUALITY

Three constructs were proposed for the system quality dimension: technical resources, KM form, and KM level. Jennex and Olfman (2002) found that the capabilities of the IS organization and the users can impact the success of KM. IS

Table 1. KMS success model data collection methods

Construct	Data Collection Method
Technical Resources	User competency survey, observation and document research of IS capabilities, interview with IS Manager on infrastructure
Form of KMS	Interviews and survey of knowledge sources and form
Level of KMS	Survey of satisfaction with retrieval times, usability testing on KMS functions
KM Strategy/Process	Survey on drivers for putting knowledge into the KMS and for satisfaction with the knowledge in the KMS, check on if a formal strategy/process exists
Richness	Usability test on adequacy of stored knowledge and associated context, interviews and satisfaction survey on adequacy of knowledge in KMS
Linkages	Usability test on adequacy of stored linkages, interviews and satisfaction surveys on satisfaction with linkages stored in KMS
Management Support	Interviews and Social Factors construct of Thompson, Higgins, and Howell's survey on perceived benefit
IS KM Service Quality	Interview with IS Manager on IS capabilities. Interviews with users on needs and capabilities. Suggest adding user satisfaction survey on service issues
User Organization KM Service Quality	Interview with user organization KM team on capabilities and responsibilities, and needs from IS. Interview with users on needs and capabilities. Suggest adding user satisfaction survey on service issues
User Satisfaction	Doll and. Torkzadeh (1988) End User Satisfaction Measure, any other user satisfaction measure
Intent to Use/ Perceived Benefit	Thompson, Higgins, and Howell's (1991) survey on perceived benefit
Net Impacts	Determine Individual and Organizational productivity models through interviews, observation, tend to be specific to organizations

infrastructure and organizational capabilities that enhanced KM effectiveness included a fast, high-capacity infrastructure, strong application development skills, network skills, and awareness of the user organization's knowledge requirements. Users' capabilities that enhanced KM effectiveness included a high degree of computer literacy and high-end personal computers. Given the importance of these technical resources, operationalization of the technical resources construct can be accomplished by focusing on the overall experience of the development group in building and maintaining networked systems that support KM; the computer capabilities of KM end users; and the quality of hardware, network, application, and operating system capabilities of workstations supporting KM.

KM level was defined as the ability to bring past information to bear upon current activities. This can be measured in terms of Stein and Zwass' (1995) mnemonic functions, including knowledge acquisition, retention, maintenance, search, and retrieval. It is expected that more effective KM will include more sophisticated levels of these functions. For example, more sophisticated KM should contain the ability to do filtering, guided exploration, and to grow memory. Usability testing of these functions can serve as measures of how effective they are implemented.

KM form refers to the extent to which knowledge is computerized and integrated. In essence, the more computerized the memory (personification and codification approaches), the more integrated it can be. That is, if all knowledge sources are available in computer-based form, then it will be possible to search and retrieved knowledge more effectively. Integration also speaks to the external consistency of the various KM tools. Jennex and Olfman (2002) found that although much of the KM used by the engineering organization was computerized, there were many different KMS components, each with varying kinds of storage mechanisms and interfaces. These components were poorly integrated, relying mainly on the copy-and-paste features of the Windows interface and, therefore, limited the ability of workers to utilize KM effectively. It was evident that more sophisticated technical resources could produce a more integrated set of components. Surveys of actual knowledge repositories that are used for KM can determine how much knowledge is stored in computerized forms. It is desired but not practical to have all knowledge in a computer. Assessment of this construct should focus on how much of the knowledge that is practical for computer storage is computerized.

KNOWLEDGE QUALITY

Knowledge quality has three constructs: KM strategy/process, richness, and linkages. Jennex and Olfman (2002) used surveys of users to determine drivers for putting knowledge into KM repositories and user satisfaction with the knowledge that was in these repositories. Jennex, et al. (2003) surveyed organizations to determine if they had a KM strategy and how formal it was. Jennex and Olfman (2002) used interviews of KM users to determine their satisfaction with the accuracy, timeliness, and adequacy of available knowledge. The need for linkages and personification of knowledge was found through interviews with users on where they went to retrieve knowledge. Additionally, it was found that users' KM needs vary, depending on their experience levels in the organization. Context of the knowledge is critical. New members did not have this context, and the knowledge repositories did not store sufficient context in order for a new member to understand and use the stored knowledge. It was found that new members need linkages to the human sources of knowledge. It is not expected that KM will ever be able to do an adequate job of storing context, so it is recommended that KM store linkages to knowledge.

SERVICE QUALITY

Service quality was defined previously as how well the organization supports KM. Three constructs are proposed: management support, IS KM service quality, and user KM service quality. Jennex and Olfman (2002) identified these constructs through interviews that found evidence to show that the service quality of the IS and user organizations can impact KM success and that service quality was determined by the organizations that possess certain capabilities. IS KM service consisted of IS being able to build and maintain KM components and to map the knowledge base. IS organizational capabilities that enhanced this service effectiveness included data integration skills, knowledge representation skills, and awareness of the user organization's knowledge requirements. User organization KM service consisted of incorporating knowledge capture into work processes and being able to identify key knowledge requirements. User organization KM capabilities that enhanced this service effectiveness included understanding and being able to implement KM techniques, such as knowledge taxonomies, ontologies, and knowledge maps, and to process analysis capabilities. Additionally, service was enhanced either by the IS or the user organization providing training on how to construct knowledge searches, where the knowledge was located, and how to use KM.

The key construct—management support—was measured by using interviews and the social factors measure of Thompson, Higgins, and Howell's (1991) survey on perceived benefit. The social factors measure uses a Likert scale survey to determine perceptions of support from peers, supervisors, and managers, and gives a good view of the ability of the organizational culture to support KM and management support for doing KM. Additionally, individual and organizational productivity models were generated by using interviews with managers that provide an assessment of the impact of knowledge use on individuals and organizations and what incentives are being used to encourage KM participation.

IS organization KM support was measured by determining the overall experience of the development group in building and maintaining networked systems that support KM and the satisfaction of the KM end users with this support. User organization KM support was measured by determining what support was provided and how satisfied the users were with it. Measures assessing specific areas of capability can be used, should less-than-acceptable service satisfaction be found.

USER SATISFACTION

User satisfaction is a construct that measures perceptions of KM by users. This is one of the most frequently measured aspects of IS success, and it is also a construct with a multitude of measurement instruments. User satisfaction can relate to both product and service. As noted, product satisfaction often is used to measure knowledge quality. Product satisfaction can be measured by using the 12-item instrument developed by Doll and Tordzadeh (1988). This measure addresses satisfaction with content, accuracy, format, ease of use, and timeliness. Additionally, measures addressing satisfaction with interfaces should be used. Other user satisfaction measures can be used to assess the specific quality constructs, as discussed in previous paragraphs.

INTENT TO USE/PERCEIVED BENEFIT

Jennex, et al. (1998) used Thompson, Higgins, and Howell's (1991) Perceived Benefit Model to predict continued voluntary usage of KM by the engineering organization. The following four factors from the model plus one added by Jennex and Olfman were in the survey:

- Job fit of KM, near-term consequences of using KM
- Job fit of KM, long-term consequences of using KM
- Social factors in support of using KM
- Complexity of KM tools and processes
- Fear of job loss for contributing knowledge to KM

All five factors were found to support continued KM use during the initial measurements. Jennex and Olfman (2002) found continued KM use throughout the five years of observing KM usage and concluded that the Perceived Benefit model was useful for predicting continued use. Jennex (2000) used these factors to design the site, work processes, and management processes for a virtual project team, using Web-based KM to perform a utility Year 2000 project. Promoting the social factors and providing near-term job fit were critical in ensuring that the virtual project team utilized KM. KM use was considered highly successful, as the project went from performing in the bottom third of utility projects to performing in the top third of all utility projects.

NET BENEFITS

The net benefits dimension looks for any benefits attributed to use of the KMS. We attempted to measure benefits associated with individual and organizational use of KM through the generation of productivity models that identified where knowledge use impacted productivity. KM benefits for an individual are found in their work processes. Jennex and Olfman (2002) queried supervisors and managers in order to determine what they believed was the nature of individual productivity in the context of the station-engineering work process. The interviews revealed a complex set of factors. Those benefiting from KM include the following:

- Timeliness in completing assignments and doing them right the first time
- Number of assignments completed
- Identification and completion of high-priority assignments
- Completeness of solutions
- Quality of solutions (thoroughness and accuracy)
- Complexity of the work that can be assigned to an engineer
- Client satisfaction

While many of these factors are measured quantitatively, it was not possible to directly attribute changes in performance solely to KM use, although improvements in performance were qualitatively attributed to KM use. Additionally, Jennex and Olfman (2002) asked 20 engineers to indicate whether they were more productive now than they were five or 10 years ago, and all but one thought that they were. This improvement was attributed primarily to KM use but also was a qualitative assessment.

Organizational impacts relate to the effectiveness of the organization as a whole. For a nuclear power plant, specific measures of effectiveness were available. These measures relate to assessments performed by external organizations as well as those performed internally. External assessments were found to be the most influenced by KM use. Jennex and Olfman (2002) found measures such as the SALP (Systematic Assessment of Licensee Performance) Reports issued by the Nuclear Regulatory Commission and site evaluations performed by the Institute of Nuclear Power Operations (INPO). Review of SALP scores issued since 1988 showed an increase from a rating of 2 to a rating of 1 in 1996. This rating was maintained through the five years of the study. An INPO evaluation was conducted during the spring of 1996 and resulted in a 1 rating. This rating also was maintained throughout the five years of the study. These assessments identified several strengths directly related to engineer productivity using KM, including decision making, root cause analysis, problem resolution, timeliness, and Operability Assessment documentation. This demonstrates a direct link between engineer productivity and organization productivity. Also, since organization productivity is rated highly, it can be inferred that engineer productivity is high.

Two internal indicators were linked to KM use: unit capacity and unplanned automatic scrams. Unit capacity and unplanned scrams are influenced by how well the engineers evaluate and correct problems. Both indicators improved over time. These two indicators plus unplanned outages and duration of outages became the standard measure during the Jennex and Olfman (2002) study, and reporting and monitoring of these factors significantly improved during the study.

The conclusion is that net benefits should be measured by using measures that are specific to the organization and that are influenced by the use of KM. Suitable measures were found in all the studies used for this article, and it is believed that they can be found for any organization.

CONCLUSION

The DeLone and McLean IS Success Model is a generally accepted model for assessing success of IS. Adapting the model to KM is a viable approach to assessing KM success. The model presented in this article meets the spirit and intent of DeLone and McLean (1992, 2003). Additionally, Jennex (2000) used an earlier version of the KM Success Model to design, build, and implement intranet-based KM that was found to be very effective and successful. The conclusion of this article is that the KM Success Model is a useful model for predicting KM success. It is also useful for designing effective KM.

AREAS FOR FUTURE RESEARCH

DeLone and McLean (1992) stated, "Researchers should systematically combine individual measures from the IS success categories to create a comprehensive measurement instrument" (pp. 87–88). This is the major area for future KM success research. Jennex and Olfman (2002) provided a basis for exploring a quantitative analysis and test of the KM Success Model. To extend this work, it is suggested that a survey instrument to assess the effectiveness of KM within other nuclear power plant engineering organizations in the United States should be developed and administered. Since these organizations have similar characteristics and goals, they provide an opportunity to gain a homogeneous set of data to use for testing the model and, ultimately, to generate a generic set of KM success measures.

Additionally, other measures need to be assessed for applicability to the model. In particular, the Technology Acceptance Model, Perceived Usefulness (Davis, 1989) should be investigated as a possible measure for Intent to Use/Perceived Benefit.

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