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Abstract

In the literature on knowledge management (KM), one of the most important research questions is about the impact of knowledge management initiatives on firm performance. A review of research on business value of KM reveals that most of the work on evaluating the effectiveness of KM efforts is concentrated on studying the association between KM and firm performance. For several reasons, measurement of firm performance and relating it to KM efforts has proven to be a difficult endeavor. Our approach changes the focus of analysis to the process level, where the work is actually accomplished. We argue that it is worthwhile to study the effectiveness of knowledge management efforts involving KM systems (KMS's) in terms of the business processes they support. This paper proposes a KMS Value model to examine the effect of KMS's on the performance of business processes, especially those that require/can benefit from substantial knowledge sharing. We identify salient characteristics of common knowledge-intensive business processes and the metrics that can be used to evaluate their performance. The proposed model provides a clearer articulation of research questions and propositions to study the impact of KMS's on directly measurable business process performance metrics.

Keywords: Knowledge Management, Knowledge Management Systems, Business Process, Knowledge-Intensive Business Process, Business Process Performance

1. Introduction

In recent years, economists and business analysts have started considering an organization's knowledge to be one of its most valuable assets. Organizations are recognizing that knowledge is a valuable resource. In the strategic management literature, a *knowledge based perspective* of the firm has emerged (Cole 1998; Nonaka and Takeuchi 1995; Spender 1996a; Spender 1996b) as an extension of the resource-based view of the organization that originated several decades ago (Penrose 1959) and later expanded by others (Barney 1991; Conner 1991; Schulze 1992; Wernerfelt 1984). According to this perspective, knowledge is believed to be a strategic resource, a source of competitive advantage. As such, its prudent management can impact organizational performance. A research note from the Gartner Research Group predicts that organizations will recognize even more the enhanced role of knowledge work and knowledge workers (Harris and Flint 2003). On the technology front, the importance given to the knowledge resource is exemplified by the emergence of a special type of information system - Knowledge Management System (KMS) (Alavi and Leidner 2001). Both academic and practitioner communities agree that properly designed and implemented KMS's have the potential to positively impact performance and afford a competitive advantage to a business.

As a result, many organizations have invested substantially in projects involving KMS's assuming they will contribute to improved performance. However, not all organizations are

obtaining the expected bottom line results (Shin 2004). Do KMS's and other KM related efforts truly provide a positive contribution to a firm's bottom line? Unfortunately, as prior research has realized, linking KM to firm performance is, to say the least, a tenuous task. According to Becerra-Fernandez and Sabherwal (2001) there are numerous articles that recognize the positive impact of KM but there is no conclusive evidence demonstrating the contribution of KM initiatives to organizational performance. Some recent work (Chen et al. 2004) shows a relationship between KM initiatives (publicly disclosed company announcements about KM projects undertaken between 1999 and 2003) and firm performance (secondary financial data), but the significance of the relationship is rather weak. Association between a KM initiative and firm performance may be confounded by other factors affecting the firm's performance. This relationship may be further complicated by the substantial time lag that is usually associated with the return on investment in long-maturity projects such as those in KM.

In order to understand the value of a KM initiative, we believe that it is necessary to see its impact on the more direct outcomes of the business processes it supports. In the context of IS research, we would also like to focus on those KM initiatives that involve a substantial KMS implementation. Hence, in this paper we present a KMS Value model that can be used to study the impact of KMS's in terms of improvement in relevant and measurable business process performance metrics. Further, our model recognizes that different business processes have differing knowledge needs; the more knowledge-intensive a process is, the more it stands to gain from an appropriate KMS. Our model incorporates this moderating effect of knowledge intensity on process performance. Finally, our model also acknowledges the role of certain aspects of organizational culture, termed as knowledge-sharing culture, in influencing the actual value derived from KM efforts.

In the next section, we first describe the concept of knowledge intensity which characterizes some business processes. As knowledge intensity is a fairly new concept, we introduce it with detailed examples of some common knowledge-intensive business processes showing leverage points where exchange of knowledge can benefit these processes. We also provide a framework for gauging the extent of knowledge intensity of a business process. Next, we briefly reiterate the characteristics of KMS's that facilitate the exchange of knowledge. KMS's with such characteristics, together with successful enhancement of the processes they support, ultimately create the value associated with the KM initiative. We also briefly discuss the ingredients of knowledge-sharing culture that may enhance the value derived from KM efforts. We then describe a way to identify metrics to measure outcomes at the process level, which we argue is both appropriate and practicable for establishing the business value of a KMS. Finally, we describe our KMS Value model that can be used to raise relevant research questions and propositions that may be further developed into testable hypotheses.

2. Business Processes and Knowledge Intensity

In order to discuss what we mean by a knowledge-intensive business process, we first look at some relevant definitions of a business process. A business process is "a set of logically related tasks performed to achieve a defined business outcome" (Davenport and Short 1990) and furthermore, is a way of describing *how* work is done rather than *what* work is done (Davenport 1993). A more recent definition describes a business process as "the complete and dynamically coordinated set of collaborative and transactional activities that deliver value to customers" (Smith and Fingar 2003). Additionally, "a business process, as a

collection of interrelated tasks, is outcome oriented, is intended for a customer, has stakeholders, and is triggered by some specific event" (Sharp and McDermott 2001).

Key concepts in these definitions are: description of how work is done, coordination, outcome/goal orientation, and customer/stakeholder identification. The first two concepts, the way work is done and coordination, focus on the choices to be made (decision making) at each step and on the need for information/knowledge exchange among decision-makers and with the environment. This leads us to the discussion on knowledge intensity below. The other two concepts, outcome/goal orientation and customer/stakeholder identification, focus on the results (performance) as seen by the benefactor of the process. This leads to the discussion on performance measurement in a later section. It is important to note that business processes may sometimes span across the boundary of the organization and involve external parties like suppliers or customers; our research model includes such processes.

Certain business processes have embedded knowledge needs. These processes have activities that can benefit from input of knowledge (from knowledge workers/decision makers, external knowledgeable experts, knowledge repositories, etc.). Such business processes are referred to as Knowledge-Intensive Business Process (KIBP) (Chen et al. 2004; Eppler et al. 1999; Massey et al. 2002; van Leijen and Baets 2003). KIBP's cannot be completely automated; they need a human to make key judgments and decisions at appropriate junctures to fully execute the process. Another distinguishing characteristic of KIBP's is that knowledge is one of their primary resources.

Based on work by (Eppler et al. 1999) who describe an elaborate characterization of KIBP's, we present a framework for determining the knowledge intensity of a business process along three key dimensions: contingency, knowledge worker participation, and knowledge characteristics. Table 1 describes the three dimensions and the manner in which they affect the overall knowledge intensity of a business process. The contingency dimension refers to the uncertainty that the decision maker (knowledge worker) faces, which depend on many environmental factors. The decision maker may have several courses of action available at different stages of the process to complete the process. Knowledge intensity is also defined by knowledge workers' participation in the process in terms of their creativity, innovation, problem-solving skills, etc., influencing the process outcome. Finally, characteristics of the actual knowledge required by the process such as its complexity, tacitness, and the need to be renewed, also determine the knowledge intensity of the process. Together, these dimensions allow one to measure the knowledge intensity of a business process. Our KMS Value model allows exploration of the impact of knowledge intensity of a business process on the relationship between a KMS and performance of the business process. We believe that the use of knowledge management systems affects knowledge-intensive business processes more significantly than processes that are not knowledge-intensive.

As an example of a KIBP, Figure 1 shows a Solution-Selling process with its basic steps – Business-development, Pre-acquisition, and Bid-preparation/Solution-creation (MacCormack et al. 2002). Knowledge exchange points and examples of different types of knowledge needed within the process are also shown. One can see that this process is knowledge intensive because 1) it is contingent upon several externalities including market characteristics, cultural issues associated with the particular customer, etc., 2) several options are available to the knowledge workers preparing the bid and they can greatly influence the nature of the final bid, and 3) the technical knowledge required to build the solution is highly specialized and up-to-date. Figure 2 shows another example of a KIBP, a

New-Product-Development process and its knowledge needs. A KMS equipped to serve the required knowledge could significantly impact the outcomes of these processes. In contrast to these knowledge intensive processes, a routine order fulfilling process has all the characteristics of low knowledge intensity; therefore such a process is not likely to benefit as much from a KMS as would any of the above two KIBP's.

Dimension	Description	Knowledge Intensity
Contingency	The knowledge worker's activities are dependent on numerous eventualities (i.e., environmental influences).	High
	The knowledge worker's activities are defined and outlined (i.e., by process policies) and do not change due to environmental factors.	Low
Knowledge Worker Participation	The knowledge worker has several options in process-related decision-making, needs creativity and innovation for problem-solving, and has capability to greatly influence the outcome of a process.	High
	The knowledge worker has no significant unstructured choices in his/her activities; his/her input is of routine nature;. outcomes are mainly dictated by process inputs rather than influenced by the knowledge worker	Low
Knowledge characteristics	The knowledge needed must be periodically renewed; the required knowledge is complex and hard to internalize.	High
	The knowledge needed is fairly fixed; the required knowledge is easy to acquire.	Low

Table 1: Dimensions of Knowledge-Intensive Processes (based on Eppler et al. 1999)

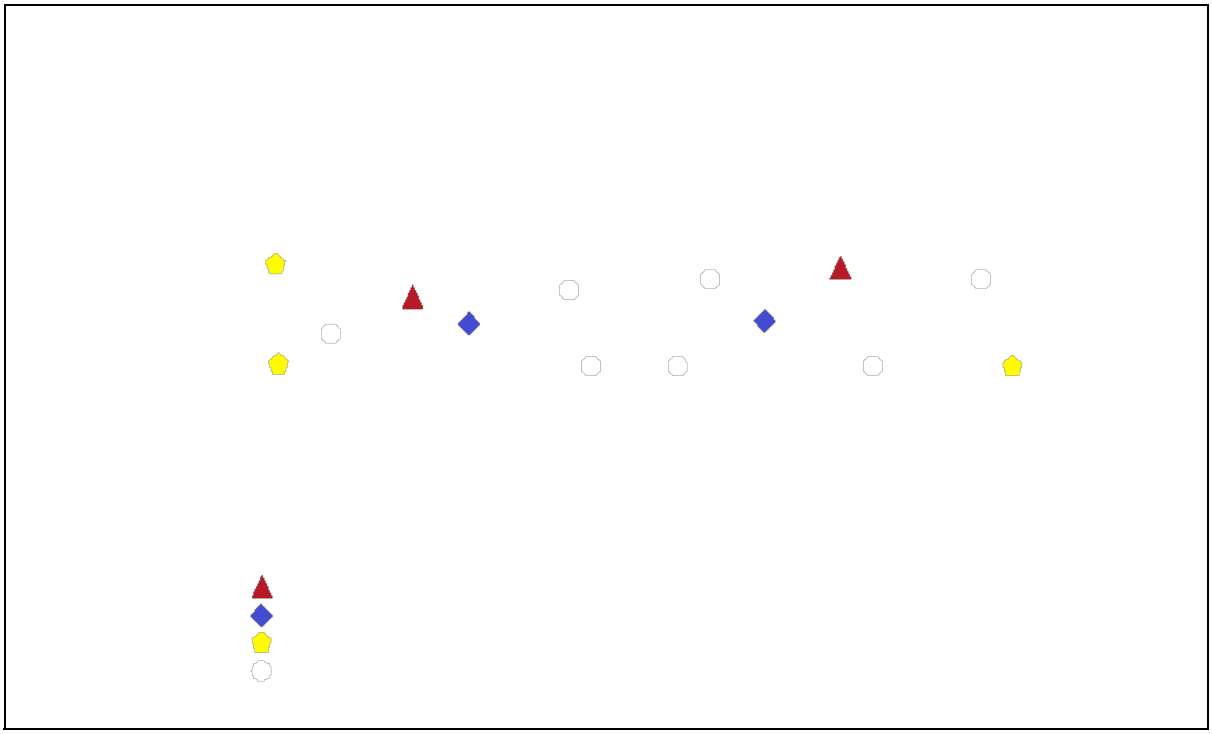

Figure 1. Knowledge Sharing along a Solution-Selling Process (reproduced from MacCormack et al. 2002)

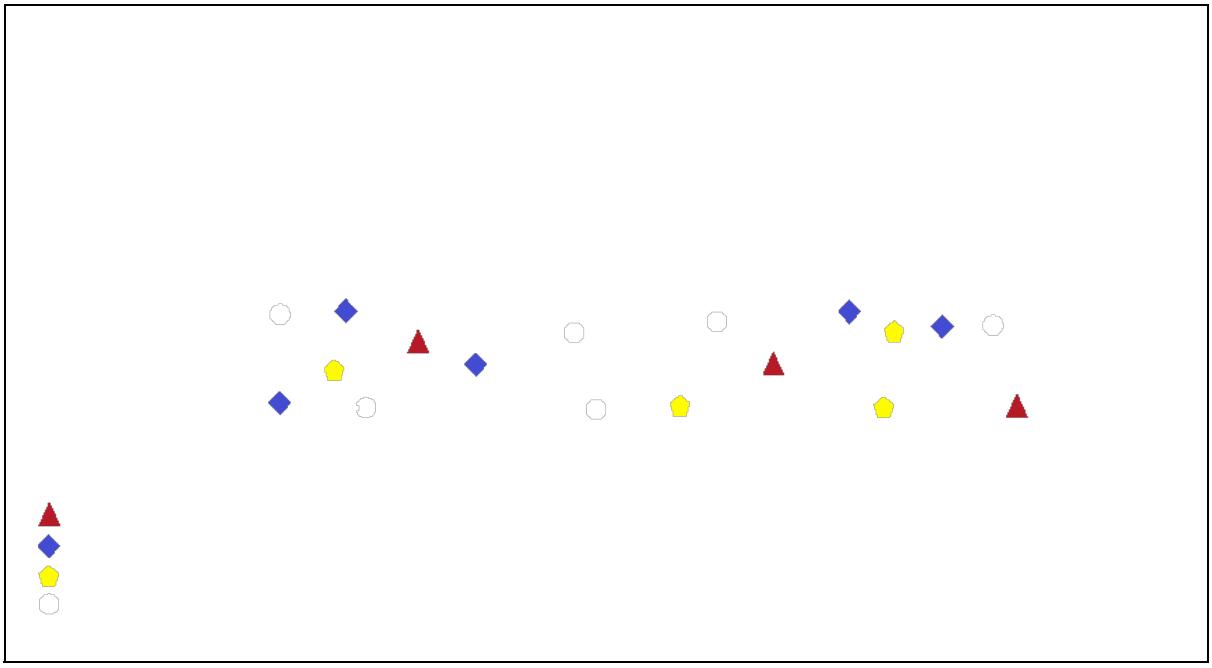

Figure 2. Knowledge Sharing along a New-Product-Development Process

3. Knowledge Management Systems and Knowledge Sharing Culture

3.1 Knowledge Management Systems

A knowledge management system is a special type of information system for managing the organizational knowledge resource. A KMS is designed to support business processes by assisting in the creation, storage/retrieval, transfer, and application of knowledge (Alavi and Leidner 2001). Traditional information systems, on the other hand, deal with data and information sourced from operations (sales, purchases, transformations, etc.) and are mainly designed to automate repetitive tasks and replace manual computational work. KMS's are different from information systems in that they deal with the complex task of facilitating knowledge sharing.

A knowledge management system is, as expected, tied to the organizational knowledge that it supports. Although obvious, it is important to make this relationship explicit. KMS's are sometimes viewed as replacing the knowledge residing in the minds of the knowledge workers. That simplistic view assumes that knowledge is static and that knowledge workers can easily be supplanted by a system. An opposing perspective considers knowledge as dynamic and being constantly renewed. This evolving knowledge is the resource that provides a competitive advantage to an organization. The resource-based view of the firm posits that resources that are valuable, rare, inimitable, and non-substitutable confer a sustained competitive advantage (Barney 1991). The interaction of knowledge workers and the KMS continually updates and enhances the knowledge resource making it inimitable and arguably valuable. Therefore, KMS's are a vital enabler of knowledge as a true competitive resource.

Due to the variety and uncertainty of inputs and outputs of knowledge work, KMS's need to handle complex representations and context-specific retrieval of available knowledge. From the organization's perspective, a KMS facilitates organizational learning and perpetual maintenance of organizational memory through knowledge repositories. In addition, KMS's allow effective dissemination of best practices, lessons learned, and expertise. From the knowledge worker's perspective, a KMS facilitates capture of individual knowledge and

search and retrieval of previously stored relevant organizational knowledge for application in their own context. KMS's also allow knowledge workers to connect with other experts to exchange tacit knowledge through knowledge networks. These characteristics of a KMS, namely 1) capture of individual knowledge, 2) search/retrieval of relevant knowledge, and 3) connecting with experts, are some of the important determinants of the effectiveness of a KMS from a knowledge worker's point of view. Our proposed model allows exploration of the impact of such characteristics of a KMS on the outcome of business processes they support.

3.2 Knowledge-Sharing Culture

It is well known that organizational culture plays an important role in the successful implementation and operation of information systems. We believe that certain aspects of organizational culture may play a more pronounced role in the successful adoption of KM practices and systems. "Perhaps the most significant hurdle to effective knowledge management is organizational culture" (Gold et al. 2001). Although, a well studied area, there is no conclusive research on what aspects of organizational culture and how exactly they affect the use of information systems. Nevertheless, ignoring organizational culture in studying the impact of KMS's on business processes may lead to erroneous conclusions. The knowledge-sharing culture includes several aspects that influence knowledge management initiatives and KMS's.

Aspects of organizational culture that influence KMS's success include norms and beliefs about the importance of knowledge and its management. Leadership of the organization can play a pivotal role by recognizing that knowledge management needs to be taken into account at the strategic level by setting goals at the highest level. This may be facilitated by appointing a senior official (such as a Chief Knowledge Officer) in a position of authority and providing appropriate resources (financial and structural) to plan and carry out the KM functions in the long term. Such a top-down approach establishes a high level of commitment (De Long 1997) and helps the leaders of the organization create an environment of trust needed for knowledge sharing (De Long and Fahey 2000). Furthermore, middle management can establish incentives and reward systems that formally encourage participation by coworkers to collaborate with each-other and motivate contribution to and reuse of knowledge in the organization's knowledge repositories (MacCormack et al. 2002). Another aspect of culture is the way knowledge workers perceive knowledge – as a depletable resource that needs to be hoarded or as an asset whose value increases with sharing. When knowledge workers recognize that sharing knowledge improves their own tasks and those of their team, they develop a positive attitude to knowledge sharing. Managers and supervisors can accomplish this by setting up appropriate working conditions for sharing – informal settings for socialization which influences the sharing and transfer of tacit knowledge (Nonaka and Takeuchi 1995) and arrange formal periodic meetings where ideas are shared and key learnings are captured for reuse.

4. Measuring Business Process Performance

In this section, we discuss the appropriateness of a process level focus for studying the business value of KMS's and the choice of performance measures for this purpose. As mentioned earlier, attempts to link KM initiatives to organizational performance have not been successful. We believe that there are several difficulties associated with using firm-level performance measures as a dependent variable. First, firm performance is affected by many different factors, both endogenous and exogenous, to the organization. For example, in spite of implementing a KMS such as a system for sharing internal best sales

practices, the sales levels may not increase. This may be due to competitors' actions or any other external events. Or, an internal breakdown in operations (due to a strike or under-ordering) may mask any gain in sales performance due to the KMS. Therefore, investment in the KMS may be mistakenly taken as a bad investment as it did not help increase revenue. Another problem is that investments in information systems, and more specifically in knowledge management systems, take some time to actually materialize into returns (Chen et al. 2004; Weill 1992), making it difficult to make the connection. Therefore, it is hard to measure the value of KM initiatives in terms of firm-level dependent variables such as firm performance (Kearns 2003; Ruggles 1998).

For these reasons, we believe that it is more appropriate to measure the value returned by a KMS at a different level. For example, (Wade and Hulland 2004) contend that IS resources affect other resources or processes within the organization; therefore it may be beneficial to use intermediate-level dependent variables at the business process, department, or project levels. (Massey et al. 2002; Ray et al. 2004) show that the performance environment has three levels: individuals (performers), process, and business. They argue that the process level is where the work is actually accomplished and is the link between the other two levels of performance: business and individual. However, they recognize that the process level of performance is usually the least managed level and therefore the one that requires more attention. (Crowston 2003) also proposes the process level as the unit of analysis because "viewing processes as the way organizations accomplish desired goals and transform inputs into outputs makes the link to organizational outcomes". (Melville et al. 2004) developed a model of IT Business Value based on the resource-based view of the firm integrating previous research published in the main outlets of Information Systems. Their model proposes a clear connection between business process performance and organizational performance. Therefore, it seems appropriate to use business process performance measures as a dependent variable for evaluating the impact of knowledge management systems.

Our review of the definitions of business process shows that they have specific objectives or goals and that they serve a customer, where the customer is the direct beneficiary of the process outcome. One central characteristic of business processes is that their performance is measurable; the measures are driven by their importance to its stakeholders – customer, performers, and owner/manager (Sharp and McDermott 2001). Performance measures of a business process therefore need to be linked to its specific objectives and goals, such that the measures are customized for each process. This is because even common business processes are customized to the environment of the organization. These performance measures, as we stated earlier, are intimately related to the needs and priorities of the stakeholders. Two types of measures are mentioned in the literature: efficiency (internal measures) and effectiveness (external measures).

In a qualitative review of "knowledge work processes" in thirty organizations, (Davenport et al. 1996) studied what we term as knowledge-intensive business processes. All these firms used customized intermediate measures as their improvement objectives for assessing the performance of their business processes. Such measures comprise both internal and external indicators. Examples of internal measures include: increased efficiency/yield, shorter cycle time, improved cycle time and consistency, improved efficiency and reuse, reduced backlog, reduced cycle-time and errors, reduced time to market, etc. Examples of external measures include: increased value to customers, increased personalization for the customer, increased value added, increased customer satisfaction etc.

Using our previous examples, in the case of the Solution-Selling process of Figure 1, an appropriate set of performance metrics could be: reduction of time for bid preparation, number of bids prepared/won per year, and revenue per bid. While evaluating the New-Product-Development process of Figure 2, some examples of measures that may be important to stakeholders include: number of new products developed per year, contribution of the new products in the first year; reduction in time to develop new products; average reduction in product development cost.

5. Evaluating Knowledge Management Systems: A KMS Value Model

In the preceding sections, we have demonstrated, mainly through examples, how business process performance can be effectively measured via appropriate customized outcome metrics. We have also illustrated that business processes can be characterized using a knowledge intensity scale and knowledge management systems are intended to enhance the outcome of such processes. Our KMS Value model, shown in **Error! Reference source not found.**, integrates these conceptual developments in order to allow researchers to explore various relationships between the key constructs. A brief description of each construct identified in our model is presented below.

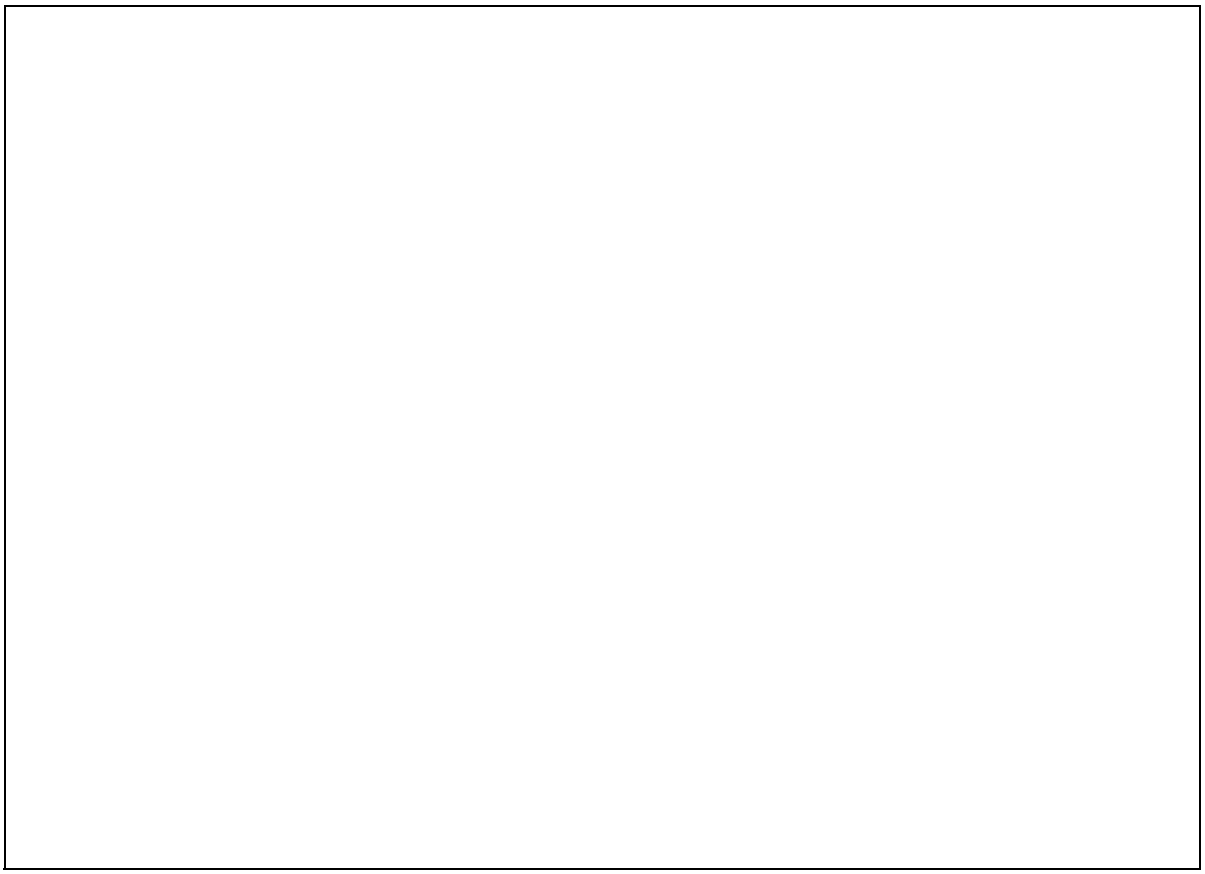

Figure 3. Constructs of the KMS Value Model.

5.1 Operationalization of Constructs

KMS Capability, the first construct, can be operationalized in terms of the characteristics of the KMS. This is a complex second order construct consisting of multiple first order variables describing how the KMS assists the various stages of knowledge life-cycle: capture, storage, search/retrieval, transfer, etc. (Alavi and Leidner 2001). While some prior researchers have used "use" measures such as number of downloads, dwell time, etc., as

indicators of success based on the IS Success model (DeLone and McLean 1992; DeLone and McLean 2003), others have suggested more qualitative measures to suit the context of knowledge – see (Kankanhalli and Tan 2005) for a review of KMS evaluation studies. Based on these studies, we chose to include the following three characteristics of a KMS as first order constructs in our model: a) *Capture of Knowledge* - the extent to which the KMS supports capture of knowledge, b) *Search/Retrieval* - the ease and accuracy of the search/retrieval capability of the KMS, and c) *Connection with Experts* - the ability of the KMS to connect knowledge workers with relevant experts when needed.

The second construct is derived from the notion of *Knowledge Intensity* characterized by the three dimensions: *Contingency*, *Participation of the Knowledge Worker*, and *Knowledge Characteristics*. The contingency dimension describes processes that may take multiple courses of action and the selection of one course of action is dependent on numerous eventualities. The more the dependency on these eventualities and the more the possible courses of action, the higher is the knowledge intensity. The knowledge worker participation dimension describes high knowledge- intensive processes as those with multiple decision-making points, where the subsequent activities in a business process are dependent on a decision by the knowledge worker. The knowledge worker needs some amount of creativity, innovation, expertise, etc., and the decision made will have great influence on the outcome of the process. Finally, the knowledge characteristics dimension describes qualities of knowledge – degree of tacitness (difficulty to internalize or learn), complexity, and need to be renewed – which can make the associated business processes more knowledge-intensive.

The *Knowledge-Sharing Culture* construct is the knowledge sharing aspect of the overall organizational culture. It represents organizational environment affecting the way the KMS is used in supporting the business process. The leadership's commitment may be manifested by the strategic importance given to KM - goal setting, investments in KM projects, communication with employees, incentives and rewards for sharing, etc. In the workplace, the worker's commitment can be manifested by the attitudes of coworkers and supervisors in willingness to share and reuse knowledge as well as actual collaboration and exchange that go on. Hence, scales designed to measure these concepts can be used to operationalize this construct.

Finally, the dependent construct *Process Performance*, aims at capturing the improvement in the business process performance associated with the use of a KMS. The performance construct must be customized to a certain degree when operationalizing the model to a particular business process and also to a particular organization. The reason for this need is that each well-defined commonly encountered business process will have a set of outcome measures associated with it, as seen from the examples in the previous section. Furthermore, each outcome measure may not be equally important to all organizations. An organization may choose its own subset of performance measures (from this overall set) according to the importance given to each aspect of their business processes. This customized set of measures may be arrived at after reviewing who the customers and stakeholders of the process are and what the desired outcome levels are. The level of these outcomes with respect to the desired level then becomes the appropriate measure of this construct.

5.2 Research Questions and Propositions

Having described our model constructs, we theorize possible relationships between them through a set of research questions. These questions are further elaborated via multiple

propositions. Our first research question examines whether and to what extent knowledge management systems are associated with business process performance.

Research Question 1: How do KMS's impact the performance of a business process?

Studies that can emanate in response to this question will focus on identifying, measuring, or estimating the relationship between KMS characteristics and various measures of performance of the business process it is intended to support. In Proposition 1 below, *KMS Capability* is construed to be a continuous second order construct comprising the aggregation of multiple characteristics (e.g., capture, search/retrieve, connecting with experts) and its degree determines the level of performance gain in the business process it supports. Proposition 1 could be further broken into three propositions in order to study in more detail the impact of each characteristic on process performance.

> Proposition 1: Higher the overall capability of a KMS, the better is the performance of the business process it supports.

The second research question extends the scope of KMS value to incorporate the role of knowledge intensity (of the business process) in contributing to KMS value.

Research Question 2: Are knowledge intensive business processes likely to benefit more from KMS's?

We believe that the knowledge intensity of a business process affects the value generated from the KMS in supporting the business process and helping to enhance its performance. The higher the *Knowledge Intensity*, as measured by its three dimensions (contingency, knowledge worker participation, and knowledge characteristics), the greater is the knowledge that can be shared and, therefore, potentially higher is the effect of *KMS Capability* on the *Process Performance*.

> Proposition 2: The knowledge intensity of a business process shapes the degree to which a KMS affects the performance of the business process it supports.

The third research question incorporates the role of organizational culture and its effect on the value derived from a KMS.

Research Question 3: Are business processes in an organization with a strong knowledge-sharing culture likely to benefit more from KMS's?

We believe that organizational cultural aspects related to KM (knowledge-sharing culture) significantly influence the relationship between *KMS Capability* and *Process Performance.* The more supportive the knowledge-sharing culture, the higher is the performance gain of the business process supported by the KMS.

> Proposition 3: The knowledge sharing culture of an organization shapes the degree to which a KMS affects the performance of the business process it supports.

6. Summary and Conclusions

We have developed and presented a KMS Value model that can allow in-depth studying of the impact of KMS's on knowledge intensive business processes in terms of relevant and measurable performance metrics. To accomplish this, we had to tackle and merge five important conceptual challenges: 1) the remoteness of a KMS's outcome from firm-level performance, 2) the special characteristics of KMS's as compared to conventional information systems, and 3) knowledge intensity of a business process, 4) defining the aspects of organizational culture that facilitate knowledge sharing, and 5) the specialized performance metrics that need to be identified for assessing the outcomes of business processes.

We believe that a unique contribution of this conceptual study is the integration of emerging ideas from KM and other related domains and presenting a cohesive model that is practical, logically sound, and theoretically grounded. Although prior research has suggested intermediate dependent constructs for measuring the effectiveness of Information Systems, KMS success measures in terms of customized business performance metrics are novel. The idea of knowledge intensive business processes has been floated in the recent past, but operationalizing knowledge intensity into a measurable construct and arguing that it moderates a KMS's effect on business process performance is new.

Research implications of this model are obvious; systematic operationalization of this model will allow researchers to test and ascertain the impact of knowledge management systems on meaningful as well as practical measures of value. The caveat is that value generating outcome measures associated with processes that the KM initiatives are designed to enhance, need to be established first. Business implications are that the application of this model would allow businesses to ascertain the true value of a knowledge management system. Presently, most organizations embarking upon a KMS project are not fully cognizant of the value of their IT investment.

One drawback of our model, like most other conceptual models, is the difficulty in operationalizing the complex constructs. KMS characteristics, knowledge intensity, knowledge-sharing culture, are all multi-dimensional and abstract concepts; measuring them would require a substantial amount of instrument building and validation work. Moreover, research needed to test the model is methodologically hard to accomplish. KMS-related case studies in single organizations are not easily generalizable and data from cross-sectional multi-organization studies are non-additive because they may involve different KMS types and processes. Nevertheless, parts of the model can be incrementally tested through rigorous research design and thus the model can contribute to our understanding of the associations and causal relationships therein over a period of time.

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