Knowledge Process Support: A Business Process Study of a Knowledge Management System

Ronald Freeze
Arizona State University
Ronald.Freeze@asu.edu

José A. Robles-Flores
Arizona State University / ESAN University
Jose.Robles@asu.edu

ABSTRACT

Although it seems intuitive that Knowledge Management Systems (KMS) should have a positive impact on the management of knowledge, research has not focused on establishing empirical evidence of this relationship and the subsequent theoretical implications. The management of knowledge encompasses multiple organizational entities and an established KMS must support the knowledge work for each entity. Knowledge processes (generation, codification, and transfer) are embedded in business processes. An application of KMS is needed in order to facilitate these knowledge processes, therefore supporting the business processes.

We present evidence of the relationship between a KMS and Knowledge Processes by describing two organizational entities in terms of their different knowledge needs. We provide evidence of how the KMS is utilized by both entities. Survey data was collected from a large semiconductor manufacturer. Results indicate the KMS supports Knowledge Processes in different degrees according to each entity's knowledge needs. Despite this difference, the two entities have a positive perception of how the KMS impacts Knowledge Processes.

Keywords (Required)

Knowledge Management, KM Processes, KM Systems

INTRODUCTION

In recent years knowledge and its management has become an important issue for managers, consultants, and researchers. A "knowledge-based perspective" of the firm has emerged (Cole, 1998; Nonaka and Takeuchi, 1995; Spender, 1996) as an extension of the resource-based perspective originated in the late 1950's (Penrose, 1959) and later expanded by others (Barney, 1991; Conner, 1991; Schulze, 1992; Wernerfelt, 1984). This perspective considers knowledge a source of competitive advantage.

We see organizational knowledge as an intangible asset. This organizational knowledge not only resides in the minds of employees, but is an integral part of the processes, procedures, systems, and organizational culture. Therefore, organizational knowledge shapes the way tangible assets are used to create value. Although today there is agreement that intangible assets significantly influence firm performance (Lev, 2001), measurement is still a matter of debate. Several intangibles (like training and consultancy) are usually reported as immediate expenses; therefore negatively impacting the bottom line in that accounting period while the benefits are not realized until following periods. Other problems in dealing with the impact of intangibles such as knowledge management initiatives include the fact that these types of investments take some time to actually influence performance (Chen, Feng and Liou, 2004; Weill, 1992). During that lapse of time, other external factors may influence the expected outcomes.

In any case, the management of knowledge, as an asset and as a resource to generate competitive advantage, is a recognized need. In order to meet the needs, specific knowledge processes are required. Although several classifications can be found in the literature, a well cited taxonomy considers three knowledge processes: generation, codification, and transfer (Davenport and Prusak, 1998). In order to facilitate these knowledge processes and given the importance of the management of knowledge, a special type of information system is being deployed as a knowledge management system (KMS). A KMS is an IT-based system built to support and leverage the creation, storage, retrieval, transfer, and application of knowledge within the organization (Alavi and Leidner, 2001). Three common applications were found: (a) the coding and sharing of best practices, (b) the creation of corporate knowledge directories, and (c) the creation of knowledge networks. These KMSs support the knowledge processes and the management of knowledge, but the ultimate goal of any project within an organization is to positively impact the bottom line, in other words to contribute somehow to enhance firm performance. Many organizations recognize knowledge as an important element for their firms, but only a few find themselves as being effective in leveraging knowledge (Holsapple, 2003). A literature review reveals that there is a number of articles that recognize the impact of knowledge management initiatives (a KMS implementation is one example of a KM initiative) on business performance (Becerra-Fernandez and Sabherwal, 2001), but they do not show conclusive results about that impact. More recent work shows some relationship between KM capability (i.e. KMS implementation) and firm performance by studying the relationship of companies that are commonly seen as serious adopters of knowledge management and their respective financial results for several years (Chen et al., 2004). However, the significance of the relationship is rather weak.

We believe that one of the problems is dealing with firm performance. In the accounting and finance literature it has long been a matter of much debate. We do not see consensus on the key factors or on how to measure firm performance. Firm level performance is affected by so many factors that it is difficult to track down the effect of a single influence (for example, the effect of introducing a KMS). Previous research has shown that process performance is related to firm performance (Melville, Kraemer and Gurbaxani, 2004). So we believe it is relevant to investigate business processes and how they are affected by the use of KMSs.

The objective of this paper is to provide empirical evidence that the implementation of a knowledge management system impacts business processes by supporting knowledge processes. Even further, we look at how one KMS affects two groups of knowledge workers differently. In the following sections we review the literature related to the business processes as unit of analysis, knowledge processes, knowledge assets, and knowledge management systems. The methodology utilized and the results achieved will then be presented. Finally, current research limitations, conclusions and future direction of this research will be reviewed.

ANALYSIS AT THE PROCESS LEVEL

A business process is defined as “a set of logically related tasks performed to achieve a defined business outcome" (Davenport and Short, 1990). Business processes describe “how” work is done rather than “what” work is done (Davenport, 1993). Business processes have the following characteristics: it is recurrent (the process is performed over and over), replicable (can be transferred to multiple contexts), consequential (affects other processes or outcomes), leverageable (integrates with other processes), and coordinated (Keen, 2004).

The business process level has already been proposed as a unit of analysis for research (Crowston, 2003). Knowledge management systems, as an information systems resource, affect organizational processes (Wade and Hulland, 2004). Previous research shows that the performance environment has three levels: individuals (performers), process, and business (Massey, Montoya-Weiss, and O'Driscoll, 2002). It is also argued that the process level is where the work is actually accomplished and the link between the two levels of performance: business and individual. However, the process level of performance is usually the least managed level and therefore the one that requires more attention (Massey et al., 2002). Recently, a model of IT business value was developed, based on the resource-based view of the firm and integrating previous research published in the main outlets of Information Systems (Melville et al., 2004). The model theoretically shows that business process performance impacts organizational performance. Therefore we focus in the process level in order to investigate how a particular type of information system, a KMS, impacts the performance of a business process through two specific knowledge processes.

KNOWLEDGE PROCESSES

In the Knowledge Management literature there are differing views about the knowledge life cycle or a defined set of knowledge management processes. However, our literature review reveals three main generic knowledge processes that encompass a large portion of the knowledge management activities: Generation, codification and transfer (Davenport and Prusak, 1998).

Knowledge Generation: Refers to activities related with the creation of knowledge either internally or externally. Organizational knowledge may be generated by acquisition, fusion, adaptation; or by the dedication of resources for a completely new development. The key issue is the intentional generation of knowledge.

Knowledge Codification and Coordination. Refers to the steps required to put organizational knowledge into a form that makes it accessible to others who may need it. The objective is not only to have the knowledge codified but also organized, easy to understand and share. In this paper we refer to Knowledge Codification.

Knowledge Transfer. Knowledge transfer is described as happening in direct interaction between and among people as well as in the interaction with knowledge repositories such as databases, knowledge bases, documents, lessons learned, documents of best known practices, manuals, procedures, etc. either in digital form or in hard copies. These “repositories” were created by people (also called “knowledge workers”).

Knowledge processes are seen as embedded in the business processes. The business process is served by the knowledge process through facilitating the transfer or creation of knowledge. For example, let us consider the tool maintenance process. This process requires "data" from previous maintenance instances. Data, in here, contains not only numbers or values but also descriptions of problems and resolutions; therefore data is also a kind of knowledge asset as described in the following section. Data as knowledge can be transferred from a repository using a knowledge management system to facilitate the tool maintenance process.

KNOWLEDGE ASSETS

Prior research (Freeze and Kulkarni, 2005; Kulkarni and Freeze, 2004) described a validated instrument that identified organizational knowledge assets. Four knowledge assets were identified: Lessons Learned, Knowledge Documents, Expertise, and Data. The knowledge assets were conceptualized by reviewing the composition of the knowledge structure, including the human capital, technological factors, the knowledge life-cycle, and the tacit-explicit nature of knowledge. These knowledge assets were operationalized utilizing the knowledge processes of generation, codification and transfer. The four knowledge assets identify how each knowledge process differs in its application within a business process. We focus our research on the knowledge assets of Expertise and Data, particularly on the specific knowledge processes of codification of data and transfer of expertise. Codification of data is a specific knowledge process that deals mostly with explicit knowledge. On the other hand, transfer of expertise is a specific knowledge process that deals mostly with tacit knowledge. Data was collected for all knowledge assets. We chose to focus on two specific knowledge process for the following main reasons: 1) the two knowledge assets were identified as most important for the jobs of the two target groups; 2) the users perceive the KMS as predominantly supporting the needs of these two specific knowledge processes, transfer of expertise and codification of data; and 3) these two specific knowledge processes present differences between the two groups studied in a way that is interesting and informative for research purposes. While differences did occur amongst the other knowledge processes, space constraints prohibit a complete analysis of this research.

The knowledge asset of Expertise consists of the knowledge gained through experience and formal education. Experts are the source of implicit knowledge that can be codified for further use by the organization (Freeze and Kulkarni, 2005). Although this type of knowledge resides mainly in the heads of people (the experts, or the knowledge workers) and cannot be stored in other forms, it can be mapped using corporate directories or knowledge maps. The knowledge asset of Data includes the facts or figures obtained from the business processes and stored in the databases. Data can be transformed into decision-relevant meaning. Its value depends on the context, usefulness, and interpretation (Freeze and Kulkarni, 2005). In other words, it also depends on previous knowledge.

KNOWLEDGE MANAGEMENT SYSTEMS

Knowledge management systems (KMS) are a special type of information systems that supports activities related to the acquisition, generation, codification, storage, transfer, retrieval, and use of knowledge within organizations (Alavi and Leidner, 2001). In other words, KMS are meant to support knowledge processes. These knowledge management systems have been deployed in many organizations with the hope that they will have a positive effect on performance. However, that has not been the case for several organizations. From an economic perspective, facilitation of knowledge sharing actually has both a negative and a positive relationship with competitiveness (Shin, 2004). Therefore, it is appropriate to further investigate the contribution of these KMS on business processes.

In this research, we have identified one knowledge management system within the organization where we carry out our study. The identified system is a KMS that fits the common applications of creation of corporate knowledge and creation of knowledge networks. Our work is focused in one organizational unit that performs knowledge processes as part of the business process. The KMS supports these knowledge processes. Although we look at one unit, we have identified two organizational entities or groups of knowledge workers that participate in the business process and both perform knowledge processes as part of their business process tasks. We investigated how these two groups view and use the KMS. Previous research indicates that users may view the same information system differently. However, there is no empirical work showing these different views. Therefore, our research is focused on these differentiated views and the utility of the KMS for each view.

METHODOLOGY

Data collection for the analysis of the KM Processes was based on a previously validated instrument (Freeze and Kulkarni, 2005; Kulkarni and Freeze, 2004). All questions encompassed a 6-pt Likert scale running from 0 – Not at all to 5 – To a Great Extent. The study of this project focused on improvements achieved based on the implementation of a specific KMS.

Subsequently, questions were designed to assess the usefulness of, satisfaction with, and how well that KMS met the needs of multiple knowledge processes. The instrument was reduced from its original length for one of the target groups because of time constraints placed on administering the instrument. Questions concerning the capture of explicit knowledge and the transfer of tacit knowledge were not reduced between the two administrations. The integrity of the prior constructs was maintained based on previous validation procedures.

KMS Identification

The KMS under study was designed as a Tool History Management System (ToHMS) in order to facilitate the tracking of knowledge related to equipment failure. ToHMS was to encompass all knowledge and information related to each failure. This knowledge was not an ex post facto capture of each failure, but an ongoing recording of occurrences in real time of the current status of any working equipment problem. When a trouble ticket was initiated in ToHMS, the initiating knowledge worker could obtain the past history of that particular piece of equipment as well as similar failures on other pieces of equipment. The ability to procure rapidly this type of prior failure history was designed to reduce equipment downtime as well as resolve quality issues rapidly. An additional feature of ToHMS allowed the identification of both referential experts (possibly vendor experts or installation engineers) as well as positional experts (such as technicians and process engineers) along with their contact information. These features allowed the rapid access of both tacit and explicit knowledge in the process of failure resolution.

Target Audience

The target audience for our project consisted of two groups, which we refer to as Technicians and Non-Technicians. The Technician group consisted of a skilled knowledge worker group whose primary responsibility is reaction to equipment failure that: stops production, reduces yields or produces low quality product. These failures may last beyond the initiating shift and so an additional responsibility incurred is the coordination between shifts of the current status of any open ticket. As the Technician group is directly responsible for equipment maintenance, ToHMS was designed to adjust the knowledge flow in order to support their corporate directive. All Technicians were required to utilize ToHMS in the accomplishment of their job responsibilities. The Technician group required the shorter administration in order to minimize lost time from equipment monitoring.

The second group, referred to as Non-Technicians, consist of those knowledge workers, predominantly engineers, within the organization's hierarchy responsible for maintaining the product flow and quality within the facility. The job titles of these engineers included: production, yield, automation and industrial. Their responsibilities differed substantially as well as their orientation and usage of ToHMS. Because the focus of our study is the different utilization of ToHMS by two homogeneous groups, the production engineer ToHMS user sub-group (the largest Non-Technician group) was selected as a comparison group to the Technician group.

Instrument Administration

Administration was accomplished during two consecutive four-week periods in the spring of 2004. The first administration was with the Technician group, which had an overall population of 650 individuals. After a random selection, 305 individuals were asked to participate. A 55% participation rate was achieved with 169 useable responses. Because time constraints were critical for the client, it is important to note that the median time to complete the survey was 10.4 minutes with an average time of 12 minutes.

The second, slightly longer, instrument was administered to the entire Non-Technician population of 320 knowledge workers. This longer survey included additional questions concerning knowledge obtained externally from the business unit. The first instrument, administered to the Technicians, did not include these questions as their job responsibilities did not allow them to make external contacts for the purposes of problem resolution. This responsibility resided with the Non-Technician population. We received 150 responses, which represents a 47% response rate. However, with the slightly longer survey, a drop off rate of approximately 1 in 4 occurred which resulted in a 37% useable response rate. For those completing the survey, the median time to complete was 14 minutes with and average time of 17 minutes. While the response rates are very good and the Technician group requested to participate were randomly selected, we recognize that the data collected is a self selected group and could therefore include a response bias. Because of constraints placed on the collection of data by the organization, we have currently been unable to collect other information to assess the extent of a response bias due to self-selection. However, our expectations of incurring any difference would be the same directional response bias for both groups. Because our analysis is aimed at a comparison of the two groups, the differences noted would remain the same.

Results

Because various knowledge processes are embedded in the overall business process of maintaining equipment production capacity and production quality, we will focus on two knowledge processes (transfer of expertise and codification of data) that highlight the different uses of ToHMS for the two separate groups identified as Technicians and Production Engineers. Our analysis begins with how important each of these specific knowledge processes are to each of the groups identified. Table 1 – Importance and Support - shows that, for their job responsibilities, Technicians deem it most important to be able to access/identify experts (transfer of expertise - tacit knowledge) relevant to their current needs. The Production Engineers overall deemed their most important knowledge process as obtaining the codified data (explicit knowledge) necessary to resolve the current trouble ticket. This disagreement of which knowledge process is most important to their jobs is not surprising as each group has different needs and responsibilities within the business unit. More significant is the strong agreement between the two groups as to how the specific knowledge process needs are met by ToHMS. Both Technicians and Production Engineers identify the obtaining of explicit knowledge (1st) and tacit knowledge transfer (2nd) as how ToHMS best supports their knowledge processes.

	Importance		**Support by ToHMS**	
	Tech	Prod Eng	Tech	Prod Eng
Codification	2nd	1st	1st	1st
Transfer	1st	2nd	2nd	2nd

Table 1 - Importance and Support

Per week	**Avg. # of Time K is Accessed**	**Avg. Time Locating K (hrs)**
Codification	6.6	4.15
Transfer	9.1	5.24

Table 2 - Technicians Knowledge Activity

	Avg. # of Times K is Accessed			**Avg. Time Locating K (hrs)**		
Per week	Internal	External	Total	Internal	External	Total
Codification	7.8	4.2	12.0	4.14	1.82	5.96
Transfer	4.1	2.5	6.6	1.26	1.34	2.60

Table 3 - Production Engineers Knowledge Activity

Identifying metrics for potential productivity gains for each knowledge process was important for both groups. However, there exists a difference that had to be noted between the two groups in their processes for obtaining knowledge. We gathered information on the “number of times per week” as well as the “number of hours per week” that each group spent obtaining the knowledge from each of the knowledge processes. This information is presented in Table 2 – Technicians Knowledge Activity and Table 3 – Production Engineers Knowledge Activity. Note that in Table 3, both metrics for the Production Engineers have a total as well as an internal and external metric for each knowledge process. Technicians do not have the responsibility nor are they provided direct access to either external explicit knowledge or external tacit knowledge. Production Engineers, on the other hand, have direct responsibility and the access to obtain external explicit or tacit knowledge as the need arises. Because all the Production Engineers utilized for comparison are ToHMS users, the internal metric can be used as an indicator for comparison to the Technicians metric. In the course of accomplishing their weekly tasks, the Production Engineers access ToHMS for codified data (explicit knowledge) approximately 8 times per week compared with the Technicians access frequency of approximately 7 times per week. This small difference in number of times accessed translated to no difference in the average time spent, with the Production Engineers spending 4.15 hours per week and the Technicians 4.14 hours per week accessing data. A difference emerges in the specific knowledge process of transfer of expertise when comparing the same access statistics. The Technicians, ranking access to expertise as most important to their jobs, spent a larger portion of their time as well as a greater frequency of access obtaining and contacting experts for their expertise. The comparisons have the Technicians connecting roughly double the access frequency (9.1 vs.

4.1) and spending four times as many hours (5.24 vs. 1.26) to access the required expertise when compared with the Production Engineers.

	Average Time per Contact (hrs)			
	Prod. Engineers			Technicians
	Internal	External	Total	Internal
Codification	.53	.43	.50	.63
Transfer	.31	.53	.39	.57

Table 4 - Time per Contact

At this point, a potential performance improvement for the Technicians can be highlighted within the specific knowledge process of transfer of expertise. Table 4 – Time per Contact – identifies a major difference in the average amount of time per contact that is occurring between the Technicians (.57) and the Production Engineers (Internal/ToHMS **-** .31). It would appear that the Production Engineers have a greater efficiency in the specific knowledge process of transfer of expertise. While an exact cause cannot be ascribed to or verified, this difference may highlight a potential training/learning issue that could improve the acquisition of expertise of the Technicians.

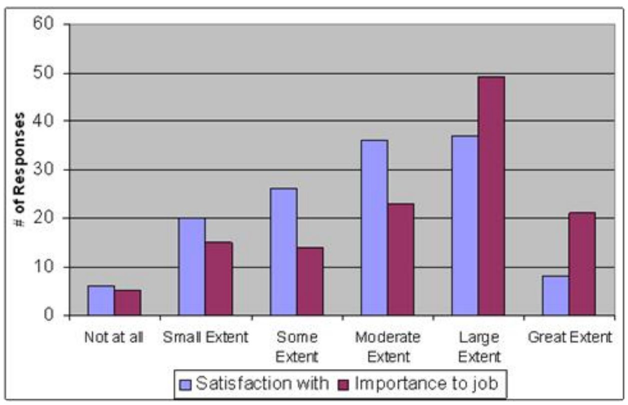

Figure 1. Technicians Perceptions of ToHMS

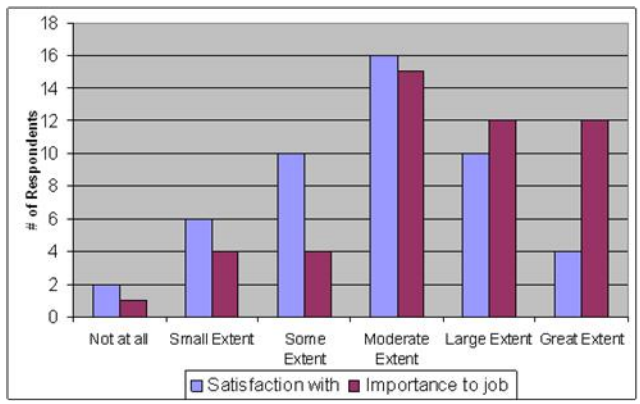

Figure 2. Production Engineers Perception of ToHMS

Recalling that all respondents are users of the KMS, a comparison of how important to their job and their satisfaction with ToHMS provides insight into how well the KMS is accepted as well as the potential for existing and continuing impact on performance. Figure 1 and Figure 2 provide the perceptions of ToHMS for each group for their Satisfaction with and Importance to their job on a 6-point Likert extent scale. As can be observed, both groups perceive ToHMS as important to their job with 81% of Production Engineers and 73% of the Technicians ranking the importance from a Moderate to Great extent. Slightly lower, the satisfaction with ToHMS reached 63% for Production Engineers and 61% for the Technicians. Contrasting these indicators provides two additional insights for the impact of ToHMS. The Importance of ToHMS, coupled with the established use of ToHMS, indicates a perception of value residing in the organization. The gap between the satisfaction and importance indicators highlights the potential improvements in ToHMS that could be made in order to have a higher impact on the organizations performance. Additionally, knowing that usage is high, modifications driven by the users would therefore be investments well spent.

LIMITATIONS

Having identified two organizational entities utilizing a single KMS, we have described noted differences in their usage of that KMS. However, we must recognize some of the existing limitations in the analysis and research that has been performed. The data currently collected provides a snapshot of a single point in time. This snapshot, coupled with the early stage of this research, means we are unable to determine if either of the two organizational entities are at a "good" level of performance for either knowledge process described. The amount of time spent with ToHMS may be an indicator of the acceptance and usefulness of the KMS, but at the same time, it can be argued that the system can and should be improved to have knowledge workers either: 1) spending less time with the system or 2) spending the same time, but solving more problems. In either case, the lack of an established reference point does not allow an assessment of how well either group is doing absolutely. This limitation can also be extended to a comparison between the two knowledge assets reviewed. It is inadequate to state that because the average time per contact is less for Expertise than Data that the organization is more efficient in these types of knowledge processes. It is possible that the transfer of knowledge that occurs in the specific knowledge process of expertise transfer is more efficient when measured in an absolute time frame that the more explicit transfer of knowledge that occurs in a the specific knowledge process of data codification.

A final limitation is the lack of access to performance indicators for the business process. Previous research has shown that measuring perceptions (time to knowledge) and satisfaction are good surrogate indicators of performance. In our case, we measured satisfaction with respect to the use of ToHMS and perception of process performance in order to obtain an indication of the successful implementation of ToHMS and its impact on process performance.

CONCLUSION

In spite of these limitations, a broad analysis has been presented identifying two groups of knowledge workers that utilize a single KMS. These two groups were identified as having different knowledge process needs (expertise or tacit knowledge – Technicians, data or explicit knowledge – Production Engineers). Both groups used the KMS and considered it highly important to their jobs. Given the difference in knowledge needs, we would expect the knowledge workers to view the KMS differently. Yet, each group identified the KMS as supporting best the same knowledge needs (explicit knowledge first, tacit knowledge second). This remarkably homogeneous view was established in spite of the fact that the two groups had varying priorities as to their primary knowledge needs. The different knowledge needs coupled with a consistent view of how a KMS meets those needs cautions future researchers as to the potential confounding influences that produce low acceptance for KMSs.

FUTURE RESEARCH

While this research provides multiple avenues for future study, we highlight two promising avenues. First, the current assessment provided a baseline analysis of the current knowledge processes. As noted in the limitations, an existing reference point to judge the success of ToHMS does not exist. However, initiatives to improve efficiency of the tacit knowledge processes could be assessed utilizing the same instrument at a future point in time. The current assessment could then be used as a reference point of change. This line of research would provide how effective the initiatives were in a relative sense only.

Second, the identification of actual performance measures of the business process would allow a more accurate identification of the relationship of these knowledge processes to the efficiency of the business unit objectives. If the KMS is positively impacting the performance of the business process, then we could argue that investments in KMS have a specific level of return in terms of the improved process performance. Even further, there will be a transitive relationship with organizational performance because there is a link established between the process level and the organizational level of performance.

REFERENCES:

1. Alavi, M., and Leidner, D. (2001) Review: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues, *MIS Quarterly*, 25, 1, 107-136.
2. Barney, J. (1991) Firm Resources and Sustained Competitive Advantage, *Journal of Management*, 17, 1, 99-120.
3. Becerra-Fernandez, I., and Sabherwal, R. (2001). Organizational knowledge management: A contingency perspective, *Journal of Management Information Systems*, 18, 1, 23-55.
4. Chen, E. T., Feng, K., and Liou, W. (2004) Knowledge Management Capability and Firm Performance: An Empirical Investigation, in *Proceedings of the Tenth Americas Conference on Information Systems*, August 5-8, New York, New York, 2255-2262.
5. Cole, R. E. (1998) Special issue on Knowledge and the Firm – Introduction, *California Management Review*, 40, 3, 15-21.
6. Conner, K. R. (1991) A Historical Comparison of Resource-Based Theory and 5 Schools of Thought within Industrial-Organization Economics - Do We Have a New Theory of the Firm, *Journal of Management*, 17, 1, 121-154.
7. Crowston, K. (2003) Process as Theory in Information Systems Research, MIT Press, Cambridge.

8. Davenport, T. H. (1993) Process Innovation, Harvard Business School Press, Boston.
9. Davenport, T. H., and Prusak, L. (1998) Working Knowledge, Harvard Business School Press, Boston.
10. Davenport, T. H., and Short, J. (1990) The New Industrial Engineering: Information Technology and Business Process Redesign. *MIT Sloan Management Review*, 31, 4, 11-27.
11. Freeze, R. D., and Kulkarni, U. (2005) Knowledge Management Capability Assessment: Validating a Knowledge Assets Measurement Instrument, *in Proceedings of the 38th Hawaii International Conference on System Sciences*, Hawaii, USA, IEEE Computer Society, 1-10.
12. Holsapple, C. W. (2003) Knowledge and Its Attributes. In Holsapple, C. W. (Ed.), Handbook on Knowlede Management Volume 1 (Vol. 1), Springer-Verlag, Berlin.
13. Keen, P. G. W. (2004) What exactly is a business process?, in Peter Keen Online, http://www.peterkeen.com/recent/articles/z_bp_def.htm (last visited: 5/5/2005).
14. Kulkarni, U., and Freeze, R. D. (2004) Development and Validation of a Knowledge Management Capability Assessment Model, in *Proceedings of the Twenty-Fifth International Conference on Information Systems*, Washington, D.C. 657-670.
15. Lev, B. (2001) Intangibles: Management, Measurement, and Reporting, Brookings Institution Press, Washington D.C.
16. Massey, A. P., Montoya-Weiss, M. M., and O'Driscoll, T. M. (2002) Knowledge management in pursuit of performance: Insights from Nortel Networks, *MIS Quarterly*, 26, 3, 269-289.
17. Melville, N., Kraemer, K., and Gurbaxani, V. (2004) Review: Information technology and organizational performance: An integrative model of IT business value, *MIS Quarterly*, 28, 2, 283-322.
18. Nonaka, I., and Takeuchi, H. (1995) The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation, Oxford University Press, New York.
19. Penrose, E. T. (1959) The Theory of the Growth of the Firm, Wiley, New York.
20. Schulze, W. S. (1992) The Two Resource-Based Models of the Firm: Definitions and Implications for Research, *Academy of Management Best Paper Proceedings*, 37-42.
21. Shin, M. (2004) A framework for evaluating economics of knowledge management systems, *Information & Management*, 42, 1, 179-196.
22. Spender, J. C. (1996) Making Knowledge the Basis of a Dynamic Theory of the Firm, *Strategic Management Journal*, 17(Special Issues), 45-62.
23. Spender, J. C. (1996) Organizational knowledge, learning and memory: Three concepts in search of a theory, *Journal of Organizational Change Management*, 9, 1, 63-78.
24. Wade, M., and Hulland, J. (2004) Review: The resource-based view and information systems research: Review, extension, and suggestions for future research, *MIS Quarterly*, 28, 1, 107-142.
25. Weill, P. (1992) The Relationship Between Investment in Information Technology and Firm Performance: A Study of the Valve Manufacturing Sector, *Information Systems Research*, 3, 4, 307-333.
26. Wernerfelt, B. (1984) A Resource-Based View of the Firm, *Strategic Management Journal*, 5, 2, 171-180.