Technical Limitation Factors of Knowledge Management Systems and a New Approach

Jaehun Joo
Department of Electronic Commerce
Dongguk University
Gyeongju 780-714, South Korea
Email: givej@dongguk.ac.kr

Sang M. Lee
Department of Management
University of Nebraska-Lincoln
Lincoln, NE 68588-0491, USA
Email: slee1@unl.edu

Sang Hyung Ahn
Editor-In-Chief
Seoul National University

Technical Limitation Factors of Knowledge Management Systems and a New Approach

Jaehun Joo
Department of Electronic Commerce
Dongguk University
Gyeongju 780-714, South Korea
Email: givej@dongguk.ac.kr

Sang M. Lee
Department of Management
University of Nebraska-Lincoln
Lincoln, NE 68588-0491, USA
Email: slee1@unl.edu

ABSTRACT

The purpose of this study is to analyze the limitations of current KM (knowledge management) systems and to propose an approach for applying the Semantic Web to KM. We analyze the factors that affect KM system user dissatisfaction through a survey. We chose a sample of five firms that had used KM systems for more than one year. A total of 222 questionnaires were used for statistical analysis. Finally, we suggested methods applying the Semantic Web to KM as an alternative overcoming the limitations of the current KM systems.

Keywords: Knowledge Management, Semantic Web, Survey Study

INTRODUCTION

Many organizations design and use KM systems as specialized

information systems into which various technologies are integrated. KM systems help organizations increase their effectiveness and competitiveness. However, there are some limitations in maximizing the objectives of KM due to limited ability for semantic integration.

The purpose of this study is to discuss the limitations of current KM systems and to propose an approach for applying the Semantic Web to KM. First, we analyze the factors that affect KM system user dissatisfaction through a survey. Second, we suggest the Semantic Web as a new approach for KM.

RESEARCH DESIGN

Even though business value often originates from the KM system, it does not always improve organizational performance, as a lag or discrepancy exists between innovation and performance (Damanpour and Evan, 1984). This indicates possible barriers or limitation factors between the KM system and business values. In this paper, we classify barriers into two types: technological factors and social/cultural factors including people as described in Benbya et al. (2004).

Limitation Factors in System Quality
- Time/Space
- Inconvenience
- Knowledge Search
- Knowledge Integration

Limitation Factors in Knowledge Quality
- Incongruence/ Incompleteness
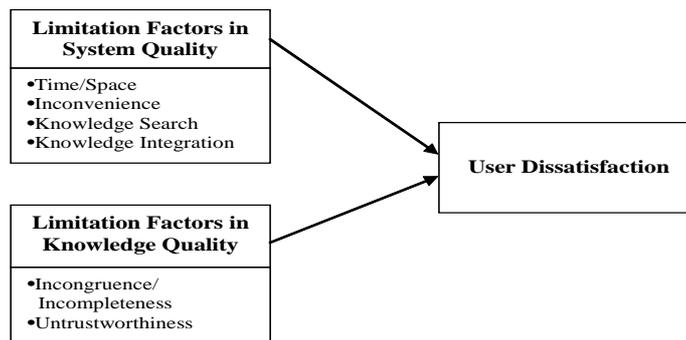- Untrustworthiness

User Dissatisfaction

Figure1. Research Model

In this paper, we focus on analyzing the technological limitations, rather than social and cultural limitations, of the KM system. We propose the research model shown in Figure 1 by considering the characteristics of the KM system and also by referring to DeLone and McLean's IS success model (Delone and McLean, 1992). We apply the reverse perspective of DeLone and McLean's IS success model (Delone and McLean, 1992). DeLone and McLean proposed system quality and information quality as important factors that affect user satisfaction and organizational performance.

Table 1 provides the definition of the limitation factors listed in Figure 1, and indicates the number of items used to measure each factor.

We derived six research questions from the research model. We were unable to find studies on the relationship between limitation factors in the KM system and user dissatisfaction. Therefore, we use research questions rather than hypotheses.

Q1: Do the limitations of system quality have a positive impact on user dissatisfaction with the KM system?
Q1a: Does the limitation of time and space in the KM system have a positive impact on the dissatisfaction with the KM system?
Q1b: Does the inconvenience of the KM system have a positive impact on user dissatisfaction with the KM system?
Q1c: Does the limitation of knowledge search have a positive impact on user dissatisfaction with the KM system?
Q1d: Does the limitation of knowledge integration have a positive impact on user dissatisfaction with the KM system?

Table 1. Definition of KM Systems Limitation Factors

Factors and Dissatisfaction		Definition	No. of Items
Limitation Factors of System Quality	Time and Space	Time and space limitation in the KM system use and limitation of access methods	3
	Inconvenience	Degree of inconvenience of the KM system use resulting from slow response and instability	3
	Knowledge Search	Limitations of keyword-based search as well as limited knowledge categorization	6
	Knowledge Integration	Limitations in integration of heterogeneous systems as knowledge resources and integration of the existing KM system with Web resources	3
Limitation Factors of Knowledge Quality	Incongruence and Incompleteness of Knowledge	Degree of incongruence or incompleteness of knowledge offered by the KM system	8
	Untrustworthiness of Knowledge	Degree of inaccuracy and untrustworthiness of knowledge offered by the KM system	6
User Dissatisfaction		Degree of overall dissatisfaction with KM system use	1

Q2: Do the limitations of knowledge quality have a positive impact on user dissatisfaction with the KM system?
Q2a: Do incongruence and incompleteness of knowledge

provided by the KM system have a positive impact on user dissatisfaction with KM system?

Q2b: Does untrustworthiness of knowledge provided by the KM system have a positive impact on user dissatisfaction with the KM system?

ANALYSIS

We interviewed four managers from two firms that have adopted and used KM systems for two or more years to pretest the survey questionnaire. The primary goal of the pretest was to check content validity and proper wording of the questionnaire. We revised a few question items for clarity and made some changes in the sequence of questions based on the pretest.

We investigated KM system solutions produced by Korean corporations. Two products 'A-wave' and 'K-wave' have been pervasively used in Korea. Thus, we selected these two products as typical KM system solutions for our questionnaire survey. We chose a sample of five firms that had used the products for more than one year. Representatives of KM teams in the five firms accepted our request for support in conducting our survey. Two hundred fifty six respondents from the five firms returned the questionnaire. However, 34 incomplete or invalid responses were discarded, because of their incompleteness or incredibility which means sequential same responses for more than seven questions. A total of 222 questionnaires were used for statistical analysis. We conducted an exploratory factor analysis and verified six factors as shown in Table 2. Cronbach's α was used to test internal consistency. The measures are acceptable as all α values exceed 0.69 (Nunnally, 1978).

Table 2. Results of Factor Analysis and Reliability Analysis

Limitation Factor[1]	Item[2]	FL[3]	α [4]
Time/Space Limitation	I should use the KM system only at limited time.	.760	.7265
	I should use the KM system only at limited locations.	.808	
	I have some limitations to access in the KM system through various access points such as mobile devices, PDA, and Internet.	.750	
Inconvenience	I think the KM system is unstable due to malfunctions or system errors.	.788	.7134
	I think the response time of the KM system is slow.	.663	
	I think it is not easy to use the KM system.	.631	
Knowledge Search Limitation	I think it is difficult to find knowledge that I need in the KM system.	.677	.8874
	I think the classification scheme for knowledge is not organized well in the KM system.	.629	
	I think the KM system provides irrelevant knowledge as search results.	.674	
	I think the KM system provides redundant or unnecessary knowledge as search results.	.716	
	I have some difficulties in finding knowledge suitable to my requirements from the KM system with only partial prior knowledge.	.717	
	I cannot find relevant knowledge when I use the keyword search method with synonyms.	.689	
Knowledge Integration Limitation	The KM system is not integrated with other information systems such as groupware and electronic document management systems.	.728	.6980
	I have some difficulties in aggregating and integrating knowledge from disparate information systems.	.599	
	I have some difficulties in integrating knowledge from internal systems with that of the Web.	.698	

Incongruence and Incompleteness of Knowledge	I think the KM system contains the knowledge irrelevant to my tasks.	.660	.8599
	I think knowledge provided by the KM system does not help me do my tasks.	.446	
	I think knowledge provided by the KM system cannot directly be applied to my job.	.485	
	I think knowledge provided by the KM system is redundant.	.607	
	I think knowledge provided by the KM system is neither comprehensive nor complete enough.	.589	
	I think knowledge provided by the KM system is too abstract.	.586	
	I think knowledge provided by the KM system is not comprehensive enough as much as it supports ad hoc decision making problems.	.421	
	I think knowledge provided by the KM system is valuable only to a certain group of employees.	.529	
Untrust Worthiness of Knowledge	I think knowledge provided by the KM system is inaccurate.	.547	.8481
	I think knowledge provided by the KM system is quite different from business practices.	.664	
	I think knowledge provided by the KM system is not verified through practical business activities.	.606	
	I cannot trust people who provide knowledge to the KM system.	.639	
	I think knowledge provided by the KM system is not verified as trustworthy.	.667	
	I think knowledge provided by the KM system is not reliable.	.782	

1) Method for factor extraction: principal component. Rotation method: Varimax with Kaiser normalization
2) All items of questionnaire are on a scale of 1 to 5, where 1 = don't agree at all, 2 = agree very little, 3 = somewhat agree, 4 = agree very much, and 5 = completely agree.
3) Factor Loading
4) Cronbach's Alpha

Multiple regression analysis is used to test research questions as shown in Table 3. User dissatisfaction is the dependent variable for research questions Q1 and Q2.

TABLE 3. Results of Regression Analysis

Dependent Variable	Independent Variables	Mean	SD	t-value	Sig.	TL[2]	Result
UD[1]	Time/Space Limitation	3.05	0.026	0.465	0.642	1.00	Non AFF[3]
	Inconvenience	2.31	0.139	2.444	0.015	1.00	AFF
	Search Limitation	2.61	0.248	4.371	0.000	1.00	AFF
	Integration Limitation	2.80	0.206	3.627	0.000	1.00	AFF
	Incongruence and Incompleteness	2.64	0.245	4.309	0.000	1.00	AFF
	Untrustworthiness	2.39	0.390	6.866	0.000	1.00	AFF

R^2= 0.336, Adjusted R^2 = 0.316, F = 17.360, Significance: 0.000

1) User Dissatisfaction
2) Tolerance Limit
3) Affirmative

Table 3 shows the results of multiple regression analysis. The regression model is significant at the p   0.001 level. Six limitation factors of the model explained 31.6% of user dissatisfaction with the KM system. All research questions, except Q1a, have significant affirmative answers. The limitation factors for system quality, such as inconvenience, search and integration, positively affect user dissatisfaction with the KM system. The limitation factors of knowledge quality such as incongruence/incompleteness and untrustworthiness also increase user dissatisfaction at significant level 0.001.

THE SEMANTIC WEB AS A NEW APPROACH

The findings of the empirical analysis presented in the previous section suggest that the limitation factors of the KM system are related to system quality and knowledge quality. The limitation factors of system quality are mainly related to technology itself while the limitation factors of knowledge quality are related to people and culture (Benbya et al., 2004). We define the Semantic Web as an innovative technology playing a critical role in overcoming the limitations of system quality.

· Overcoming the Search Limitation: The Semantic Web enables us to overcome the barriers to knowledge retrieval in the current KM system. All resources in the Semantic Web are represented in RDF (Resource Description Framework) as metadata and this representation method makes it possible for users to query and get answers as if they are using database management systems. The Semantic Web also supports RDFS (RDF Schema) and ontology which enables semantic analysis on vocabularies contained in query and domains as well as syntactic analysis. Internal or external documents of organizations and Web resources can be represented as a resource in RDF. A resource of RDF, a knowledge object, can be searched with an independent knowledge unit as a user searches a document in document management systems. Furthermore, a specific part or sentence of a Web page or a part of a document may be represented as a knowledge object. This capability allows the Semantic Web-driven KM system to search for a knowledge object unit rather than a document unit.

· Overcoming the Integration Limitation: In the integration approach based on the Semantic Web, the software agents understand the meanings of the terms and automatically process

them by exploiting the RDF and ontologies. Since W3C adopted XML (eXtensible Markup Language) as the Web document standard, XML is widely used to ensure interoperability among heterogeneous systems. The Semantic Web, RDF, RDFS, and OWL (Web Ontology Language) follow XML-based syntax. In the Semantic Web, a software agent can access heterogeneous systems and provide knowledge and information suitable to users. The Semantic Web enables software agents to extract some parts of the related knowledge from different resources and to automatically aggregate them without the user's intervention

· Overcoming Inconvenience: When the Semantic Web is combined with ubiquitous computing (Chen and Finin, 2004), users can access KM systems anytime and anywhere conveniently. The Semantic Web-driven KM systems with the support of peer-to peer (P2P) technology (Davies et al., 2003) can improve personalized KM services. Therefore, the Semantic Web enables the current KM system to overcome limitations such as time/space and inconvenience through a combination of ubiquitous networks and P2P technology.

We identified the potential of the Semantic Web overcoming limitations of the current KM system. How do organizations adopt the Semantic Web to achieve an efficient and effective global KM by supporting KM systems? The challenge is to offer adoption strategies of the Semantic Web to organizations. We identify four types of organizations classified by their diffusion capability and control capability of technology push. Diffusion capability refers to an organization's ability to recognize capabilities of the Semantic Web, then adopt, assimilate and apply it quickly to improve KM performance. Control capability of technology push refers to an organization's ability to manage and coordinate the gap between technology push and demand pull, and to reflect

requirements of the business domain to technology in the stage of its development or earlier stage of its introduction. Four types of organizations are classified by the diffusion capability and the capability controlling technology push as follows:

Type I: Stationary Organizations, where both levels are low.
Type II: Aggressive First Movers, where diffusion capability is high, but control capability is low.
Type III: Alchemists, where control capability is high, but diffusion capability is low.
Type IV: Balanced Innovators, where both level are high.

According to Cohen and Levinthal (1990), absorptive capacity is the ability of a firm to recognize the value of new, external information, assimilate and apply it to commercial ends capabilities. This capacity is critical to innovative capabilities of organizations. We defined diffusion capability similarly to absorptive capacity. However, diffusion capability not only considers diffusion speed, but also technology developed within the organization as well as things acquired from external sources.

Technology push is an important force in diffusion of innovations. It results from ideas or capabilities that are developed in the absence of a customer's specific needs (Fichman, 1992; Munro and Noori, 1988). Technology push itself can trigger hardly organization change through technology innovation and it also faces various barriers or limitations. To realize the potential of the Semantic Web in KM with minimum barriers, it is necessary for organizations to possess the capability for coordinating or controlling technology development to reflect user groups' needs or requirements. One way to get such capability is to facilitate interactions and collaboration between technology development groups and user groups.

CONCLUSION

The results of the empirical analysis indicated that there indeed exist limitation factors in system quality and knowledge quality in the current KM systems. Inconvenience, search and integration are statistically significant limitation factors for system quality. On the other hand, incongruence and untrustworthiness of knowledge are significant limitation factors for knowledge quality.

The Semantic Web provides organizations adopting it with the potentials overcoming search limitation, integration limitation, and inconvenience. There are four types of organizations adopting the Semantic Web. Although the type IV of the balanced innovators is ideal, we recommend the type III of alchemists, where the capability controlling technology push is high, but the diffusion capability is low. This means that organizations need to posses the capability controlling technology push by reflecting their business requirements in the stage of its development as well as the absorptive capability.
 One major limitation of this study is that we must further test the effectiveness of our classification model. This is the topic of the authors' future research.

REFERENCES

Benbya, H., Passiante, G., and Belbaly, N.A. (2004), Corporate portal: A tool for knowledge management synchronization, *International Journal of Information Management*, 24 (3), 201-220.

Chen, H. and Finin, T. (2004), An ontology for context aware pervasive computing environments, *Knowledge Engineering*, 18(3): 197-207.

Cohen, W. M. and Levinthal, D.A. (1990), Absorptive capacity: A

new perspective on learning and innovation, *Administrative Science Quarterly*, 35(1): 128-152.

Damanpour, F. and Evan, W.M. (1984), Organizational innovation and performance: The problem of organizational lag, *Administrative Science Quarterly*, 29: 392-409.

Davies, N.J., Fensel, D. and Harmelen, F.V. (ed.) (2003), *Toward the Semantic Web: Ontology-Based Knowledge Management*, Hoboken, NJ: John Wiley & Sons.

Delone, W.H. and McLean, E.R. (1992), Information system success: The quest for the dependent variable, *Information Systems Research*, 3(1): 60-95.

Fichman, R.G. (1992), Information technology diffusion: A review of empirical research, *Proceedings of Thirteenth International Conference on Information Systems*, Dallas, 195-206.

Munro, H. and Noori, H. (1988), Measuring commitment to new manufacturing technology: Integrating technological push and marketing pull concepts, *IEEE Transactions on Engineering Management,* 35(2): 63-70.

Nunnally, J.C. (1978). *Psychometric Theory*, New York: McGraw-Hill.