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Knowledge Management Systems Success: An Assessment Model for Project Based Knowledge Repositories

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Abstract

Knowledge has been broadly recognized as the key element for gaining competitive advantage. Companies are investing more on knowledge management systems. However, no models are customized to evaluate the success of knowledge management systems. To address this issue, this study seeks to develop and test two models for the assessment of the success of a particular type of KMS: project repositories. These two models are based on DeLone and McLean's model of Information Systems Success and Seddon's respecified model. Their models are updated for project repositories through the addition of three relationships.

Introduction

Knowledge management has become one of the key areas of attention for management over the past decade. Recent reports from International Data Corporation (IDC) estimate that the poor knowledge management practices in Fortune 500 companies cost $12 billion in 1999, and the cost will spiral upward to $31 billion by 2003 (Wareham, 1999). One of the key components of a corporate knowledge management strategy is information technology. Business organizations have extended their IT focus from Y2K and enterprise resource planning (ERP) systems to Knowledge management systems (KMS). Half of U.S. companies which have more than 500 employees plan to implement their knowledge management systems. In 1999, the spending was estimated to be $2 billion by the end of the year and $12 billion by 2003 (Wareham, 1999). The importance of KMS is further illustrated through the emergence of a large number of vendors and products through the last five years.

Nevertheless, there is currently no model that can accurately evaluate the effectiveness of KMS. This situation makes it difficult for organizations to assess the success of their KMS, to adjust their knowledge management strategy, and to justify their substantial investments in KMS. The dilemma between the necessity of investing in KMS and the inability to evaluate the effectiveness causes confusion, and organizations may have trouble making sense regarding their decisions about KMS. There is an urgent need to identify an effective evaluation model for the success of KMS.

KMS itself is a very broad category, with systems varying from data mining tools to knowledge repositories to expert systems. Rather than investigating all possible knowledge management systems, this study focuses on project-based knowledge repositories, which are popularly known as project repositories. The two effectiveness models in this study are based on DeLone and McLean's (1992) model of Information Systems Success and Seddon's (1997) respecified model. This paper outlines the theoretical background for the study, discusses the research design, and presents expected contributions.

Literature Review

Alavi and Leidner (2001) define KMS as "IT-based systems developed to support and enhance the organizational processes of knowledge creation, storage/retrieval, transfer, and application." The great range of systems that fall in this category makes it very hard to make meaningful comparisons between the systems. For example, criteria such as data integrity are essential for data mining, but more or less meaningless for bulletin boards. Instead of covering all KMS categories, the research reported in this paper focuses on one area, knowledge repositories (Alavi and Leidner, 2001). Such repositories provide fertile ground for empirical research since knowledge repositories form the core of many knowledge management systems. They are relatively bounded structures that are easy to identify by users, and are used extensively – albeit with different degrees of sophistication. IT-based knowledge repositories are in the literature usually referred to as Organizational Memory Information Systems (Stein and Zwass, 1995).

One of the issues with research in the area of knowledge management is that it has largely been divorced from empirical reality. Most of the recent publications that have been influential in the area are conceptual, and even though they provide great frameworks to think about knowledge management, it is hard to empirically test the theories and models that are proposed. One example of such work is Nonaka's (1994) important framework explaining the knowledge creation process intra- and inter-organizations and the set of knowledge conversion processes. Stein and Zwass (1995) also propose a conceptual organizational memory information system (OMIS) to support organizations to achieve effectiveness. They define OMIS as, "a system that functions to provide a means by which knowledge from the past is brought to bear on present activities, thus resulting in increased levels of effectiveness for the organizations." (Stein and Zwass, 1995) Even though they make intuitive sense, research that explores the processes in an empirical setting is very limited. The underlying issue with knowledge management and KMS conceptualizations is that they are often very general, stereotyping the behavior of knowledge management systems and their users. To overcome this problem it seems appropriate to study specific knowledge management systems, rather than generalized categories. For KMS use in practice, project-based knowledge repositories are of particular interest.

Recently, companies and organizations from various fields have widely adopted the concept of "project teams" to deal with challenging tasks, especially for knowledge intensive tasks (Fleming and Koppelman, 1998; Weiser and Morrison, 1998). For example, new product development projects usually require diversified knowledge and skills across different functional areas (Fleming and Koppelman, 1998; Raven, 1999). Many knowledge intensive firms, including Boeing, Chrysler, Corning, DuPont, Eastman Kodak, Abbott Laboratories, and Caterpillar, assemble project teams for their new product development. The results are quite successful (Fleming and Koppelman, 1998). Academic researchers also frequently form project teams to conduct knowledge intensive research (Lynch and Chen, 1992).

However, various challenges remain in these types of knowledge intensive project-teams. Dougherty (1992) and Raven (1999) indicate the interpretive barriers between the members from different functional backgrounds. Leung et al. (1998) point out the risks that project teams might encounter. Tiwana and Ramesh (2001) identify that new product development teams have difficulties. These difficulties are due to lack of shared understanding, loss of design decision context because of changing members, reinvention of solutions, repeated mistakes, unstated assumptions, inconsistent versioning of design information, loss of knowledge after project completion, and loss of skills developed during collaboration, for subsequent use.

To address these challenges, keep projects on track, and realize the full benefit of project teams, extensive effort is placed in developing project-base repository technologies. Lynch and Chen (1992) report an implemented project memory to support research groups with extensive shared knowledge. Weiser and Morrison (1998) discuss an example of a project repository at Digital Equipment Corporation. The project repository integrates product information, service manual, emails, and bulletin board messages to facilitate customer service. Tiwana and Ramesh (2001) conceive a prototype knowledge management system for information product development projects. Lotus Domino and Microsoft Project Management (Whiting, 2000), for example, are available products in the market for project repository. Whiting (2000) also reports a commercialized project repository system, with the functionalities of storing information and documents, facilitating communication and collaboration, managing activities, searching information, and creating reports, to keep large-scale projects on track. It is apparent that there is significant interest in project-based knowledge repositories, from the perspectives of both academics and practitioners.

Knowledge repositories themselves form a broad category, including systems at the organizational, business unit, project, and individual levels. Organizational and business unit level repositories are typically very large and combine a large variety of technologies. Individual repositories lack the interaction component that makes knowledge management complex and challenging. Project-based knowledge repositories, on the other hand, tend to be more bounded and typically use only one or a few technologies, while still involving enough users to reflect the key knowledge management systems issues. The level of analysis can also be narrowed from the organizational to the project level. The project-based knowledge repositories discussed have similar functions, including acquisition, retention, indexing, search, and retrieval, as proposed by existing organizational memory systems (Stein and Zwass, 1995; Weiser and

Morrison, 1998). Weiser and Morrison (1998) describe a project repository as a "subset" of organizational memory. Ackerman and Mandel (1999) term the systems that focus on key tasks "memory in the small." The main object of project-based knowledge repositories is to facilitate the knowledge management process in projects and project teams. We define that the project-based knowledge repository is an OMIS at a project level. Therefore, by focusing on appropriately bounded project-base knowledge repositories, this research can lead to a better understanding about the effectiveness of a specific type of knowledge management system.

These discussions and our object to identify the success model for knowledge-based project repository thus lead to our research questions:

> **Research Question 1:**
> **What are the appropriate dimensions for evaluating the success of project-based knowledge repositories?**
>
> **Research Question 2:**
> **What are the relationships between these dimensions?**

By answering these research questions, we will be able to conceptualize and build the intended model.

Research Models:

These questions are addressed through the development of a project repository systems success model. DeLone and McLean (1992) present a model for information systems success that greatly impact the ways in which researchers investigate the impact of IS. Using the work of Mason (1978) and Miles (1980), DeLone and McLean identify six major constructs for their model of IS Success: SYSTEM QUALITY[1], INFORMATION QUALITY[2], USE[3], USER SATISFACTION[4], INDIVIDUAL IMPACT[5], and

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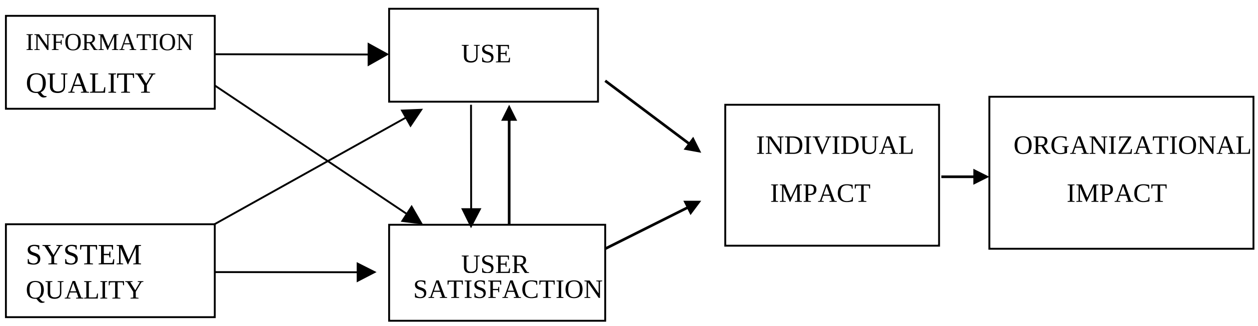
[1] System Quality: Measures of the information processing system itself
[2] Information Quality: Measures of information system output
[3] Use: Recipient consumption of the output of an information system

ORGANIZATIONAL IMPACT[6]. The model (Figure 1) depicts the temporal and causal relationships, which are explicated later, between the constructs. DeLone and McLean (1992, 2002) also indicate the importance to specify the context when applying the model.

Figure 1. IS Success Model (DeLone and McLean, 1992)



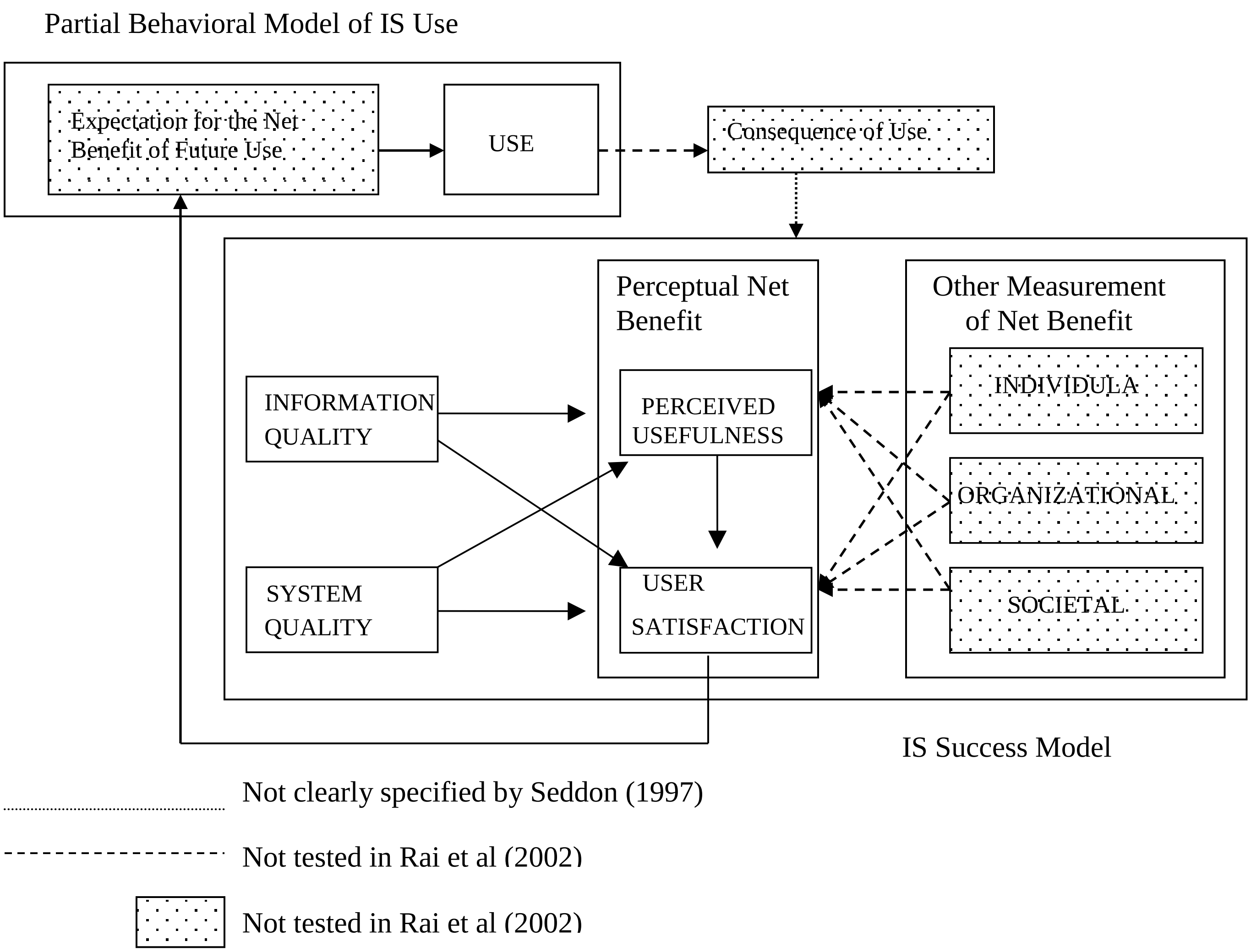
A number of empirical studies test, criticize, modify, and extend the model. More than 15 studies empirically test relationships between different variables in the proposed model, and they mostly support the model (DeLone and McLean, 2002). Typical studies adopt the whole or part of the model for a particular context, and develop measures for the constructs within that context. Some extensions to the structure of the model are suggested. For example, Pitt et al. (1995) propose to extend the model by adding SERVICE QUALITY[7], a concept from marketing. Some empirical studies support this addition (Kettinger and Lee, 1995; Li, 1997; Wilkin and Hewitt, 1999), but Van Dyke et al. (1999) challenge it. Seddon (1997) too claims that SERVICE QUALITY should not be viewed as part of the information system and excludes it.

Perhaps the greatest challenge to D&M's model comes from Seddon (1997). Seddon objects to the perceived mix of variance and process concepts within one model. Seddon also indicates that the USE construct causes confusion by having three folds of meaning at the same time: USE as a variable that proxies for the benefit of use; USE as the dependent variable in a model of future use; USE as an event in a process to INDIVIDUAL IMPACT or ORGANIZATIONAL IMPACT. To address these issues, he

[4] USER SATISFACTION: Recipient response to the use of the output of the information systems
[5] INDIVIDUAL IMPACT: The effect of information on the behavior of the recipient
[6] ORGANIZATIONAL IMPACT: The effect of information on organizational performance
[7] SERVICE QUALITY: The quality of IS department's service

first suggests PERCEIVED USEFULNESS to replace USE. He claims that PERCEIVED USEFULNESS, USER SATISFACTION, INDIVIDUAL IMPACT, ORGANIZATIONAL IMPACT, and SOCIETAL IMPACT, which he adds to represent the impact of IS to the society, are indeed an aggregated construct called NET BENEFIT. It is also important to clarify who are the target stakeholders when applying the NET BENEFIT construct due to their different interests and perspectives. Seddon then proposes a respecified pure variance model (Figure 2) depicting IS Success and a partial behavioral model about Use.

Figure 2. The Respecified Model of IS Success (Seddon, 1997)



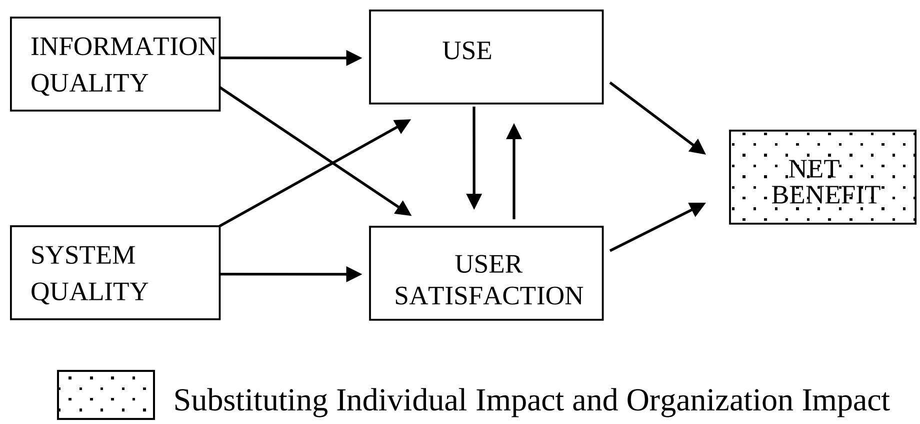
Seddon implies that USE is the consequence of IS success, but not part of it. In the Success model, Seddon retains SYSTEM QUALITY and INFORMATION QUALITY and claims their causal impact to the two perceptual constructs of NET BENEFIT, PERCEIVED USEFULNESS and USER SATISFACTION. PERCEIVED USEFULNESS will influence USER SATISFACTION but not vice versa. USER SATISFACTION impacts the behavior model and shapes the expectation about the net benefit of future IS use, which causes actual future USE. USE then causes consequences. However, Seddon does not clarify the detail of the feedback loop from the consequence of use to the IS Success.

Rai et al. (2002) test the two models and report that both models have their value in explaining IS success. Because Rai et al. do not measure the Expectation about the net benefit future IS use, the result of Seddon's model is inconclusive. Future research shall try to overcome this weakness. However, Seddon's model is strongly supported with the addition of the correlation between USE and PERCEIVED USEFULNESS. Rai et al. also acknowledge the importance to specify the context when applying these models. According to Rai et al's analysis, Seddon's model seems to theoretically comply with the Technology Acceptance Model and the Theory of Planned Behavior. With all previous studies, it is still difficult to arbitrate which model is superior, especially when the context is an important factor for applying the models. It might be a better strategy to test the two models at the same time when developing an evaluation model for a specific types of IS. We will address this issue further in the research design section.

In responding to Seddon and others' critiques, DeLone and McLean (2002) revisit their original model. They suggest collapsing the INDIVIDUAL IMPACT, ORGANIZATIONAL IMPACT, and impact to other levels, into a single construct, NET BENEFIT, and claim that whoever applies the model should specify the target audience. We find this argument somewhat parallel to Seddon's recommendation and plausible. Furthermore, D&M (2002) agree with Seddon about the confusion brought about by the mixed meaning of USE, and recommend INTENTION TO USE (ITU) to substitute USE. However, D&M do not provide strong theoretical and empirical evidence to support this substitution. Similarly, they might need more theoretical or empirical evidence to convince audience about their two propositions of the feedback loops from NET

BENEFIT to USE and USER SATISFACTION. Lastly, they recommend the addition of SERVICE QUALITY to be part of the model, which has been rebutted by Seddon (1997) and Van Dyke et al. (Van Dyke, et al., 1999). We support D&M's first recommendation but are conservative about the others, and thus propose the adopted D&M IS Success model in Figure 3.

Figure 3. Adopted DeLone and McLean IS Success Model



Orlikowski and Iacono (2001) persuasively argue that current IS research should pay more attention to the actual technological artifacts in the studies. In their view, IT is too often viewed as a black box. One step in this direction is to adapt the structure of the IS Success models for specific categories of systems. For knowledge-based project repositories, this adaptation is achieved through the addition of relationships.

In Seddon's model (Figure 1), the arrows between the Partial Behavioral Model and IS Success Model imply a cyclical relationship. Shang and Seddon (2002) also state the concept of the cycles of system improvement, which means that firms implement IS, use IS, evaluate the benefit of use, and adjust the systems and/or processes to improve their performance for the next cycle of IS use. These ideas depict the cyclical nature of IS success, which is not clear in D&M's models. We thus suggest the necessity to emphasize this cyclical nature when applying these models, and we need to indicate the relationships between the different constructs of different stage of the cycles.

The concept of knowledge half-life (Eppler, et al., 1999; Knight and Knight, 1997; Smith,

1978) refers to the nature that current knowledge becomes obsolete when new knowledge is introduced. Empirical evidence shows that this is true especially for knowledge intensive tasks, such as performed by physicians (Smith, 1978), educators (Knight and Knight, 1997), and knowledge workers in business organizations (Eppler, et al., 1999). Dove (1998) states that KMS must recognize that the value of knowledge changes rapidly. Therefore, we believe INFORMATION QUALITY is a function of time and the quality will decrease as time passes. Without the appropriate level of use at the current stage, it is difficult to maintain INFORMATION QUALITY for the next stage. As the system is used, new information is added, and old information is updated. These discussions lead to our first proposition:

> *Proposition 1: In knowledge-based project repositories, less USE in the current stage will result in less INFORMATION QUALITY in the next stage.*

This relationship is displayed in Figure 4 and Figure 5 for both models.

SYSTEM QUALITY in both D&M and Seddon's models seem to be a fixed construct, and the systems are expected to not change after their initial implementation. For knowledge repositories, however, it is necessary to consider changes that will be made to the system, and therefore the system quality. Recently, the concept of reconfigurable computing (Compton and Hauck, 2002) introduced the capability to continually improve both the software and hardware. For example, Lotus Notes has the reconfigurable feature. Also, software vendors constantly upgrade and update their products. For instance, Microsoft, Lotus Notes, and other software vendors keep updating and improving their products. SYSTEM QUALITY shall not be fixed but evolving for project repositories. Meanwhile, we observe organizations' decisions to improve and/or upgrade systems by evaluating the benefit of IS use (Shang and Seddon, 2002). Positive NET BENEFIT in one stage may cause firms to improve their SYSTEM QUALITY in the next stage. However, it is also possible that negative NET BENEFIT in one stage may stimulate firms to improve the SYSTEM QUALITY. We only postulate that current NET BENEFIT will influence future SYSTEM QUALITY but do not know in which direction.

These discussions lead to our second proposition:

> *Proposition 2:In knowledge-based project repositories, NET BENEFIT in the current stage will influence SYSTEM QUALITY in the next stage.*

In Seddon's model, as he suggests that USER SATISFACTION is the variable closet in meaning to NET BENEFIT, this proposition is displayed by connecting from USER SATISFACTION to INFORMATION QUALITY in Figure 4. In the adopted D&M model (Figure 5), this proposition is displayed by connecting from NET BENEFIT to INFORMATION QUALITY.

We also argue that SYSTEM QUALITY and INFORMATION QUALITY are not independent of each other. For knowledge-based project repositories, the quality of the information and the content in the system are in large part determined by the features of the repository. For example, in software development projects, project repositories with the capability of traceability enable strong information quality that facilitates knowledge management processes (Ramesh, 2002). Holsapple and Joshi (2002) suggest that collaborative ontological design, shared perspective, and experience can invite more critical evaluation and suggestions for development and improvement. Similarly, if a project repository has these functions, the quality of the content can be promising. These discussions lead to our third proposition:

> *Proposition 3:In knowledge-based project repositories, SYSTEM QUALITY will positively influence INFORMATION QUALITY.*

This relationship is displayed in Figure 4 and Figure 5 for both models.

The addition of the three relationships, however, is not meant to imply that those relationships would or should exist for other types of information systems or other knowledge management systems.

Figure 4. Respecified Seddon's Model of Knowledge-Based Project Repositories Success

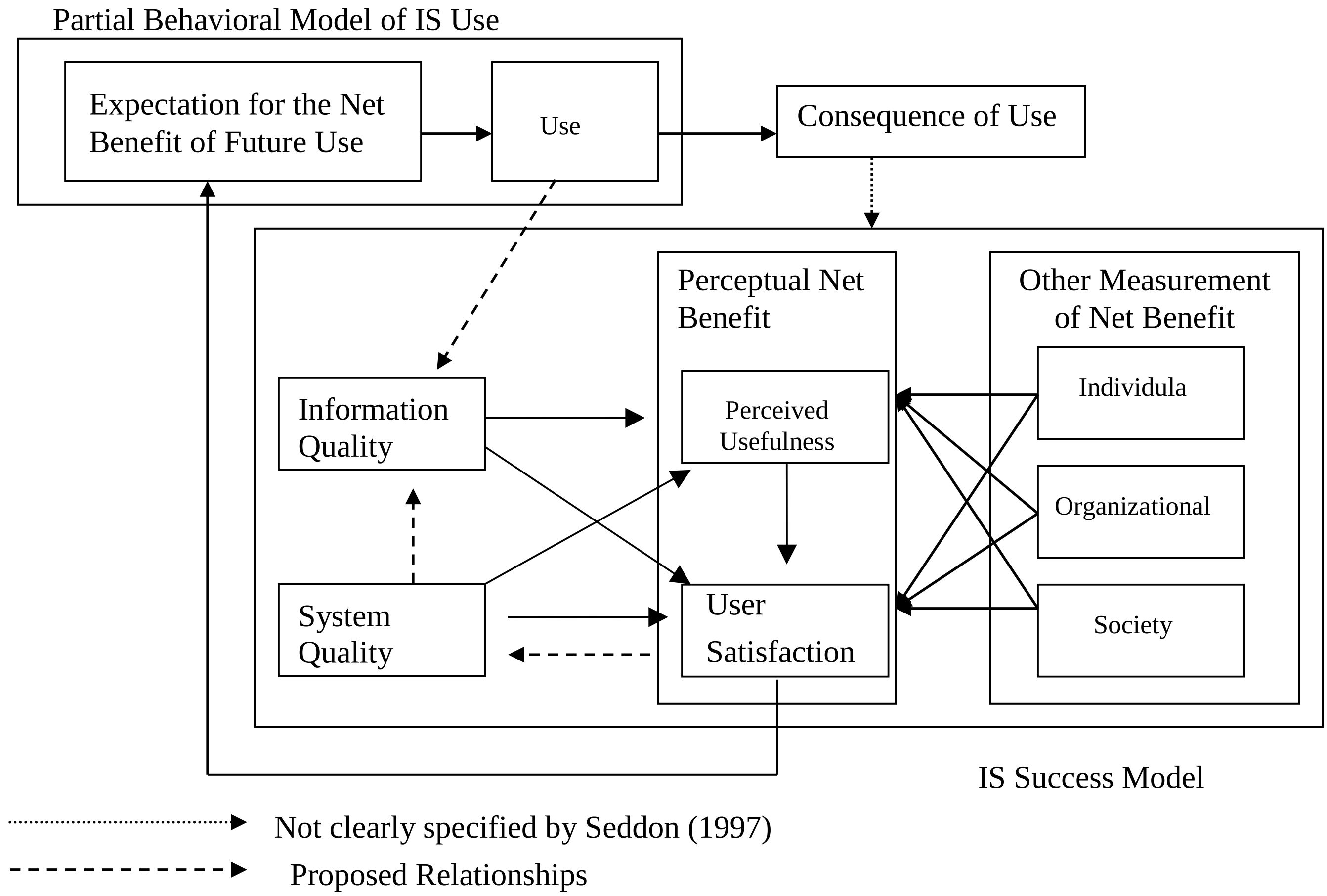
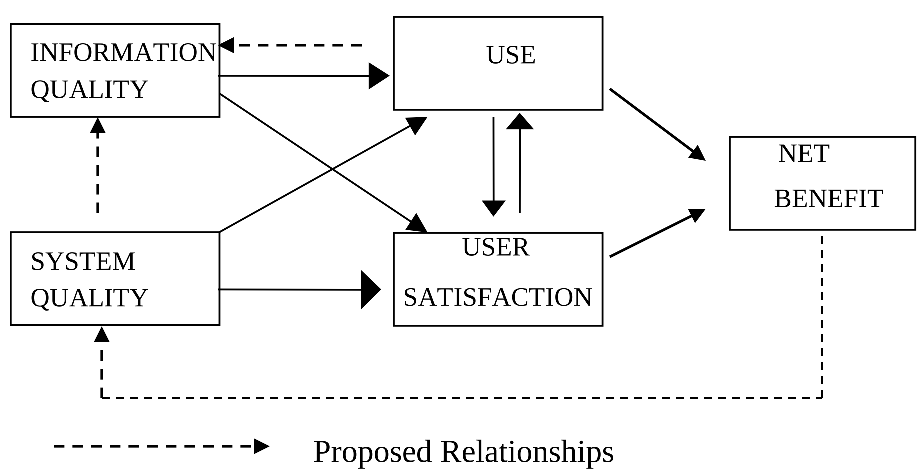


Figure 5. Adopted DeLone and McLean's Model of Knowledge-Based Project Repositories Success



Research Design

This research intends to compare the two knowledge-base project repository success models and to identify the best one. The design of competing models or theories can be seen in the works of Markus (1983) and Rai et al. (2002). This design is deemed appropriate, especially when neither is proven exceptionally superior to the other for IS Success. Also, the two models partly overlap, since they have many similar constructs, including SYSTEM QUALITY, INFORMATION QUALITY, USER SATISFACTION, and USE. Collecting data for one model is also collecting part of the data for the other.

This study has been designed as a two-phase effort. In the first phase, we adopt the case study approach. One of the strengths of qualitative case study approach is its capability of capturing the complex context (Eisenhardt, 1989; Lee, 1989; Yin, 1994). D&M and Seddon both indicate the importance of context in studying the IS success. Though there are pre-validated measurements available for every construct in the two tentative models, there is no measurement tailored for the operationalization of those constructs in knowledge-based project repositories specifically. As knowledge management processes are usually fairly complex, this qualitative field approach seems to provide the strength to understand the context, identify proper unit of analysis, and develop appropriate measurements that can really reflect the constructs. We will pay special attention to the cyclical characteristics of the models, develop proper instruments for each construct, and measure constructs in the model periodically with different time stamps. Though the case study here is not intended for theory building (Eisenhardt, 1989), we will pay attention to evidence that suggests any modification and addition to the two models. Because of our intention to achieve in-depth understanding, the number of cases will be limited to two. Methods for data collection in this phase will focus on interview, documents, and some observation if permitted. Site selection will be purposive (Eisenhardt, 1989; Mason, 1996; Miles and Huberman, 1994), and we will choose the site where knowledge-based project repositories are installed so that we can observe the different cycles of the system improvement as time goes.

The second phase is a large-scale survey based on the instruments developed from previous phases and the use of structural equation modeling (SEM) to test the models. A pilot study will be run to test the reliability of the measurements before we progress to the full-scale survey. Any problems that appear at this phase will be addressed and triangulated with the findings from the previous stage. LISREL can analyze the confirmatory structural models holistically (Joreskog and Sorbom, 1996). In order to test the cyclical nature of the models, we will measure constructs periodically with different time stamps. This longitudinal data can be analyzed by latent growth model in SEM (McArdle, 1998). To ensure the validity of these results, a large sample size is necessary. Lastly, the qualitative data obtained in the first phase may serve to triangulate and provide additional insights for eventual interpretation of the results (Kaplan and Duchon, 1988).

Expected Contributions

Knowledge management systems, though highly popular, have a number of issues associated with them. This study tends to extend D&M and Seddon's models so they can be applied in the domain of knowledge management systems. The new model may serve as a foundation to provide the diagnostic function to identify problems in project repositories. This process of developing a model for a specific IS technology can also serve as a blueprint for the process of building IS Success models for other technologies. This research acknowledges Orlikowski and Iacono's (2001) request to pay attention to specific technologies, rather than just abstract concepts. Lastly, the suggested cyclical nature is an important advance, since this brings a new perspective to the stream of IS Success research.

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