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Applying Level of Technology Use Models to Knowledge System Use

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Our fascination with technological innovations stems from its ambiguity with existing paradigms (Moersch, 1995). Does technology represent things like computers, multimedia devices, or other hardware peripherals; or processes, like financial systems, manufacturing systems, or knowledge management systems; or infrastructure (Norman, 1998) where the computer disappears behind the scenes and task-specific solutions (e.g. knowledge management) emerge? Each perspective on technological innovations has unique attributes and leads the individual to different implementation strategies.

Yet things and processes are inseparable elements of a larger composite or cluster of technologies (Rogers, 1995), where technologies converge to form inseparable entities (Norman, 1998). For example, if knowledge workers are to adopt the knowledge management system, they must concurrently adopt knowledge management processes. If knowledge workers adopt the knowledge system, they must also adopt the use of web browser software, word processing software, spreadsheet software, and graphical presentation software. Therefore, the researcher must not only evaluate individual attitudes toward the knowledge system, but also the degree to which individuals have implemented the knowledge system as part of their knowledge management processes.

The purpose of this research project is answer two questions:

- Which Level of Technology Use describes how extensively knowledge workers use knowledge systems?
- What additional factors contribute to how extensively knowledge workers use knowledge systems

LITERATURE REVIEW

Understanding why people accept or reject computer technology is one of the most challenging issues in Information Systems research (Davis, Bagozzi, & Warshaw, 1989). Additionally, researchers seek to understand why individuals choose to only implement the technology minimally or progressively integrate it into their work activities. If employees perceive that a knowledge system adds no significant benefit to their ability to learn, e.g. to construct actionable knowledge that subsequently enhances their performance, they either reject its use or minimize the degree to which the knowledge system is integrated into their task environment.

Levels of Technology Use and Implementation

Loucks (1977) reports that individuals transition through eight levels of use when adopting an innovation. Individuals progress up these levels: nonuse, orientation, preparation, mechanical use, routine, refinement, integration, and renewal, by acquiring more information concerning the innovation, increasing their use of the innovation, sharing information with peers, and assessing how the innovation impacts their work environment. However, the LoU model is innovation neutral. When Roecks and Andrews (1980) applied the LoU model to a technological innovation, they found that their subjects were unable to differentiate between the eight usage levels.

Reiber and Welliver (1989) developed the Technology Infusion Model, where individuals progress up levels by acquiring more information about how to use the technology and by increasingly integrating the technology into their work environment. Reiber and Welliver consider a technology as integrated when an individual's productivity is diminished if the technology is removed.

In summary, literature on level of technology use and implementation focuses on identifying discrete usage states. Each state describes individual behaviors on the extent to which employees integrate the technology into their work processes and is able to enhance their productivity in the process. What is missing from this literature is prescriptive information on how individuals progress up the usage levels.

Knowledge Systems

Knowledge systems are centralized computer systems that store, structure, and provide access to the corporation's document-based knowledge. Knowledge systems take a large, diverse collection of document-based knowledge, provide a physical infrastructure for storing those documents, and provide a logical structure for retrieving information (Morse, 1999 & 2000). Tobin (1997) identifies four major components of a knowledge system:

1. A repository, commonly a computerized database, of specific company knowledge and experience.
2. A directory of the specific knowledge, skills, and experience held by groups and individual employees throughout the company.
3. A directory of learning resources, within and without the company, that employees can activities.
4. A set of tools, methods, and capabilities that enable employees to learn from each other, and to learn together.

Individuals, regardless of their roles, use a knowledge system with the objective of enhancing productivity. Therefore a tight integration between core business practices, which add value to products and services in the firm's value chain, and publication and use processes in the knowledge system is essential if productivity goals are to be reached.

RESEARCH METHODS

This study employs both quantitative and qualitative research methods. The quantitative portion uses survey research, while in the qualitative research segment, interviews were conducted to collect richer descriptive data often not available from survey instruments. This study's population is employees of a firm that implemented a knowledge system approximately three years ago. The firm is a high-technology computer products and

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services supplier located in Beaverton, Oregon. The firm employed approximately 2,500 employees with corporate offices in Beaverton, Oregon and field offices nationally and internationally. A sample is created by systematically selecting from an alphabetized list of employee names stored an enterprise-wide email directory.

Level of Technology Use

Level of Technology Use is the degree to which organizational members have integrated a knowledge system into their task environment. Lower numbered responses suggest little or no use of the knowledge system; higher numbered responses report degrees of integration of the knowledge system into employees' daily work activities. Response 1 indicates non-use. Response 2 indicates that individuals utilize the knowledge system but not as their primary choice as an information source. Response 3 or infusion signifies that at this level individuals are beginning to routinize (Rogers, 1995) the technology. They now use the knowledge system equally along with alternative information sources. If respondents select Response 4, they have integrated the knowledge system into their work environment to the extent that if the knowledge system is unavailable, their productivity diminishes. Response 5 has the same characteristics as Response 4 except that employees have now expanded their use of the knowledge system to include technology-based information sources outside of their task environment.

Contributing Factors

The contributing factors questions measure the relative importance of that factor in contributing to the respondent's use of the knowledge system. Each question is measured on a four point Likert-type scale: Very Important, Somewhat Important, Not Very Important, Not at All Important. My purpose for including these questions was to gather richer supportive data, data which could offer insight into an individual's level of technology use relative to their perception of the technology's usefulness and their intent to use the knowledge system as an information source.

The final section contains open-ended questions and statements designed to gather additional descriptive data. The initial set of statements are, " I would use the knowledge system in the following situations:" followed by, "I would not use the knowledge system in the following situations". The objective of these statements is to determine what inhibits or enables your use of the knowledge system. The next set of questions asks, "What additional positive factors influence your use of the knowledge system?" and "What additional negative factors influence your use of the knowledge system?". These questions allow the respondent to add to the Contributing Factors items. The last set of statements directs the respondents to think back to when they first used the knowledge system, "Describe how you used it then" and "Describe how you use it now". Responses to these statements should provide additional insights into how people could progress up a Level of Technology Use model.

Procedures

Questionnaires were distributed to 615 employees, a sample drawn from employees of the Company. The Company's email system was used to distribute the questionnaire and to collect participant responses. Two hundred and three (203) employees responded to the questionnaire. Data collection involved capturing both qualitative data from the closed-ended questions and qualitative data from the open-ended questions.

RESULTS

Level of Technology Use

Results in this section are intended to answer the research question; Which Level of Technology Use describes how extensively knowledge workers use knowledge systems?

Table 1 Frequency Table – Level of Technology Use

	Frequency	Percent	Cumulative Percent
1 – Non-Use	5	2.5	2.5
2 – Utilization	49	24.1	26.6
3 – Infusion	86	42.4	69.0
4 – Integration	27	13.3	82.3
5 – Expansion	36	17.7	100.0
Total	203	100.0	

Level of Technology Use measures how extensively individuals have integrated the knowledge system into their work activities. Approximately twenty-four percent (24.1%) of the respondents reported that they utilized the knowledge system, but not as their primary information source. At the infusion level, 42.4% of the respondents reported using the knowledge system and other information sources equally. Employees have routinized (Rogers, 1995) the technology which indicates that the technology has replaced alternative information sources. Individuals increasingly use the knowledge system after they became familiar with how the information is organized and how to access needed information.

At level 4, 13.3% of the respondents had so extensively integrated the knowledge system into their work activities that if the knowledge system was not available their productivity would diminish. The final level, expansion, reported 17.7% of the respondents had integrated the knowledge system and additionally expanded their use of the knowledge system to include merging information from the knowledge system with information accessed from external technology-based information sources.

In summary, the largest group of knowledge workers reported using the knowledge system at the Infusion level. The sample's relative inexperience using the knowledge system and low frequency of use, discussed later in this chapter, potentially contributed to the reported levels of technology use. Additional factors such as information quality, information access and knowledge management processes, discussed later, potentially contributed to these results.

Contributing Factors

My purpose in collecting data on these factors is to examine "fidelity of implementation" issues (Fullan & Promfret, 1977), factors that create gaps between a technology's intended use and its actual use. I applied weights, 4 through 1, to Very Important through Not at All Important responses respectively. Each factor in Table 2 is ranked by its relative importance toward influencing the knowledge system use.

Table 2 Frequency Table - Contributing Factors

Factor	Very Important		Somewhat Important		Not Very Important		Not at All Important	
	Freq	%	Freq	%	Freq	%	Freq	%
Current and Accurate Info.	176	86.7	24	11.8	3	1.5	0	0
Searching Capabilities	147	72	46	22.7	9	4.4	1	.5
Relevant Information	146	71.9	48	23.6	7	3.4	2	1.0
Complete Company-wide information	105	51.7	79	38.9	16	7.9	3	1.5
Access to external web-based information	109	53.7	56	27.6	29	14.3	9	4.4
Data Communications Speed	91	44.8	82	40.4	27	13.3	3	1.5
Hypertext vs. Searching	64	31.5	112	55.2	22	10.8	5	2.5
Know how the knowledge system affects productivity	39	19.2	77	37.9	75	36.9	12	5.9
Publishing your information	32	15.8	62	30.5	75	36.9	34	16.7

I categorized three of the top four factors as Information Quality. This topic also emerged from responses to the open-ended questions, discussed in more depth next, as an inhibitor to increasing the knowledge system use. Paradoxically, knowledge sharing through publishing information, which provides current, relevant, and accurate information ranked the lowest in relative importance.

Information access, comprised of Searching, Hypertext links, and Data Communications speed, also emerged from responses to the opened-ended questions as a significant category. Searching capabilities, ranked second in relative importance was identified by respondents as a significant contributor to employee frustration with the knowledge system and a key reason for limiting their use of the knowledge system.

Open Ended Questions

In this study, participants responded to three paired questions described earlier in this paper and listed with the respective frequency tables. The final open-ended question was, "Please provide any further comments concerning your use of the knowledge system." Below are descriptions of the response characteristics from qualitative data collected for each question. Inter-rater agreement was calculated for each question pair. A doctoral candidate using my coding system coded a sample of 20 responses for each question. Percentage-of-agreement estimates are provided in the following sections.

I would use the knowledge system in the following situations. I would not use the knowledge system in the following situations.

Table 3 Responses to Would/Would not use the knowledge system

Factor	Number of responses
Information Types	**129**
Information Source	**32**
Information Access	**21**
Information Quality	**14**
Non-Use	**3**

To this paired question, 169 employees provided narrative responses. After coding and transforming the responses, the results were categorized into the following themes and sub-categories: information types, information quality, information source, information access, and non-use. The inter-rater agreement for these questions is .72.

In the largest response category, 129 employees submitted responses concerning certain types of information they would or would not access via the knowledge system. Van der Spek and Spijkervet (1997) categorized information types as people and skills (the who), content (the what), process (the how), decision making (the why), and schedules and milestones (the when). I used this framework when coding responses as information types. Respondents said they would use the knowledge system for people and skills, but were split on the other information types. Based on their responses, employees would or would not use content, process, decision-making, and schedules information based on how extensively they have integrated the knowledge system into their task environment.

In the next largest category, 32 employees responded that they would or would not use the knowledge system as their primary or secondary information source. Twenty-one employees responded that information access issues prevented them from enhancing their use of the knowledge system. Concerns surrounding data communications speed and problems with finding information through the search engine are the two information access subcategories.

Fourteen employees submitted responses concerning information quality. The information quality category was created based on responses concerning current and accurate information, relevant information, and comprehensive information. Employees repeatedly referenced information quality as a reason for not using the knowledge system. Lack of current, relevant, and accurate information forced individuals to use other information sources.

What additional positive factors influence your use of the knowledge system?

Table 4 Responses to positive factors question

What additional positive factors influence your use of the knowledge system?

Factor	Number of responses
Information access	**32**
Central information repository	**31**
Information quality	**23**
Knowledge sharing	**8**
Ease of Use	**7**

To this question 131 employees provided narrative responses. After coding and transforming the responses, the results were categorized into the following themes: central information repository, information quality, ease of use, knowledge sharing, and information access. The inter-rater agreement for these questions is .76.

Thirty-two employees responded that information access issues positively impacted their use of the knowledge system. Data communications speed and searching were the two information access categories. Thirty-one employees responded that the knowledge system provided them with a centralized location for all organizational knowledge. Twenty-one employees submitted responses concerning information quality. The information quality category was created based on responses concerning current and accurate information, relevant information, and comprehensive information.

What additional negative factors influence your use of the knowledge system?

Table 5 Responses to additional negative factors

What additional negative factors influence your use of the knowledge system?

Factor	Number of responses
Information access	**63**
Information Organization	**41**
Information quality	**34**
Knowledge sharing	**3**

To this question 146 employees provided narrative responses. After coding and transforming the responses, the results were categorized into the following themes: information organization, information quality, knowledge sharing, and information access. The inter-rater agreement for these questions is .80.

In the largest category, 63 employees responded that information access issues negatively impacted their use of the knowledge system. Data communications speed and searching were the two dominant information access sub-categories. Forty-one individuals claimed that information organization negatively impacted their use of the knowledge system. Information organization was sub-categorized into navigation difficulties and data indexing. Thirty-four employees submitted responses concerning information quality. The information quality category was created based on responses concerning current and accurate information, relevant information, and comprehensive information.

Please provide below any further comments concerning your use of the knowledge system.

Table 6 Responses to further comments question

Eighty-two employees provided narrative responses to this question. After coding and transforming the responses, the results were categorized into the following themes: information organization, information quality, knowledge sharing, training, and information access. The inter-rater agreement for these questions is .76.

In the largest category, 28 employees responded that information access issues negatively impacted their use of the knowledge system. Data communications speed and searching were the two dominant information access sub-categories. Sixteen individuals claimed that information organization negatively impacted their use of the knowledge system. Information organization was sub-categorized into navigation difficulties and data indexing.

Think back for a moment to when you first started using the knowledge system. Describe how you used it then. Describe how you use it now.

Table 7 Responses to the knowledge system use then and now

To this paired question 166 employees provided narrative responses. The objective for these questions was to gather more descriptive data concerning the dynamics of the level of technology use model. After coding and transforming the responses, the results were categorized into the following themes: no change, decreased level of use, increased level of use, and access methods. The inter-rater agreement for these questions is .80

In the largest category, 77 employees submitted responses suggesting that they increasingly integrated the knowledge system into their work activities. These responses were divided into 3 sub-categories: task integration, increased information relevance, and job changes. Sixty employees reported no change in their use of the knowledge system. The dominant sub-category for the no change responses was the dislike for the knowledge system's search engine. In the next sub-category employees commented about irrelevant information and its lack of applicability to the jobs. Characteristic of employees with a no change response was that they were either non-users or low integration users.

Seventeen individuals claimed that their usage behavior changed only in how they accessed the information. Previously they used searching to find information, now they used bookmarks, created with a web-browser, of relevant information retrieved during earlier searches. Thirteen employees stated their use of the knowledge system had decreased. These responses were divided into 3 sub-categories: navigation problems, searching, and information quality.

In summary, information quality and information access are the two dominant categories that emerged from this study. Several other categories, although smaller in ranking, emerged and are discussed in the following sections.

ANALYSIS

Contributing Factors

Contributing factors, which I now call Factors Influencing Technology Use (FITU), represent specific variables that influence technology acceptance and implementation. Factors are specific for each technology, yet review of this study suggests that three FITU categories emerged: human-technology interaction, technology infrastructure impacts, and worker expectations. Conceptually, elements within each category, if altered, could significantly affect an individual's level of technology use.

Respondents to this study indicate that searching and navigation are types of human-computer interactions that could influence their use of the knowledge system. Respondents stated that enhancing the search engine, simplifying the navigation strategy, and accessing documents with direct hypertext links would instill a stronger sense of trust in the knowledge system as an effective and efficient knowledge management tool. Two sub-categories of worker expectations emerged form the analysis: information quality and information organization. First, knowledge workers expect corporate knowledge to be accurate, current, comprehensive, and relevant. Second, they expect organizational knowledge to be stored in the knowledge system so they can find it instantly. Data communications speed is the recurring topic under the technology infrastructure category.

Level of Technology Use

Results from this study report that the largest percentage of knowledge workers' use of the knowledge system at the Infusion level followed by Utilization, Expansion, Integration, and finally Non-use. The knowledge system use at the Infusion level suggest that employees have routinized (Rogers, 1995) knowledge systems use, accessing information from the knowledge system and other information sources equally.

At both Expansion and Integration levels, employees have so extensively integrated the knowledge system into their work activities that if the knowledge system was not available, their productivity diminishes. Employees progress to the Expansion level by enhancing their use of the knowledge system to include merging the knowledge system information with information accessed from external technology-based information sources. Results from this study suggest that once individuals reach the Integration level, they quickly progress to the Expansion level. Knowledge workers at this level of task integration have overcome issues concerning searching and information access. They are self-confident using search engines and constructing bookmarks to expedite future information searches from both local and external knowledge repositories.

At the Utilization level, employees stated that although they use the knowledge system, it was not their primary information source. This level reported the second largest percentage of responses, suggesting that other factors are contributing to this low level of technology integration. Information quality and information access are factors that prevented individuals from using the knowledge system more extensively. Participants reported that a lack of current, accurate, comprehensive, and relevant information influenced their cognitive appraisal of the knowledge system's usefulness in enhancing their productivity. Searching issues and data communication speeds are two dominant access issues influencing knowledge workers' use of the knowledge system.

Technology and the Management of Knowledge

Employees use knowledge systems with the objective of enhancing productivity. Therefore, the process of publishing information and using the knowledge system must be tightly integrated with business processes if productivity goals are to be reached. In most cases, knowledge systems support knowledge workers directly by performing knowledge intensive work. In this study, employees perceived the knowledge system as useful in enhancing their productivity, but their responses ranked that desired goal lower than job relevance and job efficiency. Employees perceived that the knowledge system makes it easier to do my job and enables me to accomplish tasks more quickly. Although their responses concerning job performance and productivity were positive, a larger percentage of employees were either undecided or

responded negative. This suggests that when employees access available information, that information is converted to actionable knowledge thus enabling employees to complete their task expeditiously. If employees perceive the knowledge system as less usefulness in enhancing productivity, then a gap exists between information requirements of their task environment and information accessible through the knowledge system.

Respondents in this study indicated that two intent-to-use behaviors (sharing knowledge and publishing new knowledge) were the least likely behaviors to influence their use of the knowledge system. For knowledge sharing, via knowledge management publication processes, to become part of an individual's culture, a significant paradigm shift is needed—a shift from that of a knowledge consumer to that of a knowledge producer and extensible to a knowledge publisher.

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