TOWARDS KNOWLEDGE NEEDS-TECHNOLOGY FIT MODEL FOR KNOWLEDGE MANAGEMENT SYSTEMS

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ABSTRACT
The goal of this paper is threefold. The first goal is to provide an illustrative example of design science research. Readers will benefit from seeing how design science research guidelines, as proposed by Hevner et al. (2004), can be rigorously followed in a practically relevant study. The second goal is to describe the novel artifact constructed during the research project: a knowledge management system design model. The third goal is to provide a methodological contribution to the design science community. The paper calls for adding an exploratory step in the build phase when designing a new artifact.

Categories and Subject Descriptors
H.4.2 [Information Systems Applications]: Types of Systems---decision support; K.6.1 [Management of Computing and Information Systems]: Project and People Management

General Terms
Management, Performance, Design, Standardization, Theory.

Keywords
Knowledge management systems, design science, design model.

1. INTRODUCTION
Each research paradigm has its own nuances. Selecting the appropriate paradigm, research approach, and methodology to arrive at scientific knowledge depends on the nature and scope of inquiry. In principle, information system (IS) research can be classified under two paradigms: behavioral science and design science. Behavioral science is concerned with building theories using positivist, interpretivist, or critical lenses, seeking “what is true”. The goal is explaining and predicting phenomena related to acquisition, implementation, management and use of technologies. Design science seeks “what is effective.” It is related to achieving knowledge of a problem domain and its solution through construction and application of an IS artifact. As such, design-science is proactive towards technology and does not take it as “given” (Hevner et al., 2004).

This paper seeks to provide an illustrative example of a design science research. The goal of the research was to create a model for designing Knowledge Management Systems (KMSs). Research, inspired by the design science paradigm, was conducted in two global organizations: Parsons Brinckerhoff (USA) and Samsung Electronics (Korea). The paper provides a methodological contribution to the design science community. Based on the experiences of the research project, we call for an additional exploratory step in the ‘build’ phase of design science research.

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2. ABOUT THE DESIGN SCIENCE PARADIGM
Design and behavioral science are two distinct but complementary research paradigms [1, 2]. The behavioral-science paradigm has its roots in natural sciences. It seeks to develop and justify theories that explain and/or predict phenomena surrounding the analysis, design, implementation, management, and use of information systems. Such theories ultimately inform us of the interactions among people, technology, and organizations that must be managed if information systems are to achieve their stated purpose, namely increasing the effectiveness and efficiency of an organization. These theories impact, and are impacted by, design decisions made with respect to the system development methodology used and the functional capabilities, information content, and human interfaces implemented within IS [2]. The design-science paradigm has its roots in engineering and the sciences of the artificial [3]. It is fundamentally a problem-solving paradigm. It seeks to create innovations that define the ideas, practices, technical capabilities, and products through which the optimal analysis, design, implementation, management, and use of IS can be undertaken [4]. Most often, the behavioral science paradigm is passive in respect to technology, often ignoring or “undertheorizing” the artifact itself [5]. Its focus is on describing the implications of technology. Design science is active with respect to technology, engaging in creation of technological artifacts that impact people and organizations [6-7].

March and Smith [1] identify **two design processes** and **four design artifacts**. The two processes are ***build*** and ***evaluate***.

Purposeful artifacts are first *built* to address unsolved problems. Then they must be *evaluated* with respect to the utility provided in solving those problems. Artifacts are interdependent with people and organizations [1, 2]. The artifacts are ***constructs, models, methods,*** and ***instantiations***, which define ideas, practices, technical capabilities, and products, through which analysis, design, implementations, and use of information systems can be effectively and efficiently accomplished [4].

Constructs provide the language in which problems and solutions are defined and communicated [6]. They are concepts that characterize a phenomenon [7]. *Models* use constructs to represent a real world situation, the design problem, and its solution space [3]. Models frequently represent the connection between problem and solution components enabling exploration of the effects of design decisions and changes in the real world. They describe tasks and situations [7]. *Methods* provide guidance on how to solve problems. These can range from formal, mathematical algorithms that explicitly define the search process to informal, textual descriptions of best practice approaches, or some combination. *Instantiations* are physical implementations [7]. They show how constructs, models, or methods can be implemented in a working system. They demonstrate feasibility, enabling concrete assessment of an artifact's suitability to its intended purpose. Researchers can also learn about the real world, how the artifact affects it, and how users appropriate it [2]. Such artifacts are not exempt from natural laws or behavioral theories. To the contrary, their creation relies on existing kernel theories that are applied, tested, modified, and extended through the experience, creativity, intuition, and problem solving capabilities of the researcher [2].

"The resultant IT artifacts extend the boundaries of human problem solving and organizational capabilities by providing intellectual as well as computational tools. Theories regarding their application and impact will follow their development and use…" [2].

To ensure the quality of the design-science research, Hevner et al. [2] provided **seven guidelines**, to guide the execution of design science research. The fundamental principle being knowledge of a design problem and its solution are acquired through building, application and evaluation of an artifact.

Design-science research requires the creation of an innovative, purposeful artifact (Guideline 1) for a specified and relevant problem domain (Guideline 2) [2]. Because the artifact is purposeful, it must yield utility for the specified problem. Hence, thorough evaluation of the artifact using established methods is crucial (Guideline 3). IS artifacts can be evaluated in terms of functionality, completeness, accuracy, fit with the organization, and other relevant quality attributes. Novelty is crucial since the artifact must be innovative, solving a heretofore unsolved problem or solving a known problem in a more effective or efficient manner (Guideline 4). In this way, design-science research is differentiated from the practice of design [2]. The artifact itself must be rigorously defined, formally represented, coherent, and internally consistent. *"Research into KMS design should be built on the foundations of the cumulative body of research in the IS field and not by reinventing the wheel in a research context"* [8].

Hevner et al. [2], in their guidelines for design-science type of research, emphasize the need for research rigor (Guidelines 3 and 5). With respect to *construction of the artifact*, rigor is derived from 1) effective use of the knowledge base (theoretical foundations), and 2) selecting, and executing, research methodologies to build the artifact. In our case, we accounted for prior research in knowledge management and its allied disciplines. The analysis of the literature aided in conceptualization of constructs. However, in many cases there is very little, if any, prior research that was directly relevant to our problem. The major contribution of this work lies in an innovative recombination of the existing IS literature leading to the proposed KMS design model.

The process by which the artifact is created, and often the artifact itself, incorporates or enables a search process whereby a problem space is constructed and a mechanism is devised to find an effective solution (Guideline 6). Design science is inherently iterative where the initial artifact needs to be evaluated and redesigned until a satisfactory solution is found. The search for solutions is guided by satisficing. Searching stops when an artifact that "works well for the specified class of problems" is found [2]. Finally, the results of the design-science research must be communicated effectively (Guideline 7) both to a technical audience (researchers who will extend them and practitioners who will implement them) and to a managerial audience (researchers who will study them in context and practitioners who will decide if artifacts should be implemented within their organizations) [2].

Fundamental questions on utility (what does it do?) and its demonstration (does it really do that?) are salient: *"Contribution arises from utility. If existing artifacts are adequate, then design-science research that creates a new artifact is unnecessary (it is irrelevant). If the new artifact does not map adequately to the real world (rigor), it cannot provide utility. If the artifact does not solve the problem (search, implementability), it has no utility. If utility is not demonstrated (evaluation), then there is no basis upon which to accept the claims that it provides any contribution (contribution). Furthermore, if the problem, the artifact, and its utility are not presented in a manner such that the implications for research and practice are clear, then publication in the IS literature is not appropriate (communication)" [2].*

3. THE STUDY OF KMS DESIGN MODEL CREATION

This section discusses the design study performed, and how design science guidelines were followed in its execution. We start with the crafting of the research question and continue with detailed explanation of research methodology.

3.1 The context and the research question

Organizations continue to struggle with questions, such as how can they improve what employees know, how can they add creative insights to business decisions, how can they capitalize upon what others have learned before in doing same or similar tasks, and how can they stop employees from reinventing the same or even suboptimal solutions to problems that were already solved by someone else?

Senior executives, analysts, and policymakers from an Economist 2006 survey feel that improving the productivity of knowledge workers through technology, training, and organizational change will be the major boardroom challenge of the next 15 years. In another survey, CEOs ranked knowledge management (36%) second to sales and marketing (56%) as the business function that will be the most important in realizing corporate strategy goals over the next three years [9]. In addition, KM has become the top priority for strategic IT investments. Two-thirds of Western European senior executives in the 2005 Economist survey answered that KM and business intelligence tools will be the most important technology underpinning their company's goals over the next three years [10]. Similarly, CEOs from the 2006 Economist survey have expressed certainty that investments in technology by the year 2009 will mostly result in improved customer relationship management (39%), improved sales and marketing (34%), and improved KM (33%) [9]. Accordingly, 30% of CEOs have stated that knowledge management is the most important investment for the year 2007, second to marketing and sales improvement investment (36%) [11]. With the purpose of improving the organization's efficiency and effectiveness through better decisions, organizations consciously design and deploy KM solutions that instigate utilization of existing knowledge and new knowledge creation [12, 13]. Measuring intellectual capital, establishing corporate libraries, building intranets, sharing best practices, leading cultural change, building databases, leading training programs, installing groupware, fostering collaboration in communities of practice, and creating virtual organizations are only a few examples of what companies implement with hope of improving how knowledge is created and used in individual and group decision making. However, benefits remain elusive for most of the companies; failure rate of KM initiatives is over 70% [14-16]. Some report even higher failure rate (84%) [i.e. 84% by 17]. While there was a considerable body of literature that deals with KM projects, it more often than not merely lists variety of factors as being critical for their success [8]. Many factors have been explored in detail in the literature, such as:

- clear KM vision and strategy [18, 19]
- alignment of KM strategy to business goals [20, 21]
- promoting a learning culture [22-24]
- incentives for knowledge creation and reuse [25]
- a community that provides a context for KM to flourish [26]
- continuous top management support [27]
- employee empowerment [28]
- a positive attitude to knowledge sharing [29, 30]
- a flexible organization structure [31]
- usable and up-to-date KM systems [32-35]
- knowledge governance structure for maintaining quality of knowledge content [36]

However, there remains a lack of actionable know-how that describes how to actually build a meaningful and business-value-adding KM solution [16]. KM activities and technologies are indiscriminately deployed, without regard to the actual context into which they are being brought [37]. Based on thorough scrutiny, synthesis and combination of existing literature we posed the following research question: **How do workers' knowledge needs influence the design of KMS for supporting and enabling knowledge creation and utilization?** To this end, we created a model for designing KMSs.

3.2 The research methodology and development of the artifact

3.2.1 Literature review

A systematic review of existing literature on knowledge management was conducted. Analysis and synthesis of the literature from different research fields was conducted in order to recognize the importance of the problem, to uncover current understanding of the areas of concern, and to theoretically ground the research. The literature review was also necessary to help identify promising areas for future research.

3.2.2 Building the design model

The KMS design model was proposed up-front in a positivist manner. This artifact was constructed in the form of "ideal fit profiles," which advise appropriate technology solutions for particular knowledge work contexts. Figure 1 shows the conceptual framework of the model.

Three major theoretical lenses guided the model development. First, Task Technology Fit Theory [38, 39] was taken as the conceptual lens for construction of the KMS design model and was amended to the fit KM context. Second, Evolutionary Information Processing Theory [40] was used to describe how knowledge is created and utilized in the course of individual decision-making. This was important as we wanted to open up the 'black box' of 'knowledge creation and utilization' process. Knowledge creation and utilizations was framed as a six-stage iterative process of 1) problem recognition, 2) goal setting, 3) generation of tentative knowledge variation, 4) knowledge selection, 5) knowledge retention, 6) resource management. Third, we drew on the process value of IT Theory [41-43], which suggest organizational and technological innovations should be introduced and evaluated at the business process level and not organization-wide.

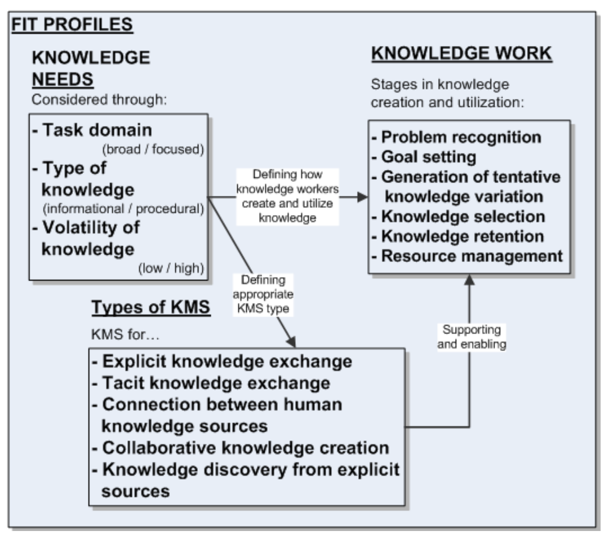

Figure 1: Concept of the KMS design model

KMS characteristics represented the "technology" part of the construct. Here, the literature was analyzed [i.e. 44, 45-48] and synthesized to arrive at five types of KMS: 1) explicit knowledge exchange type, 2) tacit knowledge exchange type, 3) connectivity between humans type, 4) collaborative work type, and 5) knowledge discovery type. KMSs have to support individuals in the course of their knowledge work. The basic tenant of our research is types of technology that are appropriate for particular work contexts will differ within, and across, organizations. We defined a contingent variable "knowledge needs". The variable was conceptualized by describing: 1) task domain, 2) type of knowledge and 3) volatility of knowledge. Different combinations of these three elements gave us eight organizational contexts in which knowledge work happens.

Thus to **complete model building** an exploratory case study was performed. Parsons Brinckerhoff is a knowledge intensive engineering company which was selected based on its reputation of being the top American company in road and highway design, mass transit and rail design, and second best in bridge design and airport design [49]. At Parsons Brinckerhoff, issues of knowledge management and learning are recognized and appreciated. Organizational and technological mechanisms (i.e. organizational structure, goals, processes and KMS) to enable and support KM had already been introduced. KM executives were interviewed to

Table 1: Initial, theory-based model

	WORK CONTEXT			KNOWLEDGE WORK PHASES						
	Task domain	Knowledge volatility	Type of knowledge	Problem recognition	Goal setting	Generation of tentative knowledge	Selection of tentative knowledge	Retention of new knowledge	Resource management	
1	focused	low	informational	EKX	EKX	EKX, KD	EKX	EKX	EKX, CON	Types of KMS
2	focused	low	procedural	EKX	EKX	EKX, KD	EKX	EKX, TKX	EKX, CON	
3	focused	high	informational	EKX, COL	EKX, COL	EKX, COL, KD	EKX	EKX	CON, EKX	
4	focused	high	procedural	EKX, COL	EKX, COL	EKX, TKX, COL	EKX, COL	EKX, COL, TKX	EKX, CON	
5	broad	low	informational	COL, EKX	EKX, COL	COL	COL	EKX, COL	EKX, CON	
6	broad	low	procedural	COL, EKX, TKX	EKX, COL	COL, TKX	COL	EKX, COL	EKX, CON	
7	broad	high	informational	COL, EKX	EKX, COL	CON, COL	COL	CON, COL	EKX, CON	
8	broad	high	procedural	COL, EKX, TKX	EKX, COL	CON, COL, TKX	COL	CON, TKX	EKX, CON	

KMS Types

EKX: Explicit knowledge exchange

COL: Collaborative knowledge creation

TKX: Tacit knowledge exchange

CON: Connectivity between human knowledge sources

KD: Knowledge discovery from explicit sources

After conceptualization of each of the constructs, relations between them were substantiated drawing on the literatures of management, KM, and IS. Existing fit prescriptions and empirical research provided a starting point for assessing key constructs and their potential relationships. Effort was invested in finding mini cases for each of the relationships. However, in some cases, there was very little, if any, prior research that is directly relevant to particular proposition. In such occurrences, theoretical concepts were searched for and applied analytically to the given situation. Fit profiles connecting knowledge needs, knowledge work and KMS technology choices were then proposed. They represent the essence of the model. The initial, theory based model, is shown in Table 1.

As per design science guidelines, the artifact was proposed in the build phase strictly based on existing research. Before assessing usability of the proposed (theory-based) model, which is the goal of the "evaluate" phase in design science, we decided to conduct a preliminary check of the model. The goal was to assess and validate the core of the model before asking about its actual usability. Initial interviews with the key informant, the KM executive of the company in which we wanted to do the evaluation study, were conducted. Interviews revealed that there were stark differences in the knowledge management practices of found in business organizations versus the academic literature.

Table 2: Examples of eight knowledge needs profiles in Parsons Brinckerhoff, that were discussed from the viewpoint of KMS support to the knowledge worker

WORK CONTEXT			EXAMPLES
Task domain	K volatility	Type of K	Short description
focused	low	informational	Determine the average rainfall in a region for the last 50 years.
focused	low	procedural	Determine the proper method to measure a river's bank erosion over time.
focused	high	informational	Establishing the overall cost of steel for a bridge project.
focused	high	procedural	Determining the best way to handle PR in a crisis situation.
broad	low	informational	Determine the overall volume of materials required for a building of specific architectural design.
broad	low	procedural	Establish a change request process for a project that involves multiple stakeholders.
broad	high	informational	Determine the cost of project depending on how the weather affects the schedule for the project.
broad	high	procedural	Determine the best way to handle public comments and protests as they arise throughout the 5-year lifespan of a project.

Table 3. Proposed knowledge needs-KMS fit profiles after the exploratory study in Parsons Brinckerhoff

	WORK CONTEXT			KNOWLEDGE WORK STAGES						
	Task domain	Knowledge volatility	Type of knowledge	Problem recognition	Goal setting	Generation of tentative knowledge variation	Selection of tentative knowledge	Retention of new knowledge	Resource management	
1	focused	low	informational	EKX	EKX	EKX,KD	EKX	EKX	EKX	Types of KMS
2	focused	low	procedural	EKX	EKX	EKX	EKX	EKX,TKX	EKX	
3	focused	high	informational	EKX,COL	EKX,COL	EKX,COL,KD	EKX,COL	EKX	EKX,CON	
4	focused	high	procedural	EKX,COL	EKX,COL	EKX,COL	EKX,COL	EKX,TKX,COL	EKX,CON	
5	broad	low	informational	EKX,COL	EKX	EKX,COL	COL	EKX,COL	EKX,CON	
6	broad	low	procedural	EKX,COL	EKX	EKX,COL,TKX	COL	EKX,COL,TKX	EKX,CON	
7	broad	high	informational	COL,EKX	EKX,COL	COL,CON,EKX	COL	EKX,CON,COL	EKX,CON	
8	broad	high	procedural	COL,EKX	COL,EKX	COL,EKX,TKX	COL	EKX,COL,TKX,CON	EKX,CON	

KMS Types

EKX: Explicit knowledge exchange

COL: Collaborative knowledge creation

TKX: Tacit knowledge exchange

CON: Connectivity between human knowledge sources

KD: Knowledge discovery from explicit sources

gain insights about *relevance* of the core of the model and its applicability. As the interviewees' everyday work was leading KM teams, the KM executives had highly developed theories-in-use, which they were forced to articulate and make explicit. They represented 'well-informed informants' who were able to reflect upon and discuss KMS and KM issues [50].

Eight different organizational settings, which correspond to the design model profiles, were analyzed to deduce the most appropriate technology for each of the knowledge work stages. As such, these eight different contexts represent mini cases within a company (see Table 2). These settings were discussed during the interviews to arrive at more generalizable framings, and to think through work situations that covered all the eight different knowledge needs profiles. The informants agreed that contingency variables were well chosen and that different combinations account for most work contexts in organizations. Through the method of envisioning a KMS for each of the eight contexts, we came to an agreement on updated design model (see Table 3, compare to Table 1). Furthermore, there was an important finding that resulted from thoroughly analyzing the core of the model. We realized that the fit-profiles-table might be too complex to be easily understood and applicable in practice. As noted by the interviewee:

> *"For a real world setting, I think you will have to consider a way to get to your answers more easily. I mean, the KMS designers would benefit from such tool, as they need to analyze knowledge needs and practices. They will not have the time to explain the entire model… all of the model's concepts to everyone. So you need a set of efficient questions that will get the analyst the answers from 'common' people, but in a way that he will be able to map that everyday discussion onto the model's concepts."*

As noted by the interviewee, utility of the model would indeed be lower if it was difficult to use. We decided to craft a short list of questions that complement the fit profiles table, and that a KMS designer could pose to improve the quality of how knowledge analysis questions are interpreted by the interviewee (knowledge worker). The questions needed to reflect the overall concept of the design model and touch its most important relationships and constructs. They were framed as 'conversation starters' for a KMS designer, when analyzing knowledge needs and knowledge work in particular organizational context. Table 4 shows the questions and their relation to the knowledge needs-KMS fit profiles. This new instrument thus complements the fit profiles table and together they constitute a design model built based on existing literatures and amended through the exploratory study in Parsons Brinckerhoff.

3.2.3 Evaluation of the design model

After the build phase was completed, the KMS design model was *evaluated*. An in-depth exploratory qualitative case study was performed in Samsung Electronics, which had just undergone a KM-organizational change project. Samsung Electronics was selected as the company enjoys a strong reputation of being one of the most innovative and successful knowledge-based organizations in the world [51-55].

The goal of the evaluation phase was to further validate the core of the model and demonstrate its usability of the model to the intended users. Utility of the model was assessed with an eye for 'satisficing'. Hevner et al. [2] suggest that the model has to be "good enough to work" as the nature and the value of the design

Table 4: Building a list of questions for the knowledge needs and organizational context analysis

Question	Explanation
Q1: What does the knowledge worker need to solve and what are the business- and knowledge-related goals behind that?	The question is concerned with overall process- and business-orientation of both KM efforts in general and KMS design as technological support for particular business problem. First, a business-related reason must exist in order to think about KMS support; KM efforts need to be oriented in improving how knowledge is created and utilized with the goal to achieve that business-related goals.
Q2: What is the shelf life of knowledge that is needed in everyday decision-making?	This question is concerned with the knowledge volatility in particular context; high or low. How we deal with knowledge and what is the appropriate KMS depends on how much time that knowledge is current. Can the same knowledge be reused for performing tasks/make decisions, or is it rapidly changing and needs to be created continuously?
Q3: How do employees make decisions: on their own, by collaborating with people in the same knowledge domain, or with people from other knowledge domains?	The question is concerned with the way of performing the task or making decision. How does he solve a particular problem/makes a decision? On his own or in collaboration with others?
Q4: What kind of knowledge do they need to arrive at a solution? Is it a piece of information, a document? Or is it a procedure, how to do something?	This question is concerned with the type of knowledge needed to perform the task; procedural or informational? Is it know-what that is important in particular context, or is it know-how? In other words, what kind of knowledge needs he have?
Q5: How do employees learn from past experience before they make a decision?	Based on the above argument on how knowledge needs to be created and utilized when employee tries to perform his activities (under Q1), an important underlying concept is learning. So in the course of daily work, employees need to learn "before" undertaking a task, learn "during" that task, and learn "after" the task (task being i.e. decision-making). By looking through these three lenses, KMS designer can answer the question of how learning and leveraging knowledge is done during everyday work. The argument for interest in how learning before making decisions is done is that it is highly likely that there is somebody out there who has already done something similar before. Thus, how can a KMS be designed in a way to provide up-front as much as possible information necessary for fulfilling the task? This question corresponds somehow to the early phases of knowledge work, i.e. problem recognition and goal setting. The argument for learning after an event is that experience and insights should be captured and transferred to similar future occasions. This question corresponds somehow to the late phases of knowledge work, i.e. tentative knowledge variation selection and knowledge retention. Again, the goal is to design such a KMS that will facilitate this. In example, ways to learn after include immediate project team meetings, codifying insights into a searchable database, and holding retrospect meetings. The logic behind learning during is that knowledge-related interventions can be introduced while making a decision, while working on a project, as one can continuously learn before reaching the end of a project, in example. Again, the goal is to design such a KMS that will take into account how learning during is usually made.
Q6: How employee learns during the particular work?	
Q7: How they instigate the double loop learning, e.g. learning after a task?	
Q8: KMS Technologies supporting these activities?	This question is concerned with existing KMS support for knowledge workers at their tasks. Should be asked with each of the Q5-Q7 questions.

science does not lie in the researching 'why' exactly the artifact works.

Data collection occurred through semi-structured interviews with a key informant, short informal discussions with key knowledge workers, and through review of written materials. First, experts from the company who were involved in the KM-related organizational change project were queried on various aspects of the project. Through the course of these discussions we learned that the Director of Organizational Development could answer questions on all aspects of the KM project and KMS design. Selection of this individual is in line with Nonaka and Takeuchi [56] who argue that members of middle management, more precisely, 'owners' of subunits, of processes, KM officers, or KM-project managers, should be interviewed as they are in possession of sufficient knowledge and are adequately involved in the KM programs of the organization. Besides knowing the business value of such projects, this person was operationally involved in design and deployment of future KM solutions, including design and implementation of KMS. The interviewee was thus able to assess applicability and usability of the KMS design model. He was also asked to reflect on past decisions and discuss how the model could help Samsung if they had to start the KM project all over again. In addition to in-depth interviews, key knowledge practitioners [56] in the company were informally observed at their daily work and were queried to evaluate appropriateness of the existing KMS design. The purpose was to assess the fit of their KMS to the context in which it is used, and to assess the value the proposed design model. Key knowledge workers know which KMS functionalities would be useful for their context of work, or at least can recognize a potentially useful KMS when they are presented with its options. The primary sampling criterion to identify knowledge workers was opportunity to learn and diversity along with balancing the constraint of access [57]. This approach allowed for obtaining first-hand experience of the challenges at various organizational levels of KM-project and by interacting with those directly involved.

Utility assessment was done by picking two different contexts in which managing knowledge is important, and analyzing them from the KMS design model standpoints: application developer solving mobile phone software bugs, and software technology manager mobilizing innovative ideas. Based on the list of seven questions and the fit profiles table, interviewees were asked to discuss the suggestions (as proposed by the model) versus real life KMS support in their work context.

No alterations were proposed to the fit-profiles table (Table 5) even though we have asked for amendments at numerous occasions during the interview. The interviewee confirmed the basic tenant of the research (need for segmented approach), repeated the practical need for the design model, and confirmed the core of the model. With regard to that, consider the following comments:

> *"Let me say that I like this concept. While kept uncluttered, it is also very powerful as it reminds you of all the important boxes you need to think about when designing a KM environment and mechanisms. I like it as it puts together the two worlds of the information architect and the process owner, and as it makes them clear for both of them. Maybe these parts are already in managers' subconscious however, I guess they are not really as structured as in here. It is advantageous to have this as it shows the relationships between the elements of successful KMS design and the role of each of the model's core elements: the nature of work and the variety of possible information technology to support it. It would be much easier to talk with the project team members and specialists if this concept was in everyone's mind from the beginning."*

> *"What I see from this example that we went through is something quite unique. As the model is well structured and as constructs are explained, analysis of existing or design of new KMS has become quite easy. The model takes me from one knowledge work stage to another and it forces me to think from the knowledge worker's view. This is really good as KMS designer remains focused on the user and his needs. All the designer needs to do is to think how to apply available KMS tools exactly in each stage. But the stages are here and the fitting technology is here, which is most welcome."*

Another goal of the study was to evaluate the set of seven questions by assessing their wording and utility. The interviewees had significant experiences in designing KM solution and

Table 5: The knowledge needs-KMS fit profiles – final version

	WORK CONTEXT			KNOWLEDGE WORK STAGES					
	Task domain	Knowledge volatility	Type of knowledge	Problem recognition	Goal setting	Generation of tentative knowledge variation	Selection of tentative knowledge	Retention of new knowledge	Resource management
1	focused	low	informational	EKX	EKX	EKX,KD	EKX	EKX	EKX
2	focused	low	procedural	EKX	EKX	EKX	EKX	EKX,TKX	EKX
3	focused	high	informational	EKX,COL	EKX,COL	EKX,COL,KD	EKX,COL	EKX	EKX,CON
4	focused	high	procedural	EKX,COL	EKX,COL	EKX,COL	EKX,COL	EKX,TKX,COL	EKX,CON
5	broad	low	informational	EKX,COL	EKX	EKX,COL	COL	EKX,COL	EKX,CON
6	broad	low	procedural	EKX,COL	EKX	EKX,COL,TKX	COL	EKX,COL,TKX	EKX,CON
7	broad	high	informational	COL,EKX	EKX,COL	COL,CON,EKX	COL	EKX,CON,COL	EKX,CON
8	broad	high	procedural	COL,EKX	COL,EKX	COL,EKX,TKX	COL	EKX,COL,TKX,CON	EKX,CON

Types of KMS

KMS Types
EKX: Explicit knowledge exchange
COL: Collaborative knowledge creation
TKX: Tacit knowledge exchange
CON: Connectivity between human knowledge sources
KD: Knowledge discovery from explicit sources

systems. Therefore, they were knowledgeable about *what* and *how* to ask knowledge workers when assessing their needs. Positive assessments were received on the questions:

> *"I think you hit the nail here by adding these to fit profiles table. My first thought when you presented the model was that "this is too complex". Well, your model does describe very complex relationships. Therefore it is natural to be complex on its own. The questions that you attached very simply ask about the constructs your model uses; I can see where each question is pointing. This is a very good interface to the model. Still, and this is a very serious comment, they need to be tweaked a little. As a whole, they are very confusing because you use different words for same thing, in example, decision making, work, task. KMS designers will be using these questions when interacting with ordinary people. Use simpler words, use one word for the same construct, and you are fine."*

Based on the feedback, we reworded a few questions accordingly; we also dropped conceptual words, such as 'double loop learning', and 'knowledge domain.' The revised list of questions is outlined in the Table 6.

Table 6: A list of questions for the knowledge needs and organizational context analysis

Q1: What is the task that knowledge worker needs to perform and what are the business- and knowledge-related goals behind it?

Q2: What is the shelf life of knowledge that knowledge worker uses when performing the task in this context?

Q3: How do knowledge workers perform the task: on their own, by collaborating with people who have the same expertise, or by collaborating with people with different expertise?

Q4: What kind of knowledge does a worker need to successfully perform the task?

Q5: How does the knowledge worker learn from past experience before performing the task? What technologies support this activity?

Q6: How does the knowledge worker learn during a particular task? How can newly acquired knowledge be transferred to other knowledge workers? What technologies support this activity?

Q7: How does the knowledge worker learn after performing the task? How can newly acquired knowledge be transferred to other knowledge workers? What technologies support this activity?

3.2.4 Further results of the research

The case of Samsung Electronics also provided for a rich data source we observed their ongoing organizational change management effort. This gave us additional insights into KM-related organizational change projects. We investigated how to use the proposed model for designing a KMS. We arrived at guidelines on how to use the model to analyze particular business context, specify an appropriate KM system, and design other (organizational) parts of the KM solution. Practitioner guidelines on how to go about knowledge-related organizational change projects were outlined by proposing steps for such organizational endeavors. We discovered that design and deployment of KM solution happens in a 6-step process (see Figure 2).

Figure 2: 6-step process to design and deploy a KM solution

The proposed process conceptually does not differ much from other organizational change projects. KM-project steps follow the same logic of "understand the challenge, set the goal, model the *as-is* and *to-be* situations, evaluate the results." In this sense, deployment of a KMS is no different from any other organizational change project, and KMS development is no different from other IS development projects. This is positive both for re-focus and for the advancement of the KM research area, as researchers are encouraged to take advantage of the cumulative body of research in management and IS. Earlier studies have proposed various information systems development methodologies (ISDM), which provide a consistent set of procedures to be followed to make the process of managing and developing information systems more efficient and effective [58]. In addition, ISDM imply a time-dependent sequence of action stages [59]. Such frameworks have been developed over the years; Jayaratna [60] estimated that there were more than 1000 available for use. Each of these ISDM has its own acknowledged strengths and weaknesses. However, one ISDM is not necessarily suitable for use in all projects [61].

3.3 Robustness of the overall research design

The table 7 shows how design science guidelines suggested by Hevner et al. [2] were adhered to.

Table 7: Ensuring robustness of the research design

G1: Design as an Artifact
Description: Design-science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation.
Addressed: *Result of this research is a KMS-design model.*
G2: Problem Relevance
Description: The objective of design-science research is to develop technology-based solutions to important and relevant business problems.
Addressed: *The criticality of knowledge creation and utilization issues and the role of technologies to foster this has been called out in the literature. In the final stage of the build phase, exploratory multiple case studies were performed to establish the face validity of the model;, including an assessment of problem relevance from the practitioner' perspective. Research questions ignited numerous discussions with executives in companies.*
G3: Design Evaluation
Description: The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods
Addressed: *Case study methodology was rigorously employed for model development and evaluation.*
G4: Research Contributions
Description: Effective design-science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies.
Addressed: *Contributions to research and practice were discussed in relation to the disciplines in which this research is situated (IS-design science and management and organizational studies).*
G5: Research Rigor
Description: Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact.
Addressed: *In terms of artifact construction, existing theories such as Evolutionary Information Processing Theory of Knowledge Creation (Li & Kettinger, 2006), Task Technology Fit Theory (Goodhue & Thompson, 1995; Zigurs & Buckland, 1998), and Process Value of IT Theory (Barua et al., 1995; Sambamurthy, 2001; Tallon et al., 2000) were used. These theories were used to inform the theoretical part of artifact-building. Exploratory multiple case studies were performed in order to complete the build of the KMS design model. In terms of artifact evaluation, this research used case study research as the research strategy. The goal was to evaluate the usability of the design model for the intended users – managers and KMS developers. In both phases, special attention was paid to rigorous data collection, analysis and synthesis, by using established guidelines and techniques, common in qualitative research. To analyze and discuss findings from the study, we used "noting patterns", making "contrasts / comparisons", and counting/listing. Counting and listing was conducted to make lists; in particular, it was used to identify KMS functionalities in place in each of the eight knowledge work contexts. Patterns and themes were noted to find support for conceptualization of the constructs.*
G6: Design as a Search Process
Description: The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.
Addressed: *The study employed iterative approach to building the model as the first version of the theory-based-model was first amended in exploratory empirical study. The final model was proposed after the evaluation stage.*
G7: Communication of Research
Description: Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences, while satisfying rigorous academic standards.
Addressed: *Findings and conclusions were presented from both research and practical aspects throughout the research report. Several academic contributions have been disseminated from the study to communicate the results of the study (Baloh, 2007a, 2007b, 2008a, 2008b, 2008c, 2009). For practitioners, research results have been communicated in a manner of executive reports and presentations. Both types of communication were prepared in a manner for technology-oriented audience to include sufficient detail to be able to construct an instantiation (computer-based KMS) in particular organizational setting, and for management-oriented audience to find guidelines on how to analyze a business context in the KM sense, and how this influences the choice of KMS functionalities.*

3.4 Contributions of the research

This paper makes several contributions to the KM literature. First, contrary to mainstream research, it confirmed that developing one company-wide KM solution is of limited value. Not only do different knowledge challenges exist in organizations, but people also perform different tasks in course of their daily work. This calls for a portfolio of KM solutions that, which are tailored to satisfy the knowledge needs of an individual. Second, the paper has introduced a model to guide the design of KMS based on knowledge needs. The model consists of "ideal" combinations of knowledge needs and characteristics of KMS, which should result in improved knowledge utilization and creation. The design model developed enables the KM community to critically evaluate efforts underway to leverage organizational knowledge with KMSs. The proposed model can also be applied to analyze successful and unsuccessful KMS implementations retroactively. Third, practitioner guidelines on how to use the model to build KMSs as a part of knowledge-related organizational change projects were proposed.

4. DISCUSSION AND CONCLUSION

March, Smith, Hevner and others [1, 2] have documented guidelines and steps for conducting design science research. A contribution of our work is to suggest a methodological enhancement to the current design science guidelines. In design science guidelines as put forward by Hevner et al. [2], the mechanics of the "build" and the "evaluate" phases are straightforward. Purposeful artifacts are first built to address unsolved problems and then they must be evaluated with respect to the utility provided in solving those problems. Rigor in the build phase is derived from the effective use of the knowledge base: artifacts should be built upon theoretical foundations provided in existing cumulative body of knowledge. This model should then be evaluated through a sturdy empirical study, where methodological decisions are justified and appropriate for the research context [2].

However, such approach is dominantly positivistic and presumes that existing body of knowledge is sufficient for construction of an artifact. Moreover, this approach is contradictory when compared with another guideline that strictly requires *novelty* of an artifact. As per Hevner et al. [2] guidelines, the only artifacts that design science should be concerned with are those that are novel, solving previously unresolved problems. Then, is existing body of knowledge on its own enough to construct a novel artifact that can go into the evaluation phase of a design science research?

To reduce the risk of building a "wrong" initial model, rooted solely in existing literature, we decided to add an exploratory empirical study to the build phase. This, we argue, added to higher level of practical relevance and novelty of the model. It allowed us to test the basic propositions of the study, justify its relevance and check if there are any additional constraints or constructs that are important. A set of in-depth interviews were performed with KM executives who represented a 'well-informed informants' to 1) gain insights about relevance and potential applicability of the model; 2) receive feedback on the model which will be used to amend and validate the tentative model suggestions. The a priori (theory based) proposed model was thus improved through acquired practical insights. Without this step, we believe, the evaluation phase would surely not have yielded the results expected. Moreover, the research instrument (interview protocol and the definitions document) were significantly amended during this additional step.

For the evaluation phase, the goal is to demonstrate *usability* of the model to the users for whom it is intended. KM managers that are responsible for design and deployment of KMS need to find it useful for the purpose intended. Here we are seeking input on the utility of the model, how it can be used thus, and if it is helpful for them. The interview protocol designed and used was thus different from the one used in the first, exploratory, study in the build phase. We believe that adding an exploratory study in the build stage is critical. Only if the artifact is constructed effectively will it be found useful by the intended audience.

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