Full Length Research Paper

A comprehensive framework for knowledge management system life cycle

Nazim Taskin¹*, Jacques Verville¹ and Ahmad Al-Omari²

¹Faculty of Management, University of British Columbia – Okanagan, 3333 University Blvd
Kelowna, BC V1V 1V7, Canada.
²Business School, Information System, Dakota State University, USA.

Accepted 6 December, 2011

Development life cycles are useful for developing systems since they offer methodologies and models. Although, there are different models or methodologies to develop systems with different purposes, but there is no such comprehensive or complete one for knowledge management systems. The reason may be the complexity and the variety of related topics in knowledge management, which is an interdisciplinary field. This paper attempts to provide such a framework, which combines task and generic approaches to propose a development life cycle for knowledge management systems. This framework demonstrates the system that deals with specific activities and organizational knowledge.

Key words: Knowledge management, life cycle, knowledge work.

INTRODUCTION

Development life cycles provide models or methodologies for people who are interested in developing system(s). Software development life cycle (SDLC), as an example, can provide a variety of methodologies to develop systems, mainly computer or information systems. The main phases of SDLC are planning, analysis, design and implementation. In a development life cycle, usually, there are steps to follow such as project planning (feasibility), requirement analysis, design, building, testing, implementing and maintenance as it is in SDLC.

Although, there are several methodologies or models developed for software development such as prototyping, rapid application development, open source development, etc., currently, there is no such a comprehensive application or framework that provides a roadmap for knowledge management. One possible reason for lacking such an application or framework may be the fact that developing a life cycle for knowledge management is more difficult than developing a system. One of the main reasons for this is that, developing a knowledge management may include developing software and it may include even more than just the system development itself.

A knowledge management may focus on many aspects from arranging a projector use for a conference [or competing a request for proposal (RFP), managing time or documents, following procedures] to developing a system/product (Kogan and Muller, 2006). Therefore, we need to see the knowledge management from different perspectives and create a comprehensive model/framework for it.

In the knowledge management literature, there are numerous studies regarding data, knowledge and knowledge management. On the other hand, knowledge management systems are still an active research area. Knowledge management life cycle has been examined through two common approaches: process approach and generic approach (Morrison and Weiser, 1996; Jennex and Olfman, 2004). However, to our knowledge, there is not such a work that combines these two approaches to a single framework.

In order to address the limitations regarding knowledge management development life cycle, we need to identify the terminology about knowledge management and some current categorizations about knowledge management as...
well as its components. A brief literature about the
terminology (that is, knowledge, process) and the
categorization (that is, segmentation, orientation) within
knowledge, knowledge management and its components
such as tasks, subtasks, methods and types would allow
us to see what can be done to address the development
life cycle. We will also propose a comprehensive model,
or a type of roadmap for developing knowledge work or
even system to fulfill the requirements.

Rest of the paper is organized as follows: Next section
provides a brief literature review about knowledge,
knowledge management, process, types of knowledge
and related terminology in order to give brief summary
about the concepts that knowledge management is
defined. The following section will be providing the model,
knowledge management system life cycle that knowledge
management field is lacking now. Finally, the discussion
and conclusion section will conclude the paper.

LITERATURE REVIEW

The main motivation behind using a development life
cycle is to provide successful results for the processes
and tasks that might be composed of complex tasks
(Bender, 2003). Development life cycles provide us
methodologies to resolve the complex issues such as
software development, or system development.

Systems development life cycle is an example for such
development cycle where the methodologies allow
people to divide the tasks into simpler ones and
accomplish the overall goals. Although, the number of
these divisions or phases and even terminology may vary
[summarized by Maier (2007) as knowledge management
system or software (Mertens and Griese, 2002; Tsui
2003), knowledge services (Conway, 2003), knowledge
management suite (Seifried and Eppler, 2000),
knowledge portal (Fernandes et al., 2005), organizational
memory system (Kühn and Abecker, 1997), etc.] in
general the phases in systems development life cycle
includes planning, system analysis, system design,
building, testing, implementation and maintenance
(Henderson-Sellers and Edwards, 1990; Davis et al.,
1988). In project planning or initiation phase, the goals of
the projects are determined. Goals are evaluated and the
 economical (that is, budget), operational (that is,
schedule), and technical feasibilities are determined. In
system analysis phase, the main objectives include
analyzing the requirements, identifying the problems in
the system as well as conducting a feasibility study
(Henderson-Sellers and Edwards, 1990; Maier, 2007). In
this phase, the problem is examined from different
angles, top-down or bottom-up and usually it is
decomposed that might be represented by a variety of
diagrams, structure charts, etc. (Henderson-Sellers and
Edwards, 1990). System design phase is examined
through several perspectives. The main concepts under
system design mentioned by Henderson-Sellers and
Edwards (1990) include broad design, logical design,
detailed design and physical design. Generally speaking,
in system design phase, more details are provided about
functions, tasks and processes through decomposition.
After this phase, a project should have been defined
[broad design (Sommerville 1989) or logical design
(Hawryszkiewycz, 1989)] in a very detailed way with its
business processes, functions, rules, structure of the
tasks, diagrams and related documentation (Wikipedia,
2011). Building phase is the phase where the actual
product (that is, software, system) is developed. Defining
the testing phase may be little bit more difficult than other
stages. Testing can be done in different levels. Tests can
be performed on units, systems (combination of units),
or even on user acceptance. Validity and sensitivity testing
are among the common testing methods for testing a
system (Henderson-Sellers and Edwards, 1990). Imple-
mentation phase is the stage where the product is
completed and installed. Maintenance phase deals with
the tailoring, modifications and updates to the system or
tailoring (Carney et al., 2000).

Each system has a purpose and in order to meet these
objectives for a system, there are several requirements
that a development life cycle should have. These
requirements include supporting the projects, technical
and managerial activities, and being usable (Bender,
2003). The same is report by Bender (2003) states that
while managerial activities include defining priorities,
managing reports, change control, identifying metrics
(that is, risk assessment, cost/benefit analysis), improving
relationships with third parties, etc., technical activities
include defining the system with its components, testing,
alternatives evaluating and identifying strategy.

The development cycle should also have a design
structure that will fit to requirements. Using a layered
approach and identifying what and how questions about
the system and components may be a good approach for
the development cycle (Bender, 2003) in terms of the
design structure. When developing a system using a
development life cycle, regardless of whether it is a
software or knowledge management, knowledge worker
or analyst must plan the development (including analysis
and design), deployment and maintenance of that project.
Therefore, the plans should be prepared carefully and
detailed in order design structure to fit to requirements.

On the other hand, although there are studies and
methodologies for developing life cycles, such as for
software and systems, there is only limited number of
studies that developed life cycle for knowledge
management systems. However, the existing models
mainly examine the knowledge from process perspective.
Therefore, the literature is still lacking a comprehensive
study examining the development life cycle for knowledge
work or knowledge management systems. This fact is
quite interesting considering that we are living in
information age where knowledge and information are
very valuable and considered as an asset for companies.
A plausible explanation regarding the lack of a development life cycle for knowledge work may be the broadness of this topic. There are numerous studies about knowledge, knowledge management (Chadha and Kapoor, 2010), types of knowledge and knowledge work (Awad and Ghaziri, 2004), different categorizations of these issues, organizations, components, etc. (Maier 2007). A study focusing on developing such a development life cycle should consider as much perspectives as possible, both organizational level and process level, in order to be able to provide a comprehensive model. In order to fulfill this requirement, in this study, we will try to look at knowledge and knowledge work from several perspectives in literature before proposing a solution for development life cycle.

In literature, different studies have mentioned knowledge, information, knowledge work, processes, tasks and related categorization about these topics. There are several definitions of knowledge. Eck (1997) defines knowledge by focusing on the motivation of knowledge as “salvation from not knowing, which assumes questions, doubts, pressure, necessity and demand for knowledge, curiosity” while Albrecht (1993) defines knowledge as “networks of information.” A more recent and comprehensive definition of knowledge by Maier (2007) is that it “comprises all cognitive expectancies—observations that have been meaningfully organized, accumulated and embedded in a context through experience, communication, or inference—that an individual or organizational actor uses to interpret situations and to generate activities, behavior and solutions no matter whether these expectancies are rational or used intentionally”. Probst et al. (1997) explain knowledge by emphasizing individuals and their skills and define knowledge as a "strategic resource."

In order to understand the knowledge management system, we need to examine the elements in knowledge management system. This includes examining the knowledge with its types and categories, and knowledge management life cycle with its elements under the examination of current proposed models. Collins (1993) and Blackler (1995) explain more about knowledge, and the authors develop and categorized knowledge in five types: embrained, embodied, encultured, embedded and encoded knowledge. Embained knowledge is the type of knowledge that is high-level and based on cognitive abilities. Embodied knowledge is action oriented and exists with interaction or practices, and mainly based on specific contexts (Collins, 1993) and physical presence (Blackler, 1995). Encultured knowledge is built upon shared understandings via socialization (Collins, 1993; Blackler, 1995). Embedded knowledge lies in systematic routines [that is, procedures, beliefs, relationships between technologies (Collins, 1993; Blackler, 1995)]. Encoded knowledge mainly deals with transmission and storage of knowledge through symbols (that is, book, data bases) (Collins, 1993; Blackler, 1995).

Knowledge has been distinguished as explicit knowledge or implicit/tacit knowledge (Hansen et al., 1999; Freeze, 2007). Explicit knowledge refers to transferrable knowledge in standardized manner. This requires knowledge to be represented in a language (Koskinen, 2003), documented and communicated (Alavi and Leidner, 2001; Freeze, 2007). Large scale databases are the common environments to keep the information so that it can be stored, transferred and reused (Hansen et al., 1999). Implicit knowledge is the one within individuals and it needs to be converted to explicit knowledge so that it can be shared, or reused (Becerra-Fernandez and Sabherwal, 2001). Tacit knowledge includes two dimensions (Nonaka, 1994): technical dimension that focus on know-how (Koskinen, 2003) and cognitive dimension that includes mental models, ideas, values, beliefs, etc. that can be transferred via observation, applying (Harigopal and Satyadas, 2001; Freeze, 2007), and experience (Nonaka, 1994). In addition, to the tacit and explicit knowledge, knowledge can be categorized as metacognitive, procedural, conceptual and factual (Salisbury, 2008). Metacognitive knowledge is the type of knowledge that is acquired through expert advice; procedural knowledge is the one that is acquired through examples; conceptual knowledge is acquired through instructions; and finally factual knowledge is acquired through documents (Salisbury, 2008).

Although, these studies are more in organizational level, looking from a broader perspective may be useful to see the overall picture for development life cycle. Nonaka (1994) proposed four modes, socialization, externalization, internalization and combination so that information can be converted between explicit and implicit. Socialization is about sharing implicit knowledge with activities (not with symbols as in embedded knowledge) and happens as the conversion from implicit to implicit knowledge (Nonaka, 1994). Externalization refers to expressing implicit knowledge and converting it to explicit one to make it easier to understand by using deductive/inductive reasoning, inference, visuals, etc. According to Nonaka (1994), internalization involves the conversion of explicit knowledge into implicit knowledge, which includes norms, values, relationships and procedures (Sagsan, 2006) with methods such as learning-by-doing/observation, meetings, etc. Combination refers to the conversion of explicit knowledge to more complex explicit knowledge (Nonaka, 1994).

Knowledge alone is not enough to add value many times, the right way to manage this knowledge is as important as knowledge itself. Therefore, there are numerous studies about knowledge management in literature. Knowledge management is defined as a process of capturing knowledge from inside and outside and transferring it through the organization in order to bring innovation (Shih and Chiang, 2005; Pablos, 2002). Balasubramanian et al. (1999) define knowledge management as “an organizational capability that allows people
in organizations, working as individuals (knowledge workers), or in teams, projects, or other such communities of interest, to create, capture, share and leverage their collective knowledge to improve performance. In addition to these concepts, based on the literature, knowledge management systems can be defined as an information systems (Damodaran and Ophert, 2000; Tsai and Chen, 2007) that contributes to organizational learning (Tsai and Chen, 2007) through acquiring, creating, storing, applying (Alavi and Leidner, 2001; Maier, 2007; Aujirapongpan et al., 2010), supporting (Jennex and Olfman, 2004), or acquiring, organizing, storing, accessing, sharing, applying and creating (Krishnaveni and Raja, 2009), and providing transformation between implicit and explicit knowledge (Maier, 2007) in order to provide the required information to the employees. The main objective of the knowledge management systems is to “manage organizational knowledge” (Jennex and Olfman, 2004).

Knowledge management systems can be examined through two perspectives (Jennex and Olfman, 2004): “process/task approach”, and “infrastructure/generic approach.” The first approach deals with processes, tasks, sub-tasks, and project and the ways to improve the effectiveness of these components. On the other hand, the second approach deals with building a systems to capture, share and use of information within the organization. While both of these perspectives are relevant for developing a knowledge management system, combining these approaches will address the needs of current business environment (Morrison and Weiser, 1996; Jennex and Olfman, 2004). This approach will allow extending the content of knowledge management work and providing a more comprehensive approach that will address not only to the specific activities of a work but also the organizational knowledge (Jennex and Olfman, 2004).

In literature, several researchers have distinguished different types of knowledge management. For example, Pablos (2002) and Tissen et al. (1998) mention two broad types of knowledge management: operational knowledge management that focuses on transferring knowledge via a link between people and the system as well as how to create a link and strategic knowledge management which is a process that deals with aligning organizational knowledge with business strategy, organizational structure and issues related to knowledge workers (Pablos 2002).

Managing knowledge requires focusing on the aspects of creating, storing, structuring, codifying, sharing, controlling, transferring, using and utilizing the knowledge (Sagsan, 2006). While Becerrera et al. (2001) identify four main processes; Sagsan (2006) extends their perspective by identifying seven sub-processes that support the main processes regarding knowledge management. According to the author, knowledge discovery is supported by combination and socialization; knowledge capture by people, artifacts, or organizational entities is supported by externalization and internalization of knowledge; knowledge sharing is supported by effective transfer, media and knowledge itself; knowledge application is supported by individual routines and directions (Sagsan, 2006).

Zhong et al. (2005) examine product development by using a history knowledge management perspective. In their approach, the authors define history knowledge as having three components: process history that includes current and previous information of design tasks, design intent that deals with the changes of design information with their steps, and finally domain knowledge that includes both implicit and explicit methods, and experiences regarding the design (Zhong et al., 2005). The authors integrate these processes with product development processes and propose a model that examined both components from process and operational levels.

In knowledge management literature, knowledge is examined as a perspective for processes (Eppler et al., 1999) that are basically ordered activities where some roles are assigned to. Eppler et al. (1999) and Hammer (1996) define process as a cluster of tasks that create or contribute to value for customers. Processes add value for customers by contributing to creating, finding, packaging, applying and reusing (shortly managing) knowledge in an organized manner (Davenport et al., 1996).

From the process perspective, knowledge work has two basic types: administrative or operational processes and knowledge intensive processes (Eppler et al., 1999). Administrative processes are usually the routine works and are structured (Eppler et al., 1999), as described by Collins (1993) as embedded knowledge, such as filling out forms, getting approval, etc. (Davenport et al., 1995). Eppler et al. (1999) proposed some attributes for knowledge intensive processes so that they can be distinguished from administrative processes. These attributes includes contingency, scope of decision, agent innovation and impact, half-life and learning period (Eppler et al., 1999). Another type of categorization regarding the attributes of processes is defined by Kogan and Muller (2006). They identify the attributes as unstructured versus structured, static versus dynamic, ad hoc versus predefined, one person versus multi-person, single use versus repeatable, business critical versus non-business critical and automated versus non-automated. A process can have one or more of these attributes. Eppler et al. (1999) also introduce the agent concept to the knowledge concept. Agents can be humans, machines, or even groups that are capable of processing information related activities for decision making processes (Eppler et al., 1999; Lebcher et al., 1998).

Complexity and knowledge intensity are other issues that provide useful analysis about knowledge work processes (Eppler et al., 1999). Number of steps to make up a process, the number of agents involved in a process,
interdependencies between agents and between processes and process dynamics are the main criteria to determine the process complexity (Eppler et al., 1999). Another dimension for the complexity determination is dependency (Wong and Dalmadge, 2004). Dependency occurs when two or more activities or processes share the same information resources. The implication of the information requirements vary based on the fit, share and flow of the processes regarding the way the processes interact (Wong and Dalmadge, 2004; Chandrasekaran et al., 1992). In order to identify the knowledge appropriate for process, an analysis about knowledge should be conducted. This analysis should include the information about know-how or basic knowledge about the process; knowledge about the content of the process; and knowledge captured from (an) other process(es) (Eppler et al., 1999).

Processes are not necessarily simple structures. Some processes may be complex and decomposition or breaking the processes into smaller processes or tasks is a useful method to analyze knowledge work. Task, another component to explain the life cycle, has several definitions that sometime create confusion. Wielinga et al. (1992) define task as "fixed strategy for achieving a goal." This definition of task is very similar to the definition by Chandrasekaran et al. (1992) for method. On the other hand, Chandrasekaran et al. (1992) define task, more specifically generic task, as "components of composite method." The authors also propose task structure that is a kind of hierarchical structure representing tasks, methods and subtasks as a tree. In this structure, the processes can be represented as a combination of tasks, methods, which are ways to accomplish tasks and subtasks. Task structure has mainly three components: an input and output, specific and determined methods/subtasks and knowledge required for managing subtasks, and method selection (Chandrasekaran et al., 1992). Tasks are usually used for converting the problem state into goal state (usually instance based) (Chandrasekaran et al., 1992); therefore, they may be useful in an analysis phase. Methods can be in various types (that is, computation, simulation) and various selections of method are available.

Chandrasekaran et al. (1992) also propose a useful and straightforward method for the analysis of task and subtasks, called propose, critique and modify (PCM). PCM allows to organize the subtasks with a simple algorithm that follows the steps as proposing a solution based on the design goal, verifying the proposal and critiquing the proposal in unsuccessful or modifying it in successful case (Chandrasekaran et al., 1992). These steps also can be organized in different combinations and also used in a recursive manner to accomplish the task.

Problem-space search is also a method in task structure analysis (Chandrasekaran et al., 1992). This method can set up alternatives, or can refine knowledge systems by using explicit knowledge and is capable of selecting and integrating different methods or subtasks. The state after selecting and integrating the subtasks or methods becomes a new state and this operation is repeated from it initial state until the goal state is reached (Chandrasekaran et al., 1992). As part of the analysis, problem-stage is converted to solution-space through functional decomposition (Henderson-Sellers and Edwards, 1990). This method may be useful while analyzing a knowledge management system in order to determine the components (tasks, subtask and methods) and the sequence among them.

Another dimension that might be useful for developing the life cycle may be orientation of knowledge processes. This is called the generic method for knowledge management systems (Morrison and Weiser, 1996; Jennex and Olffman, 2004). Alavi and Leidner (2001) state four sets of knowledge processes: knowledge creation, knowledge storage/retrieval, knowledge transfer and knowledge application. Although, it is possible to find different types of orientations in literature, since they fit well to life cycle concept and broad enough to cover many aspects mentioned in literature, we will focus on these sets in this paper.

Knowledge creation is "the interaction of knowledge, between the tacit knowledge and explicit knowledge" (Aujirapongpan et al., 2010). Knowledge creation refers to developing a new content. If the content exists, it requires replacing the existing one. It is a continuous action that involves both tacit and explicit knowledge. Knowledge creation is also mentioned by Nonaka (1994) and four types of knowledge creation were defined as mentioned above (socialization, externalization, internalization and combination). Aujirapongpan et al. (2010), mention another stage in the knowledge process; knowledge acquisition. Knowledge can be acquired either from internal resources such as reports and work practices or external resources such as competitors, partners, or clients.

Knowledge storage/retrieval refers to a kind of memory that stores the created knowledge (tacit or explicit). Written documents and databases are among the common examples for the components of this memory (Alavi and Leidner, 2001) and ideally the more the number of databases the more efficient knowledge storage and retrieval (Franco and Mariano, 2007; Aujirapongpan et al., 2010). After storing the knowledge that is created, next step includes transferring that knowledge between individuals, groups, or organizations through some channels (may be formal, informal, personal or impersonal (Marquarde, 1996; Aujirapongpan et al., 2010)).

Finally, knowledge application refers to applying the knowledge or using it for a specific purpose (Alavi and Leidner, 2001). Utilization and application of efficient knowledge has benefits for organizations. Reducing business costs and risks, improving productivity, quality, scheduling, employee and customer satisfaction and value creation are among the most highly cited benefits.
of utilization and application of effective knowledge in organizations (Maier, 2007; Aujirapongpan, 2010).

Similar perspective regarding orientation of knowledge process has been used by Sagsan (2006), Lee and Hong (2002), Awad and Ghazi (2004) and Birkinhaw and Sheehan (2002). The categories that Lee and Hong (2002) used include capturing, development, sharing and utilization of knowledge, while Awad and Ghazi (2004) named them as capturing, organizing, refining and transferring. The authors define the step where knowledge is obtained as knowledge capture. Databases and data warehouses are examples of knowledge capture applications. Once the knowledge is captured, analysts can analyze the data for a better decision making. This step is called knowledge development (Lee and Hong, 2002). On-line analytical processing (OLAP) and data mining tools are among the most common applications regarding this step (Lee and Hong, 2002).

Third step of the life cycle refers to distribution of the analyzed knowledge. Internet and group support systems can be listed as common applications of this step (Lee and Hong, 2002). Finally the last step in the life cycle deals with end users and how effectively they use knowledge regardless of their familiarity with computer systems (Lee and Hong, 2002). Organizations need to develop user friendly interfaces or applications so that all employees can reach and use the knowledge regardless of their computer skills (Lee and Hong, 2002).

Birkinhaw and Sheehan (2002) examine life cycle for knowledge and their framework for the life cycle which includes four phases such as creation, mobilization, diffusion and commoditization. This cycle emphasizes that knowledge will be generalized through organizations after it is created in one organization. Initially, the knowledge will be mobilized within only one organization and then will be diffused to others slowly. The reason for diffusing this knowledge in this stage stems mainly from the difficulties regarding keeping the knowledge to itself (Birkinhaw and Sheehan, 2002). However, organizations can develop strategies regarding diffusing the knowledge and extract benefits and values from this situation (Birkinhaw and Sheehan, 2002). In the final stage, organizations attempt to manage the knowledge that is about to be exposed to the public. The authors state that, life cycle concept is not a static structure and executives need to work hard to identify the correct stage they are in as well as their goals (Birkinhaw and Sheehan, 2002).

In his model, Sagsan (2006) identify five processes: creating, sharing, structuring, using and auditing as part of a life cycle for knowledge management. Ability, intuition, skills, behaviors and experiences of participants are the main source for creating the knowledge in an organization (Sagsan, 2006; Nonaka and Takeuchi, 1995). The author identify the requirements of knowledge sharing as formal and informal communication networks involving oral, written, nonverbal communication, organizational learning, teamwork, exercises, etc.

Organizations need to have both social and technical communication infrastructure available for a more effective interactivity (Sagsan, 2006). Main components of knowledge structuring include "sorting, organizing, codifying, analyzing and reporting information" (Sagsan, 2006). Nonaka (1995) and Sagsan (2006) mention three main reasons why organizations use knowledge. These reasons include enhancing competitive advantage, designing the product more effectively and enhancing quality, especially for services. The author defines knowledge auditing and the final process, as "what amount of knowledge can be used in organization’s products, services and processes". Benefits of knowledge auditing include defining knowledge based strategy and architecture, more efficient research and development planning, accurate intellectual capital measurement, etc. (Sagsan, 2006).

A similar but less detailed framework was developed by McElroy (1999). McElroy (1999) identifies two broad phases, knowledge production and knowledge integration as part of knowledge life cycle. Knowledge production includes four processes such as individual and group learning, knowledge claim formulation, information acquisition and knowledge validation. According to this framework, organizational learning begins with individual or group learning within the organization. Next step is formulating the produced or acquired knowledge. The third process involves improving the learning with feedbacks from the integration activities. The final process ensures the higher value of produced knowledge. Knowledge integration process deals with the transformation and integration of the produced or acquired knowledge (McElroy, 1999).

Another categorization regarding knowledge and life cycle has been provided by Firestone (2002). According to this framework, processes regarding knowledge have two main categories that also have sub-processes: knowledge production and knowledge integration. Knowledge creation deals with information acquisition, learning from individual and group perspectives, knowledge claim formulation and evaluation. On the other hand, knowledge integration includes diffusing the created knowledge, searching knowledge, disseminating the knowledge and sharing the knowledge.

Siemieniuch and Sinclair (2004a) have developed a framework for organizational readiness for knowledge life cycle management. The authors examined how knowledge was created, captured, utilized and retired within the organizations. They also identified fourteen steps in order to be ready for knowledge life cycle management. These steps include: a) building trust through leadership; b) identifying roles; c) establishing ownership (that is, process and content) policies for knowledge; d) identifying security policies to identify the leakage and ensuring the appropriate usage of knowledge; e) creating generic processes and procedures; f) altering the processes and current infrastructure; g) identifying reward
Figure 1. Proposed model for knowledge management development life cycle.

policies; h) performance evaluation on knowledge management; i) developing communities of knowledge; j) developing an activity-based costing approach; k) creating "stretch-targeting process"; m) enhancing project review procedures for knowledge; and n) building dynamic knowledge databases (Siemieniuch and Sinclair, 2004a).

Siemieniuch and Sinclair (2004b) have divided the framework for knowledge life cycle management, called as CLEVER, into four stages as problem definition, solution overview, critical migration paths and right process. In the first stage, current problems, drivers of the business, characteristics, sources availability and enablers regarding the knowledge management are identified. In the second phase, executives identify the specific components of knowledge management regarding the solution of the problem. Third phase is more detailed than the second one and in this phase specific paths for every problem or issue that are identified in previous phase are determined. The final phase ensures the readiness of the organization to proceed with the knowledge management as well as the processes suitable for the chosen path (Siemieniuch and Sinclair, 2004b). Users can use templates that are suggested by the authors to decide whether their paths require focusing on capturing, retrieving, propagating, sharing and maintaining knowledge (Siemieniuch and Sinclair, 2004b).

These different perspectives on knowledge and knowledge management provide some information regarding the knowledge management and related concepts including the ones that will be used in the proposed model as a solution for knowledge management system development life cycle. Next section will provide the model and related explanations.

CONCEPTUAL MODEL FOR KNOWLEDGE MANAGEMENT SYSTEMS LIFE CYCLE

A development life cycle for knowledge work or process is much like a system development life cycle. However, this does not mean that there are no differences between them. Awad and Ghaziri (2004) identify the key similarities and differences between two types of life cycles. First of all, in the generic life cycle, usually, the system analyst deals with the collection of data to be analyzed while in knowledge management systems life cycle (KMSLC), knowledge developer deals with collecting knowledge. While the initial one is sequential (Lam and Chua, 2009) and deals with novice users, the later one is interactive and deals with more experienced people who have the knowledge about both the problem and the solution. Another difference is regarding the nature of the systems: while generic life cycles are process-driven, KMSLC is result-oriented (Awad and Ghaziri, 2004). Last but not least, the testing phase which is much more comprehensive in KMSLC. Unlike in generic life cycles whose testing phase is usually right after building the system, in KMSLC, the testing takes place with the beginning of the life cycle, through verifications and validations (Awad and Ghaziri, 2004). Therefore, the life cycle that we are proposing address the life cycle of knowledge management systems and different from the generic life cycle systems. In addition, our life cycle addresses the knowledge process and places it in the life cycle that has not been done before to our knowledge. Considering the fact that a software development may be considered as a knowledge work (in a big picture), it is obvious that the differences might be based on the additional properties of a knowledge work. As it is in the system (software) development life cycle, the proposed model for knowledge management development life cycle has main elements or phases. The proposed model that examines knowledge work from a broader perspective rather than merely process level is shown in Figure 1 with its different stages. Requirements for a life cycle for knowledge management system can be grouped under five major categories:

1). Planning
2). Analyzing
3). Designing
4). Building, testing, and implementing
5). Evaluating

Planning

Planning phase includes several sub-sections such as identifying business problem, analyzing current infrastructure as well as identifying the alignment strategy between knowledge work and business strategies. However,
while considering the knowledge work, not the knowledge systems itself, the knowledge worker may not need to address these issues in detail. In many cases, these requirements might have been predefined and knowledge worker may just need to obey them.

In planning phase, knowledge worker can begin with determining the type of project whether it is a new one, or an existing one. Knowledge worker also needs to identify the size of project or knowledge work in the planning phase (Bender, 2003).

### Analyzing

Analyzing phase is more complex compared to planning phase. Analyzing includes identifying and evaluating processes. Analyzing can be done from different perspectives and the major perspectives are technical and managerial ones. Technical perspective provides information regarding what tasks should be performed and how (Bender, 2003). Identifying the knowledge management architecture, which can be categorized under analysis includes defining the system and its components such as current infrastructure, platforms and the technology, both current and required, is appropriate for the solution of a problem, flows, functions, processes, and even task-structure analysis that will be used in the knowledge work. Flexibility as well as support can be assured in the life cycle by separating the tasks from each other and clarifying how to achieve or do these tasks (Bender, 2003). Therefore, a task structure is a crucial step under analysis phase. In addition, the categorization or identifying the types of knowledge begins in this stage.

In this phase, knowledge work, including knowledge process, is analyzed in terms of the knowledge complexity and intensity. In this analysis, the goal is to analyze knowledge and determine the number of steps in a process, number of agents, process dynamics and dependencies among resources that are based on the fit, share and flow of processes.

Managerial perspective of analyzing involves organizing, coordinating and controlling of a knowledge work (Bender, 2003). The report by Bender (2003) also states that setting priorities within the functional area as well as within a system; defining objectives regarding the reasons to conduct the project, benefits, etc.; tracking through comparison of plans with the existing results; change control through four characteristics of “time, function, resources and quality”; risk assessment are some of the topics that must be covered in a knowledge work from managerial perspective. Works regarding generic approach begin at this phase. Staffing (that is, designing teams) can be done under either analysis phase or design phase, so we can write it under a mid phase between analysis and design. Staffing or designing teams requires identifying the potential stakeholders and associating the appropriate members to the knowledge management system. Successful team composition and team success depend on the quality of the members, size of the team based on the complexity of the project and motivation (Awad and Ghaziri, 2004).

### Designing

Design phase is arranged based on the objectives and requirements. The tasks used in the design phase should be layered and the design should be accomplished with an iterative approach (Bender, 2003). In this approach, as the layers go down, more detailed information is provided. This phase is similar to task-structure analysis where each task can be divided into sub tasks and methodologies appropriate and available in the current system development, cost is also another factor that may affect the timing for the test. The report states that the phases and processes should be organized in a hierarchical manner. Combination of the two approaches, process and generic is initiated in this phase. The strategy for designing (push, pull, index, search, profiling, etc.) is also prepared in this stage. There should be a design strategy for the format and the contents. This phase is the right one in order to identify critical points for a knowledge work and the tools that can be used for that knowledge work (including the processes and tasks). If there will be any changes in the project, these changes can be identified in this phase also.

### Building, testing and implementation (BTI)

Building a knowledge process mainly involves following the steps developed in analysis and design sections with methodologies appropriate and available in the current system. Similar to the building section, testing section also involves following several rules determined at planning and analysis phase. However, testing is different in a sense that it may be done in any section. Testing is a continuous process and may be part of every step in knowledge work (Bender, 2003; Awad and Ghaziri, 2004). Testing can be done as soon as completing a task or after a set of tasks or processes. The objectives should be very well determined for the test phase. Process complexity mentioned in previous section and knowledge intensity can be determinants by issue of when to test. According to the BRT’s (2003) report, in a system development, cost is also another factor that may affect the timing for the test. The report states that, usually cost is less in earlier stages. Simply, a test may include a simple development life cycle in itself. This development cycle may include some sections such as
defining the test criteria, designing this criterion, building test case, executing and verifying the test results (Bender, 2003). These criteria help to determine how much of the system or project have been completed, whether the current work is appropriate with the success criteria, steps, fitness of the testing activity to the plan, etc. of the tests based on the planning and the analysis (Bender, 2003).

Implementation may sometimes include several conversions that may require some amount of training in the existing system. Implementation may also include a small life cycle in itself. Setting various goals for implementation, defining the approaches and stages, including the tasks and their sequences, inputs and outputs are among the requirements of implementation part. Unlike the generic system life cycles, testing is not only after the implementation. On the contrary, testing is more comprehensive and starts with the life cycle (Awad, and Ghaziri, 2004).

In this phase, preparing a lessons learned information regarding mistakes, potential improvements in processes, tools and platform selection, budgeting, critical points and success factor, etc. (Eppler et al., 1999) might be useful for future process developments as well as preparing a background for sharing and reusing the produced processes and tasks.

**Evaluating**

The main objectives of a development life cycles include productivity maximization and producing high quality outputs (Bender, 2003; Maier, 2007; Chadha and Kapoor, 2010). Knowledge management system should be evaluated to see whether it has achieved its goals or not. Evaluation can be based on either financial or non-financial metrics (Oliveria and Goldoni, 2006). Developing metrics or measurement of quality or success of the knowledge work has been encouraged by researchers (Ahn and Chang, 2004; Owlia, 2010). Developing metrics about the knowledge work, project, or system allows management to: i) evaluate and compare the objectives and outputs of knowledge work; ii) identify the areas to be improved; iii) monitor the progress of the knowledge work (Owlia, 2010); iv) monitor the financial situation of the investment for the knowledge management system (Turban and Aronson, 2001).

Many times, while productivity is usually addressed with amount and value, the quality is based on the return on investment for that product or system (although there may be other methods for intangible assets). However, in recent studies, in knowledge management literature, there are broad criteria for the quality assessment of knowledge management systems. Functionality (providing primary knowledge and primary functions of knowledge process, user satisfaction, etc.), completeness (addressing the supplementary requirements such as expert systems, etc.), reliability (such as accuracy, consistency, etc.), usability (training, user friendliness, etc.), access (availability, response time, etc.), serviceability (customizations, responsiveness, etc.), flexibility (scalability, etc.), and security (privacy, control, etc.) of knowledge management systems are among the top criteria for the quality assessment for knowledge management systems (Owlia, 2010).

After completing a project, or in our case (a knowledge intensive work), identifying some metrics regarding the desired outputs’ goal may provide a valuable resource for the current and future processes/works. As part of evaluation, management should address the issues such as the degree to which the system has caused the organization to change, the satisfaction and perception of end users to the new system and customers to the organization, improvements in decision making, how business processes and organization have been affected financially by the new system (Awad and Ghaziri, 2004).

A hierarchical manner is recommended for a standard life cycle (Bender, 2003). In addition, the phases in the development cycle are related and sometimes a later stage may affect the previous stage. For example design decisions may affect the process of analysis and also implementation decisions may affect design and also analysis phases (Bender, 2003).

**DISCUSSION AND CONCLUSION**

In today’s business environment, greater emphasis on knowledge has been placed. The use of knowledge, its categorization as well as benefits are still an active research area. Knowledge and knowledge work has a life cycle as other information systems has. Understanding the life cycle and its dynamics allows executives to identify the criteria for the required knowledge as well as the tools and methods to manage the knowledge (Birkinshaw and Sheehan, 2002). In addition, the life cycle can improve the understanding of executives or chief knowledge officers regarding knowledge management and guide them to succeed in managing the knowledge (Sagsan, 2006).

Development life cycle ensures that all functional requirements and organizational goals are met by providing a structures process involving different phases (FEA, 2011). The phases allow knowledge worker to track the development of a system that includes several steps. Bender (2003) states that, it is not very important how the steps are called or categorized; the important issue in a development cycle is to be able to fully address the items. The framework attempted to include as much different perspectives on process and knowledge work as possible and tries to include different levels of perspectives to be examined in the life cycle.

This study attempted to provide a comprehensive model for knowledge management life cycle. The framework
provided the basic phases of the development life cycle and the steps within each one. Although some of the steps can be categorized under two different phases or a separate mid-phase, the steps were satisfactory enough to provide an abstract level of process or work categorization. Because of this overlapping, sharing and reusing the knowledge work or its components brings advantages to knowledge management development life cycle.

The proposed framework had the main phases and related steps in each phase. However, the broad perspective of interdisciplinary field of knowledge management systems makes harder to propose a more complete framework. The proposed model had the required items fully as planning, analyzing, designing, building, testing and implementing, and evaluating knowledge management systems. The framework defined the work based on the current infrastructure based on the business goals. The work then was divided into sub-components and each sub-component can be handled separately for the design. Every work was tested after building the work. As soon as the work is deployed, it is evaluated by the predefined metrics.

There are several criteria for evaluating a development life cycle. An important criterion include whether each item is addressed completely or not, while some other criteria may include evaluating effectiveness, efficiency, usability and also satisfaction. Our focus in this study was to address as many issues as possible to provide a comprehensive framework. We followed Morrison and Weiser's (1996) approach to present a framework that would address both process/task approach and infrastructure/generic approach. This approach provided a framework to deal with specific activities through process-task-project focus and organizational knowledge through acquiring, creating, sharing and using the knowledge. Therefore, this study is different from previous work in the sense that it combines the generic approach (Birkinshaw and Sheehan, 2002; Krishaveni and Raja, 2009) with the process approach. The two approaches may overlap in some areas; however, they can be used to complement each other as the framework proposes.

With the new knowledge management system, management may face a resistance from employee. In order to eliminate the resistance and motivate the users to use the systems and minimize future development problems, management may need to support user training and education and training of knowledge workers, as they provide a reward system for the experts (Awad and Ghaziri, 2004). Knowledge management systems should be considered as part of the strategic plan and its importance should be understood by both IT managers and other executives. Top managements support should be provided for the systems to be successful. Awad and Ghaziri (2004) state that, management should be informed as regard the current and future costs and benefits of the system. Management should be eager to take the required steps to ensure the quality of the system, therefore, the knowledge.

REFERENCES


Davenport T, Jarvenpaa S, Beers M (1996). Improving work processes: Center for Business Innovation, Ernst & Young LLP.


