Knowledge Management Systems Development and Implementation: A systematic Literature Review

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Abstract. Knowledge management systems can help to automate KM processes that exist in organizations. These systems facilitate knowledge discovery, knowledge capture, knowledge sharing, and applying knowledge in an organization. Using appropriate methods to develop and implementing knowledge management systems help organizations realizing these systems more effectively to enhance an organization's competitive advantage and facilitate KM processes. This study investigates the approach for developing knowledge management systems in organizations with a systematic literature review in the past ten years. The findings in the literature study show that seventeen methods are used in the development of KMS, where the SECI knowledge spiral is the most often method used for developing KMS by combining it with traditional IS development techniques. In this study, we also compare five methods as candidates for KMS development methods that can support the acceleration of the innovation process in organizations and evaluate them based on KM criteria that support innovation using the analytic hierarchy process technique. It is found that Fernandez's methodology combines with Joint Application Design (JAD) adoption is the most prominent method used in building a knowledge management system to support the innovation process in an organization and web 2.0 as the most technology applied to support organizational KM implementation.

1. Introduction

Experts give various definitions of knowledge management systems. Alavi and Leidner in [1] state that the KM system is a class of information systems applied to manage organizational knowledge by implementing IT-based systems developed to support and enhance KM. Another definition, according to Becerra-Fernandez [2], KM systems is an integration of technology and mechanisms designed to help four KM processes, namely discover, capture, sharing, and applying knowledge. Knowledge management systems are divided into knowledge discovery systems, knowledge capture systems, knowledge sharing systems, and knowledge application systems. Each of these systems automates each of the KM processes. At the beginning of its emergence in the mid-1990s, most knowledge management systems focused on identifying and capturing tacit and explicit knowledge related to the company and concentrating on a broadly accessible through the company platforms, these platform including Intranets, corporate portals, knowledge repositories, document management systems, and so on [2]. Along with the times, the KM system is no longer limited to these traditional KM systems, as is the emergence of web 2.0 and big data technology. Developing a knowledge management system is not a simple thing because it involves more dominant social aspects than technical issues, thus robust methodologies or frameworks to build a knowledge management system aligned with an organization's goal. This study explores the current methods used for developing knowledge
management systems from an organizational perspective by performing the Systematic Literature Review [3].

2. Theoretical background

2.1. Knowledge Management and KM Systems
Knowledge management is defined as a series of activities carried out, including discovering, capturing, sharing, and cost-effectively applying knowledge to achieve organizational goals. Knowledge management consists of two aspects, namely knowledge management solutions that are more specific, and knowledge management foundations that are broader and long-term. Knowledge management solutions refer to ways to manage knowledge management aspects, namely knowledge discovery, knowledge capture, knowledge sharing, and knowledge applications. Knowledge management solutions consist of knowledge management processes and knowledge management systems [2]. Knowledge management involves social and information technology aspects in its application and is sometimes seen as emphasizing social rather than technical aspects. Knowledge management also focuses attention on activities that produce explicit or tacit knowledge. Knowledge management systems are more than just information systems or IT-enabled tools for supporting KM activities. The knowledge management system must be a socio-technical system as a whole, which involves the knowledge itself which is the intellectual capital of the organization, intangibles organizational attributes such as trusting culture, policies, and procedures as some form of electronic storage and retrieval systems [4].

2.2. Systematic Literature Review
The process of identifying, measuring, and interpreting all available research evidence in the literature to answer particular research questions is defined as a systematic literature review. Kitchenham [3] designed a systematic literature review protocol consisting of 3 stages: conducting, planning, and reporting. The primary method used for the synthesis of literary journals is a systematic literature review (SLR). SLR is a rigorous methodological review of research results that aims to gather all available evidence on research questions to support practitioners’ development of evidence-based guidelines. The evidence here is defined as a synthesis of the results of scientific studies of the highest quality on a particular topic or research question [5].

2.3. Analytical Hierarchy Process (AHP)
The Analytical Hierarchy Process (AHP) method is a multi criteria decision-making method developed by Thomas L. Saaty, which describes complex multi-criteria problems into a hierarchy. The first multilevel structure is the goal (goal), the second is the criteria and sub-criteria, and so on to the last level, namely alternatives/choices. Each criterion in the AHP model will be assessed in pairs using a pairwise comparison assessment matrix. For each alternative, a pairwise comparison assessment will be carried out based on the specified criteria [6].

3. Methodology
By using Kitchenham's [3] systematic literature review method, we follow the guideline to investigate previous research to provide answers to the following research questions:

- What methods or frameworks used for the development and implementation of KM Systems?
- What technologies are used in the implementation of a knowledge management system?
- What is the most prominent method for developing KMS that supports the organizational innovation process?

Protocol reviews were provided using the concept of PICOC (population, intervention, comparison, outcomes, and context) to find related studies that will answer these research questions. Subsequently, we selected full text of titles and abstracts and extracted journal content by following the specified research questions and protocols.
Table 1. PICOC criteria.

| Population       | Knowledge Management Systems               |
|------------------|--------------------------------------------|
| Intervention     | Organizations, Governments, Private Sectors, small-medium enterprises, Education |
| Comparison       | None                                        |
| Outcomes         | KM systems development/implementation frameworks or Methodologies |
| Context          | Studies in Organizations                    |

Based on the PICOC criteria above, a search string was arranged to find related studies in some database repositories, namely Scopus, ScienceDirect, IEEE Xplore, Emerald Insight database repositories.

“(knowledge AND management AND systems) AND (organisat* OR organizat* OR government OR private OR educat* OR public OR small-medium enterprise* OR SME*) AND (method* OR framework*)”

A total of 4,816 research papers were generated based on search strings from these databases in the latest ten years. The first step is to read the title and abstract to determine the article's primary candidate to be reviewed. The inclusion and exclusion criteria were also arranged to select the literature search results found with these following rules. Based on these criteria, we evaluated the papers’ titles and abstracts to find the primary studies related to the topic that discusses methodology and framework for developing KM systems. Twenty-nine primary studies discuss the methodology and framework for the development and implementation of KM systems were selected.

Table 2. The inclusion and exclusion rules.

| Inclusion                                      |
|-----------------------------------------------|
| 1) Studies must be in English                 |
| 2) Studies must be in private/public organizations |
| 3) Studies discussing methods/framework for implementing KM Systems |
| 4) For studies that have journal and conference version, journal version will be included |
| 5) For studies that has duplicate publication, the newest study will be included |

| Exclusion                                      |
|-----------------------------------------------|
| 1) Non-English study                          |
| 2) Studies without strong validation of method/framework proposed |
| 3) Studies discuss KM systems without purpose to propose method/framework for the implementation |

4. Result and Discussion
This section presents findings from twenty-nine literature studies selected.

4.1. Method for developing KM Systems

There are seventeen methods currently used in KMS development, as shown in Table III. The first KMS development method is the SECI knowledge spiral as one of the most often used ways for developing KM systems in organizations. This method is often combined with traditional IS development methods as UML diagram modeling, data models, application prototypes, and knowledge taxonomy [7], or merge with another technique as Wiig KM Cycle and develop using open source KM application such as Alfresco [8]. Another method most often used is Tiwana's KM roadmap. Suroso et
al. [9] using all the stages in Tiwana's 10-step KM roadmap. While Retnoningsih et al. [10] using only seven steps in its method. These two researchers also designed the KMS prototype. The second KMS development method that is frequently used is Fernandez's methodology. This methodology in its original source [2] is determining the KM process most needed by the organization which is called contingency factors. By knowing the KM process required, it can also be known the most KM systems that are required. To design a complete KMS, Sensuse et al. [11] combine this method with the Joint Application Design (JAD) technique to elicit system requirements. Sutoyo et al. [12] combined Fernandez's methodology with gamification, subsequently design features for KMS using case diagrams. Irawan and Samsuryadi [13] combined Fernandez's methodology with a soft system methodology to model the KM system. Muslikhah [14] uses a soft system methodology to identify system requirements and develop them into the KMS prototype. The KMS prototype is evaluated by the user using a Likert scale to determine user-level approval for the KMS features.

| Table 3. Current KMS development methods. |
|------------------------------------------|
| KMS Development Method                   | Source                        |
| SECI Knowledge Spiral                    | [15] [7] [8] [16]             |
| Tiwana’s KM roadmap                      | [9] [10] [17] [18]            |
| Fernandez methodology                    | [12] [13] [11]                |
| Soft system methodology (SSM)            | [13] [14]                     |
| Integrated Component-Based KM Model for Healthcare | [19]                  |
| APO Framework                            | [20]                          |
| A framework for designing postgraduate research supervision knowledge management systems | [21]                   |
| Wiig KM Cycle                            | [8]                           |
| Question-based method                     | [22]                          |
| Common KADS                              | [23]                          |
| An agile methodology for implementing knowledge management systems | [24]                      |
| Knowledge management systems for tourism crisis management framework | [25]                       |
| Five grounded principles for KMSD        | [26]                          |
| An abstract methodology for developing KMS | [27]                       |
| W2KM Methodology                         | [28]                          |
| NOMAD KMS development                    | [29]                          |
| Using the statistic technique Pearson correlation to determine KM processes needed, mapping the KM processes with KM technologies, and design KMS with UML diagram. | [30]        |

Arshad et al. [19] propose an Integrated Component-Based KM model, which consists of the components needed in building KMS in health services. Nugraha et al. [20] using the Asian Productivity Organization (APO) framework to analyze existing knowledge management in the organization, which is used to analyze for developing KM systems. Yew et al. [21] propose a conceptual framework that integrates the supervision process, KMS activities, and information technology to design supervision KMS for postgraduate students. Mardhia et. [22] using a question-based method and the Global Knowledge Management Framework. Santirojanakul [23] uses the CommonKADS framework to analyze problems and opportunities, describe organizational aspects, design KM systems using case diagrams, and develop KMS prototype. Amine et al. [24] propose a new method in KMS development, which calls An Agile Methodology for Implementing Knowledge Management Systems, using the concept of Component-Based Software Engineering. Jia et al. [25] propose a conceptual framework of KM systems for tourism crisis management. This framework is an autonomous software system that can collaborate to extract and disseminate knowledge in all stages of the crisis. Woodman and Zade [26] propose five principles for developing KM systems in organizations using grounded theory. This set of principles act as a practical guide that must be considered when building KM systems in organizations. Dehghani and Ramsin [27], Orenga-Roglá, and R. Chalmeta [28] proposed novel methodologies for developing the KM system. These methods consist of stages and activities that are carried out in developing KMS. The methodology proposed by
Dehghani and Ramsin [27] is more general in the development of KMS, while Orenga-Roglá and R. Chalmeta [28] emphasize the use of web 2.0 technology and big data. Hetey et al. propose the development method of a knowledge management system for the NOMAD instrument onboard the ExoMars TGO spacecraft. The KMS maintains technical knowledge of spacecraft instrument development, which consists of the official documentation and technical documentation of projects undertaken. Last but not least, Cahyaningsih et al. [31] combine the statistical techniques of Pearson correlation to determine the KM process and the technology required. Then proceed to design the KM system using use cases and class diagrams and developing a KM system prototype.

Figure 1. Current KMS development used in the Literature.

4.2. Technology that supports KM

There are differences among experts regarding the definition of the KM system. Alavi and Leidner [1] define KM systems as a class of information systems that support the creation, transfer, and utilization of knowledge. Meanwhile, Fernandez [2] considers the KM system as an integration between the latest technology and a knowledge management mechanism developed to support the four KM processes, namely knowledge discovery, capture, sharing, and application. The two definitions provide two different points of view held by the researchers.

The first considers the KM system as part of the information system that facilitates the KM process. The second view considers the KM system as a system that supports KM processes in various kinds of technology. The following are some of the technologies used based on the two common views about KM systems.

| KM Technologies | Technologies | Source |
|------------------|--------------|--------|
| Database Management System | [25][32][21][2] |        |
| Data mining/Knowledge Discovery in Database | [25][21][2] |        |
| Information Retrieval Systems | [25][18][17][14] |        |
| Repositories of information | [2] |        |
| Wiki | [25][33][28] |        |
| Web Applications/Portal | [25][33][2] |        |
| Document management system | [25][17][14] |        |
| Web 2.0: e-Collaboration/Electronic discussion group/Forum/Chat/Blog | [25][33][28][30][32][23][18][17][14][2][34] |        |
| community of practice tool | [18][2][34] |        |
| virtual work space application | [18] |        |
| Work performance system | [30] |        |
| Video conference | [30][33][2] |        |
Researchers such as Obeidat et al. [35], Rumanti et al. [36], and Yousaf & Ali [37] reveal a positive relationship between the implementation of knowledge management and an increase in innovation capabilities in an organization. In this section, we attempt to evaluate the five methodologies we have chosen based on our subjective views to determine which KM system development methodology is most prominent for building a knowledge management system that will accelerate the innovation process in organizations. The evaluation conducted has a goal to produce KMS that supports innovation.

The evaluation criteria are obtained from a literature study's results by collecting candidates for the KMS evaluation criteria that support innovation in the literature and grouping them into four criteria. Three experts assist in this evaluation, where these experts are researchers in information systems and knowledge management with a master's educational background in the field of information technology. The following is the AHP model used in the evaluation and the results obtained.

| CR_ID | Criteria                                                      |
|-------|---------------------------------------------------------------|
| CR-01 | The method used produces KMS that facilitates collaboration  |
| CR-02 | The method used can identify critical knowledge.              |
| CR-03 | The method used can identify the technology needed            |
| CR-04 | The method used is able to identify KM Processes              |

| M_ID | KMS Development Methods                                      |
|------|-------------------------------------------------------------|
| M-01 | Fernandez Methodology + Joint Application Design (JAD) adoption [11] |
| M-02 | W2KM Methodology [28]                                        |
| M-03 | An abstract methodology for developing knowledge management systems |

4.3. Evaluation of KMS Development (KMSD) Methodology to Support Innovation
There are five methods in developing KMS, as shown in Table 6. The first method (M-01) is a combination of the Fernandez contingency factor method combined with the JAD approach known in IS development. The second method (M-02) is a novel propose KMS development method that emphasizes web 2.0 technology and big data. The third method (M-03) is also a new method proposed in KMS development. The fourth method (M-04) is an old method known in KMS development, which is often combined with UML techniques and prototypes, and finally (M-05) is a method development of KMS with a combination of SECI analysis techniques with the taxonomy of knowledge in organization and use case diagrams.

Figure 2 shows the AHP model used where the first level is the goal, which is to select the KMS method that can be used to build KMS to support the organization's innovation process. The second level is the evaluation criteria (see Table 5), then the third level is the evaluated method (see Table 6). The overall AHP pairwise comparison performed and the detailed calculation due to page limitations. Table 7 shows an example of a pairwise comparison performed by the first expert, with a consistency ratio value of 6.78%.

Table 8 shows the recapitulation results of the evaluations that have been carried out with the AHP technique, where M-01 gets the highest score with 0.276. This indicates that the M-01 method is the most prominent in developing KMS to support the organization's innovation process.
Table 8. The AHP Evaluation Results for KMS Development Frameworks and Methods.

| M_ID | M-01 | M-02 | M-03 | M-04 | M-05 |
|------|------|------|------|------|------|
| exp_ID | | | | | | |
| 01   | 0.362 | 0.154 | 0.046 | 0.136 | 0.302 |
| 02   | 0.413 | 0.217 | 0.098 | 0.226 | 0.046 |
| 03   | 0.052 | 0.188 | 0.115 | 0.420 | 0.225 |
| Avg. | 0.276 | 0.186 | 0.086 | 0.261 | 0.191 |

Table 9 shows the final results of the evaluation of KMS development methods that can be used in building KMS to support the organization's innovation process.

Table 9. The Most Prominent KMS Development Frameworks and Method to Support Innovation.

| M_ID | Scores | Ranking |
|------|--------|---------|
| M-01 | 0.276  | 1       |
| M-02 | 0.186  | 4       |
| M-03 | 0.086  | 5       |
| M-04 | 0.261  | 2       |
| M-05 | 0.191  | 3       |

5. Conclusion and future works

There are many approaches taken by researchers in building KM systems. Some analyze knowledge management practices and combine them with traditional IS development methods, using standard methods, or proposing new ways for developing KMS. The variety of approaches taken shows the complexity of KM system development, so it is necessary to take a particular approach in building it. This research describe the methods used in building KMS published in the literature in the last ten years. There are other methods of developing KMS that maybe not be reported in this study. Several technologies to support the implementation of knowledge management are also reported in this study. The existence of two different views about KM systems makes researchers separated into two different perspectives. The first perspectives view considers KMS a class of Information System, and develop KMS with an IS development approach. The second view that states KMS is any kind of system as long as it supports knowledge management and automates KM processes can be called knowledge management systems, and take a different approach from the first perspective. After knowing the most prominent method in building a KM system to support the organizational innovation process, further research can be carried out by modifying the method and adapting it to its needs. For example, in the perspective of KMS as a class of information systems, researchers can develop a framework for developing a KM system that suits organizational needs, such as to support the acceleration of the innovation process. Further research on the framework for developing KM systems can be carried out, one of which is by using a qualitative approach by using the grounded theory.

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