System Requirement Specifications for A Semantic Knowledge Management System for Collaborative Learning Environment

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ABSTRACT

In this study, a Semantic KMS Model is formulated to support collaborative learning environment based on ontology. A comprehensive review was conducted to identify the important components of existing models in Knowledge Management (KM), KMS and semantic areas, and a survey was conducted to finalize the important components of the proposed model. As a result, the proposed semantic KMS model consisted of six important components to support collaborative works; KM Processes, Ontology-based Knowledge Model, Semantic KM Features, Knowledge Quality, System Quality and KM Goals. A prototype, called Semantic KMS for Collaborative Learning was developed to illustrate how the model components are supporting KM processes in collaborative works based on the system requirement specifications described in this paper. The required modules of the semantic KMS are described in details and the ontology-based knowledge models are also presented.

Keywords: knowledge management systems, semantic knowledge management

I INTRODUCTION

In modern years, Information Technology (IT) adoption in organizations to support knowledge processes has been recognized as one of the significant KM enablers, and knowledge management system (KMS) is acknowledged as one of the most successful tools to facilitate knowledge management projects (Maier & Hädrich, 2011). This recognition resulted in surge in the augmentation of sophisticated KMS for handling organizational knowledge assets. There are various definitions of knowledge management system found in the literature and one of them proposed by Davenport, De Long and Beers (1998) that describe KMS as a technology based system that supports KM processes including knowledge creation, capture, storage and knowledge dissemination and sharing. This means that if the knowledge users fail to locate the knowledge that they need, then the KMS is not successful in meeting its user's expectation, hence is not effective to support knowledge needs of its users.

Today, as online information is growing at exponential rate and massive information collected which resulted from various business activites, the task of finding and using information becoming more difficult than ever. Especially to large and distributed organizations, it is harder for them to exploit their knowledge assets without the right KMS features designed to solve their knowledge related problems. Current KMS still requires much of human efforts to access information, extract and filter information relevant to their knowledge needs (Davies, Grobelnik, & Mladeni, 2009; Che Cob & Abdullah, 2008; Davies, Lytras, & Sheth, 2007; Fensel et al., 2000). Several studies have been conducted to discuss the limitations with current KMS related to technical issues such as the KMS architecture design and infrastructural requirements for such system. For instance, the research conducted by Joo (2006) indicated two main limitation factors in current KMS; system quality and knowledge quality. Joo (2006) proposed the recent technology of Semantic Web to overcome the limitations with existing KMS, similar with several projects proposed in the literature (Apostolski et al., 2010; Davies et al., 2007; Joo & Lee, 2009; Schaffert, 2006; Stojanovic & Handschuh, 2002; Vega-Gorgojo et al., 2010).

A preliminary model of Semantic KMS for Collaborative Leaning Environment has been proposed and discussed in Che Cob, Abdullah, Risidi, & Mohd Nor (2015). The model components are then verified through a survey. The verified model is then used as the blueprint in designing and developing a system prototype called Semantic KMS for collaborative Learning (SKMSCL). In this chapter, the system requirement specifications of the prototype to be developed to support the KM activities in collaborative learning environment is described.

Critical to the semantic based KMS is the ontology that is used to describe the domain knowledge related to teaching and learning processes that enable the semantic capabilities of the KMS to facilitate the KM processes in collaborative environment. The ontology is modelled using Protégé ontology editor.

II SEMANTIC KNOWLEDGE MANAGEMENT SYSTEMS FOR COLLABORATIVE LEARNING ENVIRONMENT

The recent technology of the Semantic Web has given a new drive to the old knowledge management research field. The goal is to build a unified information medium that is both understandable for people and computers thus allows the computers to do certain tasks on behalf of human users (Berners-Lee, Hendler, & Lassila, 2001). The development of Semantic Web has created many opinions and dialogue on the impact of associated technologies such as XML and RDF for developing effective and efficient KMS.

One of the major components of the Semantic Web is ontology. An ontology must be constructed for each domain of human knowledge to provide meaningful description about the knowledge of that particular domain. The use of ontologies in the escience community determines ultimate success for the Semantic Web (de Bruijn et al., 2006). On the Semantic Web, data is annotated using ontologies to describe background information that enriches the description of the data, hence providing contextual information about specific data. Because ontologies are shared specifications, they can be used for several data sources including Web documents and relational databases. This enables a certain degree of inter-operation between multiple data sources (de Bruijn et al., 2006) and provide meaning to content of Web documents through its structure, hence enabling software agents to perform sophisticated tasks for human users (Berners-Lee, Hendler, & Lassila, 2001). \

III RESEARCH METHODOLOGY

This research design comprises of five main phases and their research activities (as shown in Figure 1). The first phase of literature review provides critical analysis of the in depth review of current literature related to the topics of study. A comparison study has been performed on several KMS models to critically analyze and identify the important components of KMS.

The second phase, a preliminary study consisted of the activities conducted to investigate the current problems of the study to support the research gap identified in phase 1 and to identify the important components of the proposed model. A preliminary semantic KMS Model for collaborative learning environment is proposed based on the LR. In phase 2, a questionnaire was developed based on the identified constructs in phase 1. In this phase, a survey has been conducted at selected Higher Learning Institutions (HLI) in Malaysia to study the limitations of current KMS at the HLIs and to identify important KM components to manage knowledge to support collaborative works in this domain. Before the actual data collection is performed, a pilot study was conducted to validate the survey questionnaire items. Rasch measurement model (RUMM) is used to analyze and to determine reliability of respondents and items and also to determine the outliers for both respondents and items. Based on the pilot study results, the questionnaire is then modified and the final questionnaire items is used in the actual data collection to verify the proposed components of the model. The analysis of the actual study such as regression analysis is conducted using SPSS 23.

In the third phase, the preliminary model is then modified according to the findings from phase 2. A final model is then proposed in this phase and served as the blueprint in translating the proposed model into a workable prototype (Phase 4) named Semantic KMS for Collaborative Learning (SKMSCL). The prototype is then used to validate the proposed model through a post-implementation survey. The final phase, model evaluation and discussion discusses the findings of the study based on the evaluation goals and criteria defined.

This paper shall discuss system requirement specifications of the development of the SKMSCL in Phase 4 of the research methodology (Figure 1).

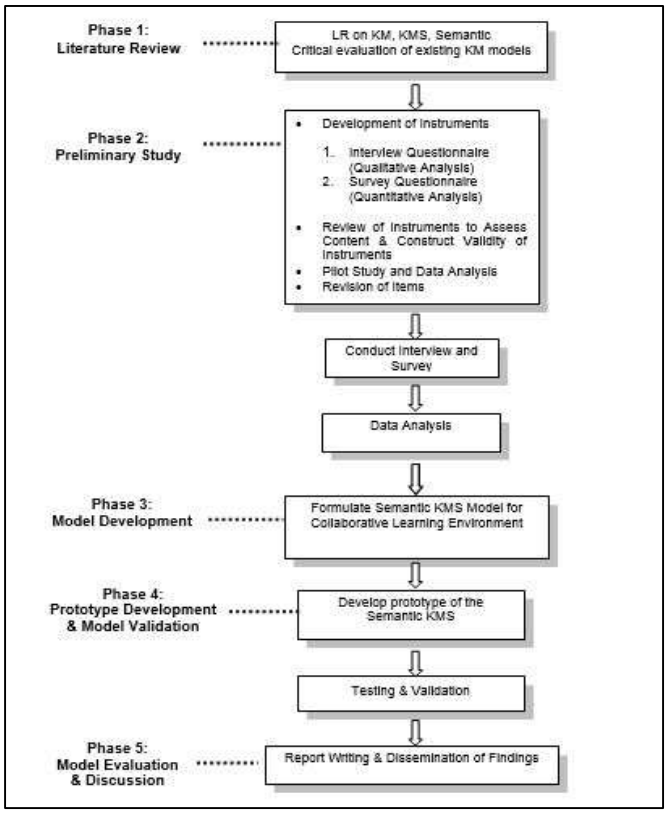

Figure 1. Research Methodology and Main Research Activities

IV A PROPOSED SEMANTIC KNOWLEDGE MANAGEMENT MODEL FOR COLLABORATIVE LEARNING ENVIRONMENT

The semantic KMS model is developed in the third phase as stated in the research methodology. The aims of this research is to establish a semantic KMS Model to guide the development of an effective KMS to ensure that successful implementation of KM initiative to support collaborative learning environment. The model exploits semantic relationships of an OWL-based ontology that provides the semantic features for KMS which leads to effective data management and enhanced collaborative environment for knowledge users.

We propose the research model shown in Figure 2 based on DeLone and McLean's IS success model (Delone & McLean, 1992) and a model of KMS limitation factors proposed by Joo & Lee (2009). DeLone & McLean model has been used by many researchers to evaluate IS success in organizations and the application varies in many different contexts. Whilst the model of KMS limitation provides the characteristics of KMS and suggested an approach in applying semantic to the KMS.

DeLone & McLean model suggests that IS success can be assessed using three different levels and six interrelated dimensions. They proposed that system quality and information quality have impact on user satisfaction and system usage. Consequently, these will results in impact on individual user, which in turn will be reflected in the organization as well.

Meanwhile, Joo & Lee, (2009) proposed a reverse perspective of Delone & McLean success model and suggested limitation factors of system quality and knowledge quality as the two main factors that affect user dissatisfaction of KMS. They proposed four factors related to system quality: 1) Time/Space; 2) Inconvenience, 3) Knowledge Search and 4) Knowledge Integration, and two factors related to knowledge quality: 1) incongruence/ incompleteness of knowledge and 2) untrustworthiness of knowledge.

As shown in the Figure 2, there are six important components synthesized from the LR and the survey conducted. The Ontology-based Knowledge Model realized the semantic KM features such as semantic knowledge search, knowledge filtering and personalization. The semantic features of KMS have significant impact on the system quality which facilitate the KM processes hence achieve the KM goals. Similarly, the Ontology- based Knowledge Model also increase the knowledge quality in the KMS, which contributes to better utilization of knowledge in the KMS and facilitate the achievement of KM Goals. The entire collaboration processes are enhanced when the KMS is built on quality knowledge with semantic capabilities. The Knowledge Quality and System Quality influence the facilitation of the KM Process hence achieved the KM Goals of the specific organization.

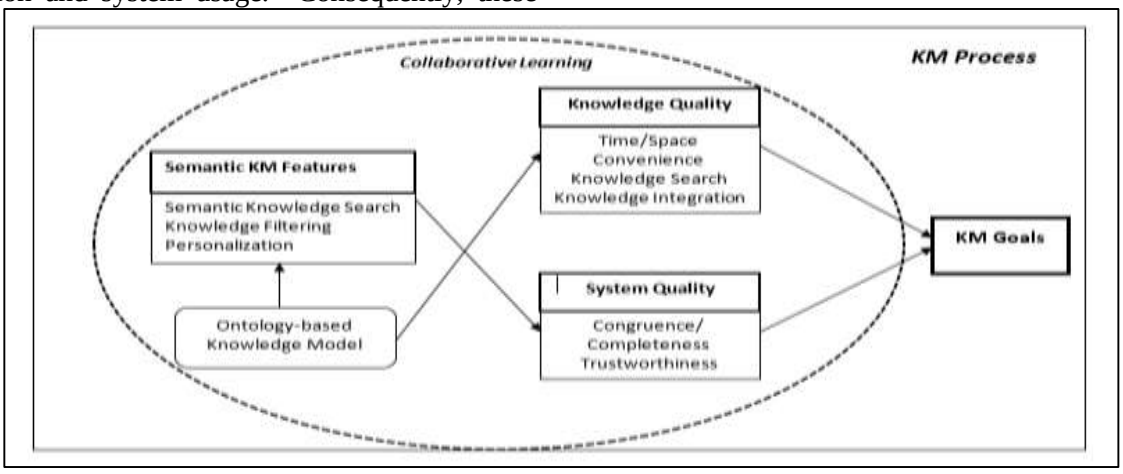

Figure 2. Semantic KMS Model for Collaborative Learning Environment

V SYSTEM REQUIREMENTS SPECIFICATION FOR SKMSCL

Semantic Knowledge Management System for Collaborative Learning (SKMSCL) is an ontology based system designed to manage knowledge to provide collaborative learning environment to support Community of Practice (CoP). The system is based on a Semantic Knowledge Management Model for Collaborative Learning as shown in Figure 2.

The system need to support four main processes of managing knowledge: i) Knowledge Acquisition, ii) Knowledge Storage, iii) Knowledge Dissemination and iv) Knowledge Application. There are several types of knowledge need to be acquired, which are knowledge of a teacher, knowledge of a student and also knowledge of a course.

The semantic capability of this system is realized through the use of ontology for knowledge model. Ontology based knowledge models (teacher's model,

student's model and course model) define the structure of the acquired knowledge to be stored in the knowledge repositories. The ontology describes the knowledge objects which provides meaning to the computer that enables computer to understand the objects, hence results in semi/ automation of certain knowledge management system (KMS) functions.

Adding the semantic to KMS will be able to answer important knowledge management questions such as know-what, know-why, know-how, know-who and know-when. Semantic KMS features provides shared description, common understanding of the knowledge objects. These shared descriptions will allow integration of knowledge across platforms (Knowledge integration). Knowledge search allows the KMS user to search the metadata rather than using keyword-based search, hence enable the system to provide more accurate search results which will reduce the user efforts to filter the relevant knowledge that they need. SKMSCL will be able to filter the knowledge to relevant KMS users (who might be interested with specific knowledge (know-who; know-what) whenever they need it (know-when). It allows personalization of knowledge that tailor to KM user's preferences and needs (based on ontology based user's model in knowledge repository).

A. System Feature for Knowledge Repositories Module

The repositories consists of teacher profile ontology, student profile ontology, learning objects for courses and course ontology. This feature is considered as high priority in order to provide the semantic capability for the system and important to allow for richer learning experience to the students.

i. Course Ontology

Course model consists of three categories of data

Course_name, Course_id, Course_credit, Course_prereq,Course_assessments, Course_Dept, Course_Programs, Course_Teacher

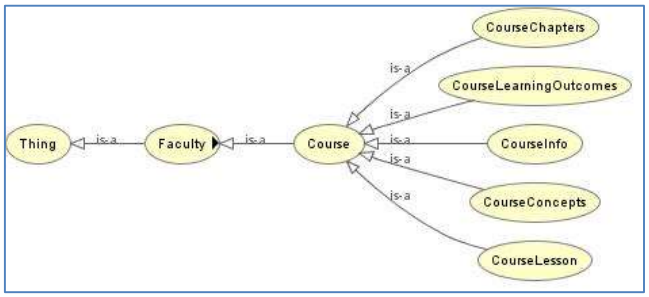

Figure 3. Course ontology

ii. Teacher Ontology

Teacher model consists of two categories of data (shown in Figure 4):

Teacher's demographic data:

Teacher_Name, Teacher_id, Teacher_age, Teacher_address, Teacher_email, Teacher_officeNo, Teacher_phone

Teacher's background data:

Teacher_qualifications, Teacher_researchInterests, Teacher_Skills

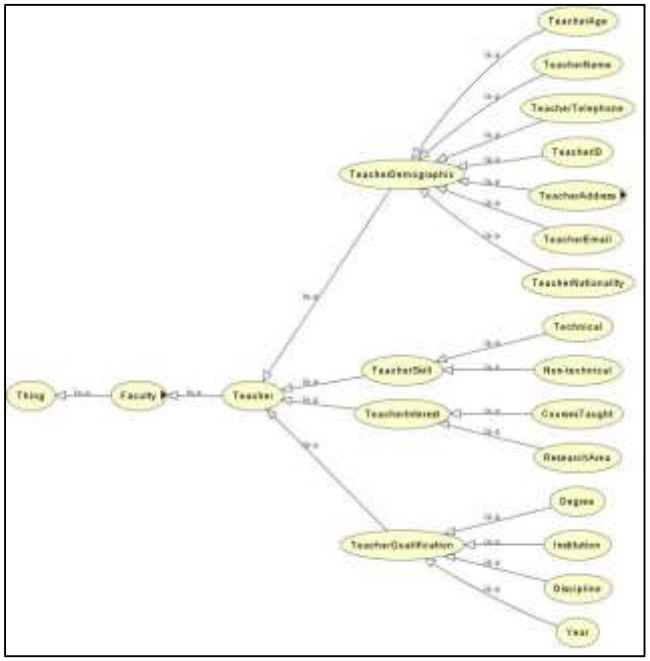

Figure 4. Teacher Ontology

iii. Student ontology

Student model consists of three categories of data (shown in Figure 5):

Student's demographic data:

Student_Demographic:
Student_name,Student_id,Student_age,
Student_address, Student_email,Student_phone

Student's academic data:

Student_Academic:
Student_Program,Student_Majoring, Student_Year,
Student_GPA, Student_CGPA,
Student_Classes_Taken

Student's Learning Experience:

Student_Competence_Level, Student_Interests

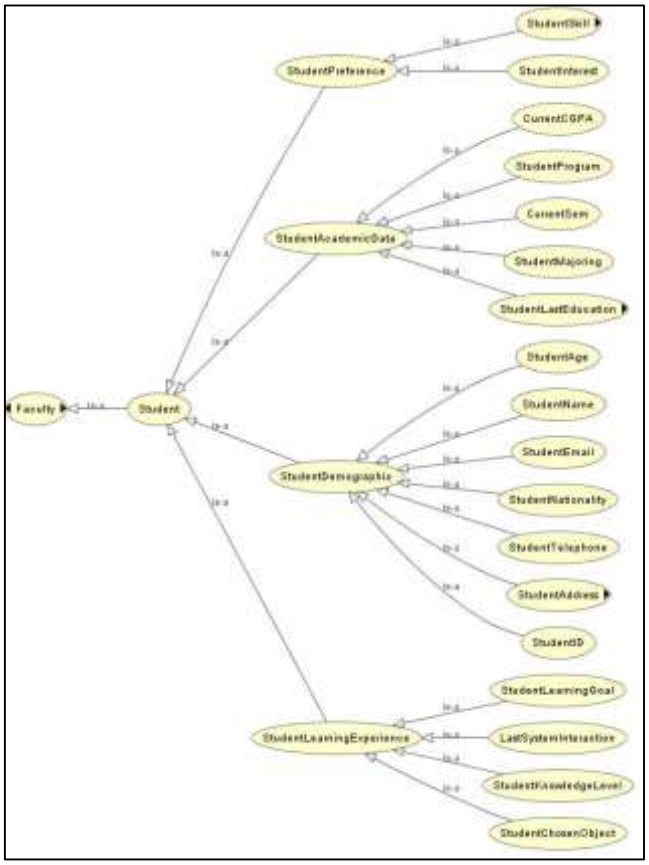

Figure 5. Student Ontology

B. System Feature for Content Management Module

The content management module allows the teacher to manage their profile, design course, manage course assessments, and view students' profiles.

i. Manage Profile

Teacher can manage their profile such as edit their research interests and skills and courses taught.

ii. Design Course

Teacher can design their course such as setting the course learning outcomes, define the course assessments and also the course delivery strategy (lecture, lab, etc.)

Teacher can manage course contents and view existing course ontology in the knowledge repositories. Teacher can edit the existing course ontology. Course content editing can be done by subject matter experts (teachers who are assigned by system administrator as the experts in specific subjects/courses). The course coordinator need to approve the edited course ontology before it will be saved and stored in the knowledge repositories.

iii. Manage Assessments

Teacher can manage the course assessments such as set the assessments questions (the objective questions only for automatic grading and tracking).

iv. View students' Profiles

Teacher can view the profiles of students registered for their course.

C. System Feature Learner's Experience Module

The Learners' Experience Module consists of features such as manage student profile, view course, take assessment, give feedback and collaborate.

i. Manage student profile

Student can edit their profile such as edit interests and contact information. Students are not allowed to edit demographic data.

ii. View Course

Student can view the course resources according to topics and course concepts as defined in the course ontology.

iii. Take Assessment

Student can take the assessment after they have learned the topics of a course. Prior to that, teacher need to assign the course topic to assess the students' mastery of a topic. The assessment score will be automatically calculated and presented to the student after the student completed an assessment. If the student do not achieve a passing mark (e.g 50%) the students will need to re-take the assessment and cannot proceed to the next topic of a specific course.

iv. Give Feedback

Student can give feedback to the course teacher through email (private message) or discussion board (public message).

v. Collaborate

Student can collaborate and discuss with the course mates about a specific course topic through a discussion board.

D. System Feature for Knowledge Search Module

The knowledge search module consists of the knowledge discovery features. The search allows student to perform simple search (search by course) and complex search (metadata search). The ontology knowledge models are important component for this module to find the relationship between knowledge objects in the repository. The result will be presented to the user according to user profile (personalization).

VI CONCLUSION

This research proposes a Semantic KMS model for collaborative learning environment to guide the development of KMS to facilitate KM processes in organizations. The proposed model consisted of six important components as critical elements for implementing KMS to support collaborative work; KM processes, ontology-based knowledge model, semantic KM features, knowledge quality, system quality and KM goals .The proposed model is than translated into a prototype called Semantic KMS for collaborative Learning (SKMSCL) based on the system requirements specification discussed in this paper. The SKMSCL prototype is then used to validate the proposed model.

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