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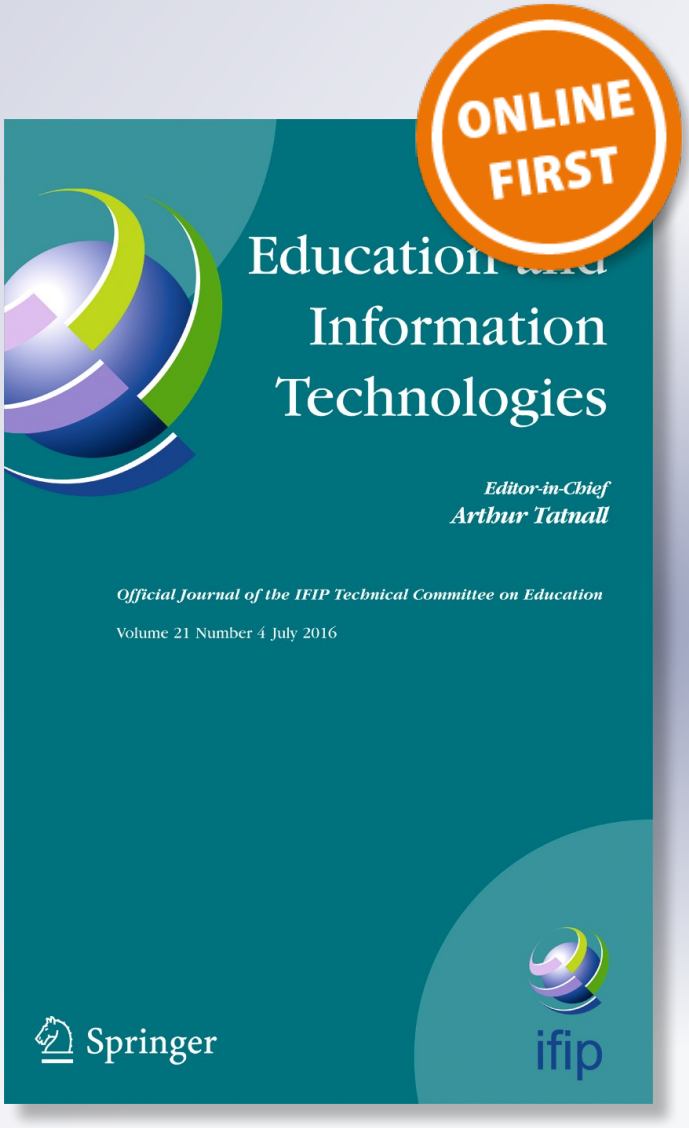

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EDRMS for academic records management: A design study in a Malaysian university

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Abstract Higher education institutes such as universities suffer from a range of issues in managing their academic records and relevant digital contents. Many universities nowadays use specific software applications for their effective mechanism in records management. The effective provision of enterprises records management (ERM) software for managing records especially for maintaining research activities are of paramount importance to meet complex criteria outlined by the university. The purpose of this study is to describe the design of a locally-innovated Electronic Document and Records Management Systems (EDRMS) implementation for managing academic records in the context of a Malaysian University. The lessons learned from the design study can be applicable for improving relevant technologies for record keepings in other similar enterprises.

Keywords Semantic web · Knowledge management · EDRMS · Records management systems

1 Introduction

Higher education institutes such as universities suffer from a range of issues in managing their academic records and relevant digital contents (Yanosky 2009; Samsudin 2015; Samsudin et al. 2014). Many universities nowadays use specific software applications for

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their effective mechanism in records management. Therefore, studies on how to improve approaches for Enterprise Records Management (ERM) systems became a popular topic area of study for education institutes (Alalwan and Weistroffer 2012; Katuu 2012). While the sheer mass of research records available from multiple sources are evolving, relevant standard ERM software applications such as Electronic Document and Records Management Systems (EDRMS) still suffer from inflexible options for meeting academic users' information demands. For instance, Katuu (2012) suspected that a very limited number of studies on EDRMS examined institutional experiences and achieved end user benefits when implementing ERM systems. Katuu (2012) called for further research to develop more practical and end user-suited EDRMS applications with the help of new emerging approaches that may have the substantial impact on organizational performance. Other studies on ERM have also supported this demanding call (Alalwan and Weistroffer 2012; Sprehe 2005).

Previous studies describe limitations of EDRMS in many problem cases (Gustman et al. 2002; Muhd et al. 2009). However, for managing research records the EDRMS became one of the popular applications for educators and students in which they can access data regarding person/figure (e.g. Celebrities in any domains) to take interviews as part of their course requirements (at undergraduate and post-graduate levels). Celebrities are the successful individuals or group of individuals in the community who have prominent contributions specific area of knowledge to build nations throughout their works and due to the impacts of their works they achieve popularity and media attention for their contributions. Students mainly use the EDRMS system to identify appropriate Celebrities in their target area of studies. On the other hand, educators use the EDRMS system to evaluate and verify whether the students have gone through the mandated process to identify the appropriate Celebrities in their relevant fields. However, the search process in the traditional EDRMS system used keywords-based searching that does not provide context-sensitive meanings to the users (Rabiyathul Basariya and Jannath Nisha 2012). Most of the times, the technique of keyword searching results inappropriate outcome due to mismatches with user's desires and content of the record base.

To address the issue in this paper we describe an in-house developed EDRMS application for academic users. We used the bottom-up approach to gathering issues with traditional approaches and then find matches with key features of semantic web (SW) technologies. We apply SW to define expected benefits for the target academic users. SW technologies have been proliferated over the past decades to provide a range of end user options for web-based applications. Although this technology became popular to web-service developer community, relevant studies in relation to using SW, especially for improving ERM system,[1] so far have still been emergent. The objective of this study is also to share lessen we learned in the development study. The

[1] As a type of ERM, EDRMS can be defined as "an automated system which supports the creation, use and maintenance of paper or electronic documents and records for the purposes of an organization's workflow and processes. EDRMS includes recordkeeping functionality and also manages documents of informational rather than evidential value. EDRMS includes, the whole of documents, records, methods, procedures, tools, [meta] data, (index terms), knowledge, means and persons with which an organization operates and fulfills its requirements to preserve evidence of its activities, maintain its memory, and preserve its knowledge" (Johnston and Bowen 2005, p.133)

paper presents a four-phase methodology embedded with the single case study in order to address the aforementioned issues in the case context of a Malaysian University.

2 Study background and problem case details

In this section, we describe the target literature details and the situations of the problem domain to highlight the design case. We outline user issues on existing EDRMS within the Malaysian University. We focus on existing literature on ERM and SW approaches in the section below.

2.1 ERM

Previous studies indicate that ERM technologies are still inadequate to meet the growing demand of industry's record preservation and its further management with effective end-user provisions (Katuu 2012). Beyond the requirements of preserving records and documents in a record repository, ERM system should provide useful features to meet users' regular information demands within their different business conditions. Sprehe (2005) highlighted three case studies that identify key limitations of record management technologies. Katuu (2012) revealed that limited studies represented institutional user experiences and their use related to implementing electronic document and records management in South Africa. Alalwan and Weistroffer (2012) reviewed the ERM literature through a structured research approach in order to point out gaps where further research is required for improving practices in records management. The study by Alalwan and Weistroffer (2012) provided a framework that also reinforces the necessity to develop more technology-enabled solutions to meet the growing demands of users. According to Extensis (2011), a digital asset management system (as type of ERM systems) is a system which manages and distributes digital assets (e.g. images, documents, creative file, audio and video clips) effectively. Such system allows organizations to catalogue, store and retrieve collections of valuable digital assets. Benefits of digital asset management are noted such as centralization of digital contents, protective storage of rare or valuable item, find-ability of digital assets, reduction of organizational costs, and the dynamic distribution of assets to internal and external teams. Many examples of the implementation of digital assets management (Meserve 2003) have been introduced for higher education organizations, which range from scientific data such as digital images of samples and possible digitization of rare archival collections including photos and other formats.

Maguire (2005) discussed the experience of implementing an EDRMS and identified the lessons learned from the process, but this study shows lacks of defining end user's issues. Wilkins et al. (2009) discussed the experience of implementing an EDRMS and found that it is quite challenging to bring the people and process together in the life cycle of records, especially when it involves a long-term commitment. On the other hand, Johnston and Bowen (2005) identified the benefits of implementing an EDRMS for record management professionals. Furthermore, Garrido (2008) explored whether the records manager had taken into consideration users' needs and preferences in creating the folder structure of EDRMS. This study found that users' objectives are

of paramount for records management. Following Table 1 shows more example studies and their relevant issues of EDRMS.

2.2 Case context of Malaysian university

The effective provision of ERM software applications for managing academic records requires adequate searching and navigating options. They are particularly important for choosing the appropriate field of interests and relevant study areas such as oral contents management. The search helps to determine whether the interviewee fulfils the complex criteria outlined by the university. Through the use of ERM features, decision-makers such as students need to ensure that the selected interviewees perform in accordance with the university mandated criteria. For example, the selected interviewee must be somebody who has made a substantial contribution to the nation and who has never been interviewed by other students in the faculty in the same topic area. Other requirements are that the interviewees must be at least 40 years old and the duration of the interview should be at least two hours. However, educators such as lecturers or supervisors (who supervise research students) need to validate the proposed interviewees within the targeted area of studies to determine their suitability. For the decision support, the use of traditional approaches EDRMS does not provide the required searching provisions for end users as in its current form the system was using index searching. It is, therefore, beneficial to have a more context-specific and systematic record management approach for end users' effective decision making.

2.3 SW technologies

The main goal of SW technologies is to develop common understanding through languages for expressing about collected or stored information (Dumbil 2001). According to Benjamins et al. (2002, p. 29).

"Semantic Web is not a separate web but an extension of the current one, in which information is given well-defined meaning for better enabling computers and people to work in cooperation".

Table 1 Relevant works in the literature

Studies	*EDRMS Issues*
Di Biagio and Ibiricu (2008)	Placed a new role of records managers to ensure the preservation of memory for the importance of improving quality of records management
Goldschmidt and Debowski (2012)	Used Alter's service work system model to the development of EDRMS especially for the improvement of human-computer interaction
Demirtel and Bayram (2014)	Analyzed concept of e-correspondence and conducted to measure the functional performance of EDRMS
Domingue et al. (2004)	Used ontologies to associate meaning with the information found on a web page

SW technologies can be a guide to new functionality so the computer systems can be better able to process and "understand" the data that they merely display. SW technologies have been a well-accepted tool for enhancing web application usages. One example of SW applications in the education domain is identified by Cardoso (Cardoso 2007), who demonstrates the applicability and the benefits of using SW technologies by developing a real-world application. The application is called a Semantic Course Management System (S-CMS), which is based entirely on semantic feature that adopted technologies in this field such as Web Ontology Language (OWL), RDF Query Language (RQL), RDF Data Query Language (RDQL) and Semantic Web Rule Language Combining OWL and RuleML (SWRL). This system focused on a requirement of providing meaningful digital contents through the application of SW, for the distance education opportunities. S-CMS offers services such as class project management, registration tools for students, examinations, management of enrolment, test administration, tools for assessment and online discussion boards (Meinel et al. 2002). It is noted that the more expressive mark-up languages like SWRL allow developers to write application-specific declarative knowledge, and can improve annotation richness of information for end users.

Gliozzo et al. (2007) developed SW technologies to enhance legacy systems. Their study introduces a framework to add an SW layer to legacy organizational information. Their findings show that an SW layer can enhance a legacy system by providing an intelligent and collaborative user interface. The legacy system holds existing data in relational database and most of the design cases, the systems are suffered by problems such as lack of documentation, obsolete functionality and higher maintenance cost (Gliozzo et al. 2007). Drawing from the aforementioned use of ontology languages such as OWL for the vocabulary and meanings enhancement, it is anticipated that SW based concepts may have the potential to improve the search-ability of EDRMS system.

In IS design context, an ontology is distinguished as "a software artefact or formal language designed with a specific set of uses and computational environments in mind" (Viinikkala and Ontology in Information Systems 2004). Furthering this notion, Zuniga (2001) noted that information systems ontology is "a formal language designed to represent a particular domain of knowledge, which depicts the structure of domain objects in question and accounts for the intended meaning of a formal vocabulary or protocols". The notion of ontology as a representation of knowledge about particular domain implies strong promises to generate rich semantic metadata structures on records.

3 Research method

The study developed a four-phase based methodology for developing an SW based EDRMS solution for the targeted issues. The adopted research methodology can complement the framework of design science research proposed by Hevner et al. (2004). Hevner et al. (2004) proposed a seven-phased guidelines (such as design as an artifact, problem relevance, design evaluation, research contributions, research rigor, design as a search process, and communication of research) for conducting studies on developing information systems solution. We comprise the activities of the seven guidelines into four distinct phases. The four distinct iterative phases are outlined such

as problem identification (design as an artefact and problem relevance correspond to problem or benefit identification); framework development (that is corresponded to design evaluation); research outcome (research contributions and research rigor correspond to research outcome); and solution development and evaluation (that corresponded to design as a search process and communication of research).

Figure 1 shows the adapted methodology. For in-depth data gathering the study was conducted through a single case study approach (Yin 2007) for identifying issues

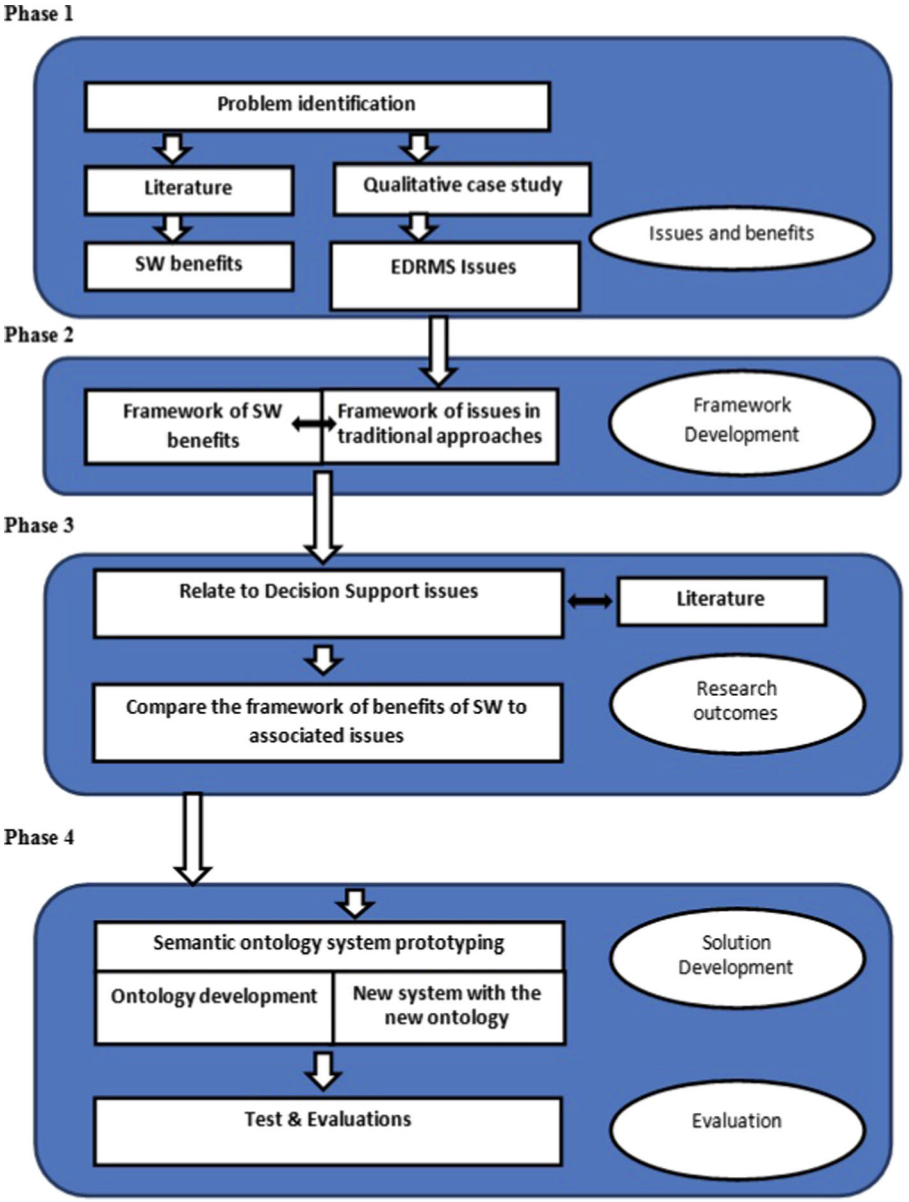

Fig. 1 The four-phased methodology adapted for conducting the development study

within the target problem domain. The finding has been validated through the development of a proof-of-concept prototype using SW technologies as the major practical component. The use of the case study approach seems to be suitable since the researchers begin with the intention to explore and seek deeper truth facts. It presents the opportunity for in-depth probing and diagnostic exploration (Yin 2007). The case study approach helps to uncover phenomenon about which little is known and the key concern is to understand the problem space from the participants' perspectives rather than focusing only the researchers' subjective thoughts (Merriam 1998). Mason (1996) highlighted the philosophy of qualitative research to gather data from an organizational context in which it is focused on how the social and technical world were understood, interpreted, experienced and produced.

The following paragraphs discuss the four phases of the methodology.

3.1 Phase 1: Problem identification

This phase involves identifying issues of traditional approaches and benefits of SW-based technologies over the issues. The semi-structured interview (Gorman and Clayton 1997) is adopted as the data collection approach. In terms of selection of the participants, non-probability sampling, i.e. purposive sampling, is deemed to be appropriate in view of a large number of interested groups. Therefore, 30 participants were involved (five developers and 25 users) in the interview. According to NASA (1993), a system developer "incorporates the technical security specifications into an operational system". In this study 'developer' refers to the person involved in developing and maintaining the EDRMS system. Rob and Coronel (Rob and Coronel 2002, p. 20) stated that "end users are the people who use the application programs to run the organization daily operations". In this study 'end users' refers to the educators and students of the target case institute. The developers are also included in this study in order to obtain feedback and an overview of current end user' features from a technical perspective. The issues and benefits of SW approaches are explored through the literature survey using content analysis. In this case, the sources are based on published literature on the potential benefits of SW in supporting features for enhanced decision-making.

3.2 Phase 2: Conceptual framework development

The second phase consists of solution development activity. In this phase, data analysis was conducted to obtain a clear understanding of the issues and benefits of SW. Decision-making aspects are highlighted in this study since this activity was important in improving learning activities in education institutes. Enhancing the decision-making ability of educators and students (in this context) were vital to making a quick improvement. This saved time and ensured services to run learning activities smoothly. The solution was then developed through taxonomy descriptions according to a systematic and reliable process (Protégé knowledge management method (Gennari et al. 2003). In this study, solution framework was developed for matching the issues of traditional EDRMS with SW features. Table 2 shows the details of case study findings and key benefits of SW that were determined through literature review. We sorted the findings of the interview using various themes such as searching, navigating,

Table 2 Issues vs benefits of SW

OHMS Problems	*SW/Ontology approach benefits*
Searching	Searching (Benjamins et al. 2002; Joo and Lee 2009)
Effectiveness	Availability
Precision	Enhanced meanings
Navigating	Interoperability between ontologies
Browsing	Reasoning
User interface	Visualisation
User Friendliness	Vocabularies
Flexibility of web environment	Navigating (Benjamins et al. 2002)
Language	User interface
Knowledge Management	User friendliness
Data integration	Multilinguality
Representation	Personalisation
Abstract	Knowledge Management (Joo and Lee 2009)
Description of collection	Lack of access control
Description of figure	Semantic annotation
Database Management	Database Management (Blomqvist 2012; Joo and Lee 2009)
Data quality	Efficiency
Data redundancy	Data visualisation
Display	Interoperability
Maintenance	Others
System feedback	Content (Benjamins et al. 2002, Blomqvist 2012)
System performance	Availability
User guide	Scalability
Others	Optimization
Content	
Updating issues	
Scope (e.g more content needed)	

knowledge management, database management and others to compare with established benefits of SW technologies. Definitions of the themes are:

- Searching: it is the requirement for making easier to find records or contents in the EDRMS system. Simplified searching is to ensure features to find a complex topic on which user starts to gather knowledge.
- Navigating: it is the requirement for guiding users in a path to find records or contents in the EDRMS system. Effective navigating means friendly driving of user from the top level to lower level by providing assistance in order to find about their topic.
- Knowledge management: it is the requirement for making the records organized such a way or using a set of principles so users can obtain an effective abstract of information as the display and integration of their target records or contents.

- Database management: it is the requirement for making the records or contents stored in a form of a table including its data dictionary, importer and query handling approaches so users can obtain access to stored items.
- Other themes can also be significant for contents or records management such as change management or scope definitions.

3.3 Phase 3: Research outcomes

The solution framework initially targeted to enhance decision support options for end users, such as educators and students, who use the system to obtain assistance in the process of selecting the subjects to be interviewed in their studies. The idea in this phase was to compare and improve solution to focus on the key uses of SW over the traditional EDRMS features. For the purpose ontology as SW based features came into use as a solution to offer enhanced vocabulary, taxonomy and better representation of knowledge, in the searching process of records. It was also suggested that ontology can improve database management issues such as data redundancy (Iqbal et al. 2010).

3.4 Phase 4: Solution development

The fourth phase of this study involved the system component of the in-house development and testing. Using a bottom-up approach a prototype was developed and evaluated through potential users in an education institute. In this phase, the solution prototype was to construct based on comprehensive ontologies through the guidance of the adapted methodology in this study. The Protégé system (Gennari et al. 2003) provides an application platform for more general purpose knowledge organization, so the components of the repository can be structured within the problem domain prior to system design. Using the Protégé platform the study demonstrated how ontology components can be turned into system components in order to achieve agreement in focus group meetings. Figure 2 shows the ontology structure that was developed from protégé. The Protégé 4.0.3 which supports OWL has been used in the implementation of the proposed ontology approach. OWL is a common ontology language designed to represent rich and complex knowledge about things, groups of things, and relations between things within the problem domain. This activity helped reduce the knowledge acquisition issues by minimizing knowledge engineers' roles in constructing the proposed system.

4 Proposed SW based EDRMS

The proposed EDRMS solution was based Joo and Lee's (2009) KM system model that was developed for improving user collaboration. As it is mentioned earlier about the contribution of ontology, in many instances, we adapted the ontology in our solution.Ontology is used to describe the knowledge domain (we called oral history management) into which performs queries. Ontology -based navigation provided semantic level reasoning in order to retrieve meaningful resources with respect to a given information request (Bonino et al. 2004). Ontology provides simplified descriptions of

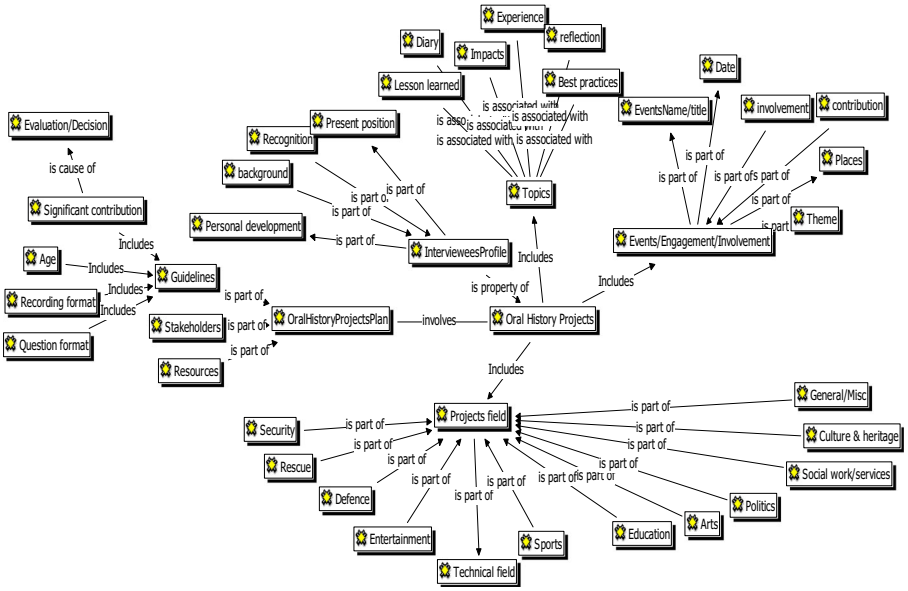

Fig. 2 The final domain ontology

record components for the searching process. The following Fig. 3 shows proposed SW based solution. In this diagram, SW services for our oral history management were produced by the ontology language through the application of OWL for enhancing records' vocabulary. The ontology language also helped to produce inference formalism that filters the searching result to find relevant outputs. Ontology consisted of the query language such as RDQL and SPARQL to hold an adequate link to various data in the record repository. The ontology editor holds features of the query language and ontology language to produce semantic outcomes. The solution model used protégé as ontology editor to develop semantics of various oral history documents such as recorded interviews relevant to Celebrities and their abstracts stored in the repository. Through the ontology based interaction, the entire approach improved search-ability and navigability for the students and educators in better decision making. The following Fig. 3 compares the traditional and semantic integration that was proposed.

Figure 4, shows a comparison between the current EDRMS (we locally so-called Oral History Management Systems - OHMS) system and the semantic integration based on ontology-based representation. Joo and Lee (2009) proposed a structural integration of SW to represents the meaning of the terms through the application of ontology and argued that SW-driven system can support the KM process to overcome its search and integration limitation. Drawing from this, SW-based EDRMS was proposed as such to overcome the limitation of current issues as identified through our case study.

5 Lesson learned from the implementation

We conducted focus group sessions to gather the overall experience so the next version of the system can be improved through refining the ontology of oral history management.

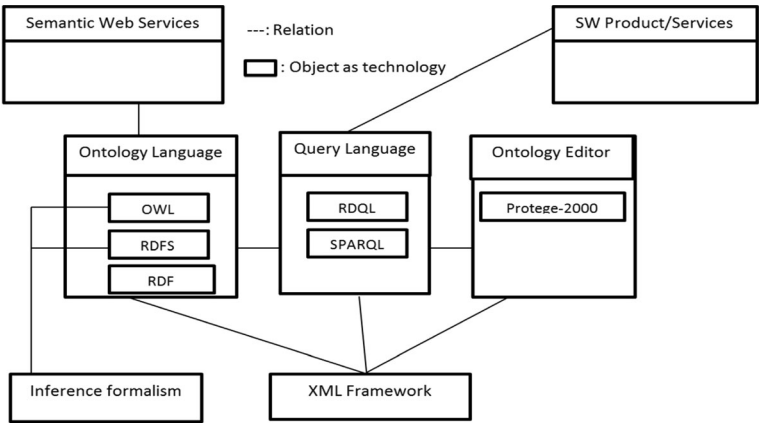

Fig. 3 Proposed SW solution diagram adapted from Joo and Lee's (2009) model

During the process, the ontology draft was improved and refined until complete satisfaction was achieved. In conducting the continuous evaluation and refining process of the design this study used a protocol whereby the facilitator first presented the developed SW based system to the participants by showing them every aspect of features and how they can be enhancing the end user's ability in relation to searching, navigating, knowledge management and data management. Each and every ontology concept, its subclasses and the relationships between them were discussed. Participants were given 2 weeks to use and play with the new system to offer some experiences. After the third round of iteration through focus group session, we concurred that the proposed SW based EDRMS has provided optimal benefit to the extent that it serves to enhance business efficiency at the institute, administrative and end user level. We learned through the preliminary evaluation that our executive officials (Academic members) and end users (Students) who used the system as well as those who were in charge of technical development of the systems records showed positive view, for the purpose of revealing administrative and operational benefits of the EDRMS application.

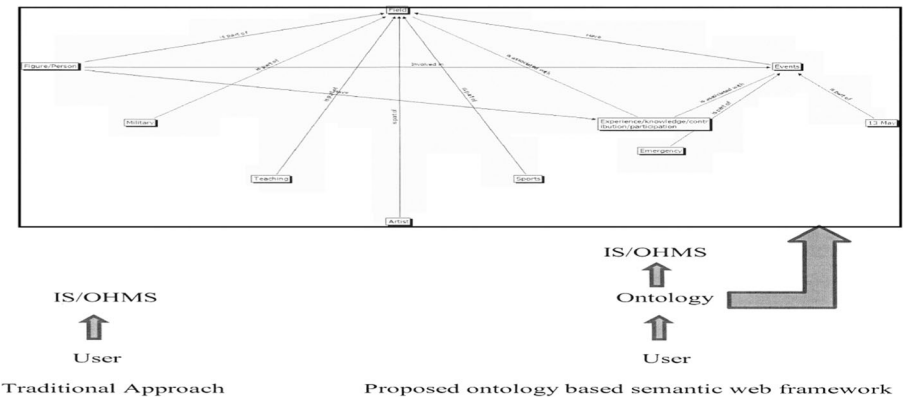

Fig. 4 Comparison of traditional and semantic integration

a. Facilitate and guide users in searching the information:

We learned that the proposed SW-based EDRMS facilitated support to its target users in finding their records to make decision. Users were expressed their views positively:

"This system offers a variety of options to facilitate the searching activities to the users. I think it will assist the students in the process of determining the interviewees" (Developer 2)

"Based on my experience using the system, I found that it is user friendly and easy to use to find the materials needed. This can assist me to make a quick decision related to my study". (User 7)

These views suggest that users achieved benefits from the system. The system offered them the features to simplify their searching process.

b. Allow users to navigate through the ontology to find information:

We learned that the proposed SW-based EDRMS allowed support to its target users in navigating their records to make decision. Users were expressed their views positively:

"I found the system has better navigation support that helps to find my preferred answer to find interviewees" (Student 1)

"Compared to the previous system, I found that the new system is better than the previous one especially in terms of navigability. This system provides many links which facilitate the user to browse and navigate through the system easily. This can assist the supervisor to validate the students' proposal quickly" (Developer 4)

"Compared to the previous version, this system improves a lot especially in terms of searchability and navigability. This will benefit other students too" (Student 15)

These views suggest that users achieved benefits related to navigation through the developed ontology based features of the system. The system offered them the features to simplify their navigation process.

c. Facilitate the process of categorizing the information

We learned that the proposed SW-based EDRMS facilitated process of categorizing records according to user inquires in navigating their records to make decision. Users were expressed their views positively:

"From the lecturer view/perspectives, if we can access/refer through the system so we can see which figure is not/less being interviewed by the students, so we can proposed them to the students." (Academic user 5)

"The new system exactly implemented according to the improved ontology model, so I think it is much better than before and process of categorizing is understandable" (Academic user 7)

These views suggest that users achieved benefits from the process of categorizing and that helped to find appropriate information. The developed ontology model was useful for offering to understand through features of the system. The system offered them the features to simplify their searching process.

d. Improve the method of searching information

We learned that the proposed SW-based EDRMS provided an improvement on the searching method meet to user inquiries in searching their records to make decision. Users were expressed their views positively:

"When I use the new system, I can find the information easily and I got a quick answer" (User 2)

"I think the system becomes more efficient. There are lots of actions taken such as reducing redundancy" (Academic user 6)

These views indicated that the developed ontology of the EDRMS was useful for offering to understand through features of the system. The system offered them the features to simplify their searching process.

e. Improve precision of information retrieved

"From the taxonomy/ontology perspective, maybe we can come out with general taxonomy to specific. This can facilitate users to their needs. So, it is hoped that the system can provide taxonomy/ontology or specific user searching which can guide the users." (Developer 3)

"After using this system, I found that the function of the system is user-friendly and easy to use because it offers more options of searching method. For me this system is very helpful to assist my students in getting the information quickly" (Academic user 7)

These views indicated improvement in precision and accuracy in records management. The embedded features were useful for offering to understand the search process. The system offered them the features to simplify their searching process.

6 Discussion and conclusion

The objective of this study was to develop a new SW-based EDRMS solution to address user access issues on traditional approaches. To enhance end users' support

features the proposed system offered potential benefits of using SW technologies. A significant development was taken place by adapting Joo and Lee (2009) research to address the identified issues. Saito et al. (2007) classified KM technologies according to its type of various strategies of supports: collaboration, dissemination, discovery and repository functions. By analysing through the four functions and its types, our study complies with repository functions through the use of SW in order to simply records management approaches and enhance end-user accessibilities.

The ontology has been the vital features of SW to address support issues of end user. The problems were addressed through the solution framework with an ontology based provision in which ontology editor holds ontology data and query language to represent semantic meaning of records. It offered benefits to develop the meaningful taxonomy that guides the user in their database searching process through providing specific meta-data. It helped reduce the time taken by the user to search for the records so that the decision could be made quickly. At the same time, by using an ontology, it can improve precision and relevancy of searching output as we noted in section five. Our view is similar to Domingue et al. (2004) approach in that ontologies were provided meanings for web content. Based on the identified meanings, relevant services can be invoked, or value-added functionalities offered to the user. We haven't supplemented the technical details of the proposed solution in this paper, rather focusing on the solution framework as well as the use of our approach in the target case context. We finally concur that although the study represents a case-based practical contribution to the target community, the principles drawn out of this can be applicable in other industries such as in public libraries or any other archrival management, especially for enhancing existing conventional approaches of similar records or contents management. Based on the discussion throughout, the study can have a contribution to the body of knowledge in the ERM field.

7 Further research

The paper reported on the importance of SW technologies to design a new EDRMS. The further study is required for developing a fully functional prototype, based on the solution outlined in the paper. At first, comprehensive ontologies are required to develop in order to address the targeted issues of decision makers, for further evaluation. A comprehensive evaluation study will also be helpful to identify technical difficulties of implementing SW approach and various challenges associated with user's acceptance and satisfaction. Presently, the solution prototype was constructed using conventional SW such as ontologies as a case based solution demonstration to industry stakeholders. Developing the fully-functional integration in record repositories with the ontology model will be another major effort in this study. This will allow appropriate knowledge discovery over multi-types of records such as Oral History collections in other similar institutes.

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