UNIVERSITI PUTRA MALAYSIA

ONTOLOGY BASED RECOMMENDATION SYSTEM FOR RESEARCH COMMUNITIES

SITI HAJAR BINTI ABDUL RAZAK

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By

SITI HAJAR BINTI ABDUL RAZAK

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirement for the Degree of Master of Science

May 2015

I dedicated this thesis, especially to:

My awesome Husband,

Muhammad Ashraf bin Mohamad Jalani

My wonderful Parents,

Abdul Razak bin Abdul Rashid &
Siti Esah binti Md. Hussain

My beloved Daughter

Siti Safiya binti Muhammad Ashraf

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

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May, 2015

Chairman: **Professor Rusli bin Hj. Abdullah, PhD**
Faculty: **Computer Science and Information Technology**

The enhancement of Virtual Community of Practice (VCoP) among research universities (RU) in Malaysia has led to a proper system model for new researchers to ensure that they are joining the right research communities effectively. It is important for researchers to capture and express their expertise in a form that can be easily accessed and used by others. Besides, it has led to devise a proper system model to group researchers in a community with mutual research interest since there is a limitation of system model in finding the right people to work together. The formation of virtual research communities in RU is known as VCoP where it provides a flexible way for researchers to interact, reuse, and share knowledge virtually. In this context, researchers are lecturers, as well as postdoctoral and postgraduate students. Thus, this research had adopted the Quick Ontology Mapping (QOM) as an ontology mapping technique since this technique had been proven to be effective and the applications of ontology are to classify, as well as to model the VCoP. In addition, the aim of this research was to propose an ontology-based model in recommending research groups to new researchers, besides proving the effectiveness of the system model that implemented the ontology mapping technique. The proposed system modelwas constructed based on literature review. Then, a case study was conducted upon the research community at the Faculty of Computer Science and Information Technology (FCSIT) in Universiti Putra Malaysia (UPM). The aim of this case study was to validate the elements of the proposed system model. As a result, the research findings showed that: (i) most of the respondents agreed that there was a need to group the researchers in the same field, and (ii) most of the respondents agreed that the proposed system modelcould recommend suitable research groups based on their interests. Apart from that, in order to prove the effectiveness of the proposed system model, this study compared the ontology mapping with simple matching technique. The purpose of this comparison had been to differentiate the mapping technique with and without ontology for it to function in a more relevant manner based on user's perspective. With that, a system prototype was developed to transform the proposed system modelinto a more workable state. Then, a post survey was conducted to prove the effectiveness of the system prototype. In addition, the results were analyzed by using Rasch Model since

this tool has been proven good in analyzing small sample size. The findings indicated that: 58% of respondents completely agreed (Strongly Agreed and Agreed) with the implementation of ontology mapping technique, and (ii) most of the respondents like the way ontology mapping technique recommended the research group. Hence, this research showed that this system model could be used as a guide to recommend research groups to new researchers. Finally, this proposed system modelcould be used by other communities to group their members with similar knowledge. Indirectly, knowledge can be shared and reused effortlessly.

Abstrak tesis ini dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

SISTEM CADANGAN BERASASKAN ONTOLOGI UNTUK KOMUNITI PENYELIDIKAN

Oleh
SITI HAJAR BINTI ABDUL RAZAK

Mei, 2015

Pengerusi: **Professor Rusli bin Hj. Abdullah, PhD**
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Peningkatan komuniti amalan maya (*VCoP*) di antara Universiti Penyelidikan (*RU*) di Malaysia membawa kepada keperluan untuk mempunyai sebuah model sistem yang sesuai untuk penyelidik baharu bagi memastikan mereka menyertai kumpulan penyelidikan yang betul secara berkesan. Ini adalah penting untuk penyelidik mengambil dan menyatakan kepakaran mereka dalam bentuk yang mudah diakses dan boleh digunakan oleh penyelidik lain. Oleh hal yang demikian, sebuah model sistem yang sesuai telah dirangka untuk mengumpul penyelidik di dalam komuniti yang mempunyai minat penyelidikan yang sama kerana kekurangan model sistem dalam mencari orang yang tepat untuk bekerjasama. Pembentukan komuniti penyelidikan maya dalam *RU* dikenali sebagai *VCoP* di mana ia adalah cara yang fleksibel untuk penyelidik berinteraksi, mengguna semula, dan berkongsi pengetahuan secara maya. Dalam konteks ini, penyelidik merupakan pensyarah, juga *pasca* kedoktoran, dan pelajar *pasca* siswazah. Seterusnya, kajian ini telah menggunakan *Quick Ontology Mapping (QOM)* sebagai teknik pemetaan *ontology* kerana teknik ini telah terbukti berkesan dan penggunaan *ontology* adalah untuk mengelaskan dan juga untuk memodelkan *VCoP*. Di samping itu, tujuan kajian ini adalah untuk mencadangkan sebuah model sistem yang berasaskan *ontology* untuk mencadangkan kumpulan penyelidikan kepada penyelidik baharu, dan membuktikan keberkesanan model sistem yang melaksanakan teknikpemetaan ontologi. Model sistem yang dicadangkan dibina berdasarkan kepada *literature*. Kemudian, satu kajian kes telah dijalankan di kalangan komuniti penyelidikan di Fakulti Sains Komputer dan Teknologi Maklumat (FSKTM), Universiti Putra Malaysia (UPM). Tujuan kajian ini adalah untuk mengesahkan model sistem yang dicadangkan. Keputusan menunjukkan: (i) kebanyakan responden bersetuju bahawa terdapat keperluan untuk mengumpulkan penyelidik dalam bidang yang sama dan; (ii) kebanyakan responden bersetuju bahawa model sistem yang dicadangkan boleh mengesyorkan kumpulan penyelidikan yang sesuai berdasarkan minat mereka. Selain daripada itu, untuk membuktikan keberkesanan model sistem yang dicadangkan, kajian ini mengambil keputusan untuk membandingkan teknik pemetaan ontologi dengan teknik padanan ringkas. Tujuan perbandingan ini adalah untuk membezakan teknik pemetaan dengan *ontology* dan tanpa *ontology* untuk

menjadikannya lebih relevan berdasarkan kepada perspektif pengguna. Dengan itu, sebuah sistem prototaip telah dibangunkan untuk mengubah model sistem yang dicadangkan ke dalam fasa yang lebih berkesan. Kemudian, satu kajian pasca telah dijalankan untuk membuktikan keberkesanan model sistem prototaip. Selain itu, keputusan telah dianalisis menggunakan *Model Rasch* kerana alat ini terbukti berkesan dalam menganalisis sampel saiz yang kecil. Hasil kajian menunjukkan: (i) 58% daripada responden sepenuhnya bersetuju (sangat bersetuju dan bersetuju) dengan penggunaan teknik pemetaan *ontology*, dan (ii) kebanyakan responden bersetuju dengan cara teknik pemetaan *ontology* mencadangkan kumpulan penyelidikan. Justeru, kajian menunjukkan model sistem ini boleh digunakan sebagai panduan untuk mencadangkan kumpulan penyelidikan kepada penyelidik baharu. Akhir sekali, model sistem yang dicadangkan ini boleh digunakan oleh komuniti lain untuk mengumpul ahli yang mempunyai pengetahuan yang sama. Secara tidak langsung, pengetahuan boleh dikongsi dan digunakan semula dengan lebih mudah.

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I certify that a Thesis Examination Committee has met on 25 May 2015 to conduct the final examination of Siti Hajar binti Abdul Razak on her thesis entitled "Ontology-Based Recommendation System For Research Communities" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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Declaration by graduate student

I hereby confirm that:

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LIST OF ABBREVATIONS

CoP	Community of Practice
CoPE	CoP of E-learning
FCSIT	Faculty of Computer Science and Information Technology
FOAF	Friend of a Friend
FSKTM	FakultiSainsKomputerdanTeknologiMaklumat
ICT	Information and Communication Technology
IHL	Institute of Higher Learning (IHL)
IS	Information System (IS)
ISC	Information Systems and Computing
IT	Information Technology
KM	Knowledge Management
MNSQ	Mean-Square
NC	New Comer
NOM	Naïve Ontology Mapping
NR	New Researcher
O'COP	Ontology Dedication for Communities of Practices
ODBC	Open Database Connectivity
Onto'CoPE	Ontology for Communities of Practice
OntoGP-VCoP	Ontology Group Profiling- Virtual Communities of Practice
On-to-knowledge	Ontology-Based Tools for Knowledge Management
OntoShare	Ontology-Based Knowledge Sharing System
OVCoP	Ontology Virtual Community of Practice
OWL	Web Ontology Language
PCA	Principal Contrast Analysis
PMBOK	Project Management Body of Knowledge
QOM	Quick Ontology Mapping
RDF3	Resource Description Framework
RG	Research Group
RU	Research University
SD	System Development
SLP	Learner Profile Ontology
SQL	Structured Query Language
SRS	System Requirement Specification
UPM	Universiti Putra Malaysia
VC	Virtual Communities
VCoP	Virtual Communities of Practice
W3C	World Wide Web Consortium
WWW	World Wide Web
XOL	Ontology Exchange Language
Z-std	Z- Standard

CHAPTER 1

INTRODUCTION

1.1 Research Background

Communities of Practice (CoP) has been rapidly used in Knowledge Management (KM) practices (Eri *et al*., 2014; Food *et al.*, 2003; Wenger, 1998). According to Etienne & Wegner-Trayner (2015), the importance of CoP is to improve the performance of an organization, where CoPs are groups of people who share similar interests and are able to make it consistently (Eri *et al.*, 2014). In addition, the growth of the internet has given an impact to the organizations, including Institute of Higher Learning (IHL). Moreover, according to Eri *et al*., (2012), IHL is one of the knowledge organizations with several research-based communities that are known as research communities, which are formed based on mutual research interests or research areas.

On top of that, the evolution of the internet infrastructure has an impact on the CoP, whereby CoP can form Virtual Communities of Practice (VCoP). Furthermore, Andreatos (2009) asserts that VCoP is a virtual place for communicating and exchanging practices between the professional units that build around common interest, and the members may communicate virtually. Nonetheless, the limitation of channel in finding the right people to collaborate (Eri *et al.*, 2014) has affected new researchers since Holm (2001)has claimed that finding the right experts is important for making better decisions. In line with the evolution of the internet, this research study has proposed an ontology-based system model to recommend research groups to new researchers. According to Kim *et al.*, (2010), the recommended system mostly focuses on the recommended items to individuals rather than groups of people in participating in a group activity. Besides, Burke (2000)and Ruotsalo (2010) reveal that system recommendation guides users in selecting the item they wish to analyze, rather than searching for the information manually. Hence, this research study has proposed a recommendation system where new researchers can identify suitable research groups effectively, without wasting time searching for information manually.

Apart from that, this research study has focused on the technique used to map new researchers to suitable research groups. With that, the application of ontology in this research study models and classifies the proposed system model since ontology could be employed to model and classify the VCoP based on related work (Eri *et al.*, 2012). In fact, recently, a research has discovered that ontology has become an important field in the Information System and Computing (ISC) discipline(Al-debei & Fitzgerald, 2009). Besides, according to Davies *et al*. (2003), ontology specifies the ontological classes where users can identify information. In addition, in order to identify a modular coupling among bodies of knowledge, ontologies are used as knowledge-level protocols for input, output, and communication (Gruber, 1991).

Therefore, in order to construct the proposed system model, a protégé has been chosen to model and to classify the ontology since it could design and query the ontology. Details pertaining to the protégé are discussed in Section 2.4.1 in Chapter 2.

1.2 Problem Statement

As noted earlier, according to Holm (2001) perspective on Knowledge Management (KM), working with the right people is important. Meanwhile, Jakovljevic *et al*. (2013) concluded that the evolution of Communities of Practice (CoP) has impacted the Institute of Higher Learning (IHL). However, they highlighted that there was no specific guidance to group the CoP for IHL. Jakovljevic *et al*. (2013) listed six phases of their study: (i) developing a theoretical framework for communities of practice, (ii) exploring preliminary learners' attitudes toward communities of practice, (iii) forming pilot communities of practice, (iv) evaluating pilot communities of practice groups, (v) implementing action research to pilot communities of practice, and (vi) applying the communities of practice model to other groups. However, they failed to help the groups' members to identify the CoP virtually. The formation of VCoP is important as the internet users continue to grow rapidly.

The VCoP formation is imperative, as members can obtain and share knowledge virtually, anywhere and anytime. Eri *et al*. (2014) stated that the information of the research community (i.e. research interests, grants, publications, and member's profile) of the IHL were kept in a static form and displayed in the related portal. Searching for the information of the research groups manually was time consuming. At times the information was outdated or undefined. It caused managing groups and managing group knowledge to become a difficult task (Eri *et al*., (2012); Eri *et al*., (2014)).

Muhammad & Nordin (2013) determined that currently, there was no available ontology model that can be used for group formation. Therefore, their focused were to ascertain the semantic group formation model for CoP. They proposed group formation and implementation in order to share knowledge and to develop professional skills. To have a group formation is important, but to identify suitable groups for new members is even more important, to ensure that knowledge can be shared and developed easily.

A survey that was conducted by Eri *et al.* (2014), indicated that most of the respondents faced difficulty to identify members that interest them. Nowadays, applicants (new researchers) should identify and contact a possible researcher personally. There is no systematic tool available to guide new researchers to identify suitable research groups effectively. Hence, new researchers have to undertake this task manually. According to Eri *et al.* (2012), channels to find the right people to work with were non-existence, therefore their aims were: (i) to classify virtual communities in research communities ofIHL and, (ii) to model virtual communities based on similar research interest using ontology.

As discussed previously, most of the scholars focused on how to manage the knowledge, formed groups for CoP, and classified the community in order to have better KM activities. However, they overlooked the fact that it is more crucial to help new members to identify suitable research groups virtually, as this will provide the opportunity for new members to gain knowledge from current members of the group; thus knowledge will be used and shared effortlessly.

1.3 Research Questions

In line with the problem statement, 3 research questions are depicted, as in the following:

- What kind of appropriate ontological model can be used to recommend the suitability of new researcher's participation?
- Which appropriate mapping technique can be used to recommend suitable research groups?
- How does the model work to prove its effectiveness in recommending new researchers to suitable research groups based on their research interest?

1.4 Research Objectives

Based on the research questions, the aims of this thesis were:

- To propose an ontology based system model in recommending research communities to new researchers.
- To prove the system model using ontology mapping technique is effective.

1.5 Research Contribution

This research study has contributed an ontology-based recommendation system model for new researchers to guide them in recommending the suitable research groups that meet their research interests effectively. Besides, this research study has adopted the Quick Ontology Mapping (QOM) as a mapping technique, and some tools have also been used to implement the prototype system model, as discussed in Chapter 3. On top of that, the research focuses further on knowledge reuse and sharing between research communities virtually.

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1.6 Scope of Research

This research study has focused on the research communities in the context of academician environment. In addition, this research has examined and proposed the best practices that could offer benefits to researchers in the research communities. Besides, the scope of research for this particular study is the mapping technique employed, as well as the research communities involved. As for the mapping

technique, this research has selected the Quick Ontology Mapping (QOM), which is explained in Chapters 2 and 5.

1.7 Structure of Thesis Organization

This thesis is generally divided into 7 chapters, where the first chapter is the introduction of this research study that explains the research background. Next, the statement of the problem, the research questions, the research objectives, the contributions of this research study, the scope of the research, and lastly, the organization of the thesis, are depicted.

Chapter 2 of the study looks into the related articles of the Communities of Practice (CoP) and Virtual Communities of Practice (VCoP), the recommended system model, as well as ontology, which includes ontology tools, uses of ontology, ontology languages, ontology modeling, ontology classification, ontology applications, ontology mapping, and advantages of ontology. Basically, this chapter reviews the important information concerning this research study in order to achieve the research objectives.

Chapter 3 describes the methodology employed in this research study that starts with research methodology flowchart. There are 2 main phases in this research study: (i) the proposed system model, and (ii) the translation of the model into the prototype system. Besides, the chapter also discusses the ontology mapping process in the development of the prototype system model, the ontology hierarchy for research communities, the system model construction, and the system model process diagram.

Chapter 4 discusses the results and the analysis of the preliminary survey in order to validate the elements of the proposed system model based on the literature review, as discussed in Chapter 2. Next is Chapter 5, which discusses the Software Requirement Specification (SRS) documentation, and the development of the system model prototype. In addition, this chapter discussesmapping technique implementation, interface of the
OVCoP system, system validation and testing, as well as user manual for prototype system.

Chapter 6 presents the results and the analysis of the system model prototype in order to evaluate the effectiveness of the system model that uses ontology mapping technique. Finally, the conclusion of this research study is presented in Chapter 7, which includes findings of this research, research contributions, strengths and limitations of this research study, as well as recommendation for future works.

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