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Ontological Model of Virtual Community of Practice (VCoP) Participation: a Case of Research Group Community in Higher Learning Institution

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Abstract

The increasing number of Virtual Communities of Practice (VCoP) leads to the needs of having an ontological model in mapping new members (new researchers) to their relevant Research Group(s) especially in Higher Learning Institution. This paper proposes a new model of ontology of Virtual Community of Practice (VCoP) called Ontology-based VCoP (Onto-VCoP) that can help new member of researcher to identify themselves for the suitability of joining research groups efficiently. The efficiency of our model is based on mapping technique that was adopted from Ehrig and Staab [1] Quick Ontology Mapping (QOM). Onto-VCoP model applied ontology to represent knowledge and QOM to map data between new researchers and research groups. Systematically reviewed for literature and pre-survey is done to get the user requirement and to support objective of this paper. The result shows Onto-VCoP model may help new researchers to identify research groups based on their research interest efficiently.

Keywords: Virtual Communities of Practice, Ontology, Quick Ontology Mapping, Research, Research Group, High Learning Institution.

1. Introduction

The growth of Research University (RU) in Malaysia gives an impact to the Institute of Higher Learning (IHL). According to [2], virtual communities of research communities are lacking of proper management in managing group and managing groups' knowledge. This has caused the need to organize knowledge among researchers. Virtual Community of Practice (VCoP) is a community that shares the common practices in a group virtually [2]. There a lot VCoP(s) in IHL; among these are research groups community. In the context of VCoP research group(s), there are consists of researchers and research students. Increased number of people joining researches leads to the need of a proper system that can manage new researchers in order to choose research group. Trend of IHLs in Malaysia is; research students are assigned to their respective research groups without further understanding of student's research interests and needs. Finding the right knowledge and the right people to working with is very important in order to make better and critical decision thus to increase organizational of knowledge and productivity [2, 3]. Therefore, it is important to produce a model that can help new researchers to identify research group that suit their research interest. To determine the correct research group for new researchers, we proposed a model called Onto-VCoP.

Since ontology can represent knowledge, enable knowledge sharing and reuses [4], we use ontology to define an

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explicit specification of a conceptualization where ontology is a standard representation of knowledge [5].

There are a lot of mapping method according to [6] such as Analysis and Reconciliation Tool Environment for Multiple Information Sources (ARTEMIS), A system for flexible combination of schema matching approaches (COMA), Algorithm and Tool for Automated Ontology Merging and Alignment (Anchor-PROMPT), Quick Ontology Mapping (QOM) and Semantic Schema Matching (S-Match). Based on our reviewed, the suitable mapping method that suit with our work in term of efficiency is QOM where QOM produces high quality results with marginal loss of quality [1]. The main objective of this paper is to propose an ontology-based VCoP model in identifying research group for new researchers based on related work and pre-survey. The main contribution of our proposed model is to map new researchers with the right research group by using ontology and mapping techniques.

This paper has been divided into five sections. Section II deals with related work on Ontology, Community of Practice (CoP), Virtual Communities of Practice (VCoP), and Quick Ontology Mapping (QOM). This followed by research method that will be explain in section III. In section IV, we will explain about our proposed model. Next is section V that will be present our pre-survey result and analysis to investigate the research community perception in handling research project. Finally, conclusion will be drawn in section VI.

2. Related Literature

2.1 Ontology

In recent years, there has been an increasing amount of literature on 'Ontology' in the field of computer and information sciences [1]. In the context of knowledge sharing, ontology mean as specification of a conceptualization [4]. Gruber [5] has reported that, ontology is an explicit specification of a conceptualization. In the context of Artificial Intelligence (AI), ontology can be described as a program by defining a set of representation term [5].

While a variety of definitions of the term 'ontology' have been suggested, this paper will use the definition suggested by [4] saying that ontology as an appropriate modeling structure for the purpose of enabling knowledge sharing and reuses. Benefits of ontology that have highlighted by [7] are:- 1) Interoperability: ontology is an interoperability tool where its allowing to access ontology of each components to design thus can design a mapping between concepts in different components; 2) Browsing and Searching: The meta knowledge within an ontology can assist an intelligent search engine in processing query; 3) Reuse: ontology have library and can be reused by another component; 4) Structuring: by using "ontological bootstrapping", it is faster to built a new system. All of the aforementioned benefits of ontology are suggested to support in order to propose an ontological model of VCoP.

2.2 Communities of Practice (CoP) and Virtual Communities of Practice (VCoP)

Several studies have produced definition of Communities of Practice (CoP) and Virtual Communities of Practice (VCoP) where [8] said CoP as a groups within (or sometimes across) organizations who share a common set or problems . Previous studies that was revealed by [9] defined CoP as well-established forums since VCoP is a virtual or online Communities of Practice (CoP). The example that was given by [2]; VCoP is a virtual places communication and exchanging practices and information that is built around common interest where member mostly or entirely is communicated via Information and Communication Technology (ICT). In another major study about CoP, [2] suggest that members need to identify and trace their own community. Since research cannot be done individually, its found importance for new researcher to identify research group that have same research interest. So, they may compose a group-based researcher who share similar research interest and working together virtually [2].

2.3 Quick Ontology Mapping (QOM)

As explained in introduction part, there a lot of mapping method and focus on this section is to summarize the key features of each method and why we decide to apply QOM as our mapping techniques instead of others. Based on [6], reviewed mapping technique that was done by them such as:-

a) **ARTEMIS** (Analysis and Reconciliation Tool Environment for Multiple Information Sources) by [10]- This method is aimed at solving the problem of independent data stores and database. This method is based on theoretical framework where metadata can be used to automate various aspects of data integration.
b) **COMA** (A system for flexible combination of schema matching approaches) by [11] – A system that combining different ontology mapping approaches based on the situation, or source schemas. Propose of this method

is to overcome problem when using a single matching approach that will not always yield the best results.

c) **Anchor-PROMPT** (Algorithm and Tool for Automated Ontology Merging and Alignment) by [12]- It is known as "traditional" ontology mapper that attempts to automatically find semantically similar terms between two ontologies.

d) **QOM (Quick Ontology Mapping)** by [1] – this method is emphasize speed over accuracy of results and extends from Native Ontology Mapping (NOM) in [11]. QOM a much more feasible method for real-world practical applications where often the ontology schemas can get quite large.

e) **S-Match (Semantic Schema Matching)** by [13] – This ontology mapping method based on semantic integration of independently constructed schemas.

The summarizes of mapping method and key features explain further in Table 1.

Based on Table 1, the first column gives the name of method. For second and third columns differentiate between element-level and structure level where for each differentiation, there are divided into syntactic and external for element level; and syntactic and semantic for structural level. Under element level, syntactic refer to what kind of features the method provides when analyzing the syntactical information of ontology while for external, is to the ontology that the method may rely on (example: a dictionary). For structure level, syntactic refer on how the method analyze the structure of the ontology and its related syntax to gain further information while for semantic, its only applies to the S-Match method [6].

Based on experiments that was conducted by [1], shows that QOM gives up some of the possibilities for producing high-quality results in favour of efficiency and the result shows it loss of quality is marginal. QOM a much more feasible method for real-world practical applications where often the ontology schemas can get quite large. Because of the accuracy, QOM is on a par with other good state-of-the-art algorithms concering the quality of proposed mappings, while outperforming them with respect to efficiency [1]. Therefore, to have an efficient mapping process, QOM is the best technique to map two ontologies O_1 and O_2.

"Mapping" in the term of [1]: given two ontologies O_1 and O_2, mapping one ontology onto another means that for each entity (concept *C*, relation *R*, or Instance, *I*) in ontology O_1, where this mapping technique will try to find the corresponding entity, which has the same intended meaning, in ontology O_2. QOM is the best technique that will be applied in Onto-VCoP model. Figure 1 shows the example of ontologies and their mapping adopted by [1].

In order to identify the suitability of research group for new researcher, QOM is proposed to map data between new researcher's databases with research group's database.

Table 1. Mapping Method and Key Further

	Element-level		Structure-Level	
	Syntactic	External	Syntactic	Semantic
ARTEMIS	Domain compatibility: language-based	Common thesauraus: synonyms, broader terms, related terms	Matching of neighbors via common thesauraus	
COMA	String-based, language-based, data types	Auxiliary thesauri: synonyms, hypernyms, abbreviations, alignment reuse	DA (tree) matching with a bias towards leaf or children structures	
Anchor-PROMPT	String-based, domains and ranges		Bounded paths matching (arbitrary links); bounded paths matching (processing is-a links separately)	
QOM	String-based, domains and ranges	Application- specific vocabulary	Matching of neighbors-; taxonomic structure	
S-Match	String-based, language-based	WordNet: sense-based, gloss-based		Proposition SAT

Source: Adopted from Godugula [6]

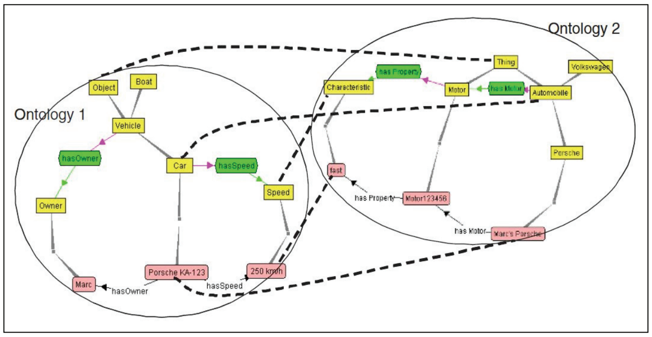


Figure 1. Example of Ontologies and mapping.
Source: Adopted from Ehrig and Staab [1]

According to [1], QOM is a method that emphasizes speed over accuracy of results and extends from Native Ontology Mapping (NOM).

3. Methodology

Initial work and literature review is a first step in order to proposed Onto-VCop model. Finding the right literature related with this work is the first move to get the information that is needed for this research project. After we have compiled and analyzed literature review, the most related literature will be reviewed systematically. All the information will be compiled to make sure we have the right and latest information. To get user requirement for this model, we need to do a Pre-Survey. This pre-survey will be explain further in section Pre Survey Test. Tools that were use to analyze the pre-survey is Rasch Model [14]. Results for this pre-survey will be discussed later in part V; Results and discussion. The user requirements for our proposed onto-VCoP model were constructed based on findings from pre-survey. This model will be explained further in section IV; Proposed Model.

3.1 Pre Survey Test

The pool of expert reviewers in the content validity test comprised 20 lecturers and 30 postgraduate students with thesis from the faculty of Computer Science & Information technology, Universiti Putra Malaysia. The objective of this survey is to investigate researcher's perception in handling research project. A questionnaire was developed to determine whether the experts agreed with the problem statements and the proposed solution besides to get users requirements and the needed of having ontology-VCoP model. Respondents for this pre-survey includes 19 experts (lecturers) and 30 postgraduate students with thesis. Responses were tabulated and analyzed using the basic Rasch dichotomous model [14].

3.2 Proposed Model

This proposed model section will be explaining each part in our model detailed where this model was divided into 3 parts that are Part A, Part B and Part C. Part A is a first stage where new researcher will be ask to insert all the relate data and it will be stored temporarily in new researcher's database. Part B and Part C is a process stage. There are three (3) steps includes in part B that are mapping process, searching for the related research groups and suggesting relevant research group. For mapping process, data from new researcher's database will be map with data from research group's database using mapping technique adopted by [1]. After done mapping data between new researchers and research group, the next process is searching for the suitable researcher groups then, suggesting the relevant research groups and suitable researchers to the new researcher. Last step is system will going back to Part A and post the suggested research groups and researchers to the new researcher. New researcher may choose which research groups and researchers that suit with them and request to join their research group. Figure 2 shows our constructed Onto- VCoP Model based on findings.

Mapping process will be done in part B and C where two ontologies O_1 and O_2 will be map based on data from new researcher's temporary database and research group's database. According to [1], there are six (6) main steps. Started with two ontologies O_1 and O_2, where O_1 represent new researcher's temporary database and O_2 represent research groups database which are going to be mapped onto one another, as its input [1]:-

1. Feature Engineering : From OWL/RDF, we will classify classes for the subsequent similarity calculation. Then, create table to store ontologies, ontology classes, ontology relations, ontology mapping, and ontology similarity aggregations. After that, populate the tables from OWL/RDF. This table able to link the classes to the transaction tables that were used by VCoP (Researcher).
2. Search Step Selection : Since the objective is to select the suitable Research Group, we first select the Research group classes as the primary candidates and Researcher classes as the secondary candidate mapping. Because of QOM using heuristic algorithm to reduce mapping possibilities, we choose to combine class label and

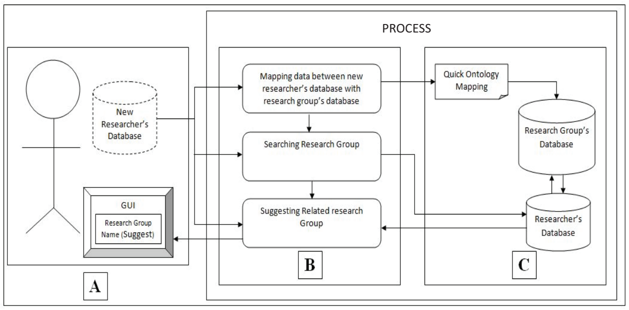


Figure 2. Onto- VCoP Model.

INPUT: 43 Persons 41 Items MEASURED: 43 Persons 40 Items 5 CATS 1.0.0

SUMMARY OF 43 MEASURED Persons

	RAW SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	106.7	32.4	.31	.21	1.02	−.1	1.01	−.1
S.D.	18.4	5.1	.37	.02	.38	1.7	.38	1.6
MAX.	140.0	40.0	1.64	.27	1.64	2.4	1.64	2.3
MIN.	81.0	28.0	−.67	.18	.24	−4.2	.22	−4.4

REAL RMSE .23 ADJ.SD .29 SEPARATION 1.24 Person RELIABILITY .61

CRONBACH ALPHA (KR-20) Person RAW SCORE RELIABILITY = .93

SUMMARY OF 40 MEASURED Items

	RAW SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	114.7	34.8	.00	.22	1.00	−.1	.98	−.1
S.D.	47.9	11.7	.95	.05	.36	1.3	.36	1.3
MAX.	186.0	43.0	2.56	.34	2.11	3.7	2.17	3.8
MIN.	39.0	15.0	−1.58	.16	.51	−2.6	.51	−2.5

REAL RMSE .24 ADJ.SD .92 SEPARATION 3.87 Item RELIABILITY .94
MODEL RMSE .22 ADJ.SD .92 SEPARATION 4.16 Item RELIABILITY .95
S.E. OF Item MEAN = .15

Figure 3. Summary Statistic.

equivalent class strategy. It is because class names alone are not sufficient.

3. Similarity Computation : QOM uses top-down strategy (not pair-wise) to further optimize mapping pairs. This means we only pair the mappings based on parent classes.
4. Similarity Aggregation : As mentioned before, we choose combination of class label and equivalent class strategy. In this case, the example is "Research Interest" could be linked to "Interest" via Label. But "Leader" and "Member" could only be linked via Equivalent Class (as defined in OWL).
5. Interpretation : In this step, the objects (or values) of the classes are processed, based on the above aggregation complexities.
6. Iteration : Then once a while, steps 2–5 will be run again, especially right after ontology updates.

4. Result and Discussion

Results and discussion will be divided into two (2) section that are section A) Pre-Survey Test that will be explain results and analysis for pre-survey; while section B) QOM will be discuss about the efficiency of this technique compare to the another mapping technique based on related literature.

4.1 Pre-Survey Test

Figure 3 shows the summary statistic for the analysis of the sample of 49 the researchers (survey response = 98%) on the 41 dichotomous scale items that comprise the content validity test to investigate the researcher perception in handling research project in research group. The mean of the individual person measures is .31, which is noticeably lower than the 0 calibration of the quality item scale, which is set as the default option of the analysis. This indicates that most of the respondents agree with most of the items.

Based on Figure 3, for person reliability (.61) is low. It shows that the number of item used to measure the number of person is low. The item reliability of .94 shows that the number of person to measure number of item is high. But overall, the instrument is reliable because the Cronbach Alpha is .93. This indicates that the survey instrument for measuring content validity is reliable and results are reproducible. Next, this instrument is reliable and can use this result for further analysis.

The Wright map in Figure 4 displays the distribution of researchers on the left and the distribution of item agreement on the right according to item number. To represent respondents for lecturers, we are using capital 'L' and capital 'S' to represent students. The most agreed-to items is I0028 (*easily to collaborate in the same field*). The least agreed-to item is item I0001 (*don't know why I joining this current research group*). The person distribution confirms the result from summary statistics.

This indicates that all respondents involved in the content validity test tend to agree to the entire set of quality categories and their assigned criteria. So, from the wright map we can conclude that respondents tender to collaborate in a research group that have similar research members of interest. The probability of agreement by the respondents to the perception in handling research project in research group can be established by using formula [14]:

$$P(\theta) = \frac{e^{0.31-0}}{1+e^{0.31-0}}$$
$$= 0.576$$

The standard deviation of the person measures is .37 logits, while the standard deviation for quality item measures diverges even further to .95. The summary fit statistics for quality items and persons imply a satisfactory fit to the model. Most agreeable respondent is S14. The least agreeable

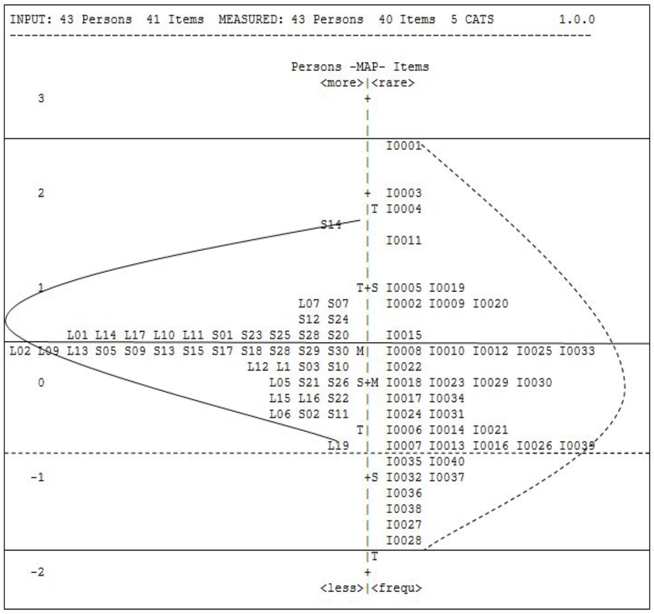


Figure 4. Wright Map.

respondent is L19. Mean of the item distribution is higher than the mean of the person distribution that state in Figure 3. Thus, the respondent's reviewers in the content validity test indicate their level of agreement to the proposed criteria at 57.6%, which is fair. According to Shirazi et al. [15], rating scale instrument quality criteria for variance in data explained by measures, 50–60% in the fair range. Most of the respondents agree to the proposed criteria in handling research project for research group.

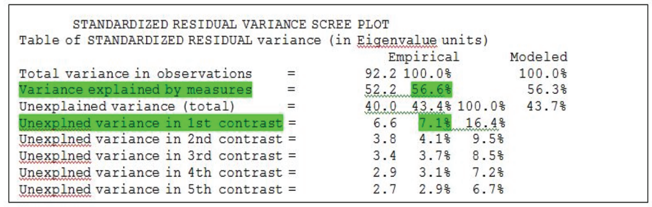
Figure 5 shows a segment of principal contrast analysis of Rasch residual variance. The variance explained by measures is noticeably good (56.6% (greater than 50%)). The unidimensionality of the survey instrument is confirmed by having an acceptable unexplained variance in the first contrast (7.1% (less than 15%)). This evidence of unidimensionality further supports the structural aspect of construct validity. Thus, this instrument is valid for further analysis and support our objective the needs to have a model that can help new researchers to identify research groups in the same fields.

4.2 Quick Ontology Mapping [1]

4.2.1 Formula of matching

i) Class Label

Figure 6 shows ontology mapping for O_1 and O_2 where O_1 is ontology for research group and O_2 is ontology for researchers (new members). To map this two ontology, we



STANDARDIZED RESIDUAL VARIANCE SCREE PLOT
Table of STANDARDIZED RESIDUAL variance (in Eigenvalue units)

		Empirical			Modeled
Total variance in observations	=	92.2	100.0%		100.0%
Variance explained by measures	=	52.2	56.6%		56.3%
Unexplained variance (total)	=	40.0	43.4%	100.0%	43.7%
Unexplned variance in 1st contrast	=	6.6	7.1%	16.4%	
Unexplned variance in 2nd contrast	=	3.8	4.1%	9.5%	
Unexplned variance in 3rd contrast	=	3.4	3.7%	8.5%	
Unexplned variance in 4th contrast	=	2.9	3.1%	7.2%	
Unexplned variance in 5th contrast	=	2.7	2.9%	6.7%	

Figure 5. Variance explained by measures should be >= 50% and unexplained variance in the first contrast should be <= 15% [16].

choose the combination of class Label and equivalent class strategy. In this case, for example we link the "Research Interest" [label = 7] from the researchers ontology to the "Research Interest [label = 103] from research group ontology via label that is [7 → 103]. But for case "Leader" and "Member" could only be linked via Equivalent Class (as defined in OWL).

ii) Equivalent Class

Figure 7 shows the equivalent class mapping for O_1 and O_2 where O_1 is ontology for research group and O_2 is ontology for researchers (new members). In this case, for example the "Group Name" [label = 23] from O_2 will be map to the "Group Name" [label =101] from $O_1 \rightarrow O_2$ where [23 ↔ 114 ↔ 10 ↔ 101]

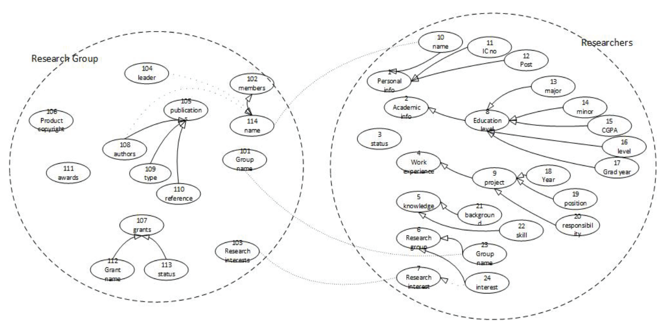


Figure 6. Ontology Mapping for O_1 and O_2.

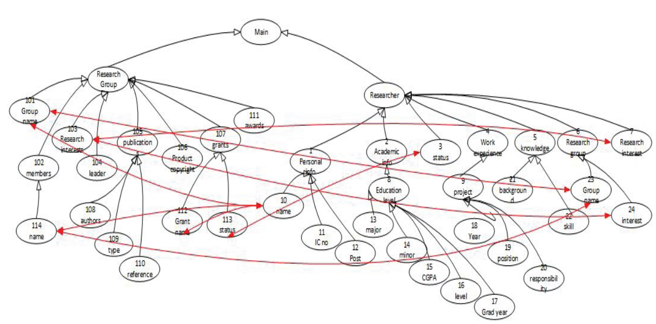


Figure 7. Equivalent class for Ontology 1 and Ontology 2.

4.2.2 Algorithm for mapping technique

```
BEGIN

DECLARE a INT DEFAULT 0;
    DECLARE done,done2 INT DEFAULT FALSE;
    DECLARE d_cotopic_distance,d_string_equality,d_string_similarity DECIMAL(11,4);
    DECLARE i_ont_similarity_agg_id,i_ont_id,i_class_id,i_sim_ont_id,i_sim_class_id INT;
    DECLARE c_first_table_name, c_first_field_name, c_second_table_name, c_second_field_name VARCHAR(50);
    DECLARE cur_ont1 CURSOR FOR SELECT ont_similarity_agg_id,ont_class_id,ont_id,sim_ont_id, sim_class_id,
first_table_name, first_field_name, second_table_name, second_field_name, cotopic_distance,string_equality,string_similarity
FROM v_sim_agg_class_mapping WHERE first_table_name <> '' AND second_table_name  <> '' and ont_id = 1;
    DECLARE cur_ont2 CURSOR FOR SELECT ont_similarity_agg_id, first_table_name, first_field_name, second_table_name,
second_field_name FROM temp_user_rg WHERE user_id = a_user_id;
    DECLARE CONTINUE HANDLER FOR NOT FOUND SET done = TRUE, done2 = TRUE;

    OPEN cur_ont1;

    SELECT count('X') INTO a FROM temp_user_rg where user_id = a_user_id;
    IF a > 0 THEN
        DELETE from temp_user_rg where user_id = a_user_id;
    END IF;

    read_loop1: LOOP
        FETCH cur_ont1 INTO i_ont_similarity_agg_id,i_class_id,i_ont_id,i_sim_ont_id,i_sim_class_id,c_first_table_name, c_
first_field_name, c_second_table_name, c_second_field_name, d_cotopic_distance, d_string_equality, d_string_similarity;
        IF done THEN
            LEAVE read_loop1;
        END IF;

        INSERT INTO temp_user_rg
        (ont_similarity_agg_id, user_id, first_table_name, first_field_name, second_table_name, second_field_name, cotopic_dis-
tance, string_equality, string_similarity)
        VALUES (i_ont_similarity_agg_id, a_user_id, c_first_table_name, c_first_field_name, c_second_table_name, c_second_
field_name, d_cotopic_distance, d_string_equality, d_string_similarity);

    END LOOP;
    CLOSE cur_ont1;

    OPEN cur_ont2;

    SET a = 0;
    SELECT count('X') INTO a FROM temp_user_rg_det where user_id = a_user_id;
    IF a > 0 THEN
        DELETE from temp_user_rg_det where user_id = a_user_id;
    END IF;

    set done2 = FALSE;
    read_loop2: LOOP
        FETCH cur_ont2 INTO i_ont_similarity_agg_id,c_first_table_name, c_first_field_name, c_second_table_name, c_sec-
ond_field_name;
```

```
            IF done2 THEN
                LEAVE read_loop2;
            END IF;

            INSERT INTO temp_user_rg_det
            (ont_similarity_agg_id, user_id, first_field_value, second_field_value)
            VALUES (i_ont_similarity_agg_id, a_user_id, 'test1', 'test2');

        END LOOP;
        CLOSE cur_ont2;



    END
```

Source: Ehrig and Staab [1]

5. Conclusion and Future Work

As a conclusion, the paper has shown our proposed Onto-VCoP model explain in section IV (Proposed model) based on related work and results of pre-survey obtained in section V (Results and Discussion). Our pre-survey shows that the summary fit statistic for items and persons imply a satisfactory fit to the model. Respondent's shows the needed to have a model in order to identify research group that have similar research interest. This imply to them where they feels easy for research members to collaborate if they are in the same field. As for future works, our proposed model will be implemented to check the validity of our proposed model in term of efficiency of our model. The validation will be done by distributing post-survey to the same respondents from pre-survey to get the user acceptance of our model.

6. Acknowledgement

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