Journal of Theoretical and Applied Information Technology
15th September 2021. Vol.99. No 17

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

ONTOLOGY FOR CORPUS OF OCCUPATION AND COMPETENCY STANDARDS

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ABSTRACT

The ability of personnel in the field of information and communication technology varies greatly, in line with the emergence of various formal and informal educational institutions in this field. Increasing the capabilities and competencies of Human Resources in accordance with the demands of the global labor market needs a reciprocal relationship between the providers of Human Resources and the industrial world in need. There are many occupations in the Information and Communication Technology (ICT) field, each occupation has several competencies. Each occupation has more than one competency. The many occupations and competencies, in Indonesia, are grouped under the name Occupation Map and Competency Standards (CS). The first thing to do is review the Occupational Map document and Competency Standards (CS) document. The results of the analysis of the two documents produce elements that can be used to build ontologies. So that based on this, in this study a method was developed to produce ontology from Occupational Map and Competency Standards (CS). The results obtained from this study are the Occupational Map ontology and Competency Standards (CS) ontology. The ontology concept of the Occupational Map and Competency Standards (CS) can be used as the basis for making the Occupational Map corpus and the Competency Standards (CS) corpus. The Occupational Corpus and Competency Standards (CS) Corpus can be used by governments, private companies or industry when making job vacancies information or looking for prospective employees and that can be used to see the suitability between occupation and competence.

Keywords: *Ontology, Occupation, Competency Occupation Map, Competency Standards, Corpus*

1. INTRODUCTION

In the current era of globalization, the development of technology is very rapid along with the development of science. The use of information and communication technology has become a part of everyday life, both for personal, business and government purposes. This has spurred the need for competent human resources in the field of information and communication technology. The ability of personnel in the field of information and communication technology varies widely, in line with the emergence of various formal and informal educational institutions in this field, so that appropriate competency standards are needed.

Increasing capabilities and competencies of Human Resources in accordance with the demands of the global labor market needs a reciprocal relationship between the providers of Human Resources and the industrial world in need. This relationship can be in the form of openness and cooperation in determining the standards for the required qualifications or competencies of Human Resources, in the form of standard requirements for qualifications of Human Resources carried out by industry and the development of educational programs to meet these standards by Human Resources side.

Most of the information about job vacancies issued by companies today is through online media, website-based job vacancies information on the problems faced by job seekers and companies who want to open job vacancies. The website can be used as an information provider, besides that various activities such as e-commerce, e-learning, online transactions, and online advertising can use the website. Job vacancies are opportunities that a

person has to be able to get a job that can generate compensation in return for his services. The information contained in job vacancies is the occupation and the list of competencies of the occupation.

The Indonesian government has ratified an occupation list in the form of an Occupational Map document and a list of competencies in the form of a Competency Standards (CS) document for the Information and Communication Technology (ICT) sector. This document can be used as a reference when the company will make job vacancy information.
Information in job vacancies is the name of the occupation and the competence of the occupation. However, it was found that the information on job vacancies made by the company did not match the name of the occupation with the competency or the competency stated did not match the name of the occupation.

Occupation [14] is any activity that uses physicality and / or mind to achieve certain goals and uses energy and / or mind to get rewards in order to fulfill their human needs.

Job seekers who will apply to a company will state their occupation and competencies. There are many occupations in Indonesia, the ministry of manpower together with the relevant ministries and companies and academics in Indonesia have determined an occupation map along with the competencies that these occupations must have, and the translation of competencies is down to the Competency Standards (CS). Each occupation has several competencies, specifically for occupations in the field of Information and Communication Technology (ICT), the grouping has been made in the occupation map.

The occupation map, especially in the field of Information and Communication Technology (ICT), is a document that maps the types of job titles based on qualification levels. The contents of the occupational map document will continue to be developed along with the development of information and communication technology. The Occupational Map is compiled collectively by stakeholders as a reference in meeting needs related to human resource development, which refers to regional, national and international needs. Each occupation has several competencies. The compilation of competencies in Indonesia must be based on standards set by the government.

Competency Standards (CS) are the formulations of the abilities that a person must have to perform a task or job which is based on knowledge, skills and work attitudes in accordance with the required performance [9]. Competency Standards (CS) can be used in education and training institutions, companies, and professional certification bodies. In educational and training institutions Competency Standards (CS) are used as a reference in curriculum preparation and teaching development, as well as encouraging consistency in conducting education and training, and determining their qualifications. In the business world / companies, competency standards are used as a management tool, while in professional certification bodies, they can be used as a reference in the preparation of classifications and qualifications as well as testing criteria and testing instruments or measuring instruments. Competencies that exist in the Competency Standards (CS) can be owned by several occupations. The number of occupations and competences, especially in the field of ICT, needs to be made ontology so that the element structure of the Occupation Map and Competency Standards (CS) is clearly visible. the required performance [9]. Competency Standards (CS) can be used in education and training institutions, companies, and professional certification bodies. In educational and training institutions Competency Standards (CS) are used as a reference in curriculum preparation and teaching development, as well as encouraging consistency in conducting education and training, and determining their qualifications. In the business world / company Competency Standards (CS) are used as a management tool, while in professional certification bodies, they can be used as a reference in preparing classifications and qualifications as well as testing criteria and testing instruments or measuring instruments. Competencies that exist in the Competency Standards (CS) can be owned by several occupations. The number of occupations and competencies, especially in the field of ICT, needs to be made ontology so that the element structure of the Occupation Map and Competency Standards (CS) is clear.

Ontology is a formalization, the explicit specification of a joint conceptualization [5]. Ontology is a concept that has begun to develop in Information Systems (SI). According to the philosopher Aristotle ontology as metaphysical (something after physical). Meanwhile, Gruber defines ontology as "the details of the idea" (specification of conceptualization), all knowledge related to ideas, both implicitly and explicitly [6].

Guarino added ontology as "a logical theory of recording a meaning of formal words", the meaning of the relationship is an important thing independent of existing circumstances [7].

A number of frameworks designed using ontology-based integration approaches have developed in recent years with many advantages. Some of these advantages include that the ontology provides a rich, predefined vocabulary that serves as a conceptual interface that is stable and independent of the data scheme, the knowledge represented by the ontology is comprehensive enough to support the translation of all relevant sources of information, the ontology supports the management that is consistent and recognizes inconsistent data. [2]. The results of the ontology contained a lot of occupational data and competency standards, a corpus was needed for the database.

A corpus is a closed set of text that has a machine-readable form or computer, with predefined criteria [4]. The corpus must be able to represent and have a balance with special or certain factors, for example a specific genre or a limited domain (closed domain). For example, a particular genre (theme) newspaper article, fictional story or literature, blogs, diaries and legal documents. In addition, according to him, the corpus must represent or reflect the generalization of language variations [8].

The current condition is that there are many occupations in the ICT field and each occupation has many competencies and each competency can be owned by several occupations. With such conditions, it is necessary to make a concept from the Occupational Map document and the Competency Standards (CS) document, so that the relationship between each occupation and the competencies that each occupation must have is correct. Ontology is one of the solutions to describe the relationship between the elements in the Occupational Map and the elements in the Competency Standards (CS). The method developed, built ontology on occupation map data storage and Competency Standards (CS).

Another study that discusses the making of ontology is a study entitled "Towards a Human Resource Development for Combining Competence Management and Technology-Enhanced Workplace Learning". This research discusses competence at the organizational level by integrating the formation of goal-oriented human assets and competencies at the operational and technical levels in the form of workplace learning using technology. Both have unity so that the same domain conceptualization is needed, then a reference ontology is built using competencies at the organizational level and competencies at the operational and technical levels [18].

In this study, building the ontology from the Occupational Map document and the Competency Standards (CS) document because the number of occupations and lists of competencies issued by the government, especially in the field of Information and Communication Technology (ICT).
Occupational Maps relate to Competency Standards (CS) based on the competencies that human resources must possess. In the developed method, an ontology of Occupational Map and Competency Standards (CS) was built and the resulting ontology concept.

The scientific contribution of this research is to produce an ontology concept from the Occupational Map and Competency Standards (CS). Another contribution from this research is that the ontology concept can be used to build an Occupational Map corpus and a Competency Standards (CS) corpus. One of the functions of this corpus can later be used to help labor providers when looking for employees who are in accordance with the competencies and in accordance with the needs of the company.

STATE OF THE ART

2.1. Competency Standards

Competency Standards (CS) are formulations of work ability that include aspects of Knowledge, Skills and / or Skills and work attitudes relevant to the implementation of duties and job requirements which are determined in accordance with the provisions of the prevailing laws and regulations.
There are several Competency Standards (CS) models:

1. Company Standards
   Company Standards or Enterprise Standards is a standards set by a company or company industry.

2. Position Standards
   Position standards are standard developed referring to existing positions in institutions / institutions / industries as a description of the organizational structure.

3. Special Standards
Special competency standards are standards in certain fields formulated and stipulated by national / international institutions or organizations, for example in the fields of welding, petroleum, aviation, and so on.

Several models of Competency Standards (CS) setting:

- ***Model Occupational Skills Standard (MOSS)*** is a model for compiling Competency Standards (CS) based on occupation or position. This model is not suitable when applied in Indonesia because there are variations in the job at the same position.
- ***Regional Model Competency Standard (RMCS)*** is a Competency Standards (CS) setting model introduced by the International Labor Organization (ILO), whose development uses a functional approach from the work process of a similar business / industrial activity.

Figure 1 is the structure for compiling Competency Standards (CS), which consists of unit code, unit title, unit description, competency elements and performance criteria.

The compilation of Competency Standards (CS) is by compiling an occupation map first, from the occupation map, it can be seen that positions in the Information and Communication Technology (ICT) sector do not have Competency Standards (CS). Each competency unit can be used by companies to determine what types of skills and competencies are needed. The existence of an Occupation Map can make it easier for someone to choose a job position that is in accordance with their competence.

The uses of Competency Standards (CS) are:

- As a reference for competency-based education/training
- As a reference for implementing competency tests (competency certification)
- As a reference for structuring the company
- As a reference for preparing company SOPs

Competence that is mastered and in accordance with predetermined standards, a person is able to:

a. Do a task or job
b. Organizing so that work can be carried out
c. Determine what steps should be in the event something different from the original plan
d. Using the ability they have to solve problems or carry out problems or carry out tasks with different conditions

The research that has been done regarding competency standards is Increasing National Intelligence through Optimizing the Application of Journalist Competency Standards [15]. Journalists are at the forefront of news production. If the news is of high quality, the press will be good, the public will also be enlightened, the life of the nation will also be enlightened. Optimization of the application of journalist competency standards in Indonesia can be achieved through: optimization of training / courses / workshops / comparative studies, optimization of monitoring and evaluation (Monev), optimizing awarding, optimizing the application of sanctions objectively, selectively, gradually, fair, procedural and educational, optimizing the welfare of journalists, optimizing journalist advocacy and optimizing journalist competency tests

UNIT CODE :
UNIT TITLE :
UNIT DESCRIPTION :

ELEMEN OF COMPETENCE	PERFORMANCE CRITERIA
1.	1.1 1.2 1.3
2.	2.1 2.2 2.3
3.	2.1 2.2 2.3

Figure 1: Structure of Competency Standard

2.2. Occupational Map

The preparation of the Occupational Map for Information and Communication Technology (ICT) in Indonesia is an effort as a manifestation of the implementation of the task of professional development of human resources in the Information and Communication Technology (ICT) field.

The purpose of developing an Occupational Map is as a standard reference in the context of:

1. To carry out competency certification activities based on the national occupation scheme
2. To develop a higher education curriculum in the field of informatics in accordance with the prevailing laws and regulations
3. Preparation of job descriptions for various Information and Communication Technology (ICT) functions in a commercial or non-profit organization
4. Mapping the profile of the needs and availability of human resources in various job positions
5. Development of various modules and competency-based instructional designs that are needed by educational and training institutions throughout

Figure 2: Occupational Map Structure

Figure 2 is the structure of the Occupation Map preparation in Indonesia which consists of framework, position strata and function areas. Framework has 2 parts, namely: level and category. The position strata has 2 parts of the government bureaucracy and industry (private), while the function area has occupational names.

In Figure 2, the occupation map is very important to provide a macro overview of the Competency Standards (CS) map in the Information and Communication Technology (ICT) function area. The Occupational Map consists of a Qualification Framework, Position and Area of Information and Communication Technology Functions.

Each occupation has several competency units which are described in accordance with the Framework. Competence is something that is associated with abilities, knowledge or insights and attitudes which are used as guidelines in carrying out job responsibilities [11].

Research on the use of occupational maps that has been carried out is Building Infrastructure Curriculum for Visual Communication Design (DKV) Study Programs Based on Core Busines Competencies [3], namely Formulating a curriculum for Visual Communication Design (DKV) study programs that have work competencies according to user needs (End-User) and being able to adapt to global developments, it requires the presence of formulating institutions (stake-holders) that are truly capable of laying scientific foundations with reference to competencies according to core competencies.

2.3. Ontology

According to Boris Wyssusek, ontology will be useful in the development of information systems if the effort in creating ontological foundations leaves the notions of classical (or metaphysical) philosophy. In this case, the ontological model is considered as a presentation (or mapping) of the existing reality. Today's symbolic world, formed from linguistic and social interactions, shows a pluralistic state. When the ontology is completely focused on the formal aspect, it will result in searching for the right answers to the wrong questions. So the belief in the importance of ontology must start from building the modeling grammar from scratch according to the expected goals [17]. According to the philosopher Aristotle ontology as metaphysical (something after physical). Gruber defines ontology as "the details of the idea" (specification of conceptualisation), all knowledge related to ideas, both implicitly and explicitly [6]. Guarino added ontology as "a logical theory of recording a meaning of formal words", the meaning of the relationship is an independent important thing of existing circumstances [7]. Ontology is a concept that has begun to develop in Information Systems.

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2.4. Ontology as a Mechanism of Breakdown

Gruber states that the collection of objects involved and their relationships are drawn in vocabulary and processed by the program to produce knowledge. In determining how to present something, a decision design is needed, based on objective criteria according to the desired results. Following are the design criteria with the aim of sharing knowledge and cooperation between programs: [6]

- **Clarity,** which is an ontology that can explain the desired meaning objectively.
- **Linkage,** that is, an ontology must be interrelated among its objects and be consistent according to definition.
- **Can be expanded,** the ontologies are designed to anticipate shared vocabulary.
- **Minimal coding bias,** the ideas must be determined at the level of knowledge without relying on coding with certain symbols.
- **Minimal ontological commitment,** that is, an ontology requires minimal ontological commitment in supporting knowledge sharing activities.

Intrinsic coding of concepts avoids meaning bias by stating the underlying concepts (eg time points) and units of measurement (eg timepoint years). The resulting breakdown of existing constraints makes programming and knowledge yield useful conclusions.

An ontology must have the following components, namely: [12]. An ontology must have the following components, namely: [12].

- *Classess*, representing concepts in physical / specific or abstract / conceptual form. Classes can be organized into a taxonomy to define the hierarchy of their superclass or subclass.
- *Relations,* a relationship that represents the relationship between classes. Usually in binary form.
- *Attributes,* or often called properties or slots, describe the features of an existing class.
- *Formal Axioms*, is a model for making statements that are always true.
- *Functions,* are special rules regarding relations.
- *Instances,* representing elements or individuals in an ontology.

Previous research is [12], discussing and classifying approaches based on ontology which are widely used in order to evaluate the advantages and disadvantages and compare their performance based on theory and practice. This paper also provides a new ontology measurement based on the exploitation of taxonomic features. The advantages of this study are the results of the new ontology measurements introduced with two bench marks, providing a high degree of accuracy without any drawbacks, while the limitations have not used a deeper data mining process and statistical disclosure control methods. Both can provide an immediate advantage to a more accurate assessment of similarity.

2.5 Operations on Ontology

In building an ontology, it is possible to build more than one ontology, especially when the ontology is built with a modular model or when the ontology built will be integrated with systems that use other ontologies. In these circumstances, several operations on the ontology are required. Some operations on ontology that can be performed for ontology maintenance and integration are [http://www.obitko.com/tutorials/ontologies-semantic-web/operations-on-ontologies.html]:

• **Merge,** build a new ontology by combining existing ontologies. The condition is that the new ontology contains all the knowledge of the original ontology even though the results are not always satisfactory because the original ontology may not be completely consistent. This kind of new ontology includes some selected knowledge from the original ontology so that the results obtained can be consistent. The result of combining this ontology can produce new classes and relations that become bridges between frameworks that apply in the original ontology.

• **Mapping**, mapping one ontology to another ontology shows how to translate statements from one ontology to another. The translation meant here is the translation between concepts and their relationships. Mapping cannot always be done one by one. Some of the information that is in one ontology can also be lost when mapping.

• **Alignment**, is a two-way inter-ontology mapping process where it is possible to modify the original ontology in order to find the appropriate meaning without losing information from each ontology during the mapping process. Therefore it is possible to add a new class and relation which will form a

suitable equivalent to be mapped. This specification is called articulation. But just like mappings, alignment may only be partial.

Refinement, is a mapping that is done from an ontology A to ontology B which makes each class from ontology A have its equivalent in ontology B, however a simple class from ontology A can match the class defined from ontology B.

• **Unification**, is to align all classes and relationships in ontology so that inference in one ontology can be mapped to inference in another ontology and vice versa. Unification is usually done as a refinement of the ontology in both directions.

• **Integration**, is the process of finding the same part of two different ontologies A and B when developing a new ontology C which allows to translate between ontology A and B and allows interoperability between two systems where one uses ontology A and the other uses ontology B. The new ontology C can replace ontology A and B or can be used as an interlingua for translation between these two ontologies. Depending on the difference between A and B, the new ontology C may not be required and only translation between A and B is the result of integration.

Inheritance, means that ontology A is a derivative of ontology B. Ontology A inherits all classes, relations, limitations or axioms and inherits all classess, relations and restrictions or axioms and there are no inconsistencies introduced by the additional knowledge contained in ontology A.

2.6. Corpus

Based on taxonomy, the corpus can be distinguished by, namely [8]:

• Media used
• Design methods
• Size
• Variable language
• Mark-up
• Anotosi

In Figure 3 it can be seen that the corpus can be classified according to six categories.

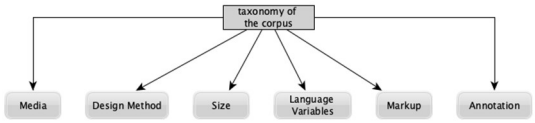

Figure 3: Taxonomy of the Corpus [9]

The media classification consists of printed media, electronic texts, conversations, videos. Another classification is based on how the method used to build the corpus. The classification based on the size used by the corpus is whether the corpus is of a fixed size or not. Another classification is based on language and how to annotate the corpus. [1] conducted a study to create annotated corpus on Self-Annotated Reddit Corpus (SARC) to detect sarcasm text. The detection method used is N-Gram and Bag of word and human assessment. SARC annotation corpus is generated by using the / s tag in the text containing sarcasm.

3. ONTOLOGY DEVELOPMENT

The processes that occur at the ontology and corpus development stages are shown in Figure 4, namely:

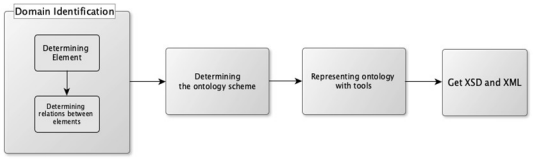

Figure 4: Research Stages Process

The research stages are as follows:

3.1 Domain Identification

At the Domain Identification stage, the first thing to do is get elements from occupation map documents and competency standard documents. After getting the elements from each of these documents, the second step is to get the relations of the Occupational Map elements and Competency Standards (CS). Grouping of Occupational Map documents based on the anatomy of Occupational Maps and Grouping of Competency Standards (CS) documents based on the Decree of the Minister of Manpower regarding the determination of Competency Standards (CS).

a. Obtain Element

• Occupational Map Elements

Occupational Maps, especially in the field of Information and Communication Technology (ICT), are documents that map the types of job titles based on qualification levels. Occupational Map elements consist of:

- Framework Level
- ICT Domain
- Occupation Number
- Occupational Name
- Competency
- Unit Code
- Unit Name
- Type Code

Information:

- Framework Level is a framework for ranking human resource qualifications that juxtapose, equalize and integrate the education sector with the training sector and work experience in a work ability recognition scheme that is tailored to the structure in various sectors of work
- The ICT Domain is the environment that exists in the field of information and communication technology
- Occupation Number is the number owned by the occupation on the occupation map
- Occupational Names are any activities that use physicality and / or mind to achieve certain goals
- Competency is the work ability of each individual which includes aspects of knowledge, skills and work attitudes in accordance with established standards
- Unit Code is the code for the competency unit according to the category, main class, class, sub-group and main function of the job
- The Name of the Unit is a form of statement regarding the task or work to be performed. Using active sentences, beginning with an active or performative verb
- Type Code is the code number for the reference source for the competency unit

• Competency Standards (CS) Elements

Competency Standards (CS) model whose development uses a functional approach from the work process to produce goods / services. The four provisions of the Competency Standards (CS) are:

a. contains 4 (four) competency dimensions, namely: contains the formulation of task competencies, task management competencies, competence in dealing with emergencies, competence to adapt to the work environment, including responsibility and working with others
b. realistic with what applies in the workplace
c. work result oriented
d. measurable

The elements in the Competency Standards (CS) consist of:

- Years CS
- Field of CS
- Sub Field of CS
- CS number
- Unit Code
- Unit Title
- Competency
- Elements Competency
- Performance Criteria

Information:

- Years CS is the year the Minister of Manpower Decree is issued
- Field of CS are the division of expe rtise groups or aspects of knowledge and skills of competency standards
- Sub Field of CS is a group of special expertise part of the field of competency standards
- CS Number is the letter number of the Minister of Manpower's decree issued
- Unit Code is the code number of the competency unit according to the category, main class, class, sub-group and main function of the job
- Unit Title is the result of identification of needs or requirements such as knowledge and skills in the workplace
- Competency is the work ability of each individual which includes aspects of knowledge, skills and work attitudes in accordance with established standards
- Elements Competency is describing the process of a job in a sequence that is carried out in one competency unit
- Performance Criteria describe the performance that must be achieved in each competency element

b. Relationships between occupational map elements

The relationship between each of these elements is presented in Table 3.1.

Table 3.1: Relationships between Occupational Map Elements

No	Predicate	Relation	First Order Logic (FOL)
1	CS ⊕ Years CS	belong to	belong to (cs, years cs)
2	CS ⊕ Field of CS	belong to	belong to (cs, field cs)
3	CS ⊕ Sub Field of CS	belong to	belong to (cs, sub field cs)
4	CS ⊕ CS Number	belong to	belong to (cs, cs number)
5	CS Number ⊕ Unit Code	belong to	belong to (cs number, unit code)
6	CS Number ⊕ Unit Title	belong to	belong to (cs number, unit title)
7	CS Number ⊕ Competency	belong to	belong to (cs number, competency)
8	Competency ⊕ Element of Competency	belong to	belong to (competency, element of competency)
9	Element of Competency ⊕ Performance Criteria	belong to	belong to (element of competency, performance criteria)

In this study, because the ontology is represented in XSD and XML. Table 3.1, shows the relations between elements of an occupation map written in formal First Order Logic (FOL) notation. Suppose that the "Competence" element has a "property" relation on the "Unit Code" element.

- Relationships between elements of Competency Standards (CS)

In this study, because the ontology is represented in XSD and XML, Table 3.2 is the relationship between elements in the Competency Standards (CS), which shows the relationships of the elements in the CS. Suppose that the element "CS" has a relation "belonging" to the element "Unit"

Table 3.2: Relationships between Competency Standards (CS) Elements

No	Predicate	Relation	First Order Logic (FOL)
1	Occupation ⊕ CS Level	classification	classification (occupation, cs level)
2	Occupation ⊕ ICT Domain	category	category (occupation, ict domain)
3	Occupation ⊕ Occupation Number	belong to	belong to (occupation, occupation number)
4	Occupation ⊕ Occupation Name	belong to	belong to (occupation, occupation name)
5	Occupation ⊕ Competency	belong to	belong to (occupation, competency)
6	Competency ⊕ Unit Code	belong to	belong to (competency, unit code)
7	Competency ⊕ Unit Name	belong to	belong to (competency, unit name)
8	Competency ⊕ Type Code	belong to	belong to (competency, type code)

Table 3.2 shows the relations between elements of the Competency Standards (CS) written in the formal First Order Logic (FOL) notation. Suppose that the element "Competency Unit" has a relation "belonging" to the element "Unit Code".

3.2 Schematic of Ontology

The compilation of the ontology is carried out using the buttom-up approach, namely: an approach used to build the ontology by finding the elements as a first step through domain analysis, then determining the relations of the finite elements to form the ontology.

The ontology in this study is described as a building ontology graph knowledge. In Equation 1 is the formulation of a building ontology graph knowledge [16], which is formed from (s, t) which is the node / node of a graph, and r is a relation that connects between nodes / vertices in the graph. The builder ontology is an implementation of the knowledge graph.

$$KG_{OP} = (s, r, t) \quad (1)$$

dengan:
KG_{OP} adalah *knowledge graph* ontologi pembangun
$s, t \in E$ dan E adalah himpunan entitas
$r \in R$ dan R adalah himpunan relasi

The builder's ontology knowledge graph represents the ontology built in this study. Figure 5 is a generic form of the builder's ontology graph knowledge.

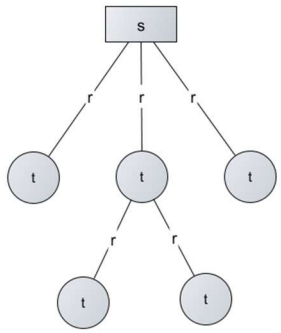

Figure 5: Builder Knowledge Graph Ontology (Source: Wahyuni, 2019)

Figure 5 is a generic form of the builder's ontology graph knowledge consisting of: s is the root of the builder's ontology, t is the node / node / point that forms the graph, and r is the relation that provides the relationship to the node in the graph.

3.3 Representing Ontology With tools

In this study, there are 2 (two) knowledge graph ontology builders that are formed, namely:

1. Knowledge graph ontology of occupation map builder

2. Knowledge graph ontology which builds Competency Standards (CS)

The two builder ontologies in this study are related to the relation at the root of the builder's ontology, namely: the 'qualification' relation and the 'matching' relation on one node that connects to other nodes with different builder ontologies. The following in Figure 6 shows the relationship between 2 (two) building ontologies in this study.

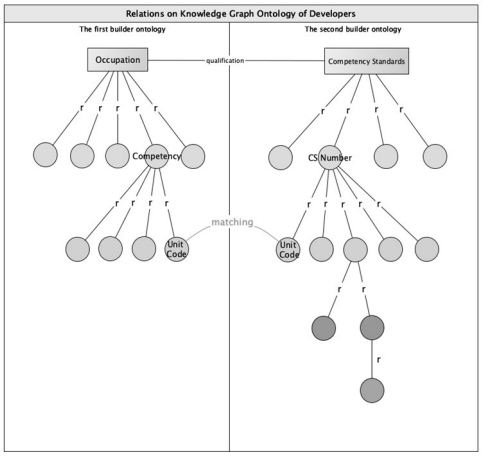

Figure 6: The Relationship of the Two Builder Ontologies

In this study, the relationships formed between the ontologies of builders are formulated in Equation 2 below.

$$KG_{OP} = (s, r, t) \quad 2$$

dengan:
KG_{OP} adalah *knowledge graph* ontologi pembangun
$s, t \in E$ dan E adalah himpunan entitas
$r \in R$ dan R adalah himpunan relasi

The relationship between ontology nodes that are on the same building ontology is formulated in Equation 3.

$$OD_n =< node_1 \overleftrightarrow{\oplus} node_2, ..., node_{n-1} \overleftrightarrow{\oplus} node_n > \quad 3$$

keterangan:
OD = ontology *development*
$node$ = node ontology/ elemen
$\overleftrightarrow{\oplus}$ = *relation*
n = *number of ontology development*

Ontology nodes can have relations with nodes that are on different ontologies. This relation is formulated in Equation 4.

$$R_{bo} = node_n^m \overleftrightarrow{\oplus} node_n^{m+1}, ..., node_n^m \overleftrightarrow{\oplus} node_{n+1}^m, ..., node_n^m \overleftrightarrow{\oplus} node_{n+1}^{m+1}$$

dengan:
R_{bo} = ontology different relation
$node$ = node ontology/element
$\overleftrightarrow{\oplus}$ = relation
n = number of node
m = ontology to- 4

3.4 Get XSD Schema and XML

Based on the ontology concept on the Occupational Map and Competency Standards (CS), an XML Schema Definition (XSD) was built. Furthermore, using the XML Schema Definition (XSD), the Extensible Markup Language (XML) was built. Occupational maps will have XSD and XML according to the ontology concept, as well as CS will have XSD and XML according to the ontology concept.

The general form of the XML Schema Definition (XSD) is as follows:

$$< xs : elementname = "node_{k,n}^m" type = "xs : string" / >$$
$$< xs : .../ >$$
$$< xs : elementname = "node_{k,n}^m" type = "xs : string" / >$$

Ontology representation with XML Schema Definition (XSD) is visualized in tree form using qXMLedit application which is an application for Simple XML editor and XSD viewer.

$$< xml... >$$
$$< schema >$$
$$< node^m >$$
$$< node_{k,n}^m > data < /node_{k,n}^m >$$
$$< ... >$$
$$< node_{k,n}^m > data < /node_{k,n}^m >$$
$$< node^m >$$
$$< node_{k,n}^m > data < /node_{k,n}^m >$$
$$< ... >$$
$$< node_{k,n}^m > data < /node_{k,n}^m >$$

The results of the Extensible Markup Language (XML) are displayed in tree form using the XML tree view application, so that they can show nodes in the ontology and see the level of the ontology.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

4. RESULT AND DISCUSSION

4.1. Occupational Ontology

The Occupational Map document contains a lot of data, so it is necessary to first group it by type or based on certain keywords to make it easier later to find connections between data. The Occupational Map document contains occupation, each occupation has more than one competency unit code and competency unit name.
The results of the domain identification get the elements from the existing Occupational Map consisting of: Framework Level, ICT Domain, Occupation Number, Occupation Name, Competency, Unit Code, Unit Name, Type Code

Based on occupational ontology elements, an occupational ontology can be built as shown in Figure 7. Figure 7 is an ontology image of an occupation map.

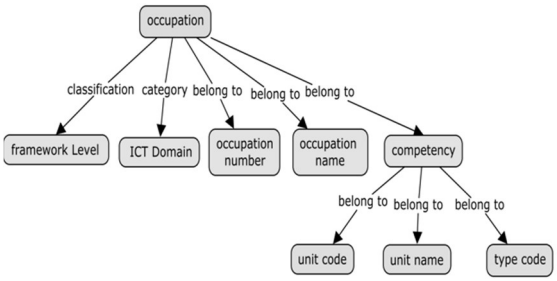

Figure 7: Occupational Map Ontology

Figure 7: Ontology Occupation is a representation of the ontology of occupation maps created using the CMaps application. In Figure fig: Ontology-Occupation, the oval shape is the node of the ontology, and the line connecting the nodes has a description of the relation.

Occupational Map ontology shows that in the occupational domain, there are 8 nodes, namely: framework level, ICT domain, occupation number, occupation name, competeny, unit code, unit name, type code.

4.2. Competency Standards (CS) Ontology

Each Competency Standards (CS) document has a different document number and year for each CS Sector and CS sub-sector. Each Competency Standards (CS) document also has a list of competency units consisting of competency unit codes, competency unit titles and different competency elements. Each Competency Standards (CS) field in the Competency Standards (CS) document has more than one competency unit code and competency unit title. Elements of Competency Standards (CS) which are determined in the first step of the domain analysis for Competency Standards (CS), it is found that the elements in the Competency Standards (CS) consist of: Years CS, Field of CS, Sub Field of CS, CS Number, Unit Code, Unit Title, Competency, Elements Competency, Performance Criteria

Based on the Competency Standards (CS) ontology element, a Competency Standards (CS) ontology can be built as shown in Figure 8. Figure 8 is a Competency Standards (CS) ontology image.

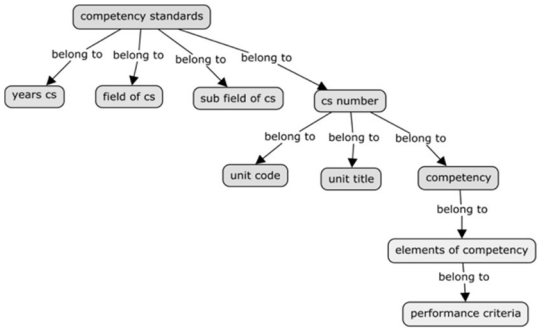

Figure 8: Competency Standard Map Ontology

Figure 8: Ontology CS is a representation of the ontology concept for CS which is illustrated by the cMaps application. Shown in Figure 8 Ontology CS, the ontology concept for the CS corpus has 4 (four) levels.

The Competency Standards (CS) ontology shows that in the Competency Standards (CS) domain, there are 9 nodes, namely: years CS, field of CS, sub field of CS, CS number, unit code, unit title, competency, elements competency and performance criteria.

A review of the Occupational Map document and the Competency Standards (CS) document produces elements that can be used as the basis for the ontology concept. The relationship between these elements results in the concept of ontology. Representing the relationship between elements so that it becomes an ontology concept using CMap tools. The results of this study are the ontology concept of the Occupational Map and Competency Standards (CS).

Similar research entitled "Ontology Based Skills Management: Goals, Opportunities and Challenges", discusses the repository of skills that can be used to find people, staff, competency gap analysis and professional development. An ontology-based skills management system was developed to address this problem at Swiss Life using the RDF scheme to store ontology. The query interface is based on a combination query engine between RQL and HTML [19].

The benefit of this research is that the resulting ontology concept can be used to build an Occupational Map corpus and a Competency Standards (CS) corpus. The corpus can be used to search for occupational names in the field of Information and Communication Technology (ICT) and seek competences from each of these occupations.

5. CONCLUSION AND FUTURE WORK

The novelty resulting from this research is the ontology concept for the Occupational Map and Competency Standards (CS). The resulting ontology concept comes from the elements in the Occupational Map document and the Competency Standards (CS) document.

In this study, an ontology was built for the occupational map corpus and competency standard corpus. This ontology shows the relationship between the elements in the Occupation Map and the Competency Standards (CS), so that the competencies that each occupation must have are clearly arranged. Companies that will make job information can see the ontology of Occupation Maps and ontology of Competency Standards (CS) that there is no misinformation of occupational names and competencies. Job seekers can see the ontology of the Occupation Map and Competency Standards (CS) when making a curriculum vitae so that they are not mistaken in determining the suitable occupation for their competence.

The resulting ontology concept of the Occupational Map and Competency Standards (CS) can be used for the creation of the Occupational Map corpus and Competency Standards (CS) corpus. One of the benefits of the corpus is that it can be used for the process of finding the appropriate occupation name and competence for the occupation.

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