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SEMANTIC-WEB-BASED SEARCHING APPLICATION FOR DOCTORS SCHEDULE AND FACILITIES IN HOSPITAL

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ABSTRACT

A Hospital as a health supporting media has main information such as existing doctors praxis schedule and availability of facilities. Each hospital has its own format in delivering its information. With the diversity of available information, it is needed a technology that could be able to combine and uniform almost the same information and then present it to the user in the form of mutual relevant to their intended context. The technology used is an ontological semantic-web based search engine. The semantic web method with ontology approach is not only capable of understanding the meaning of a word and a concept, but also the logical relationships between them. In this paper it will be explained the development of search engine with two kinds of data, which are grabed directly (live data) by using the concept of Ontology Web Language (OWL) and manually entered (dummy data) by using the concept of Resource Description Framework (RDF).
Keywords: *Doctor, Ontology, OWL, RDF, Semantic Web*

1. INTRODUCTION

Today hospital services are needed increasingly. One way to improve health care which is especially for poor peoples, is the issuance of Jakarta Health Card (JHC) program under the leadership of Governor and Deputy Governor of Jakarta. The purpose of this program is to provide health care insurance for residents of Jakarta.

In some cases, sometimes a patient needs may not be met from one hospital alone. Sometimes, at the time a doctor who is needed, takes off-duty or the provided hospital facilities are inadequate for patients with certain conditions. In addition, not all hospitals enrolled in the JHC program. Therefore, we need an information system that i) could provide important information, such as the availability of doctors and praxis schedules based on the existing facilities, in all JHC reference hospitals with easy, up to dated and valid, and ii) could also communicate with other information systems.

The problem is that each hospital typically build information systems according to their needs. As a result, there are many standard of data, information, and schemes. It means that there is no standard of data between hospitals. To overcome this problem, we made an application that could be an interface to several different hospital systems, by using Ontological Semantic Web with Web Language Ontology (OWL) and Resource Description Framework (RDF) method, so that the difference is not perceived by the end user or end users in finding information, such as doctors schedules and facilities care from several different information systems, could carry enough on the interface of the site.

2. RESEARCH METHODS

2.1 Literature study

Seeking, learning and summarizing a wide range of literature that is related to the formulation of the problem, and the theories that are related to the Semantic Web, XML, OWL, RDF, PHP, MySQL, SPARQL and the Simple HTML DOM Parser.

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2.2 Determination of class

Determining the classes that will be used in the semantic web structure.

2.3. Designing query forms

Designing query forms and its output results.

2.4 Content of decision table with Simple HTML DOM Parser

Taking the table content of hostpital web sample and puting it into the database.

2.5 Testing the searching of hospital's schedule doctor and care facilities on the semantic web based web services of hospital

Testing the searching form, both searching with the data live (results of captured content) or with the data that is input manually (with RDF), can run well or not.

3. THEORY

3.1 Semantic Web

Broadly speaking, the semantic web is a very large amount of information on the World Wide Web that are globally connected in a certain way and are understood by machines, so it can be processed directly by the engine into knowledge that is displayed to the user. Semantic web can also be regarded as an efficient way of representing data on the World Wide Web as a globally linked database [5].

3.2 Ontology

The term ontology actually comes from the term philosophy of "ontology" which means something that actually exists and how to describe it. In the computer world ontologyy is used to specify a conceptualization. In other terms ontology is described as a representation of a particular knowledge domain that contains the terms in the domain along with the relationship between the terms that exist [7].

3.3 RDF

Resource Description Framework (RDF) is a metadata that are used to describe resources on the web address [11]. Metadata may include title, author, copyright, and licensing in a web document. Elements in the RDF statement consist of a subject, predicate, and object. Subject is something that is described and usually as a URI address. In this case the URI represents the resource. Predicate is a property of a resource that explains the relationship between the subject with the object. In addition the object is the value of a predicate. Object has two data types, i.e. object that has a URI type such as http://airplane.com/id/102 and object that has a literal type, e.g. "adam water". Subject and predicate contain data that include resources while objects can be of type resource or literal [11].

3.3.1 RDF Data Model

From the design of the data model of OWL Data Graph, it will now be translated into OWL XML. OWL XML means that a data model in the form of OWL are embedded into XML procession that follows the rules of XML Grammar. The use of XML OWL here intended that the application can read and perform queries on the data model. OWL XML is also a form of standards recommended by the W3C. As in the form of XML syntax, the model can be placed on the internet and read by other web applications. While the RDF data model are created to describe the resources that are properties and values.

3.5 OWL

Web Ontology Language (OWL) is a language that can be used by applications which not only displays the information to the user, but also are needed to process the content of information. Ontology itself can be defined as a way to describe the meaning and relationships of terms. It contains descriptions of classes, properties, and instances. This description can help a computer system in using these terms with a easier way [10].

3.6 Interoperability

The term "interoperability" is used differently among different communities. This term is used to describe the ability of information exchange between systems are developed separately, where a separate system capable of understanding the form, purpose/meaning, and also the quality of the information being exchanged [15].

Brodie gives a functional definition of Interoperabilias in the information system as follows [2]:

"Interoperability: Two component (or object) X and Y can interoperate (are interoperable) if X can send a service request (or message) R to Y based on a mutual understanding of R by X and Y, and Y can restore the response / feedback S to X based on a mutual understanding of S as (respectively) the response R by X and Y. "

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3.7 PHP Simple HTML DOM Parser

Simple HTML DOM Parser is a PHP 5 + class which helps to manipulate HTML elements. Not only limited to valid HTML class, but it can also work with the HTML code that does not include W3C validation. Documents can be found using the object selector, similar to that of jQuery. Can be found in the HTML DOM elements by id, class, tags, and more. DOM elements can also be added, deleted or modified [13].

HTML DOM elements are found by using the *find function*. This function returns an array of object or multiple objects. This object is similar to the first object, so that all classes of existing function can be used [13]. The output results are strings.

4. RESULTS AND DISCUSSION

4.1 Analysis and Troubleshooting

4.1.1 Analysis of Needs

There are few data required in this study to be used as the mateial solution of a problem. On this semantic web research, it is needed some multiple data sources such as praxis schedule as well as facility of each hospital that is included in the referral JHC. The data is obtained from official websites of each hospital.

4.1.1.1 Analysis of Issues

Issues have to be analyzed in advance to provide the definition of a precise description, in order to obtain a solution of the problem in a study.

4.1.1.2 Defining the problem

In this study there is a case, i.e. if the user wants to search for a doctor schedule or facility of one or more hospitals without open all pages of existing hospital site. Therefore, it is needed a search engine where by entering a few keywords, then the engine will then show schedule doctor according to the keywords entered.

The displayed data are adjusted to standardize existing in previous research because this research is the development of the research. This study is divided into two parts, such as collecting the data which is grabed directly from each hospital site, in other words the data is live, and searching the data which is entered manually by using the RDF file (dummy data). It should be done in order to get a comparison between the data live and dummy data.

However, there are some problems, especially on the live data that are, such as:

1. First, a site that can be grabed to be the site live data with a praxis schedule table with properties corresponding to the specified standards in previous studies. Meanwhile, from 77 referral hospitals in Jakarta Health Card (JHC) there are only 43 hospitals that has its own website. Unfortunetly there are only four sites in accordance with existing standards, and only from two sites data can be retrieved. For two other sites, it will be used as material for a search with RDF.
2. Second, there are differences in the properties of the site table between data live and dummy data.
3. Third, the data live can not be directly displayed. There are some settings so that data can be displayed in accordance with existing standards.

4.1.2 Troubleshooting

In problem of properties differences on the data live, the possible approach to be used as a solution is a semantic web that utilize the concept of ontology mapping to achieve interoperability based on the diversity of the data. Its main focus is on the ontology mapping of multiple data sources that have a heterogeneous terminology in semantic level at domain that is used the doctor's schedule .

The design of the ontology mapping is described as a mapping that should be done between two ontology, i.e. between ontology User View and the ontology of the data source. The mapping terminology sourced from both the ontology are linked by a ontology called *Common Ontology*. User View is ontology which is used as a reference terminology that is often used by the user in a searching, and it selections represent another terminology, while the data source is a web site that is the source of terminology that is used as material mapping.

Implementating the design of ontology mapping is done in several stages beginning with the establishment of a data source ontology, Common Ontology, and ontology User View. Furthermore the mapping between the User View and Common Ontology, and the mapping between Common Ontology and Local Schema data sources.

4.1.2.1 Data Sources Local Schema

This stage is to determine the local schema description of the data source, i.e doctor praxis schedule in hospitals. Hospitals that are made as objects of this study, are as follows.

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a) Figure of local schema of Kartika Pulomas Hospital is shown as following

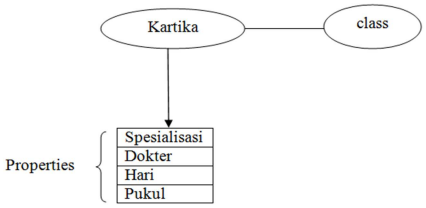

Figure 1. Schema Form Of Ontology Data Sources Of Kartika Pulomas Hospital

b) Figure of local schema of Marinir Cilandak Hospital is shown as following:

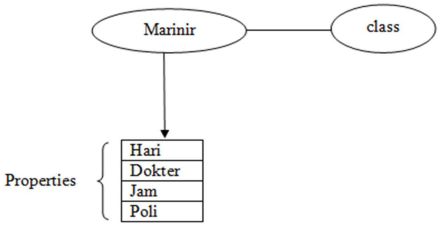

Figure 2. Schema Form Of Ontology Data Sources Of Marinir Cilandak Hospital

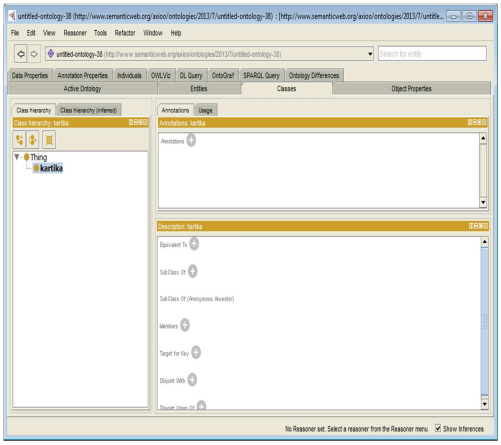

Figure 3. Local Class Schema Creation For Kartika Pulomas Hospital

Terminology contained in each data source will be used as properties of all the ontology, i.e. the local schema, a common ontology, and user view. Local schema consists of the name of the hospital, the name of the class that will be used for ontology mapping, and terminology of each hospital to be used as a data property in Protege tool.

First of all, the protégé will be made for the local schema of Kartika where Kartika is class. (see Figure.3)

After making class, we assign properties that are made on the object properties page in Protege.

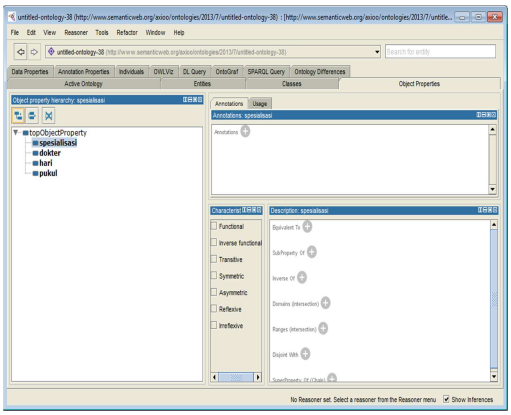

Figure 4. Properties Creation For Local Schema Of Kartika Pulomas Hospital

4.1.2.2 Common Ontology

Common Ontology is an ontology that has properties which are formed from the combination of all properties contained on the data source schema. This common ontology become a ontology containing terms of the diversity of the captured data sources which has the same purpose or meaning, and also as the ontology which is used as mediation or mapping connecting two other ontologies, i.e. ontology schema of data source and ontolgy schema of user view. Structures form of common ontology which is contained in a class is common ontology and property of the class Kartika which is the whole terminologies of the captured data sources. After we know the class and properties which are created ontology, we can then make Common Ontology in Protege tool with the same stage as previously when we build the ontology of data source. However, this particular common ontology needs to be done to separate terms which have the same meaning.

4.1.2.3 User View

User view is a form of terminology from the data source that is almost always there for each data source because it is the main data contained in an object in the case of Kartika Hospital, ie. praxis schedule, and is data which often searched by the user or internet users. Based on the data sources that have been used by the authors then it is determined the hospital name, doctors name, praxis days and hours of praxis. After we know the class and properties which are created ontology, we can then make User View in Protege tool with the same stage as previously when we build the ontology of data source. The next stage of this research is the establishment of the first mapping, i.e. the mapping between the User View dan Common Ontology.

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4.1.2.4 Mapping between User View and Common Ontology

This mapping is a mapping between the terms contained in the user view dan the terms contained in the common ontology. The mapping is mapping at property level that if there are two or more concepts in which these concepts have the same meaning it by using the Protégé tool, these concepts will be equated or made equivalent property. Equivalent property is an interconnections between properties that expresses inter commensurate meaning or similar. Mapping composition is used to create the direction of semantic relationship between the User View and the various data sources.

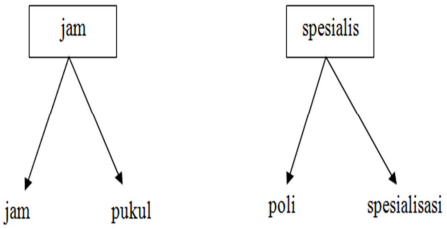

Figure 5. Examples Of Ontology Mapping Results

4.1.2.5 Mapping between Common Ontology and Data Sources Local Schema

Just like the previous mapping, this mapping is a mapping between the terms contained in a common ontology to the terminology contained in the source data. The mapping is the mapping of the property. If there are two or more concepts in the common ontology where the concepts have the same meaning to the concepts included in the data source using the Protégé tool, then these concepts will be equated or made equivalent by using one the menu in RDF/OWL, i.e. `owl: equivalentProperty`. After all the mapping is done, then it is formed a flow of mapping process as shown in Figure 6 below.

4.2 Live Data Retrieval

In data collection for directly (live) searching the hospitals schedules we use PHP Simple HTML DOM Parser. Two samples of data are grabed from the following hospital :

1. Kartika Pulomas Hospital (http://rskartikapulomas.com/?Jadwal_Praktik).
2. Marinir Cilandak Hospital (http://www.rsmarinir.com/jadwal.praktek.php).

Data were grabed from each hospital's site. Data (get content) are in the form of a table that contains the praxis schedule. How to grabe the data is the following: we open the site page of the praxis schedule, e.g. praxis schedule of Kartika Pulomas Hostpital. Grabing the content of table is based on the class of the table obtained by viewing the page source of praxis schedule that has been opened.

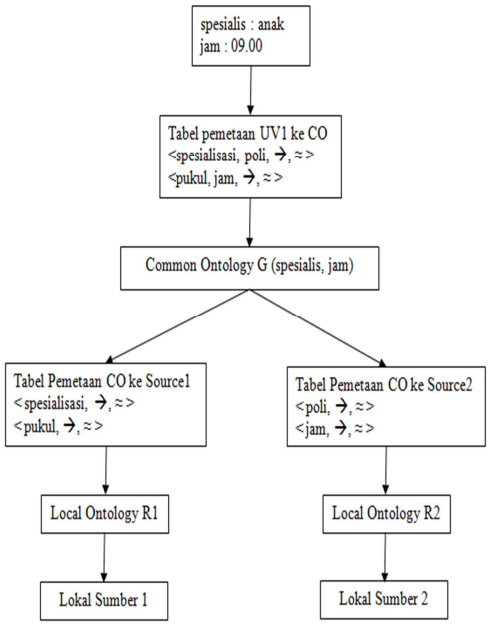

Figure 6. Example Flow Of Mapping Process

Here is a sample script content retrieval table with PHP Simple HTML DOM Parser based class of table:

```
<?php
        include('simplehtmldom/simple_html_
dom.php');
        include('common.php');
        $link = dbConnect();
        $html =
file_get_html('http://rskartikapulomas.com/
?Jadwal_ Praktik');
        foreach($html->find('p.MsoNormal,
p.MsoNoSpacing') as $e)
        {
        $data[] = $e->plaintext."|";
        unset($data[138]);unset($data[139])
;unset($data[140]);
        }
```

The results of the grabed data will be String data, so it can not be displayed in accordance with existing display standards, i.e. in the form of tables. Therefore, these data must be converted into an array that can be seen in the following command:

```
$data[] = $e->plaintext."|";
```

Array that has been formed is separated to spruce up the layout. That's because on the site of Kartika Pulomas Hospital, specialization has content that is the name of each existing doctor, day and time of the doctor's praxis, as shown in Figure 7.

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Figure 7. Display Kartika Pulomas Hospital Praxis Schedule

4.3 Database Creation for Live Data

In this research, the database is only used for data obtained directly. While for the dummy data data are manually put in the RDF file that does not require a database. To create the database, it first needs to be run several applications supporting the server, web browser and phpmyadmin. Table 1 shows the structure of the tables in this database.

Table 1. Table Data Structure Practice Schedule

Field Name	Type	Size	Description
id	bigint	20	Id per doctor's schedule
rumah_sakit	text	-	Name of the hospital
dokter	text	-	Name of doctor
spesialis	text	-	doctor specialties
hari	text	-	days of practice
jam	text	-	practice hours

4.4 RDF Graph for Doctor Schedule

On the structure of RDF for semantic Doctor Schedule in Figure 8 below, there are six major components, namely class name Doctor, Hospital, Specialist, Day, Time, and Website. Each object class has the following properties: hasNama, hasRumahsakit, hasSpesialis, hasHari, hasJam, and hasWebsite. Domain of each of the properties is the class schedule doctor, while the other class serves as a range.

4.5 Graph Data Model

Graph RDF data model is a symbolic of the semantic structure design that will be created. This graph model will be applied directly in the application being made. The model is more emphasis on the design of the data that will describe the relationship between the properties of RDF. By looking at this graph it will be easier to see the overall data design.

Figure 9 is a semantic data model for the structure of doctor schedule that describes the relationship between the domain property, property with range, and a class with another class. Figure 9 is described in Table 2 .

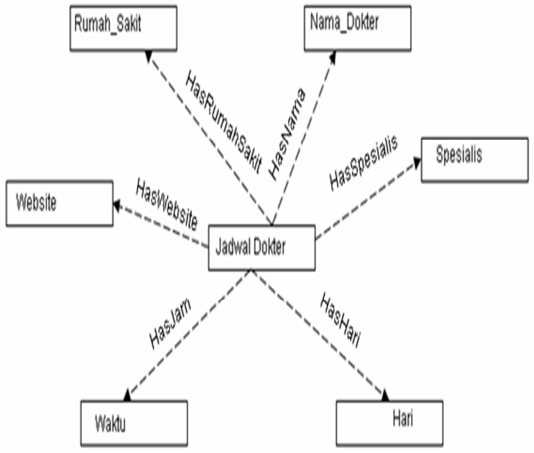

Figure 8. RDF Graph Structure For Doctor Schedule

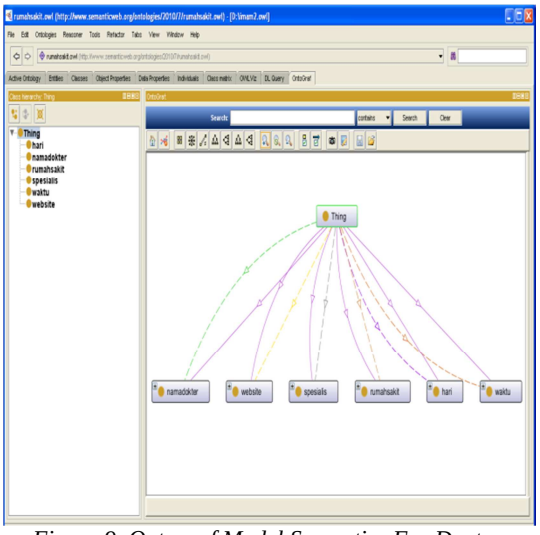

Figure 9. Ontograf Model Semantics For Doctor Schedule

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Table 2. Property Description Of Doctor Schedule

Properties Name	Domain	Range	Properties Type
Has_hari	Doctor Schedule	day	Class
Has_jam	Doctor Schedule	time	Class
Has_nama	Doctor Schedule	Name of Doctor	Class
Has_rumah sakit	Doctor Schedule	hospital	Class
Has_spesialis	Doctor Schedule	specialist	Class
Has_website	Doctor Schedule	website	Class

4.6 Testing and Evaluation

The testing is conducted to determine whether the application of context-based searching process on doctors schedule are able to get the results as expected by the user, and to examine overall whether the all functionalities are running as desired.

In the scenario test the first thing that should be conducted is to test the accuracy level in searching doctors schedule of hospital both in data live or dummy data. We use in this case a black box testing.

The evaluation is done by making a table of the results of the testing.

4.7 Results of Testing and Evaluation

For hospitals that use the concept of OWL, the succeful percentage of doctors schedule searching are as the following:

- If we use the complete keyword, it produces 100 % of searched data.
- If we use only one letter, it generates a succefull percentage less than 60 % .

For searching of hospital facilities we can apply the OWL concept with live data and RDF concept with dummy data. This is due to the data from the web of each hospital does not use a database facility.

5. CONLUDING REMARKS

5.1 Conclusion

Based on testing results, searching by using the live data is much better. This is because the amount of data and the variety of data more than dummy data. So it does not guarantee that a search based on the live data is always better, if the data to search with dummy data is also better, then the performance will be as good as a search with the live data.

The advantages of our semantic web-based searching, i.e. it could perform the function of Semantic Web Services so that the data obtained by the user is *up-to-data*, although it still less than perfect.

5.2 Future Works

For the 34 hospitals that do not yet have an official site they should immediately establish a web site that could be standardized for ease of information access.

For the 39 hospitals that have had a web site they should enhance its website with OWL concepts for data and information, especially doctor schedules and facilities that could be accessed via the application portal.

For data menu and facilities information that are available at each hospital web it should use a database, so that data can be applied to the web services.

For development of web portal services for searching doctor schedule doctor and facilities it could be refined by the addition of searching menu for the hospital facility by using RDF or OWL concept.

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