A process for building domain ontology: an experience in developing Solat ontology

Saidah Saad#1, Naomie Salim*2, Hakim Zainal^3, Zurina Muda#4

#1,4 School of Information Technology, FTSM, UKM, Bangi Selangor, Malaysia
1saidah@ftsm.ukm.my
2zm@ftsm.ukm.my

*2 Department of Information System, FSKSM, UTM, Sekudai Johor Bahru, Johor, Malaysia
2naomie@utm.my

^3 Faculty Islamic Studies, UKM Selangor, Malaysia
2haza@ukm.my

Abstract— during the previous years, there has been a growing concern on ontology due to its ability to explicitly describe data semantics in a common way, with independent data source characteristics and to provide a schema that allows data interchanging among heterogeneous information systems and users. Several works have been aimed to improve ontology technological aspects, like languages representation and inference mechanisms, but less attention has been paid to the aspect of practical results of application development method. In this paper we present a discussion on the process and the product of an experience in developing ontologies in the field of Islamic knowledge which focuses on the Solat. This is done as a prototype to ensure what should be considered if a larger domain of knowledge of Islam itself is applied. It is because in generating a relevant knowledge of Islam, a number of sources involved and should be used to understand the essence and truth of such information. Accordingly, utilization of any other sources depend on the prior knowledge of the Qur'an. The Qur'an is the criterion and standard reference for judging all other sources. The Muslims judge hadith and sunnah in the light of the Qur'an. They can accept them only when they are in accordance with the Qur'an, otherwise they will not accept them. This is a primary resource in order to develop a semantic Knowledge of Islam. The secondary sources of the Islamic Knowledge are Qiyas – analogy – and Ijma – consensus. We extract all this information with the guidance from the domain expert and build an ontology for solat according to the methodology that being identified suitable for developing semi automatic ontology creation.

Keywords— ontology, Islamic knowledge, Solat Ontology System.

I. INTRODUCTION

Ontology defines a common vocabulary for researchers who need a machine interpretation of common vocabulary that can be shared within a domain and in digital form. Information from the generation of this ontology can be shared and reused. Protege, OILEd, KAON, TopBraid and Apollo is an example of the ontology editor that are being used at present for ontology construction. These ontology editor are quite difficult to use and require a skilled knowledge to use it, but with the integration of various other tools in facilitating the generation and visualization of the ontology, the ontology construction become easier. Currently, ontology is an important factor in the generation of semantic information. To build the ontology, many ontology languages have been developed, such as OWL, RDF (S), DAML + OIL and others. Many ontology tools have been designed based on these languages. Ontology also being applied in various fields such as health services, e-business, e-commerce, knowledge management and information retrieval.

In the generation of ontology, there are two concepts that should be developed and emphasized which include the general concepts and specific concepts. Depending on the domain to be developed, there are certain techniques that can be used to identify the concepts and relationships between concepts / instances. A related concept that has been identified and included in a particular part depends on the definition of the concept developed. Various specific properties of a concept defined and will help to distinguish among various concepts used. The restrictions or facets also rates for these properties are defined and at last, the designed ontology is revised according to the requirements.

To further understanding the use of ontologies and how they are built from scratch in a different domain, we develop our own ontology based on the Islamic Knowledge. In generating and constructing this ontology we must ensure that the information source used should be from the trusted source of Islamic knowledge. And these should be extracted according to the Islamic Knowledge hierarchy established in Islam starting with Al-Quran followed by the Hadith, Qiyas and Consensus. Therefore, in the generation of the ontology we use Solat as a subject to be addressed.

II. METHODOLOGY

To develop an ontology based on the Al-Quran, the development process can be divided into two stages. The first stage is to identify the best subject or topic that will be focused and to comprehend all documents or resources of the best text for further studies in this field. The second stage is the
ontology development process that involves the design and implementation.

For this development, we used the information gather from [1], [2] and other related Islamic sources. In the process of creating the ontology, some basic rules should be emphasized in the design of the ontology. According to [3] other things that need to be considered are:

i. There is no right way to model a domain - there is always a suitable alternative. The best solution depends on the application to be developed and thought out and extension that you anticipate and develop.

ii. Ontology development is a repetitive process.

iii. The concepts in the ontology should be close to the object (physical or logical) and relationships in the domain that you study. Normally nouns (objects) or verbs (relationships) in sentences that clarify and explain our domain.

Thus, in this Solat-based ontology development we used the following methodology and is based on information from multiple sources provided by the domain expert. It involves the Al Qur’an, the authentic Hadith, and books that focuses on the Shafie’s school of thought.

The ontology was developed from information gathered by domain experts and assigned to the ontology expert in the form of a set of concepts, relationships and definitions. This methodology is done by using steps defined in [4]. The steps are:

A. Determine the domain and scope of the ontology

The first step in ontology development is by defining ontology domain and scope in which the ontology will be developed in order to answer some basic questions: What subjects will be covered by the domain ontology? What is the use of the ontology? What types of questions could be answered by the information in the ontology? Who will use and maintain the ontology? The answer to these questions may change during the ontology design process, but at the present, it can help establish the scope of the model that is going to be developed.

For this work, the ontology development started by defining its domain and scope, where the domain include Islamic Knowledge main source which comprises of the Quran and Hadith. The research started within the scope of Solat or prayer. It is performed semi automatically and formalized by both the domain experts and ontology developers.

These are informal questions that the ontology must be able to answer and will be used to check the ontology is fit to its purpose. The following are the examples of possible competency questions in domain Solat:

a. What is Solat (prayer)?
b. What type of Solat?
c. When can I perform Solat?
d. What characteristics should I have, if I want to perform Solat or Prerequisites of the Solat?
e. Where can I perform Solat?
f. What is purification?
g. What is ablution (wudu')?
h. What is tayammum (the dry ablution)?
i. What is menstruation?
j. What is azhan, call to Solat?
k. What are obligatory acts of prayer?
l. What are sunnah acts of prayer?

B. Consider reusing existing ontologies

This step is to consider what other people have done and to check whether we can improve and expand the available resources for our particular domain and task. Reusing existing ontology may be required if our system needs to interact with other applications that have been committed to a specific ontology or controlled vocabulary.

For our purposes in developing Solat Ontology, we used general language knowledge such as Quran Indexes as shown in Figure 1. But this general ontology will be the TBox or upper layer of the Solat Ontology.

C. Enumerate the important terms in the ontology

It is useful if we could list all the words that we want to use, either in the form of a statement or explanation to the user. What are the terms Solat that we want to talk about? What are the properties owned by these terms? What do we want to say about Solat? These entire questions are based on the competency question and the elaboration of the questions in more details. For example, the important solat-related terms include solat, wudhu, tayammum, different type of solat such as fardhu and sunnah, their characteristics and so on.

Figure 1. Classes based on Quranic Indexes
D. Define the classes and the class hierarchy

This step starts by defining classes. From the list which created in Step C, the terms are selected whether its describe objects having independent existence or terms that describes these objects. These terms will be classes in the ontology and will become anchors in the class hierarchy. Classes are also organized into a hierarchical taxonomy.

There are 3 possible way to developing the class hierarchy [5] which is top-down approach, bottom-up approach or combination of both. In our approach, we used the combination approach where we start by defined the few top-level concept such as solat and chastity(tayammum, ghusl, ablution) and few specific concept such as Zuhr, Asr and others. After that, we can relate them to a middle level concept such as rukn, condition, hukm, nullification, requirement of Solat and others. And then we generate all the other classes that could be expand from solat such as chastity related concept which also have the rukn, condition, hukm, nullification, requirement of that concept for example ablution. (Please refer figure 2 as example).

E. Define the properties of classes—slots

Classes alone will not provide enough information to answer the question of competency from Step 1. Once we have defined some classes, we must clarify and reflect the internal structure of concepts. This can be deemed as property of the developed classes. The properties that being extracted as illustrated in figure 3. For Example: Solat have two types of Solat which are obligatory and sunnah and each type of Solat has an instances such as Solatul Zuhr (afternoon prayer). Every instance of Solat has properties such as hasDescription, hasRakaah, hasRequirement, hasRuknOf Solat and others. (see figure 4)

F. Define the facets of the slots

Slots can have different facets describing the value type, allowed values, the number of the values (cardinality), and other features of the values the slot can take. In our case most of the slot values are string either using ASCII or UTF-8 (Arabic)
III. EVALUATION

In developing the ontology based on Solat that involves the type of Solat, characteristics of Solat, hukm, purification, such as ghusl, wudu and Tayammum and other related matters, including Quranic verses in Arabic language, images and video. From the construction of the ontology we have generated the concept, relationship properties and instances show in table 1 below.

<table>
<thead>
<tr>
<th>NO.</th>
<th>Concept</th>
<th>Properties</th>
<th>Instances</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td>51</td>
<td>282</td>
<td></td>
</tr>
</tbody>
</table>

Based on the ontology, we generate a number of questions to ensure that all the concepts and the inference is made, and the information generated is correct and accurate, hence could answer all the competency questions. Among the questions raised and part of the results obtained are as the example below.

i. Questions: What is Solat (prayer)?
   Execute Query using SPARQL:
   ```sparql
   SELECT ?X
   WHERE {
     ?Y owl:equivalentClass :Salat;
     rdfs:comment ?X
   }
   ```
   Answer:

ii. Questions: What characteristics or requirement should I have if I want to perform Solat or Prerequisites of the Solat?
   Execute Query using SPARQL:
   ```sparql
   SELECT ?X ?solatrequirement
   WHERE {
     ?X :hasCondition ?solatrequirement .
   }
   ```
   Answer:

iii. Questions: What is Rukn of Solat?
   Execute Query using SPARQL:
   ```sparql
   SELECT ?X ?ruknofsolat ?seq
   WHERE {
     ?X :hasRukn ?ruknofsolat .
     ?ruknofsolat :hasSequence ?seq .
   }
   ```
   Answer:

iv. Questions: What rakat of each Solat?
   Execute Query using SPARQL:
   ```sparql
   SELECT ?rakaat ?fardhuain
   WHERE { ?fardhuain :hasRakaat ?rakaat .
   }
   ```
   Answer:

v. Questions: What is duration of each Solat?
   Execute Query using SPARQL:
   ```sparql
   SELECT ?solatrequirement ?X
   WHERE {
     ?X :hasSolatDuration ?solatrequirement .
   }
   ```
   Answer:
IV. CONCLUSION

Ontology development based on the domain Solat is an attempt to understand the characteristics of an ontology development involving a concept of Islamic knowledge. The development of Islamic knowledge is based on information about contextual linking between Al-Quran and other knowledge sources which are contextual links within the Qur’an and contextual links exist between the Qur’an and books of hadith and other scholars’ texts and followed by a consensus of scholars in interpreting each concept according to their understanding (based on school of thought). This is our initial step as an efforts to develop ontology-based Al-Quran and related knowledge that should be taken into account.

REFERENCES


Appendix 1 Visualization the part of the Solat ontology