# Salaat Ontology: A Domain Ontology for Modeling Information Related to Prayers in Islam

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#### Abstract

**Objectives**: This work is directed towards development of a domain ontology and a semantic tool for Muslim's prayer called Salaat. **Methods/Statistical Analysis**: The proposed ontology has been developed on Protégé tool based on TODE, a test driven ontology development methodology. A prototype application has been developed on JENA semantic web toolkit for the utilization of Salaat ontology. **Findings**: The proposed ontology comprises 113 concepts and 85 properties. A set of 40 queries were run to analyze the accuracy of proposed ontology. All the queries were successfully executed and extracted the desired information. **Application/Improvements**: The proposed tool can help a novice user to gain knowledge about Salaat (Islamic prayer). It becomes very easy to get the precise information through keyword based search.

Keywords: Domain Ontology, Islam, Ontology, Prayer, Salaat

# 1. Introduction

Internet can be envisaged as a disruptive technology that has greatly affected mankind. However, the problem with the internet is that most of the web contents are consumed by software tools and agents without any consideration to its meaning. They usually work based on keywords. Hypertext Markup Language (HTML) which is the standard for writing web pages annotates contents with tags for presentation purpose. These contents are easier for consumption by Humans. However, machines can't comprehend these contents. Semantic web has evolved in an attempt to address this difficulty. It is based on embedding semantics with domain information using software ontology. An ontology is a specification of a domain provided through a collection of concepts, their attributes, relationships and instances. Using the domain ontology, machine can understand the meaning of concepts present in the web contents.

In the past few years, there has been growing interest in the development of ontologies for various domains. Examples of such ontologism are software ontology for ad hoc and vehicular environments (SLAVE), community ontology, standard ontology for ubiquitous and pervasive applications (SOUPA), friend-of-a-friend ontology (FOAF) and DublinCore<sup>1-3</sup>. Besides those mentioned above, there are several ontologies available for healthcare, knowledge management, e-commerce and military applications. However, it has been observed that very little work has been done on development of ontologies for describing concepts in religious domain. There are very few ontologies developed mostly in the domain of

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Holy Quran<sup>4-10</sup>. Holy Quran is the sacred scripture of Muslims revealed on Prophet Muhammad (P.B.U.H) and is the primary source of Islam. Since, it is available in Arabic; hence, the paramount research on development of Ontology for Holy Quran is evident.

Besides Quran, some of the ontologies have been developed for Hadith (sayings or actions of Prophet)<sup>11</sup>, Tibb-e-Nabvi (Islamic medicine)<sup>12</sup> and Islamic banking<sup>13</sup>. However, it is observed that there is a lot of research work required on the development of ontology for other religious concepts. To fill this gap, this paper provides an ontology for Salaat (a form of Islamic prayer) ontology. The paper also proposes a methodology called Testdriven Ontology Development (TODE) for ontology development. In addition, a prototype tool has also been developed to test the propose ontology.

The objective of the proposed work is to develop an application that can answer frequent queries related to Salaat based on its semantics. The acquisition of domain knowledge is one of the imperative tasks of Salaat ontology development. The main task for such type of ontology design is that the knowledge should be true and authentic. For authenticity, we mostly focused on Al-Quran, Hadih, Sunnah, Internet authentic pages and religious scholars. This Salaat ontology has ability to answers with authenticity, most frequently asked questions by users.

An important question that arises is why Salaat ontology? To answer this question, we need to understand the implication Islam is having on this geo-political world. Islam is the second largest religion in world, the followers of which are called Muslims. Islam literally means "Submission" to the will of Almighty God. It is based on five major pillars: Testifying to oneness of Allah and prophet hood of Muhammad (P.B.U.H), Salaat, Fasting, Zakaat and Pilgrimage. Salaat (also called Prayer, Namaaz) has been greatly emphasized in Islamic literature such as Quran and Hadith. A Muslim offers Salaat five times daily. There are approximately 1.5 billion Muslims in the world. Besides Muslims, there has been a growing interest among Non-Muslims to obtain information about Islam. The primary reason being the political factor (such as 9/11) and the misconception spread about Islam. Unfortunately, most of the information about Islam is scattered and primarily available in Arabic. A common person who would like to acquire basic information about Salaat found it very difficult and often confusing to understand terminologies. Realizing this problem, the Salaat ontology has been proposed in this paper. It is expected that the proposed ontology and the associated tool will serve as an important vehicle to disseminate information about Islam in a positive way.

In recent years, there have been several works put forward for representation of religious concepts using semantic web technologies. Specifically, there have been intense investigation of the topic Digital Quran Computing<sup>8</sup>. There are three approaches to employ search on Quran<sup>6</sup>: ontology, synonyms-net, cross-language information retrieval. In the next paragraphs, we discuss the work primarily related to ontology.

The authors in<sup>14</sup> have emphasized and proposed a vision for employing semantic web technologies for efficient modeling, storage, publishing and reasoning of religious literatures and Holy books. In some of the approaches, automated extraction of concepts from Quran has been proposed for the development of ontology. In<sup>15</sup>, different approaches have been proposed to extract concepts from the Quran. In the first approach, direct ontology extraction from the concept is employed. For example, formatting (such as rounded and square brackets) and text-patterns can be used to extract synonyms, attributes and relationships. All the upper case letter implies a concept. Similarly, there can be rules identified for compound nouns, apposition and copula. The second approach is based on meta-ontology based extraction. The proposed approach was analyzed on 3378 words of Holy Quran related to Solah. Based on proposed formats and patterns, different concepts and relations were reported for the test scenario.

An ontological approach has been proposed in<sup>10.16</sup> for the extraction of knowledge from Quran. The author employed an ontology re-use approach in which an existing ontology from University of Leeds is annotated with additional attributes. The user natural language queries are translated into SPARQL queries and then posed

against the ontology. The precision and recall of the system were measured to determine the effectiveness of the proposal.

Semantic Quran, a multi-lingual RDF representation of Holy Quran has been presented in<sup>12</sup>. The ontology consists of all the chapters of Quran represented in 43 different languages. The concepts were extracted from two data sources: Tanzil project and Quranic Arabic coprpus. The proposed ontology comprises four basic classes: Chapter, Verse, Word and Lexical Item. The Tanzil project's delimited text files were used to extract concepts. The proposed ontology has been linked with the versions of Wikitionary and DBpedia. The ontology is interoperable due to the capabilities of NIF. In<sup>18</sup>, a framework has been proposed to identify semantic opposition terms based on Natural Language Processing (NLP) and ontologies. An ontology for Quran has been presented in<sup>5</sup>.

In another direction, the authors have manually developed ontologies by consulting domain experts and religious scripts. In<sup>9</sup>, the authors have shared experience of developing Quran ontology by incorporating contextual information essential for understanding the verses of Holy Quran. The authors employed an ontology development methodology which is a combination of Gruninger and Fox's methodology and METHONTOLOGY. The methodology comprises four steps: identifying the motivating scenarios, deriving the competency questions, implementation and evaluation. The Quran ontology was developed for Juz Amma based on the concepts extracted from Quran Corpus.

Several search tools have also been developed for Quran. Al-Bayan<sup>4</sup> is an Arabic question answering system in the domain of Quran developed for scenarios where high accuracy is desired such as religious affairs.

The system accepts a question about Quran and then extracts relevant verses from Holy Quran along with passages from Tafseers. The system is claimed to achieve 85% accuracy.

AQSTT employed information retrieval and semantic search techniques to develop a tool for Quranic search<sup>6</sup>. Along with ontology, the system incorporates different translations, tafseers, dictionary and revelation reasons to perform a comprehensive searching. The user query is first parsed into tokens and techniques such as part-ofspeech tagging, spell correction and stemming is applied. Then, synonyms are generated. Semantic tags are then added and SPARQL query is used to extract the concepts. If no result is found based on semantics, key word based searching is performed. In the final step, scoring and ranking is performed.

Besides the Quran, work on other religious sources such as Hadith, Tibb-e-Nabvi and Islamic banking have also been cited in literature. Semantic Hadith is a linked data approach that is based on an ontology for Hadith and then linking with appropriate Quranic verses<sup>11</sup>. The conceptual design includes Hadith, Matn, Narrator, Sanad, Hadith Class, Hadith Chapter, Hadith Book and Hadith Collection. There are macro-links (direct link to a verse) and micro-links (link to sub-verses) exist between a Hadith and Quran. Similarly, there are links between one Hadith and other Hadith. The proposed work is linked with QuranOntology and SemanticQuran.

An ontology for Hadith Isnad (chain or narrations) has been proposed in<sup>19</sup> that comprise concepts such as Hadith, Person, Narrator, Author, Book and Chapter. The objective of the proposal is to determine the authenticity of Hadith as accepted or rejected. The proposed ontology is evaluated based on Hadith example and DL-queries.

The information about Hadith is scattered at various sources. Even though, different online tools provide support for searching Hadith, Isnad, term searching, narration view and classification; for a common person, Hadith commentary is required. In this direction, a Hadith commentary ontology has been proposed by<sup>20</sup>. The main objective of the proposal is that Hadith commentary can be integrated with ontology such that a base for online Hadith corpus can be developed. A framework for ontology construction for Hadith is also proposed in<sup>21</sup>.

A lot of work has also been proposed in miscellaneous directions. An ontological approach enabling an integrated knowledge base for Islamic laws and commandments has been provided in<sup>22</sup>. Similarly, an ontology for various Islamic concepts have been presented in<sup>23</sup>. An Islamic web based search engine has been proposed in<sup>24</sup>. An ontology for Tibb-e-Nabvi (medicine of Prophet Muhammad P.B.U.H) was proposed in<sup>12</sup> such that medical applications can be developed. An Islamic banking ontology has been proposed by<sup>13</sup> that aims to serve as basis for Islamic banking information system. There are various peculiarities of Islamic banking such as different terminologies, diversity of different banks and juristic schools; that are dealt by the proposed ontology.

The study of various semantic web approaches to represent religious information reveals that the current work is very trivial in nature. Most of the work has been done on the development of ontology for Quran. An overview of various semantic-web approaches for extracting Quranic information has been provided in<sup>2</sup>. The main objective of these proposals was to improve the accuracy of retrieved contents by utilizing the semantic information associated with the keywords. However, it is concluded that domain ontologies for other topics of religion such as such as Saum, Zakat and Pilgrimage are intensely required. Specifically, we don't find much work related to knowledge representation/ ontologies for Salaat. The only work on Salaat is presented in<sup>25</sup>. The proposed work is based on the information extracted from Al Qur'an, the authentic Hadith, and books that focuses on the Shafie's school of thought. The domain experts were also consulted. However, the ontology proposed in this work is very limited in scope. There are also discrepancies found in the proposed ontology.

In order to fill the research gap, this work proposes a Salaat ontology. The proposition follows a well-defined methodology based on which various concepts, attributes, relations and instances have been defined. In order to exploit the ontology, the paper also proposes a semantic tool that reasons and answers basic questions related to Salaat.

## 2. Proposed Salaat Ontology

This section discusses the proposed domain ontology for Salaat. We start with discussion on methodology for construction of proposed ontology which is followed by an overview of proposed ontology.

#### 2.1 TODE Methodology

For the development of proposed ontology, a systematic and well-defined methodology called *Test-driven* 



*Ontology Development (TODE)* has been proposed. The proposed methodology is an adoption of test-case driven software development. The basic idea is to start the development with defining what aspect of the product is to be tested.

A set of test-cases are first defined and development follows in the direction of developed test-cases. Following the same approach, Figure 1a shows the methodology adopted for Salaat ontology development.

#### 2.1.1 Domain Identification

The development of ontology begins with domain identification during which information from various sources such as Quran, Hadih, Sunnah, and reliable internet sources is acquired. Our search is restricted to concepts relevant to Salaah. Primarily, more than 100 fatawa of askimam.org is indexed to acquire basic concepts. In addition, various other Islamic websites are also consulted.

#### 2.1.2 Test-Case Development

The next step is the development of a set of test-cases upon which the developed ontology can be tested. A complete test-plan along with the desired resources is developed. Figure 1b shows some sample test-cases.

#### 2.1.3 Conceptualization and Classification

This step is followed by conceptualization and classification. Major concepts of the domain are identified based on the test-cases. These concepts eventually become classes and sub-classes of the proposed ontology. During this phase, several brainstorming sessions were done. Essentially, all the nouns of the domain are identified as classes and then by using technique of generalization and specialization, class hierarchy is developed.

#### 2.1.4 Properties Identification

In the next step, attributes of each concept are found out, relations among concepts are found and instances are then created for each concept. For this purpose, the literature is review and description about each concept is investigated to find the attributes and relations.

#### 2.1.5 Evaluation

Testing is the pivotal part of any software development. The final step of the proposed methodology is the evaluation of proposed ontology by executing the developed test plan. All the test cases are executed and results are reported.

Title:	No. of units in Asar	
	Fardh Prayers	
Test Case Id:	1	
<b>Pre-Condition:</b>	Ontology is loaded	
Steps:	Execute SPARQL query	
<b>Expected Behavior:</b>	4 units	

Title:	How many schools of	
	thoughts are there in	
	Islam?	
Test Case Id:	2	
Pre-Condition:	Ontology is loaded	
Steps:	Execute SPARQL query	
Expected Behavior:	Hanafi, Shaafi, Maliki,	
	Hanbali	

#### 2.2 Proposed Ontology

Figure 2 shows the top level view of the major classes of proposed ontology. The most important class is Pillar in which we define the basic pillars of Islam. There are few impermissible times for performing Salah, which is defined by Impermissible\_Time concept in our ontology. In order to perform Salaah, Muslims need to purify themselves. There are three types of purification (as defined by Purification class): Ghusul, Ablution and Tayammum. Tayammum is performed in the situation there is no water available for performing ablution. The Nullification\_ Matters defines the situations in which Salaat, Ghusul or Ablution becomes nullified.

Figure 3a shows the sub-concepts of Salaah. Some prayers are performed on timely basis such as daily prayers, Eid prayers that are performed on yearly basis, Friday prayers performed on every Friday, and Taraveeh prayers that are performed in Islamic month of Ramadan. There are some prayers that are performed on special occasions such as on death of a Muslim (called Funeral prayer) or on Solar eclipse (called Kasoof prayer). Some prayers are performed to invoke the help of Allah such as during shortage of rain (Istaska), some need (Hajaat), to get rid of fear (Khauf) or to ask for forgiveness (Repentence). There are some special prayers that are performed after ablution (Tahiyyat-ul-Wuzoo) or for special reward from Almighty (Salat-ul-Tasbeeh). Figure 3b shows the various components of each of Salaat and purification methods.

Figure 3c and 3d shows some of the properties of proposed ontology. A Moazzin calls for prayers. Moaazzin, Prayer Leader and Muqtadee face Qibla while offering prayers. Some of the prayers have Khutbah. There are certain things that nullify Salaat and purity. Salaat is performed on prayer's mat.



Figure 2. High level view of proposed ontology.



studies

nullifies\_ablution
 nullifies\_ghusul
 nullifies\_salat
 performed\_on
 performs\_in
 performs\_salah
 prescribed\_in
 sayings\_or\_action

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**Figure 3.** Proposed Ontology of Salaat along with properties and relations. a: Different types of Salaah. b: Components of Salaah and purification methods. c. Properties of ontology. d. Relationship between concepts (object properties)

## 3. Salaat Search Engine

In order to make the use of proposed ontology, a semantic web application has been developed. First the proposed Salaat ontology is developed in Protégé editor<sup>26</sup> and then exported into OWL format. The JENA semantic web toolkit<sup>1</sup> has been selected for implementation of the proposed tool and Java Enterprise Edition platform has been used



(a)

NAME COENES	NAMAZ QUERES
how manay farz namaz	What is Narros
What is Nerrisa: How meaning types of nerrisa Teen meaning types for rearisa how meaning Science Institut how meaning Natil nerrisa	Paarraat is a pilar of islars
SUBMIT	SUTIMIT

**Figure 4.** Proposed web application. a. Architecture of proposed application. b. User interface of proposed application. c. Response of the user query.

for web application development. Figure 4a shows the architecture of proposed web application. The proposed application is a simple n-tier application. The user of the software can pose any natural language query over the web using a standard browser. At the server end, a web container receives the request from the client and passes the request to user agent. The user natural language query is parsed using an NLP analyzer. First, it performs lexical analysis to convert the query into tokens which is then parsed using a context free grammar and then syntax directed translation is performed to convert the query into a SPARQL query. A query engine is running to parse and execute the SPQARL query. At the bottom is the Salaat ontology that comprises information in the form of OWL.

OWL is an XML document with additional rules and axioms. The ontology API is provided for processing of OWL based ontological information. The reasoner applies inferencing process to the Salaat ontology to derive additional information.

## 4. Discussions on Results

In order to test the effectiveness of proposed ontology, the same set of test-cases that were developed in the initial stage were used to test the ontology for correctness. The natural language query is translated into SPARQL and then posed against the ontology. Figure 5 shows the various types of queries executed against the proposed ontology. There were 113 concepts and 85 properties identified during ontology development. Overall 40 queries were run against the ontology. The evaluation produces results with 100% accuracy that shows that the proposed ontology fulfills all the requirements of Salaat ontology.

## 5. Conclusion and Future Work

In this research work, an ontology for Islamic prayer (Salaat) has been proposed and a prototype application has been developed for utilization of proposed ontology. The paper describes the core classes of the ontology, the attributes of classes and relationships. The architecture of proposed small semantic web application has been discussed along with the results. The proposed tool can be helpful for interested people to better understand the details about Salaat.

The future work can be done in the development of domain ontologies for other religious notions. In Islamic domain, for example, ontology for Fasting, Zakaat and Hajj can be developed. For Christianity, concepts such as

Question: What are the pillars of Islam?	Question: What are the different invocational prayers in Islam?	Question: What are the daily prayers that Muslims perform?
<pre>?subject rdfs:subClassOf NS:Fillar . } Result:</pre>	Query: SELECT ?subject WHERE { ?subject rdfs:subClassOf	Query: SELECT ?subject WHERE { ?subject rdf:type NS:Daily Praver
spint	NS:Invocational_Prayer. }	.)
Praver	Result:	Result
Fasting	subject	Asar Fajar
72kat	Haagat_Prayer	Awwabeen Isha
Shahadat	Repercence_Hayer	Maghrib Chasht
Plorimane	Indvol_Playd	Dhuhr Tahajjud
	Istacka Dravar	Ishraq
	Khauf_Prayer	
Question: What are the optional prayers that muslims perform daily?	Question: What prayers are offered in congregation?	Question: What are the obligatory prayers that Muslims perform daily?
?subject rdf: type NS:Daily Prayer .	ns:leads_salahrdfs:range?salah.	Query : SELECT ?subject WHERE
?subject NS:nature_of_prayer	}	{
"Nafil"^xsd:string.	Regult	?subject rdf:type NS:Daily Praver
Result:	Daily_Prayer	?subject NS:nature_of_prayer
	Friday_Prayer	"Fardh" <sup>**</sup> xsd:string.
Awwabeen	Eid_Prayer	} Result
Chasht	Taraveeh_Prayer	
Ishraq	Funeral_Prayer	Asar
Tabaijud		Dhuhr
s		Fajar
		Isha
		Maghrib
Question: What are the components of Funeral prayers?	Question: What are the impermissible times for Salah?	Question: What are the different schools of thoughts?
Query: SELECT ?components WHERE { NS:Funeral_Prayer NS:hasParts	Query: SELECT ?time WHERE { ?time rdfs:subClassOf	Query: SELECT ?mazhab WHERE {
Parts . Poarts NS had Inite Amite	ns:Impermissible_Time.	?mazhab rdfs:subClassOf
?units NS:hasComponents	Result:	}
?components .	Asar_to_Sunset	Result
Results	Zawal	Maliki
takhir	Dawn_to_Sunrise	Hanati Haobali
recitation		Shaafii
salaam		
Question: Which prayers have Khutbah?	Question: What are the parts of Asar pray	vers?
	Query: SELECT ?parts ?rakaat WHERE {	
Query: SELECT ?salah WHERE {	NS: Asar NS:hasParts ?parts .	
}	}	
	Asar Fardh "4"^^_http://www.w2	oro/2001/XMI Schema#strings
Kesult:	Acar Curpat "4"AA data //	ara/2001/MII Cebama Estrings
Friday_Prayer	Asar_Sunnat 4 *** <nttp: td="" www.w3<=""><td>.org/2001/XMLSchema#string&gt;</td></nttp:>	.org/2001/XMLSchema#string>
Eid_Prayer		



Trinity, Baptism; and for Hindiusm, details about Dewali, Holi etc. can be described via development of corresponding ontologies.

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# 7. References

- 1. TODE: A Dot net based tool for ontology development and editing [internet]. https://ieeexplore.ieee.org/document/5486292. Date accessed: 16/04/2010.
- 2. Islam N, Shaikh ZA. Towards a robust and scalable semantic service discovery scheme for mobile ad hoc network, Pakistan. J. Eng. Appl. Sci. 2012; 10: 68–88.
- 3. SOUPA: Standard ontology for ubiquitous and pervasive applications [internet]. https://ieeexplore.ieee.org/document/1331732. Date accessed: 26/08/2004.
- 4. Al-Bayan: An Arabic Question Answering System for the Holy Quran [internet]. https://www.aclweb.org/anthology/ papers/W/W14/W14-3607/. Date accessed: 10/2014.
- Al-Quran themes classification using ontology [internet]. https://www.semanticscholar.org/paper/ Al-Quran-themes-classification-using-ontology-Ta'a-Abi din/3ffa41953b94f043ee7590bab5c81e537a02f4ec. Date accessed: 2012.
- Arabic Quranic Search Tool Based On Ontology [internet]. http://eprints.whiterose.ac.uk/101257/1/alqahtani16nldb. pdf. Date accessed: 2016.
- Computational ontologies for semantic tagging of the Quran: A survey of past approaches [internet]. https://www. researchgate.net/publication/267590803\_Computational\_ ontologies\_for\_semantic\_tagging\_of\_the\_Quran\_A\_survey\_of\_past\_approaches. Date accessed: 01/2014.
- Zakariah M, Khan M K, Tayan O, Salah K, Digital Quran Computing: Review, Classification, and Trend Analysis. ARAB J SCI ENG. 2016; 42(8): 3077–3102. https://doi. org/10.1007/s13369-017-2415-4.
- Iqbal R, Mustapha A, Yusoff Z M, An experience of developing Quran ontology with contextual information support, Multicult Educ Tech J. 2013; 7: 333–343. https:// doi.org/10.1108/METJ-03-2013-0009.

- Ontology Semantic Approach to Extraction of knowledge from Holy Quran [internet]. https://ieeexplore.ieee.org/ document/6588752. Date accessed: 27/03/2013.
- Semantic Hadith: Leveraging Linked Data Opportunities for Islamic Knowledge [internet]. http://ceur-ws.org/Vol-1593/article-14.pdf. Date accessed: 2016.
- Al-Rumkhani A, Al-Razgan M, and Al-Faris A, TibbOnto: Knowledge Representation of Prophet Medicine (Tibb Al-Nabawi), Procedia Computer Science. 2016; 82: 138– 142. https://doi.org/10.1016/j.procs.2016.04.021.
- 13. Characteristics and development criteria for Islamic banking ontology [internet]. https://ieeexplore.ieee.org/ document/7806350. Date accessed: 2016.
- 14. Leveraging semantic web technologies for standardized knowledge modeling and retrieval from the Holy Qur'an and religious texts [internet]. https://www.researchgate.net/ publication/220791503\_Leveraging\_semantic\_web\_technologies\_for\_standardized\_knowledge\_modeling\_and\_ retrieval\_from\_the\_Holy\_Qur'an\_and\_religious\_texts. Date accessed: 01/2009.
- 15. Islamic knowledge ontology creation [internet]. https:// ieeexplore.ieee.org/document/5402635. Date accessed: 09/11/2009.
- 16. Yauri AR, Kadir RA, Azman A, Murad MAA. Quranic Verse Extraction base on Concepts using OWL-DL Ontology. Research Journal of Applied Sciences, Engineering and Technology. 2013; 6: 4491–4498. https://doi.org/10.19026/ rjaset.6.3457.
- 17. Sherif MA, NgomoA CN. Semantic Quran. Semantic Web. 2015; 6(4): 339–345. https://doi.org/10.3233/SW-140137.
- Al-Khalifa HS, Al-Yahya MM, Bahanshal A, Al-Odah I, SemQ: A proposed framework for representing semantic opposition in the Holy Quran using Semantic Web technologies, Proceedings of International Conference on the Current Trends in Information Technology (CTIT). 2009; 1–12. https://doi.org/10.1109/CTIT.2009.5423145.
- Building Hadith Ontology to Support the Authenticity of Isnad [internet]. https://www.researchgate.net/ publication/297702365\_Building\_Hadith\_Ontology\_ to\_Support\_the\_Authenticity\_of\_Isnad. Date accessed: 12/2014.
- 20. Hadith Commentary Repository: An Ontological Approach [internet]. https://www.semanticscholar.org/paper/Hadithcommentary-repository%3A-An-ontological-Jaafar-Pa/ 216af68fe6d17bad5409480eb3f1eb77091ee368. Date accessed: 2016.
- 21. Towards Ontology Construction from Arabic Texts-A Proposed Framework [internet]. https://ieeexplore.ieee. org/document/6984743. Date accessed: 11/09/2014.

- 22. An ontology based framework for Shariah sustenance in the west. https://ieeexplore.ieee.org/abstract/document/7020671. Date accessed: 17/11/2014.
- 23. Ontological knowledge Management System of Islamic Concepts [internet]. https://dokumen.tips/amp/ documents/ontological-knowledge-management-system-of-islamic-jisr-knowledge-management.html. Date accessed: 2013.
- 24. Ishkewy H, Harb H, ISWSE: Islamic Semantic Web Search Engine. Int. J. Comput. Appl. 2015; 112: 37–43.
- 25. A process for building domain ontology: an experience in developing Solat ontology [internet]. https://www. researchgate.net/publication/221013843\_A\_process\_for\_ building\_domain\_ontology\_An\_experience\_in\_developing\_Solat\_ontology. Date accessed: 07/2011.
- Musen MA. Protégé Ontology. Encyclopedia of Systems Biology. 2013; 1763–1765. https://doi.org/10.1007/978-1-4419-9863-7\_1104.