ONTOLOGY-BASED APPROACH FOR RETRIEVING KNOWLEDGE IN AL-QURAN

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Abstrak

Capaian maklumat maklumat bergantung kepada data berkaitan yang diperolehi dari satu set sumber pengetahuan, seperti Al-Quran. Pencarian boleh berdasarkan metadata, pengindeksan teks penuh, atau lain-lain yang berasaskan kandungan. Al-Quran adalah kitab yang paling banyak dibaca di dunia dan mengautomasikan kaedah pencarian pengetahuan dari kesusasteraan agama telah mendorong minat para penyelidik dan ianya amat mencabar. Ini telah membawa kepada pembangunan beberapa aplikasi carian, yang boleh membuat carian pengetahuan berdasarkan kata kunci atau ayat. Mendapatkan pengetahuan daripada ontologi Al-Quran berdepan dengan beberapa masalah asas, iaitu satu daripadanya adalah ketepatan. Dalam kebanyakan kes, pencarian yang tidak boleh mengambil konsep yang berkaitan sesuai dengan ayat-ayat yang berkaitan. Pendekatan semasa menggunakan kaedah konvensional seperti taksonomi, haraki, atau struktur pokok yang hanya menyediakan takrif konsep tema tanpa dikaitkan dengan konsep ilmu yang betul daripada Al-Quran. Tujuan utama kajian ini adalah untuk membangunkan ontologi Al-Quran berdasarkan klasifikasi tematik. Pendekatan kajian yang baru terdiri dari dua peringkat. Peringkat pertama: melibatkan pembangunan ontologi Al-Quran berdasarkan bahasa RDF/OWL melalui alatan Protégé-OWL. Peringkat kedua: melibatkan pembangunan kaedah carian dengan menggunakan rangka kerja JENA yang berasaskan bahasa pengaturcaraan Java. Kaedah carian membolehkan pemprosesan ontologi, dan dilakukan pencarian menggunakan kata kunci yang diberikan dan mendapatkan pengetahuan yang berkaitan dengan kata kunci. Pendekatan carian adalah, dinilai menggunakan ukuran Recall dan Precision yang menunjukkan ketepatan yang tinggi dalam carian pengetahuan ontologi Al-Quran. Tambahan pula, klasifikasi ontologi telah dinilai oleh dua orang pakar dalam bidang pengajian Islam. Kajian ini menyumbang kepada kemudahan pembelajaran dan kefahaman Al-Quran kepada semua orang di semua peringkat umur.

Kata Kunci: Ontologi, Capaian Maklumat, Carian Semantik, Pengurusan Pengetahuan, Ilmu Al-Quran.

Abstract

Information retrieval relies on obtaining relevant data from a set of knowledge resources, such as Al-Quran. Searching can be based on metadata, indexing, or other content-based. Al-Quran is the most widely read book in the world and automating knowledge retrieval from this of religious literature is very challenging. This has led to the development of a number of search applications, which can retrieve knowledge based on keywords. Retrieving the knowledge of Al-Quran ontology includes several fundamental problems, one of which is the lack of accuracy. In most cases, the searching cannot retrieve the relevant concept of knowledge and verses. Current approaches use conventional methods such as taxonomy, hierarchy, or tree structure, which only provide the definition of the concept of themes without linking to the correct knowledge concept of Al-Quran. The main aim of this study is to design a method that uses the ontology approach to search and retrieve relevant verses in Al-Quran. The new approach consists of two stages. The first stage: involves the Al-Quran ontology development based on thematic classification which was implemented using Protégé-OWL. The second stage: involves the development of a search method by using the Jena framework which is based on Java programming languages. The search method allows ontology processing, and performed the searching using the given keywords and retrieve the knowledge pertaining to the keyword. The search approach was evaluated using the Recall and Precision measurements, which shows a high accuracy in retrieving the knowledge of Al-Quran. Furthermore, the ontology classification was evaluated by two experts in Islamic Studies field. This study contributes to the ease of learning and understanding Al-Quran by people of all ages.

Keywords: Ontology, Information Retrieval, Semantic Search, Knowledge Management, Al-Quran Knowledge.

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List of Abbreviations

API	Application Programming Interface
DDL	Data Definition Language
GUI	Graphical User Interface
HTML	Hyper Text Markup Language
IDE	Integrated Development Environment
IS	Information System
JSP	Java Server Pages
OWL	Ontology Web Language
RDBMS	Relational Database Management System
RDF	Resource Description Framework
SQL	Structured Query Language
UML	Unified Modeling Language
URL	Uniform Resource Locator
XML	Extensible Markup Language

CHAPTER ONE
INTRODUCTION

1.1 Introduction

This chapter provides an overview of this research. It includes a background of the study, which focuses on retrieving knowledge in Al-Quran using the ontology approach. Then, the research problem, research questions and research objectives are discussed. This is followed by the scope and significance of this research, at the end.

1.2 Background of the Study

Islamic scholars have described Al-Quran as the holy book of Muslims that teaches morals, purification, and good deeds. Al-Quran provides guidance to mankind, promotes justice between one another, and provides guidance on how to live on earth with neighbors (Ahmad et al., 2013; Yauri, Kadir, Azman, & Murad, 2012). A related study described Al-Quran as the source of information on any subject matter concerning the world and the hereafter (Shoaib, Nadeem Yasin, Hikmat, Saeed, & Khiyal, 2009). In other words, knowledge gained from Al-Quran cannot be compared with scientific books because the former provides real and deep discussions on matters under examination unlike the latter (Ahmad et al., 2013; Shoaib et al., 2009).

The study of Khan, Saqlain, Shoaib, and Sher (2013) emphasized that searches and retrieval of knowledge in Al-Quran sometimes lacks clarity and accuracy due to the non-implementation of sophisticated and dynamic ways for retrieving knowledge or

verses. Besides, the present way of searching in Al-Quran is not based on knowledge classification (Khan et al., 2013). Hence, this shows that there are weakness in searching and retrieving the verses in Al-Quran or Islamic literature due to the non-use of a proper technique such as ontology.

Ontology uses concepts, such as classes and relationships between properties of classes, to search verses and establish the knowledge contained in Al-Quran (Beseiso, Ahmad, & Ismail, 2010). The concept in Al-Quran is referred to as verses, which are defined by hierarchy of division, chapter, and verse (Syuhada & Ta'a, 2013). Previous studies have emphasized that verses in Al-Quran are grouped into chapters and divisions, which can be significantly retrieved by using an ontology-based approach (Khan et al., 2013; Shoaib et al., 2009).

The classification and search for Al-Quran verses require a well-structured definition in information technology (Saad, Salim, Zainal, & Muda, 2011). Several researchers have indicated that further studies are required to produce a semantic search method to facilitate the search and retrieval of exact and relevant verses in Al-Quran ontology (Ahmad et al., 2013; Yauri et al., 2012). Moreover, there is a selection of ontology editors available for constructing the ontology, such as Protégé-OWL. However, the efficient use of such editors while carrying out visualization during ontology development is important (Saad et al., 2011; Shoaib et al., 2009). Thus, Protégé-OWL is among the best ontology editors for research because it is stable, has a number of features, and is free of charge (Khan et al., 2013; Knublauch et al., 2005).

In addition, researchers have stressed that searching and retrieving a specific verse or issue in Islamic literature and Al-Quran can become easier with the use of an ontology system (Khan et al., 2013; Saad, Salim, & Zainal, 2009) because of the capacity of an ontology system to mine and retrieve words or verses. Retrieving verses from an ontology base system becomes possible because of the attribute of the system to accept a query from users and rank the relevance of the searched verses among the documents (Du, Hu, Yi, & Hu, 2007; Fang, Zhang, Wang, & Dong, 2005). Moreover, Khan et al. (2013) argued that retrieving verses from Al-Quran is possible when using an ontology system due to its characterized accuracy and functionality of an ontology system. Therefore, retrieving verses from Al-Quran and Hadith becomes possible by employing an ontology-based approach system.

This study aims to design a method that uses the ontology approach to search and retrieve relevant verses in Al-Quran. More importantly, the method should be easy to use by readers. Therefore, this study develops a theme-based retrieval system for Al-Quran, and defines classes, properties, and instances for the ontology based on theme classification of knowledge in Al-Quran. The development of an Al-Quran ontology is based on themes concepts, which classify knowledge according to division, chapter, and verse.

1.3 Problem Statement

Knowledge in Al-Quran is gathered through the interpretation of verses classified by division, chapter, and verse from those represented in an ontology structure (Khan et al., 2013). The search method in Al-Quran ontology faces several fundamental problems, such as the inability to retrieve relevant knowledge and verses (Yauri et al., 2012). Ul Ain and Basharat (2011) suggested that the search and knowledge retrieval process may lack clarity without the use of a classification approach, which may cause readers to difficulty in understanding the verses. Most readers, such as students, teachers, and scholars find difficulty in using the current approach because of its lack of accuracy and the ambiguity of knowledge of Al-Quran ontology (Saad et al., 2009). These reasons have led to a lack of ontology-based search methods (Saad et al., 2009; Yauri, Kadir, Azman, & Murad, 2013).

Meanwhile, the ontology that represents Al-Quran knowledge can be more structured by using a thematic approach, which is referred to as theme classification (Khan et al., 2013). This approach supports the understanding of a particular aspect for learners (Jones, Coviello, & Tang, 2011). Thus, the use of ontology to capture the semantics of information domain is successfully applied in some research fields, including the knowledge of Al-Quran (Staab & Studer, 2010), which has motivated the present research to explore the semantic-based search approach by using a thematic concept. Moreover, conventional methods, such as taxonomy, hierarchy, or tree structures, only provide the definition of the concept of a theme without progressing to a more in depth thematic approach which can provide additional explanation (Ahmad et al., 2013).

The current approach increases the difficulty in obtaining accurate knowledge because the verses are retrieved in an unclassified manner. The results are difficult to sort and facilitate reader understanding (Atwell et al., 2010). However, this deficiency can be resolved by employing the ontology approach and by classifying Al-Quran verses according to themes that can be more easily understood by readers (Khan et al., 2013). Themes classification, which is referred to as thematic approach, is a way of teaching and learning such that many areas of knowledge are integrated and connected within a theme. Therefore, it allows learning to be less fragmented and more natural (Hislop, 2013).

Many of the existing works, including the study of Khan et al. (2013) is based on semantic search for related verses in Al-Quran, which do not give accurate results in retrieving knowledge when searching for the keywords as it does not use the themes concept. However, finding verses in Al-Quran through the keyword search and retrieving using ontology approach is much more easier and straight forward. Therefore, this research intends to design a system that would perform search and retrieval of relevant verses in Al-Quran through ontology approach.

1.4 Research Questions

The research questions of this study are:

i. How can Al-Quran knowledge be defined in thematic-based classification?
ii. How to perform a keyword search in an Al-Quran?

iii. How to evaluate the proposed search approach in retrieving the knowledge from Al-Quran?

1.5 Research Objectives

i. To develop Al-Quran ontology based on thematic classification.

ii. To develop a searching method to be used in the thematic classification ontology.

iii. To evaluate the ontology searching method.

1.6 Scope of the Research

This study focuses on several divisions, chapters, verses, and the definitions in English, which contains themes classification of Al-Quran from the *Classification of Al-Qur'an's contents (original format)* book by Khalid (2011). The prototype of the searching mechanism is designed in English and uses the thematic concept for verses classification in Al-Quran based on ontology. Hence, this study (only) uses three concepts (themes), where each of them contain sub-concepts (sub-themes). The main concepts (Allah, Angels, and Unseen) were chosen as the research scope because it concerns all people and are frequently described in Al-Quran. Knowledge about basic themes, such as Allah (knowing of Allah, characteristics of Allah), Angels (the duties of Angels, e.g., blowing the trumpet, organizing all matters and others), and Unseen (e.g., Allah knows all that in the hearts, and others), were used while retrieving the knowledge (verse) from Al-Quran. Table 1.1 shows the structure of the themes used in the study.

Table 1.1

The Classifications of Themes (Khalid, 2011).

Root	Theme(s)	Sub-theme(s)
Al-Quran	Allah	1- Knowing. - The innate character of mankind. - The universe and his creation. 2- Characteristics. - Existence. - Oneness. - First and the Last. - Differs from what has created. - Omnipotent. - The Will. - Alive does not die. - The Knower. - The All-hearing and the All-Seeing.
	The Angels	1- The duties. - Organize all matters. - Pacify the hearts of the Prophets and the Faithful. - Praying for the Faithful and ask for forgiveness. - Glorify Allah and prostrate before him. - Recording the actions of 'mankind'. - The Blowing of the Trumpet. - Convey the revelation to the prophet. - Guarding the hell and punish its occupants.
	Unseen	- Allah knows the keys of unseen. - Allah knows the affairs of the hidden. - Allah knows all that is in the heart.

1.7 Significant of Research

The motivation to conduct this research is due to the lack of accuracy and clarity in the retrieval of Al-Quran knowledge provided by currently available systems. Moreover, the lack of classification of knowledge concepts leads to difficulty in understanding search results. This study seeks to provide appropriate solutions to these challenges by designing a system that is capable of search and retrieval processes for verses in Al-Quran using an ontology approach. The perceived advantages of the system is it can benefit studies by both Muslims and non-Muslims and it can be easily used by people of all ages and socio-economic groups. The successful implementation of the classification and search system can contribute to increasing the understanding of Al-Quran by readers anywhere and anytime.

1.8 Summary

This chapter presents the research background and explains the existing challenges in search method of Al-Quran knowledge. It presents an ontology based approach to overcome these challenges by using the English language to classify verses for building an Al-Quran ontology. The chapter also contains the research questions that are in line with the research objectives. Finally, the scope and significance of the research are discussed to highlight the decision of the researcher to design an improved ontology-based search method for Al-Quran.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter focuses relevant literatures that are related to the context of this research. Most of the literatures that are highlighted in this chapter are related to the conceptual knowledge about ontology search as far as Al-Quran is concerned. It discusses about the concept of ontology, information retrieval, overview of ontology and its impact on the information system, basic notion of ontology and relevant studies of ontology. Lastly, the chapter reviews the previous search operations in ontology-based retrieval of Al-Quran knowledge.

2.2 Concept of Ontology

Ontology is defined as "*an explicit formal specification of common concepts*" (Gruber, 1993). Ontology is a branch of philosophy that involves the study of the types and structures of objects, properties, events, and the processes of relations, in every area of reality. Descriptions of concepts and relationships can exist as an agent or a community of agents, which is consistent with the use of ontology as a set of concept definitions. The studies of Khan et al. (2013) and Al-Saif and Markert (2010) revealed that the application of ontology in various fields of social and natural sciences serves as a problem solving platform.

Researchers have argued that many types of editors are fit for the construction of an ontology system such as Protégé-OWL because of their robustness and flexibility of use (Ameen, Khan, & Rani, 2012). An earlier study by Khan et al. (2013) emphasized that the use of Protégé-OWL editor during ontology is acceptable while retrieving and searching for an exact word in a pool of texts. However, the appropriate selection and efficient use of editors are important while conducting ontology visualization and development, and thus, should be given consideration (Saad et al., 2011; Shoaib et al., 2009). Hence, the Protégé-OWL editor should be considered in the development and construction of an ontology-based system and in the context of this research due to its flexibility.

Furthermore, there are some reasons why would anyone want to develop an ontology (Syuhada & Ta'a, 2013), which are: i) sharing a common understanding of the structure of information among people or software agents; ii) enable reuse of domain knowledge; iii) make domain assumptions explicit; iv) separate domain knowledge from the operational knowledge; and v) analyze domain the knowledge. Moreover, the application of ontology in an Islamic field is not new in the epistemology of information technology, due to its ability to describe Al-Quran verses in a common and meaningful ways (Yauri et al., 2012). Previous researchers have used ontology approach for prayer classification (Solat), categorization of Islamic concept and searching approach in Al-Quran (Ahmad et al., 2013; Saad et al., 2011; Shoaib et al., 2009).

2.3 Query in Ontology-based Retrieval

In a query, a user can choose a concept from an existing ontology application for the query. Thus, the concept of a query allows a user to define a concept based on a given shared vocabulary that fits his or her conceptual understanding (Visser, Stuckenschmidt, & Schlieder, 2002).

Furthermore, the present application of ontology concepts ensures the use of a defined and meaningful concept of ontology, which is referred to as the query concepts (Khan et al., 2013; Mika, 2005), giving clues to the supplied query while calling for retrieving and searching for a word from a pool of texts.

The actual search is performed by automatically mapping the query concept and concepts of different ontology applications within the same domain (Beck & Pinto, 2002). The present research adopts this method by focusing on theme-based concepts for the search mechanism.

2.4 Information Retrieval

2.4.1 Knowledge Retrieval

The goal of knowledge retrieval from a large volume of information is to provide user support for interpreting and obtaining adequate information, which could be achieved through an ontology-based approach. The approach has the ability to resolve the challenges of free-text search facilities in catalogs and to support an intuitive interpretation of specific words. The approach needs to navigate differences

in meaning (Harvey, Kuhn, Pundt, Bishr, & Riedemann, 1999). Moreover, Sminia and Stuckenschmidt (2002) suggested the use of explicit context models to re-interpret information for new applications. Thus, ontology gained popularity in information science because of its capacity to explicate contextual information (Gruber, 1995; Studer, Benjamins, & Fensel, 1998; Uschold, 1998).

Furthermore, searching for knowledge of an exact word in the volume of texts is not limited to knowledge retrieval, but includes keywords search (Mika, 2005). Previous studies have argued that keyword search is a form of retrieving knowledge in a situation while there is need to call-out a particular text and its relevance is superimposed on others (Saad et al., 2011; Shoaib et al., 2009). Thus, the keyword search approach of retrieving word is attributed to its iterative nature and easier when integrated with the ontological approach system (Mika, 2005; Saad et al., 2011).

Another method of retrieving and searching from a pool of texts is framework search, which is algorithmic in nature because of the consideration it gives to other elements in the system (Du et al., 2007; Fang et al., 2005). Framework search has been used in the natural sciences when retrieving exact text during the development of programming languages (Bryman & Bell, 2011; Saad et al., 2011).

Hence, framework search, as an approach of retrieving from the pool of texts enjoys more construction then developing an ontology system, due to its usefulness in the development of high level programming languages.

2.4.2 Knowledge Representation

Understanding the knowledge contained in Al-Quran is a major research challenge for computer science and artificial intelligence (Atwell et al., 2010). Knowledge representation is a systematic approach to acquire understanding, which can be based on a number of classification methods (Kuhn, 2009). Some of the methods adopted by researchers such as taxonomies, hierarchies, tree structures, paradigms, and constrained facet analysis, can discover and construct new knowledge (Kuhn, 2009; Villa, Athanasiadis, & Rizzoli, 2009). Ontology is used in the current study to represent knowledge in the broad context of Al-Quran.

Creating information systems that enable Al-Quran knowledge to be accessed online, have already been implemented by researchers and system developers. Among them are Atwell, Brierley, Dukes, Sawalha, and Sharaf (2011) who have built Al-Quran ontology-based information system in common Arab language and Arabic corpus; however, the study lacks sequential representation of knowledge. The ontology structure focuses on the relationship of concepts in Al-Quran according to Arabic. Moreover, the study of Saad et al. (2009) have developed ontology that uses Al-Quran and Hadith as the source for determining the related concept of knowledge in Islam. The system puts retrieving of exact verse into consideration, and thus requires further research.

Given that few studies were conducted on the ontology of Al-Quran, the study domain still needs further work in order to have a better contribution in the field of study. Most Al-Quran ontology are developed based on the English and Arabic languages, and do not have a complete application that allows searching and learning

with a semantic-based method. The application of Al-Quran, which is still being developed based on traditional methods, such as using entity-relationship modeling, which requires simplicity in retrieving knowledge.

Al-Quran is the most widely read book in the world. Al Quran has stimulated interest in automating the extraction of knowledge from religious literature. This in turn has led to the development of a number of search applications, which aim to provide retrieval of knowledge using keywords (Qurany, 2009). A plethora of websites containing Quranic and Hadiths, search tools and reference materials have been designed. However, none of these websites adhere to any standardization, which is important in machine processing of information. Zekr (2009) and Noor (2009) presented some tools and programs that use keyword-based extraction architecture to model and retrieve data.

2.5 Ontology-based Information System

Knowledge exchange is a popular issue among various research groups (Nguyen & Rusin, 2006). Ontology has been regarded as a good structure to store and sharing knowledge. Ontology has been built as a tool to explore, infer, and describe web sources (Decker, Erdmann, Fensel, & Studer, 1999). Moreover, ontology has been applied in other fields, such as electronic commerce and in creating health sector terminology services (Decker et al., 1999; Klein, 2001). To date, ontology has become an essential tool for computer science applications. Ontology has been expanded to satisfy the new generation vision of the Semantic Web, which goes beyond the current worldwide web concept of content sharing. The aim of ontology

is to build data in semantic web in a way that is easily understood by machines (Qawaqneh & Kayed, 2007).

Information systems can process unstructured or semi-structured natural language texts through an ontology-guided mechanism to extract certain types of information and present the output (Wimalasuriya & Dou, 2010). Ontology creation can be done manually, automatically, or semi-automatically, depending on the researcher's choice and research conditions. The vision for ontology learning incorporates a number of complementary disciplines, including machine learning, natural language processing, and data mining. The application of ontology has been extended into business information systems, which support knowledge storage concerning the most important issues in an organization (Bilal & Khan, 2008).

A business model can be adequately stored in ontology by using a knowledge management framework to accomplish search activities (Yang, 2005). In other words, organizations and companies could easily exchange, reuse, search, store, vital information or relevant words in a volume of data using an ontological approach (Fensel et al., 2001). The fact that Al-Quran has been widely read and has attracted researchers to study knowledge extraction and retrieval from religious literature, which has led to the creation of knowledge retrieval on the basis of keywords (Baqai, Basharat, Khalid, Hassan, & Zafar, 2009). Many websites with Quranic and Hadith texts, search tools, reference materials, and the like have all been designed around natural language for human readers. Many tools and programs that use keyword-based extraction architectures to model and retrieve data have been introduced the searching in Al-Quran.

Geyer (2005) has created ontology for the bible. He created several classes and properties for each chapter in the bible. Each class has characteristics that define the class and examples related to other classes. Certain classes have subclasses. For example, the class "book" has a relationship with the class "chapter", by using abbreviation properties.

2.6 Searching in Al-Quran Ontology

A large number of digital Quranic databases provide root verse searches (Shoaib et al., 2009). The database processes a morphological analysis, with a query verse as the input and the root verse as output. The need to search for related words in Al-Quran has resulted in the creation of keyword-based searchable interfaces, indexed by chapter number. The interfaces assist users to browse Al-Quran and conduct searches using translation and Tafsir. A multi-lingual Al-Quran software provide Arabic and English Quranic commentaries. Translations into French, German, Spanish, Urdu, Malay, Indonesian, Japanese, Tamil, Hausa, Turkish, and Indonesian, are also available on many websites equipped with a word-based search facility.

The software by "Harf" provides a subjective search facility, but only in the Arabic language. This software also provides an exact match search for words, terms, parts of verses, and even some consecutive verses. Technically, this software provides the ability to search static files in a way that the verses are pre-linked to a topic or sub-topic. Thus, semantic search in Al-Quran is sometimes based on Internet searches that reveal some works on Al-Quran (Qawaqneh & Kayed, 2007).

2.7 Search Model in Al-Quran

The search model has been successfully applied to validate that the verse number in each chapter is correctly written in Al-Quran XML format document. The checker also validated that Al-Quran XML document contained exactly the same number of chapters as the holy book by comparing the verse numbers in each chapter and the chapter numbers. Several researchers have described the use of ontology in keyword and key phrase extraction related to the searches in Islamic literature (Nguyen & Rusin, 2006; Yang, 2005). Baqai et al. (2009) argued that a distinct need exists to create automated contextual and thematic associations among heterogeneous and distributed sources in Al-Quran and the Book of Hadith. Digital multimedia religious contents available to date are only suitable for online publishing. However, retrieving suitable data, consulting verses on demand, and integrating all aspects perfectly is difficult for humans. Across the various Quranic resources, authors and scholars use contrasting terminologies to define and describe a concept.

2.8 Islamic Ontology-based Development

Saad et al. (2009) in Build Islamic Ontology based on Ontology Learning, defined Al-Quran as the solution to all problems and the basis of a stable, homogenous, and peaceful social order. They also stated that the Hadith and Tafsir are ways to acquire religious clarification and perspective. Ontology has been used to conceptualize Al-Quran by classifying and clustering it by phrases, terms, or verses. Ontology can show the relationship between classes. Developing ontology is similar to defining a set of data and its structure in other programmers. Problem-solving methods,

domain-independent applications, and software agents, use ontology and knowledge bases built from ontology as data (Syuhada & Ta'a, 2013).

2.9 Summary

This chapter discussed an overview of the concept of ontology research and its role in data system and relevant Al-Quran words or phrases and information retrieval. All discussions are gathered from relevant literature of knowledge and ontology works by several researchers. The research in Al-Quran with technology becomes more important due to the enhancements in information technology.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter explains the methods that would be used to achieve the research objectives. It discusses the phases required in designing a system that is capable of searching for related verses in Al-Quran. The steps used to validate and evaluate the search method are also discussed in this chapter.

3.2 Research Design Methodology

In any research, the methodology is used to articulate the activities that are executed in completing the research (Hoffer, 2004). Theorists claim that the research methodology is not only about selecting the methods to carry out the research, but also a systematic ways of solving the existing problems. There are various methods that can be applied when carrying out research. Many common approaches adopted by researchers for studying aspects of information technology, depend on the goal of the study (Nyame-Asiamah & Patel, 2009). According to Ardakan and Mohajeri (2009), frameworks are more generally used to establish a research base, and contribute to the augmentation of the knowledge base through scientific investigation. In the current research, Figure 3.1 shows the common research design used by many researchers in information technology (Kuechler & Vaishnavi, 2008),

which has been adopted in for the design and development of this search method in relation to knowledge contained in Al-Quran.

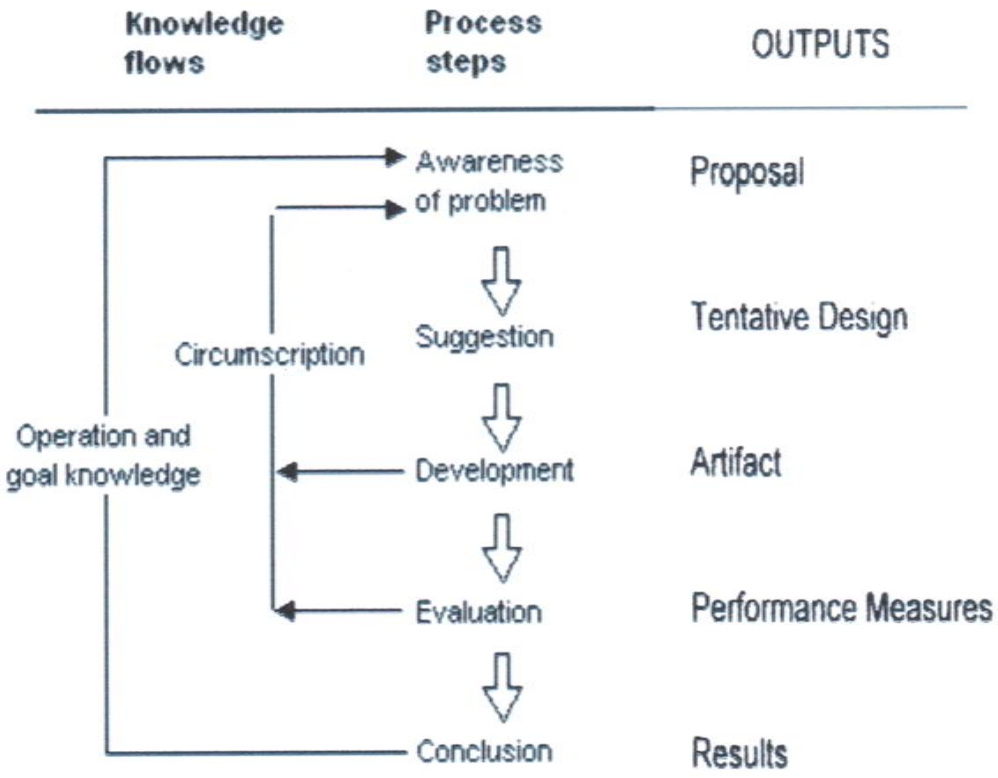

Figure 3.1. The General Methodology of Design Research (Kuechler & Vaishnavi, 2008).

3.2.1 Awareness of the Problem

Awareness of the problem highlights on the general understanding of the research idea. Thus, it eases the exploration of possible ways to find the lasting solution to the existing problem of searching for knowledge in Al-Quran by using semantic search knowledge that is ontology-based by using the English Language. Therefore, this study focuses on retrieving of exact verses in Al-Quran through classification of

relevant verses by using ontology and thematic approach. Therefore, retrieving the verses and the related knowledge in Al-Quran by using a thematic approach would be easier for the readers.

3.2.2 Suggestion

In order to address the identified problem (section 3.2.1), this research seeks to develop the ontology of Al-Quran and the development approach that is searching for knowledge in Al-Quran on the ontology-based by using theme concept. Initially, Al-Quran is a root of all the classes (themes) and it's described by subclasses of (Divisions), (Chapters) and Verses. Al-Quran knowledge is a collection of division, chapter and verses, whereby the Verse is a subclass for chapter, and chapter is a subclass for division. All these classes are related to each other, and form the Al-Quran knowledge, which can be represented by the ontology structure (Syuhada & Ta'a, 2013) as illustrated in Figure 3.2.

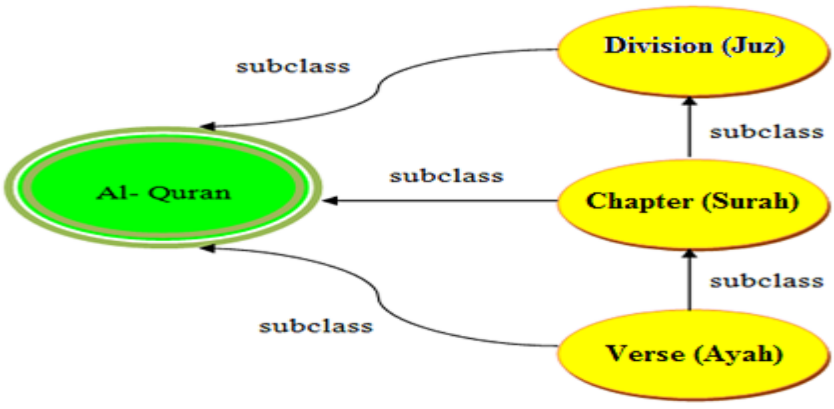

Figure 3.2. The Al-Quran Content Hierarchy (Syuhada & Ta'a, 2013)

Al-Quran verses can be more than one sentence or part of sentences. A group of verses form a chapter with a given unique name for explaining about the content of the chapter. Indeed, the scripts of Al-Quran can be viewed with its chapters and verses in a defined manner, such as 2 : 255, where 2 depicts (chapter) and 255 (verse of Al-Kursi). The concept of Al-Quran knowledge is defined by the structural hierarchy, which can be further classified into relevant themes. The thematic approach can assist teaching and learning in such a way, that many areas are integrated and connected within a theme. This enables the knowledge to be less fragmented and is a more natural way to learn (Hislop, 2013).

3.2.3 Development

Based on the design presented in section 3.2.2, the development includes the following:

(i) Development of Al-Quran Ontology

All of the classes and subclasses, properties have to be linked in this phase. The result appears on the user screen after all of the relationships between terms are correctly by using the editor Protégé-OWL.

(ii) Develop Searching Method

The prototype application is developed by using Java programming language and Jena framework for ontology manipulation. The Java programming language would provide developers with an opportunity to create and deploy applications and services to the end users. It uses the output of the previous step (Development of Al-

Quran Ontology) and the file type is (RDF/OWL). This RDF / OWL file translates and saves in the database and is used in program for retrieving verses from the Al-Quran.

These services facilitate communication between the users and the system through the use of query language. Hence, the environment is attracted to developers because it is a language-neutral environment that can deliver content to the end users (Sridaran, Padmavathi, & Iyakutti, 2009). Indeed, the system for retrieving relevant verses in Al-Quran would allow different users for searching the useful verses while listening sermon in the prayer room or personal studies.

3.2.4 Research Design

Studies have shown that research design guides and provides a framework for the collection and analysis of data and reflects decisions about the priority given to a range of dimensions of the research process (Bryman & Bell, 2011; Churchill, Brown, & Suter, 2010). In other words, the research design is considered as the techniques for collecting data which involves specific methods, such as self-completed questionnaires, structured interviews and experimental way of gathering data.

3.2.4.1 Sampling Approach

Sampling in research method is the process of selecting a few (a sample) from a bigger group (sampling population) to become the basis for estimating or predicting the prevalence of an unknown piece of information, situation or outcome regarding

the bigger group (Ranjit, 2011). In other words, Sherri (2011), Lynn and Ronald (2010) emphasized that sampling in research is the selection of units to be studied. Moreover, Churchill et al. (2010) categorized sampling method into probability and non-probability. Thus, this study using a non-probability sampling approach in selecting the sample for gathering the perception expert validation of the ontology based system for searching verses in Al-Quran.

3.2.4.2 Sample Size

The experts on the field of Islamic studies who have been working in the university for twenty years were selected to validate the Al-Quran ontology due to their vast knowledge in Al-Quran.

3.2.4.3 Research Instrument

Previous studies have stressed the needs for designing of research instrument in order to understand some underlying assumptions which help in formulating good questions that need to be answered by the participants (Colton & Covert, 2007). Redesigning of research instrument for data collection is necessary in some cases that the previous and existing tools are to be used in a scope that different from previous research (Leiyu, 2008). Indeed, Leiyu (2008) argued that the object of study, research concept and dimensions require proper understanding before designing of the research instrument. The instrument used in this research is the of open ended question as shown in Table 3.1.

Table 3.1

Illustration of the Opinions of Experts on the Ontology Based System for Searching and Retrieving Verses in Al-Quran.

No.	Questions	Experts' Opinions	
		Yes	No
1.	Is it difficult to identify Al-Quran content manually?		
2.	Does the main themes and sub-themes in the system based Ontology are correct?		
3.	do you the relationships between themes in the system based on ontology correct?		
4.	Does obtaining the knowledge in the system based on Ontology from Al-Quran is effective?		
5.	Do the verses that appear in the system based on Ontology reflect the conceptual description (knowledge) in Al-Quran?		
6.	Does the contents of the themes (knowledge or verses) easy to determine by using the ontology-based system?		
7.	Are you interested in having a system that helps in searching for knowledge in Al-Quran?		

3.2.5 Evaluation

System evaluation is an important step in information system development to assess and improve the quality of the prototype. Moreover, the evaluation of the system is the feedback stage, which guarantees the success of the system for searching related verses in Al-Quran across the various Quranic resources as authors and scholars use contrasting terminologies to define and describe a concept. Identifying the weaknesses and the strength of the prototype system for searching and classification

of some related verses in Al-Quran, is done using the approach evaluation of the accuracy of the searching results by using two measurement which are “Recall and Precision” (Aleksovski, 2008).

The evaluation results done through the two experts in the field of Islamic studies. The experts verify the validation of the ontology based system for searching and retrieving verses from Al-Quran, while the survey questions were presented to the experts for gathering their perception on the accuracy of the search mechanism of the developed ontology system. On the other hand, the evaluation of accuracy of the searching mechanism to retrieve knowledge in Al-Quran based on sample queries as examples to assess the accuracy of the search method by using the measurement tools : Recall and Precision.

Recall and Precision are the basic measures used in evaluation search strategies. These measures assume:

i. There is a set of verses in the ontology relevant to the search topic, which is either relevant or irrelevant.

ii. The retrieval set may not perfectly match the set of relevant verses.

Recall is defined as the ratio of the number of relevant records retrieved to the total number of relevant records in the database. It is usually expressed as a percentage.
Precision is the ratio of the number of relevant records retrieved to the total number of irrelevant and relevant records retrieved. It is usually expressed as a percentage.

This method is explained in the Figure 3.3.

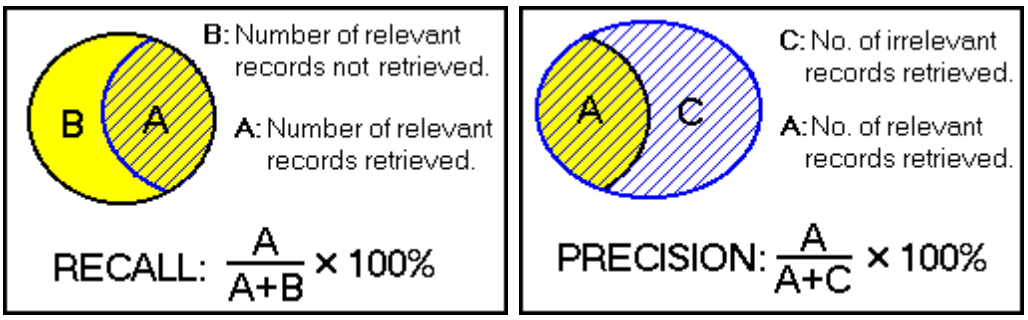

Figure 3.3. Measuring Search Effectiveness (Recall and Precision) (Aleksovski, 2008).

3.3 Summary

This chapter explained the methodology used to conduct this research. The methodology focuses on the development of ontology, method of searching verses in Al-Quran, and evaluating the proposed solution. The results obtained from the evaluation include the findings of research used to developing the searching method of knowledge in Al-Quran. Hence, the practical searching of Al-Quran knowledge based on ontology was achieved by developing the prototype as presented in the next chapter.

CHAPTER FOUR

AL-QURAN ONTOLOGY KNOWLEDGE RETRIEVAL

4.1 Introduction

In this chapter, the phases of the methodology are implemented as discussed in the previous chapter. Section 4.2 discusses Al-Quran ontology model based on the concept of themes. Section 4.3 discusses Al-Quran ontology development. Section 4.4 discusses Al-Quran knowledge retrieval method. Finally, Section 4.5 presents the implementation details of the system, which includes an explanation about Java programming language, Jena framework and MySQL database.

4.2 Al-Quran Ontology Model

The ontology presents the contents of Al-Quran in a systematic and structured manner. The display is by mapping the meaning of themes and verses, which provides the correct semantics of Al-Quran knowledge. The development of an ontology includes determining the classes in the knowledge domain, and arranging the classes in a taxonomic (subclass–super class) hierarchy (Syuhada & Ta'a, 2013). In addition, defining the properties and describing the allowed values for these properties, and assigning the values for properties of examples are done. This ontology model is as shown in Figure 4.1.

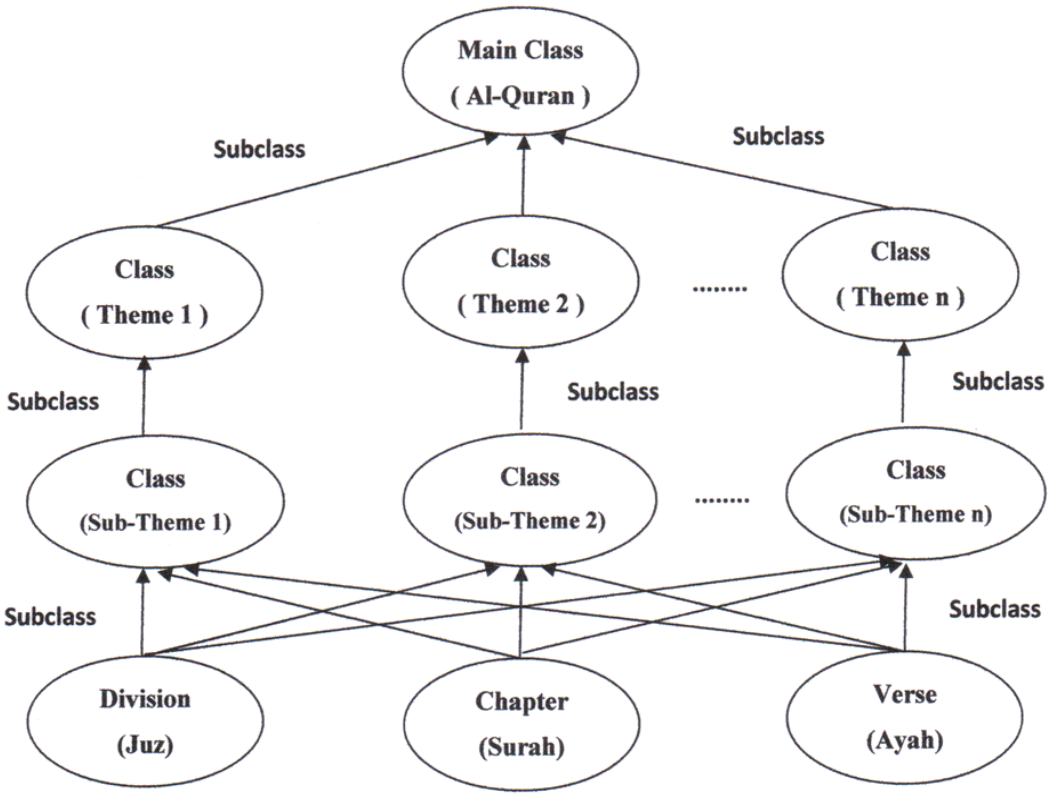

Figure 4.1. Al-Quran Ontology Model (Syuhada & Ta'a, 2013).

Based on the model depicted in Figure 4.1, the Al-Quran ontology structure includes: the classes (the themes and sub-themes), and the properties (the relationship between the themes). Properties are connected the themes and sub-themes with each other to form a logical and correct relationships between the themes and individuals (verses). The thematic approach includes three themes in this study, which also contain sub-themes. The classification themes of Al-Quran is based on book *Classification of Al-Qur'an's contents (original format)* by Khalid (2011), as presented in Appendix 4.1.

4.3 Al-Quran Ontology Development

4.3.1 Define Ontology Specification / Definition

Al-Quran knowledge based on selected themes (Allah, Angels and Unseen) is analyzed further to identify the appropriate classes, properties and individuals. This is important to establish the ontology that contains the knowledge of Al-Quran, which explain about Allah, Angels and Unseen. The details explanation about the concept, and the relationship between these concepts and sub-concepts are elaborated further. This research only focuses on themes of Allah, Angels and Unseen. Protégé-OWL was used as the tool to develop the ontology as shown in Figure 4.2.

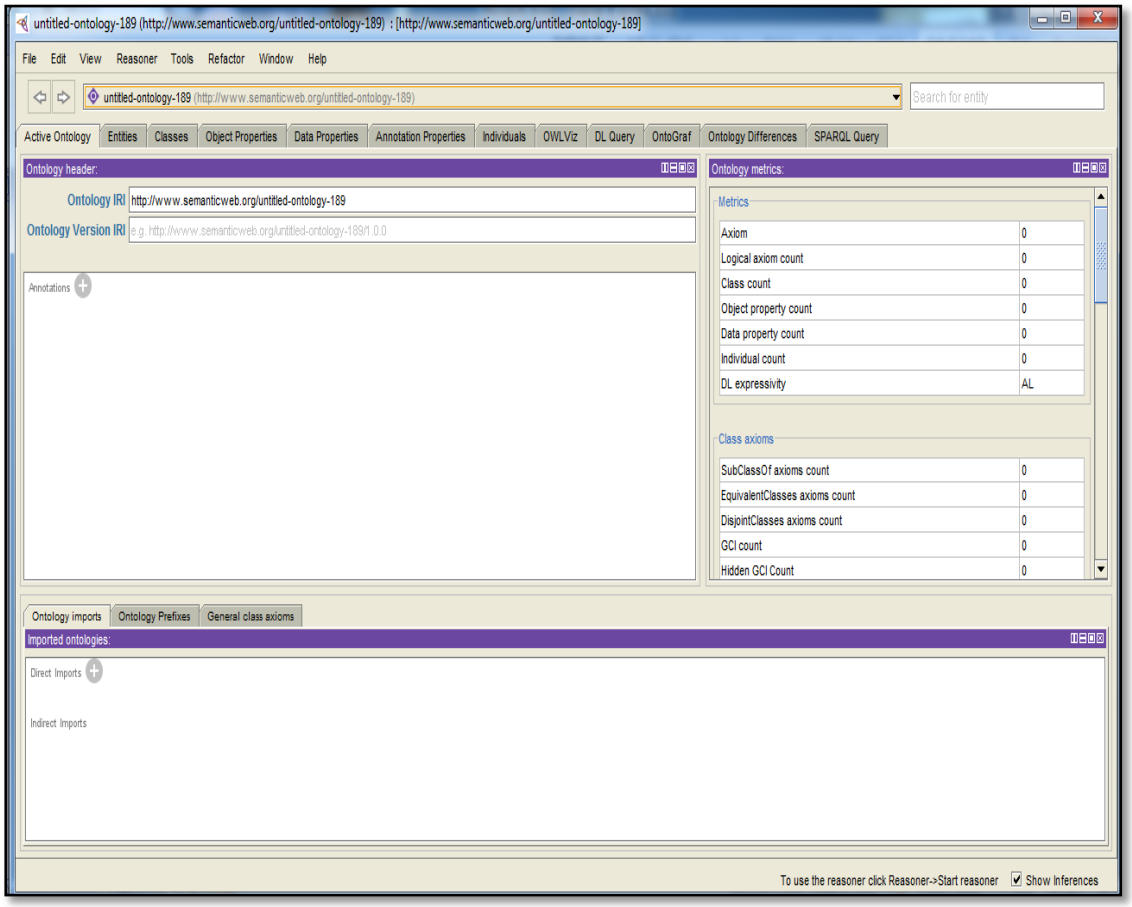

Figure 4.2. The Main Interface of the Protégé-OWL.

(i) Define Classes

The first step in designing was to build the main class hierarchy. There are three main classes (i.e., Allah, Angels and Unseen). Figure 4.3 shows the main class hierarchy.

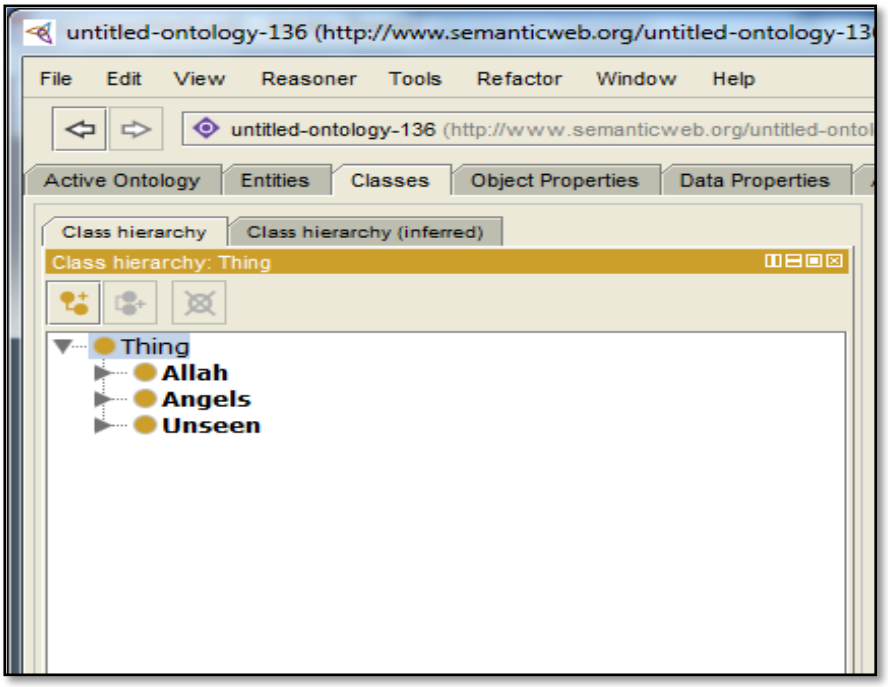

Figure 4.3. The Main Classes Hierarchy.

After the main themes were defined, the next step is the insertion of sub-themes according to the main themes. Figure 4.4 shows the sub-themes for the main themes in the class hierarchy.

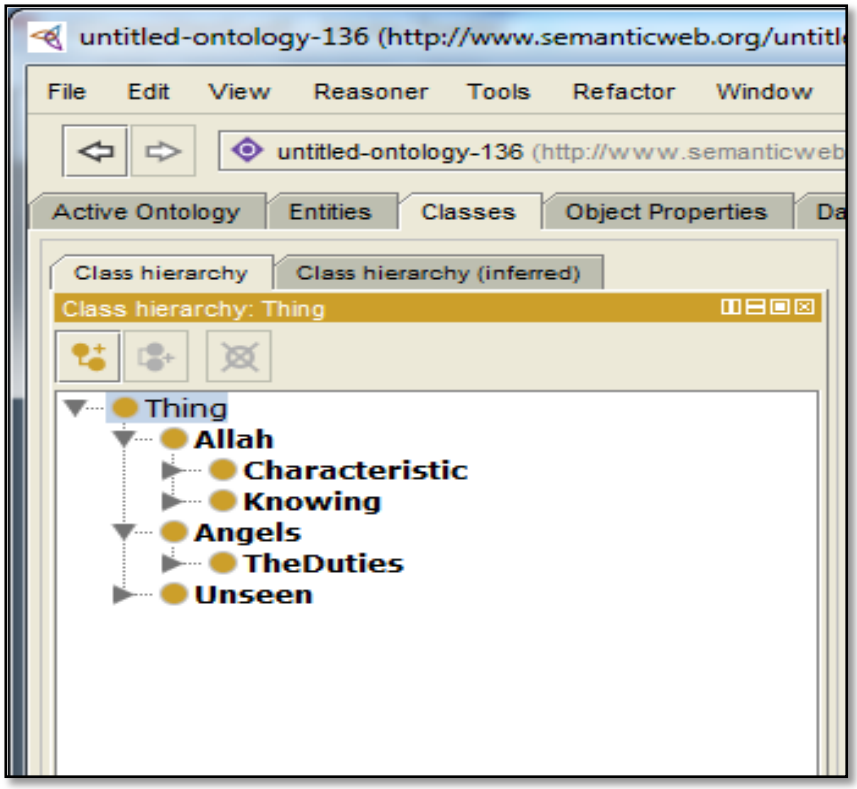

Figure 4.4. Class Hierarchy for Al-Quran Ontology (Sub-themes).

From the sub-themes, the (Sub-sub themes) are derived. Figure 4.5 describes the (Sub sub-themes) of the class hierarchy in this research.

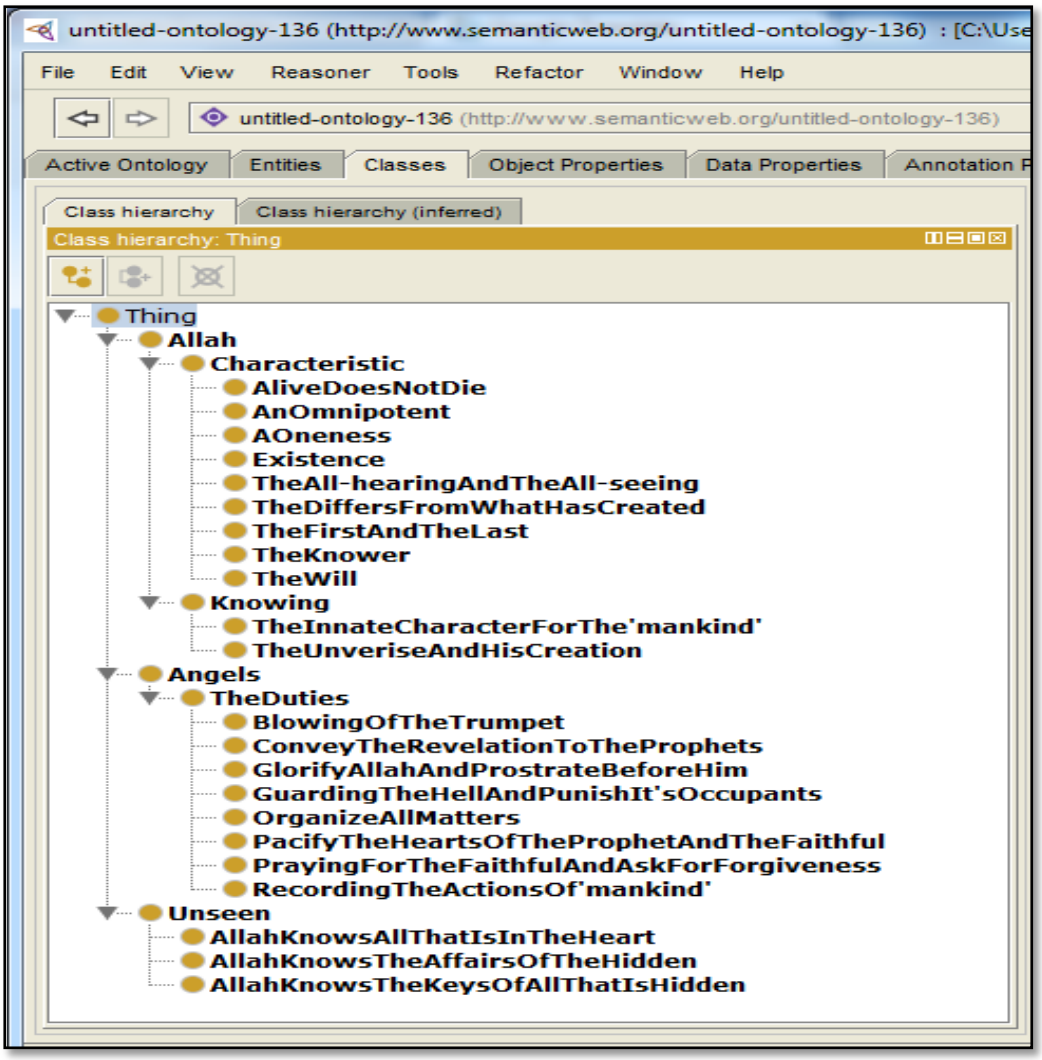

Figure 4.5. Class Hierarchy for Al-Quran Ontology (Sub-sub themes).

All the main themes, sub-themes and sub-sub themes were endorsed by Al-Quran experts from the Islamic Center in University Utara Malaysia (UUM).

(ii) Define Properties

Object properties that have been set in this research were the terms which have been discussed and endorsed by the experts as relevant to the main themes, sub-theme and classes derived from Al-Quran. The terms also have been classified and finalize by

them in order to achieve the relationships main themes and all the sub-themes derived from each theme. Appendix 4.2 illustrates the relationships between concepts.

Data properties that have been set in the research were originally taken from Al-Quran and derived from the book the *Classification of Al-Qur'an's contents (original format)* by Khalid (2011), and have been discussed and endorsed by Al-Quran experts of the Islamic Center in University Utara Malaysia (UUM) as relevant with the main themes, sub-themes and sub sub-themes derived from Al-Quran. The divisions, chapter and verse also have been classified and finalized by them in order to achieve the relationships between the main themes and all the sub-themes derived from each theme. Appendix 4.3 illustrates the Content of themes and sub-themes from Al-Quran, and which consists of chapter and verse. After these stages, the properties (object properties and data properties) are derived from the classes. Figure 4.6 and Figure 4.7 shows the both properties in relations with the classes.

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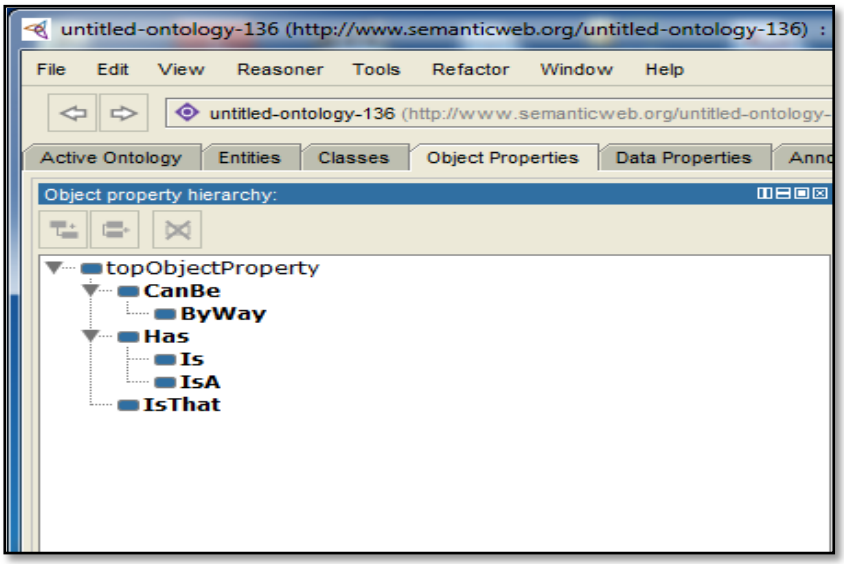


Figure 4.6. Object Property Hierarchy.

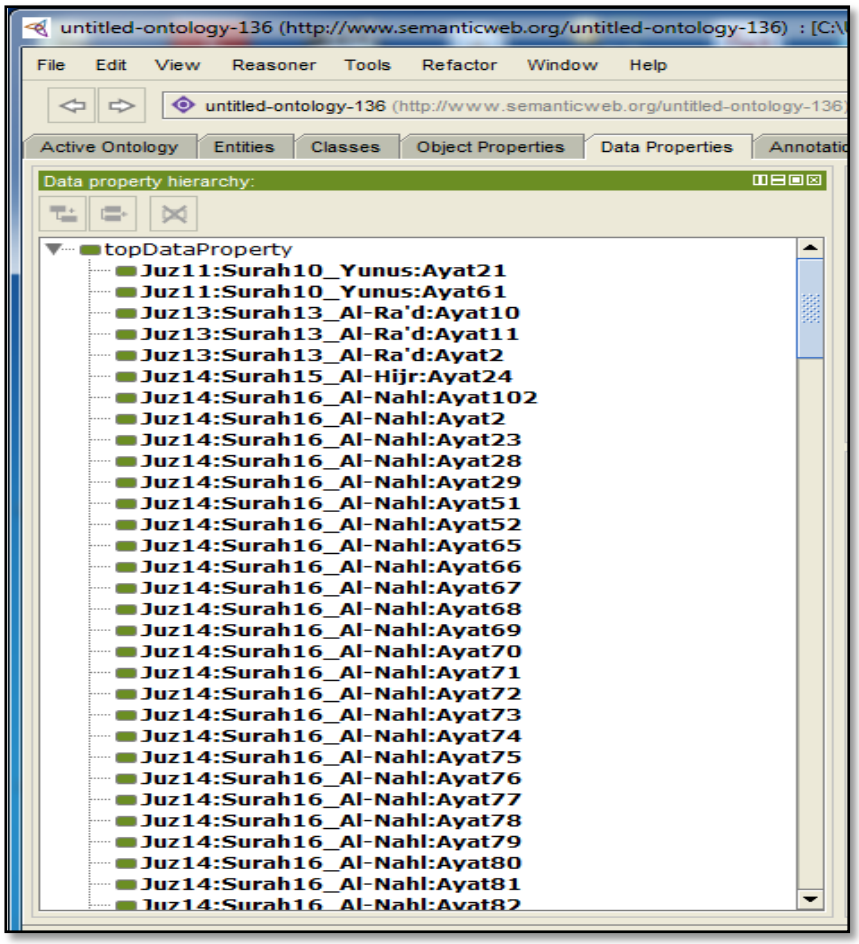


Figure 4.7. Data Property Hierarchy.

(iii) Define Individuals

Individuals that have been set in the research were determined from the book the *Classification of Al-Qur'an's contents (original format)* by Khalid (2011) and have been discussed and endorsed by Al-Quran experts from the Islamic Center at University Utara Malaysia (UUM) as relevant with the main themes and classes derived from Al-Quran. The terms also have been classified in order to achieve the relationships between the main themes and all the sub-themes derived from each theme. Figure 4.8 shows individuals derived between classes and properties.

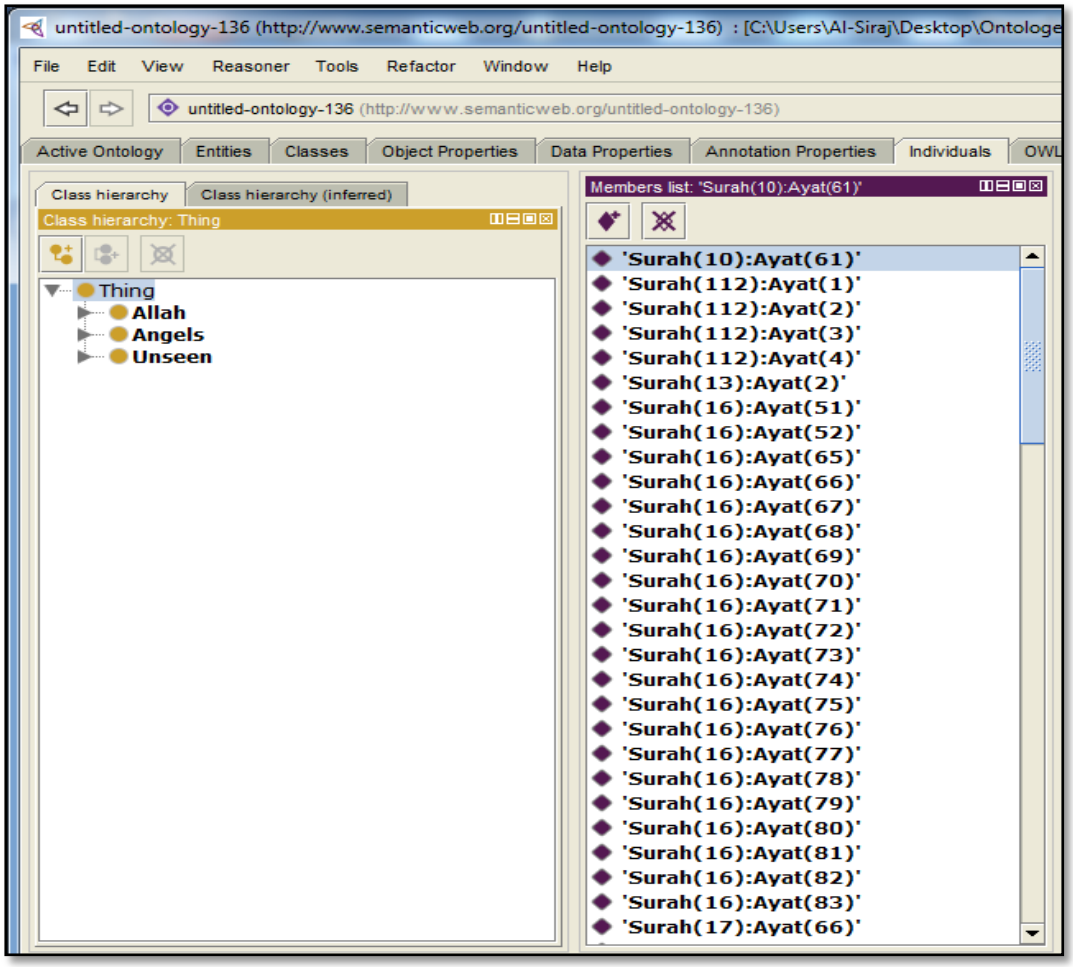


Figure 4.8. Individuals Derived from Classes and Properties Hierarchy.

The value of an annotation is always text string, but most values are more constrained than this, as:

- A literal data in a particular format (e.g. date, float, integer).
- A prior version of the ontology.
- A URL refers to a related resource.

After these stages, annotations were set according to the classes and properties as shown in Figure 4.9.

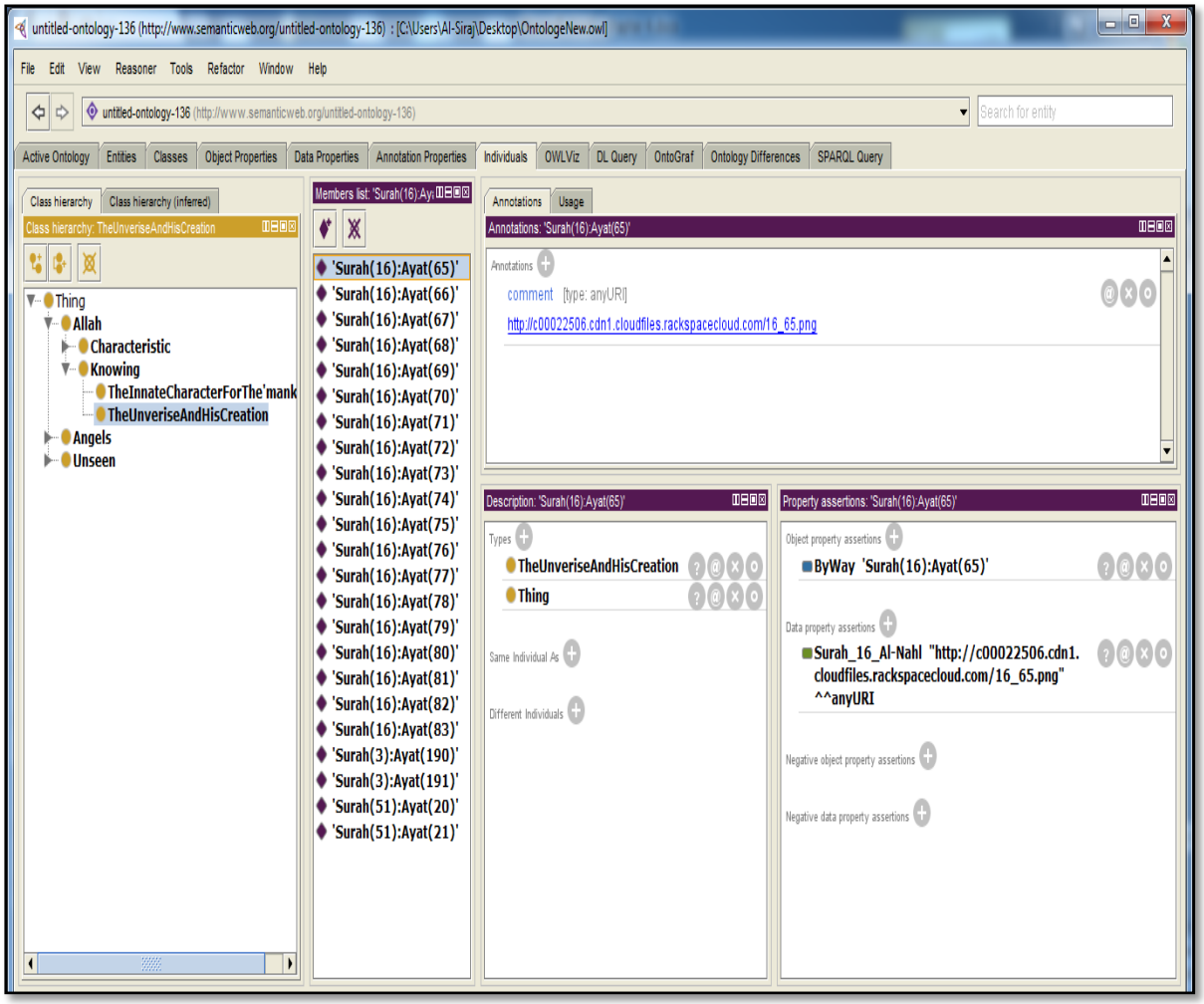


Figure 4.9. Annotations Derived from Classes and Properties Hierarchy.

4.3.2 Representation the Application Ontology

All the classes, properties (object and data properties) and individuals have to be linked in this phase. The results are the image or URL that appears on the user screen after all the relationships between those terms are correctly ontologism by Protégé-OWL as illustrated in Figure 4.10.

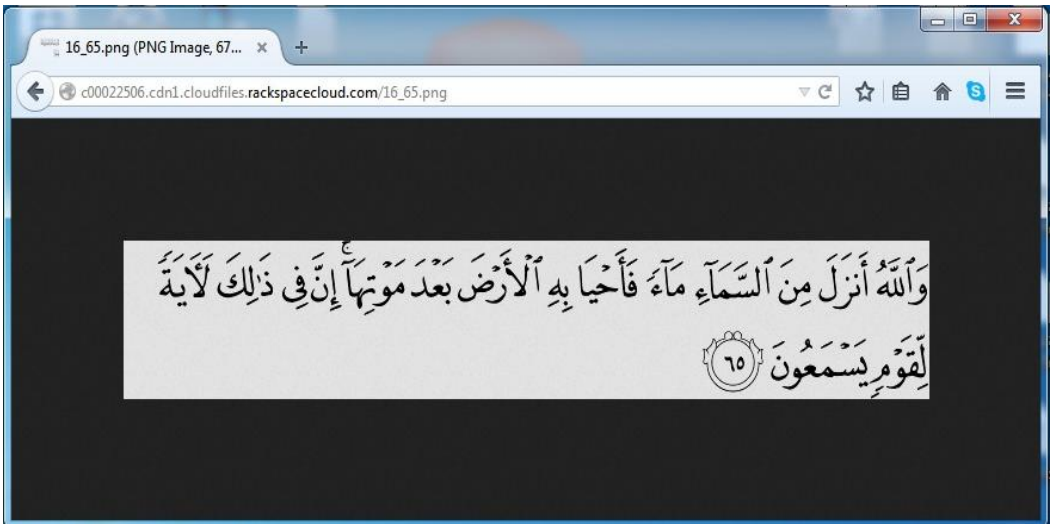


Figure 4.10. Results from Annotations Comment after the Classes and Properties have been Defined.

4.4 AL-Quran Knowledge Retrieval Model /Method

The entry point of this step starts after the RDF/OWL file output from the previous step of the development of ontology using (Protégé-OWL) translated as RDF/OWL file to database, where RDF/OWL file was be saved into database. Figure 4.11 shows the data flow of RDF/OWL processing. Table 4.1, Table 4.2 and Table 4.3 shows examples of content of each table into database.

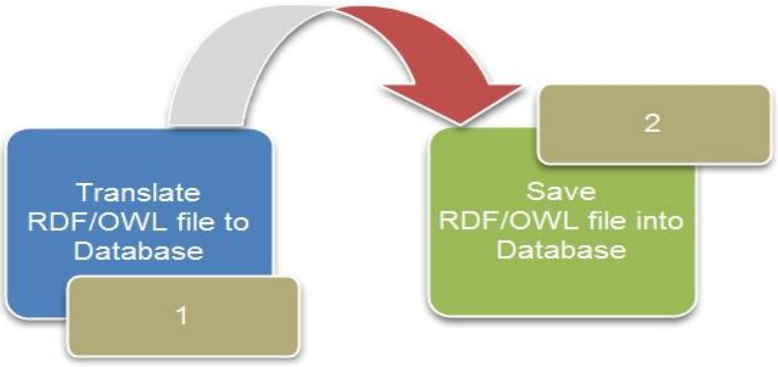


Figure 4.11. The Data Flow of RDF/OWL Processing.

Table 4.1

Al-Quran Ontology in the Database.

Theme	**Position in Al-Quran**
AOneness	Surah (21): Ayat (21)
AllahKnowsAllThatIsInTheHeart	Surah (16): Ayat (23)
OrganizeAllMatters	Surah (77): Ayat (4)
OrganizeAllMatters	Surah (77): Ayat (1)
AllahKnowsTheKeysOfAllThatIsHidden	Surah (6): Ayat (59)

Table 4.1 shows the Al-Quran ontology locate in the database to each theme in Al-Quran, for example "A Oneness" theme located in Surah (21), Ayah (21), and others.

Table 4.2

Number of Chapter used in this Research.

Chapter Name	**Number of Chapter in Al-Quran**
Al Fatihah	1
Al Anbiya	21
Al 'Imran	3
An Nisa"	4
Al Kahf	18

Table 4.2 shows the chapter name with its number in Al-Quran. For example, in above paragraph mentioned that the location of "A Oneness" theme is in chapter (21), based on Table 4.2 chapter (21) is show to chapter Al Anbiya.

Table 4.3

The Content of the Database.

Text	**Short Text**	**Keyword**
The innate character for mankind	TheInnateCharacterFor Mankind	Innate character
Existence	Existence	Existence
Glorify Allah and prostrate before him	GlorifyAllahAndProstrate BeforeHim	Prostration

Table 4.3 shows the original text with its short text and keyword, the short text retrieved from RDF/OWL file, while the text and keyword are inputs of users.

The database contains the extracted verses form RDF/OWL file which include the location of the verses in Al-Quran. Users may utilize this database to search for certain keywords. The searching process is based on actual question which is converted to SQL query on the database. Web based interface is designed and developed using Java Server Pages (JSP) server side language to facilitate user queries or inputs. For example, the user can select the main theme, sub-theme and sub sub-theme and then enter the target keyword. The implemented searching approach is based on exact matching. The result of search will be listed if there is a match between the input keyword and database keyword. Figure 4.12 shows the database design for the new method. Figure 4.13 shows the DDL for admin table. Figure 4.14 shows DDL for lookup table. Figure 4.15 shows the DDL for RDF/OWL data table. Figure 4.16 shows DDL for locating the chapter in Surah name table.

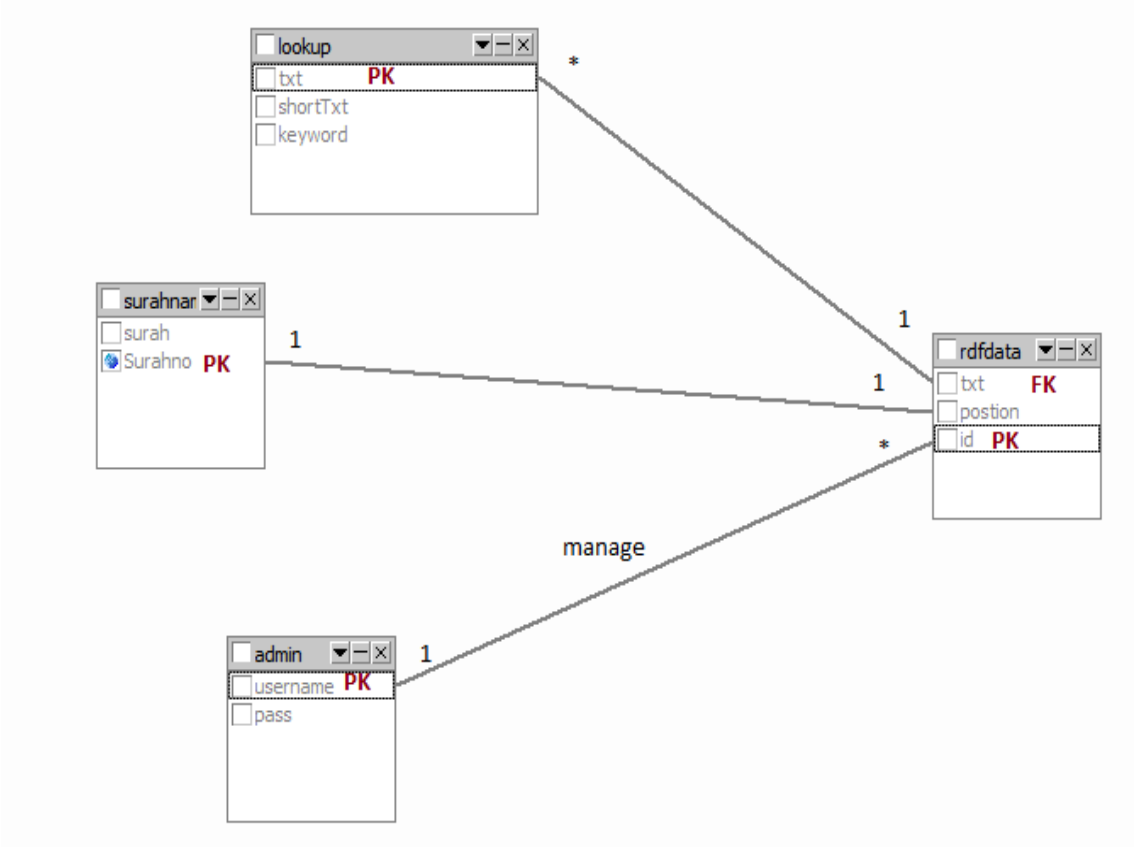


Figure 4.12. The Database Design for the New Method.

```
CREATE TABLE `admin` (
  `user` varchar(100) NOT NULL DEFAULT '',
  `pass` varchar(100) DEFAULT NULL,
  PRIMARY KEY (`user`)
) ENGINE=InnoDB DEFAULT CHARSET=latin1;
```

Figure 4.13 . DDL for Admin Table.

```
CREATE TABLE `lookup` (
  `txt` varchar(200) DEFAULT NULL,
  `shortTxt` varchar(200) DEFAULT NULL,
  `keyword` varchar(200) DEFAULT NULL,
  `id` int(11) NOT NULL AUTO_INCREMENT,
  PRIMARY KEY (`id`)
) ENGINE=InnoDB AUTO_INCREMENT=23 DEFAULT CHARSET=latin1;
```

Figure 4.14. DDL for Lookup Table.

```
CREATE TABLE `rdfdata` (
  `txt` varchar(200) DEFAULT NULL,
  `positron` varchar(100) DEFAULT NULL,
  `id` int(11) NOT NULL AUTO_INCREMENT,
  PRIMARY KEY (`id`)
) ENGINE=InnoDB AUTO_INCREMENT=206 DEFAULT CHARSET=latin1;
CREATE TABLE `rdffiledata` (
  `file` varchar(200) DEFAULT NULL,
  `path` varchar(200) DEFAULT NULL,
  `id` int(11) NOT NULL AUTO_INCREMENT,
  PRIMARY KEY (`id`)
) ENGINE=InnoDB AUTO_INCREMENT=31 DEFAULT CHARSET=latin1;
```

Figure 4.15 . DDL for RDF/OWL Data Table.

```
CREATE TABLE `surahname` (
  `surahTitle` varchar(200) DEFAULT NULL,
  `surahNo` int(10) NOT NULL DEFAULT '0',
  PRIMARY KEY (`surahNo`)
) ENGINE=InnoDB DEFAULT CHARSET=latin1;
```

Figure 4.16 . DDL for Surah name Table.

Be checking the keyword input with the keywords in the database, if there is a matching, then the verses related to the entered keyword will be listed. Figure 4.17 shows the exact matching flow chart.

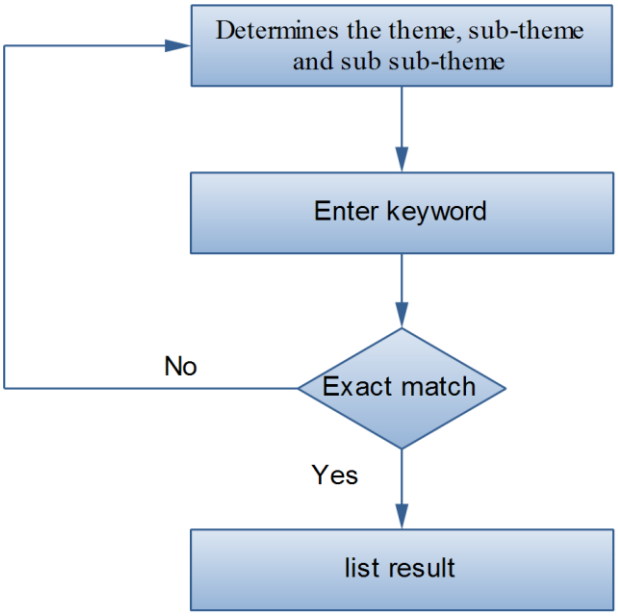


Figure 4.17. Exact Matching Flow Chart.

The algorithm for Searching Process is as follows:

1. **Let** theme && sub-theme && sub sub-theme && target word = user inputs
2. **Read** RDF/OWL file
3. **Load** file into database
4. **If** user inputs is same data into database **Then**
5. List out all verses that pertain the inputs in addition to its location in Al-Quran (No. of division, Name of chapter)
   else
6. **No result be listed**

The actual searching process starts from step 4 to step 6, while the first three steps is related to database preparation. In addition, the first three steps are done one time only in contrast with last three steps, which can be performed each time the user wants to search for a certain keyword.

4.5 The Prototype Implementation

The prototype implementation is a realization of a technical specification or algorithm as a program, software component, or other computer system, achieved through computer programming and deployment. The prototype system is implemented using Java programming language, Jena framework, Java Server Pages (JSP) and Hyper Text Markup Language (HTML).

4.5.1 Jena Framework

The Jena Semantic Web is an open-source Java. It provides an API to retrieve the data and recording RDF graphs. Graphs are presented as an abstract "model". The model can be derived from the data files, databases, and URL-addresses. RDF file, which is an anthology of Al-Quran is derived from the export OWL file as an RDF file using Protégé-OWL program. Appendix 4.4 shows the Java code used for reading and processing RDF/OWL file. Appendix 4.5 shows the Java code used for reading data from database. Appendix 4.6 shows the Java code used for connecting the database with the search system.

4.5.2 Software Tools

The software utilized in this project is JCreator professional 4.5, Microsoft Front Page 2003, and Premium Soft Navicat project. JCreator professional 4.5 is an IDE for Java and JSP, Premium Soft Navicat to design and manage MySQL database. Microsoft Front Page 2003 is HTML editor employed to design static pages.

4.5.3 System Functionality

The main function in the prototype is to enable users to enquiry about certain verse. The system can be accessed via the web browser URL: 127.0.0.1:8888/rdf. This section consists of two subsections 4.5.3.1 and 4.5.3.2.

4.5.3.1 Interfaces for Users

The user can search for a certain verse in Al-Quran, Figure 4.18 shows the main interface of the prototype, through which the user enters their search criteria as shown in Figure 4.19. Figure 4.20 shows the result of searching.

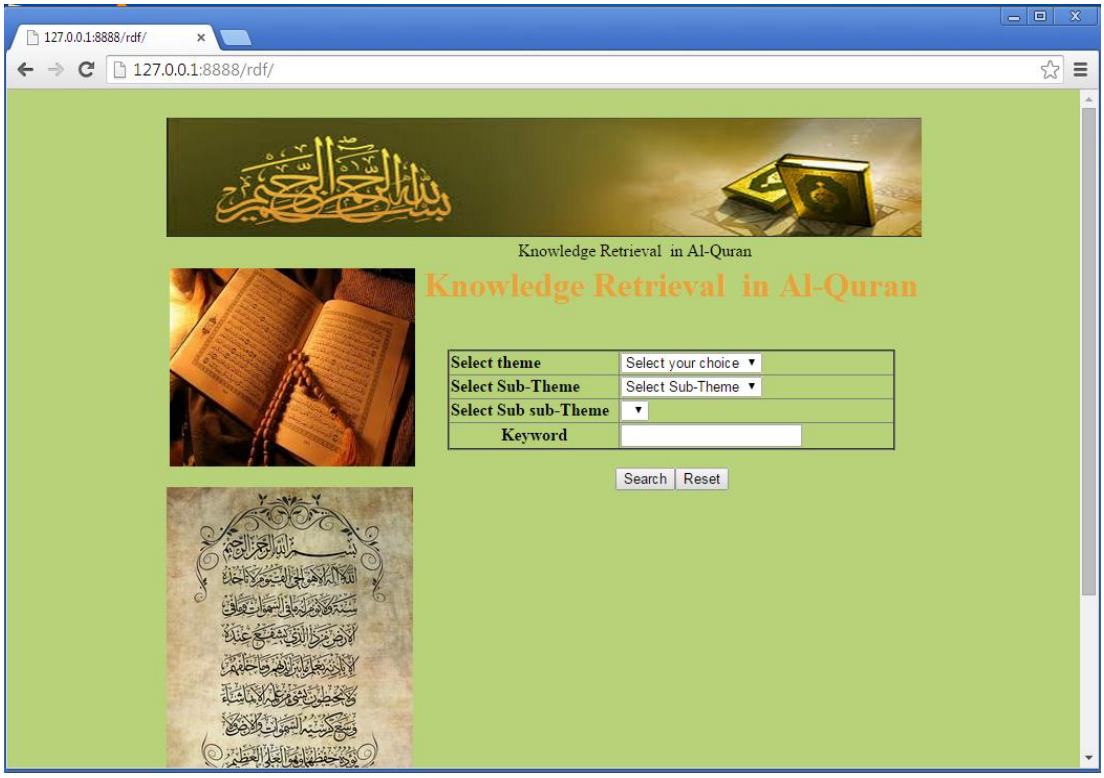


Figure 4.18. The Main Interface of the Prototype.

As shown Figure 4.18, user selects the main theme, sub-theme, sub sub-theme and enter the target keyword (Table 4.4 shows the target keyword that corresponds to each sub-theme or sub sub-theme). Then, the user submit his query, where the

system processes the submitted query and show the result in a separate page as illustrated in Figures 4.19 and Figure 4.20.

Table 4.4

The Target Keyword that Corresponds to Each Sub-theme or Sub sub-theme.

Themes	Sub-Themes	Sub Sub-Themes	Keywords
Allah	Knowing :	Innate character for mankind .	Innate character
		The universe and his creation.	- Universe
			- Creation
	Characteristics :	Existence.	Existence
		Oneness.	Oneness
		First and the Last.	First and the Last
		Differs from what has creation.	Differs from creation
		Omnipotent.	Omnipotent
		The will.	The will
		Alive does not die.	Alive, die
		The knower.	Knower
		Allah is the All-hearing and the All-seeing.	- Hears
			- Sees
Angels	The duties :	Organize all matters.	matters
		Pacify the hearts of the Prophets and the Faithful.	- Pacify, Prophets
			- Faithful
		Praying for the Faithful and ask forgiveness.	- Praying
			- forgiveness
		Glorify Allah and prostrate before	Prostration
		Recording the actions of 'mankind'.	behaviors
		The Blowing of the Trumpet.	Blowing , Trumpet
		Convey the revelation to the	revelation

		Guarding the hell and Punish its occupants of hell .	- Guarding
			- Punish
Unseen	Allah knows the keys of unseen.		unseen
	Allah knows the affairs of the hidden.		hidden
	Allah knows that is in the heart.		heart

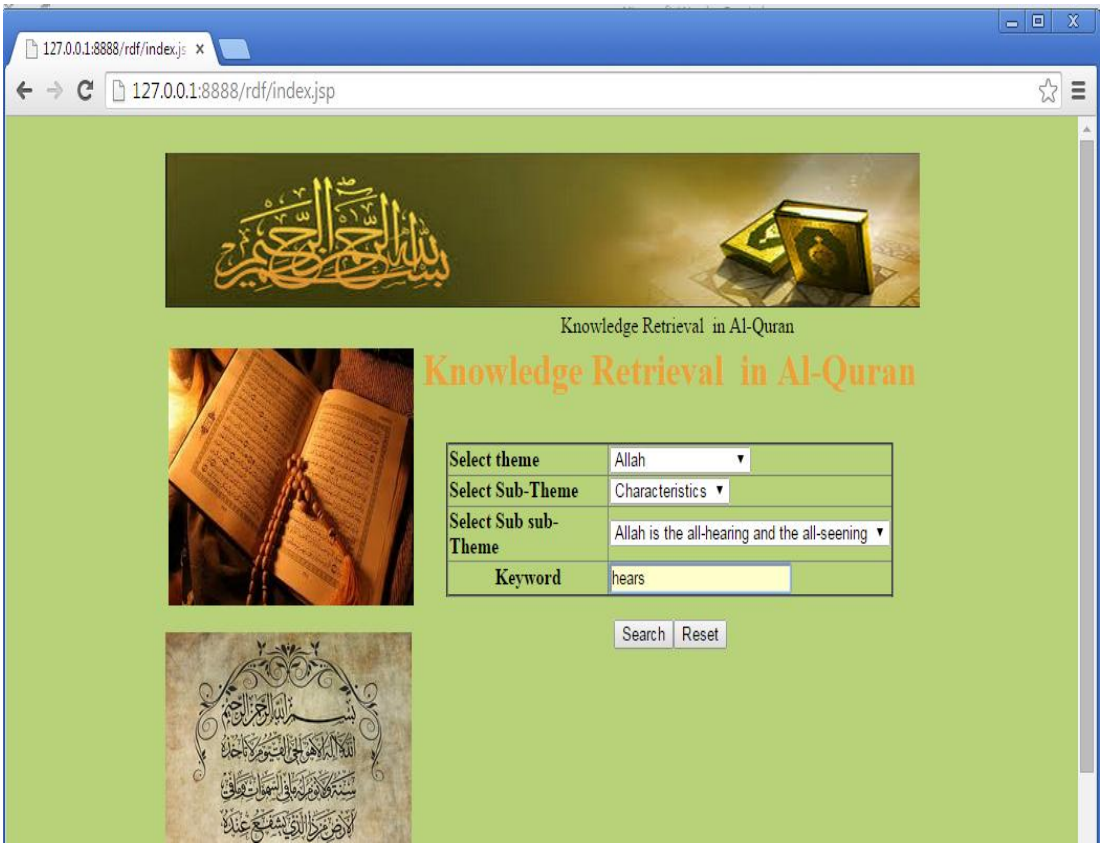


Figure 4.19. Input Search Criteria Interface.

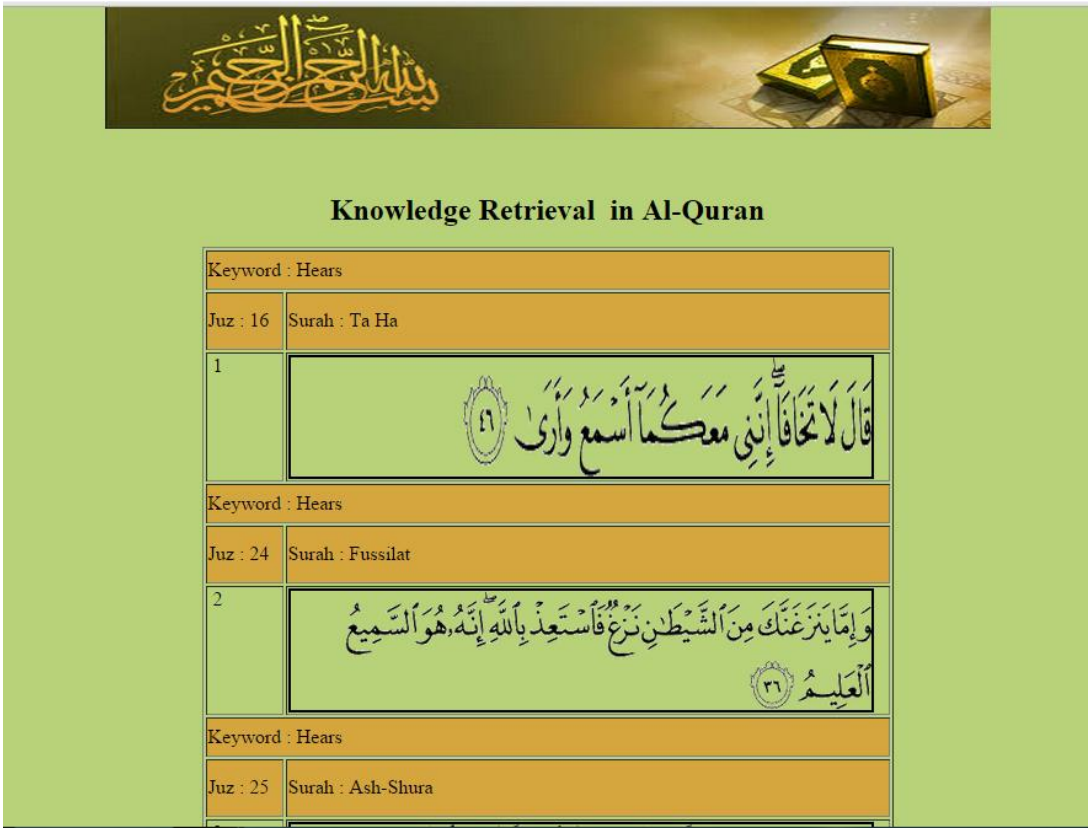


Figure 4.20. The Result of Searching.

4.5.3.2 Interfaces for Administrator

The administrator is responsible for the login, read RDF file, and delete RDF file data. The system is accessed by web browser URL: 127.0.0.1:8888/rdf/admin. The login and main interface for administrator are shown in Figure 4.21 and Figure 4.22 respectively. After the administrator enters (User name, Password) and click Login, then the administrator click on " Read RDF File " link (Figure 4.22). The system processes the RDF file and load the database with the RDF content, or click on "Delete RDF data" link to delete the old data in RDF file and replacing the RDF file another data file.

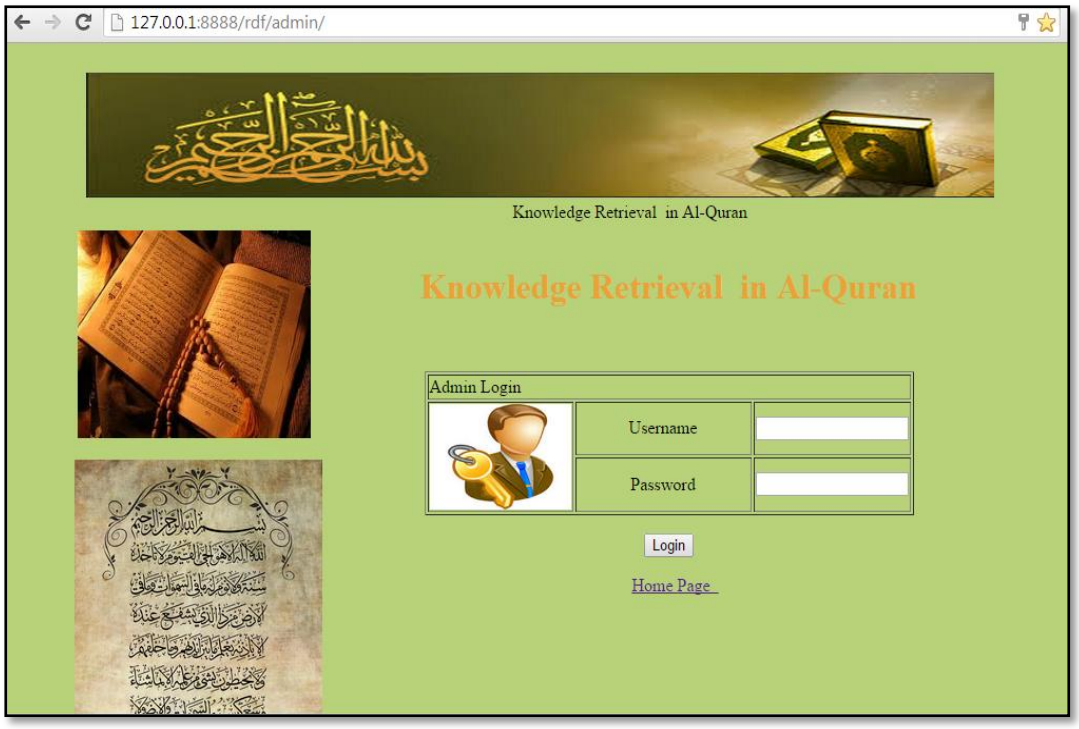


Figure 4.21. Administrator Login.

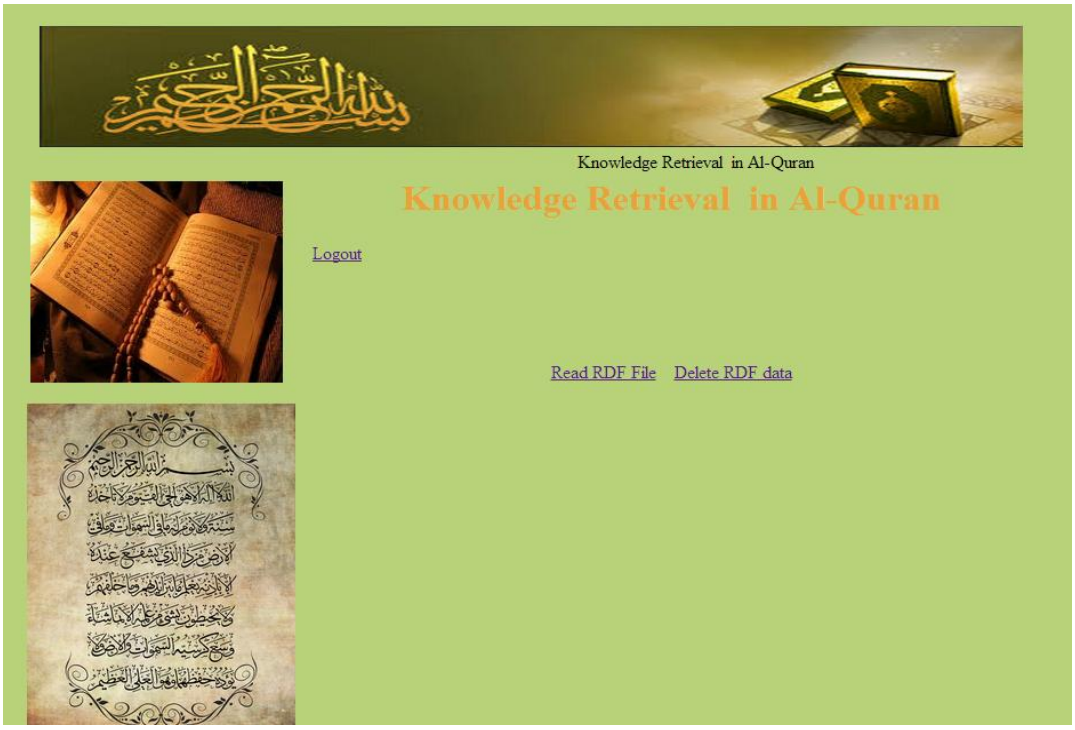


Figure 4.22. Main Functions for Administrator.

4.6 Summary

Al-Quran ontology specification is defined and created using Protégé-OWL. The prototype application is designed and implemented using Java programming language and Jena framework. The database design is discussed and the DDL for each database tables is explained. The keys for each table are highlighted. In addition, the content of each table is listed. The chapter also discussed the searching method, which is used into the system is discussed. The searching method is based on exact matching of keyword, and in other words, the result can be listed if there is a matching between user inputs and database content.

CHAPTER FIVE

VALIDATION AND EVALUATION

5.1 Introduction

This chapter focuses on the validation and evaluation of the searching method. Section 5.2 includes validation of the concepts (themes) used in the construction of ontology. Section 5.3 discussed knowledge retrieval evaluation that is to evaluate the ability to retrieve the relevant themes or sub themes. In addition, Section 5.4 discusses on the accuracy check of the new searching method in retrieving Al-Quran verses. Finally, Section 5.5 discusses the evaluation metrics of the searching method.

5.2 Ontology Validation

Al-Quran ontology has been validated by using interviews with Al-Quran experts. They are : 1) Assoc. Prof. Dr. Ismail Ishak, Director of the Islamic Center, and 2) Ustaz Mohd. Yusnaidi Sabri, Officer in the Islamic Center. Both experts are working at the Islamic Center of University Utara Malaysia (UUM). They were asked some of the questions during the interview to evaluate the validity of Al-Quran ontology which carried out by using the program (Protégé-OWL). The answers from the experts, are shown in Appendix 5.1.

The complete definition of Al-Quran ontology based on selected themes (i.e., Allah, Angels and Unseen) were validated by the experts. The experts were asked to check and corrected the specific relationship between themes and relate to the relevant verses of Al-Quran. The experts have endorsed the relationship as shown in Appendix 5.2.

5.3 Evaluation

The purpose of evaluation is to evaluate the ability to retrieve accurately and correctly the themes or sub-themes. The knowledge retrieval is tested by using a pre-defined test case, and the purpose of using a test case is to test all functionality and trigger of the searching method system. Therefore, any change request can be very easily traced. According to (Kaner, 2003), the purpose of a test case is to help us to discover information, different types of tests are more effective for different classes of information. Test cases can be “good” in a variety of ways.

The test case that is prepared for this method is basically aimed to test the accuracy of searching method. The inputs (theme, sub-theme and sub sub-theme) for searching method are predetermined and it's given to user in the testing exercise. This research has used 9 queries as an example of the test case. Table 5.1 shows the prepared test case. By giving a keyword, the relevant themes / subthemes retrieved were evaluated on their Precision and Recall. These two measurements are commonly used to measure the retrieval performance (Aleksovski, 2008).

Table 5.1

The Test Case for Searching Method.

No. of query	Theme	Sub-Theme	Sub sub-Theme	Number of Verses in RDF/OWL file	Keywords in search
1	Allah	Knowing	The innate character for mankind.	21	Innate character
2	Allah	Knowing	The universe and his creation.	23	Universe Creation
3	Allah	Characteristics	Existence.	15	Existence
4	Angels	The duties	Organize all matters.	12	Matters
5	Angels	The duties	Praying for the Faithful and ask for forgiveness.	5	Praying Forgiveness
6	Angels	The duties	Guarding the hell and punish its occupants.	13	Guarding Punish
7	Unseen	Allah knows the keys of unseen.		6	Unseen
8	Unseen	Allah knows all that is in the heart.		5	Heart
9	Unseen	Allah knows the affairs of the hidden.		5	Hidden

In Table 5.1, the number of query shows the inputs by the user. Firstly, the user selects "Allah" as a theme, "Knowing" as a sub-theme, "The innate character for mankind " as a Sub sub-theme and "Innate character" as a keyword to be search.

The searching method must produce a list of the verses that contain the themes / subthemes related to the keyword. Number of verses in column shown in Table 5.1 indicates the number of verses in ontology.

The evaluation process is to check the success of the system for searching related verses in Al-Quran. Indeed, to identify the weaknesses and the strength of the prototype system for searching and classification of some related verses in Al-Quran, the approach was used to conduct the evaluation through the accuracy of the searching results by using two measurement are: Recall and Precision (Aleksovski, 2008).

Recall and Precision are the basic measures used in evaluating search strategies. These measures assume:

i. there is a set of records in the database relevant to the search topic, which are either relevant or irrelevant (these measures do not allow for degrees of relevancy); and
ii. the retrieval set may not perfectly match the set of relevant records.

5.4 Experiment and Finding

This section aims to check the accuracy of the new searching method in retrieving Al-Quran verses. The test case consists of 9 queries and each query has a different data, these inputs are used by user to test the new searching method.

The new method response by listing the result that is related to the user entered inputs. Table 5.2 shows the details calculation of Precision and Recall for theme "Allah" (3 queries). Table 5.3 shows the details calculation of Precision and Recall for theme "Angels" (3 queries). Table 5.4 shows the details calculation of Precision and Recall for theme "Unseen" (3 queries).

For examples, based on query number 1 in Table 5.2, the keyword search is “Innate character ". Thus, the calculation for knowledge retrieval is followed:

$$\text{Recall} = \frac{No.\ of\ relevant\ \ records\ \ retrieved}{No.\ of\ relevant\ \ records\ \ retrieved\ + No.\ of\ relevant\ \ records\ \ not\ retrieved} \times 100\%$$

$$= \frac{19}{19+2} \times 100\% \ = \ 90.4\ \%$$

$$\text{Precision} = \frac{No.\ of\ relevant\ \ records\ \ retrieved}{No.\ of\ relevant\ \ records\ \ retrieved\ + No.\ of\ \ irrelevant\ \ records\ \ retrieved} \times 100\%$$

$$= \frac{19}{19+1} \times 100\% \ = \ 95\ \%$$

The results for Recall is 90.4% and Precision is 95% as shown in query number 1 for sub-theme "The innate character for mankind" for theme "Allah" in table 5.2. Another examples, based on query number 1 in Table 5.3, the keyword search is “Matters". Thus, the calculation for knowledge retrieval is followed:

$$\text{Recall} = \frac{No.\ of\ relevant\ \ records\ \ retrieved}{No.\ of\ relevant\ \ records\ \ retrieved\ + No.\ of\ relevant\ \ records\ \ not\ retrieved} \times 100\%$$

$$= \frac{10}{10+2} \times 100\% \ = \ 83.3\ \%$$

$$\text{Precision} = \frac{No.\ of\ relevant\ \ records\ \ retrieved}{No.\ of\ relevant\ \ records\ \ retrieved\ + No.\ of\ \ irrelevant\ \ records\ \ retrieved} \times 100\%$$

$$= \frac{10}{10+1} \times 100\% \ = \ 90.9\ \%$$

The results for Recall is 83.3% and Precision is 90.9% as shown in query number 1 for sub-theme (i.e., Organize all matters) for theme "Angels" in table 5.3. Another examples, based on query number 2 in Table 5.4, the keyword search is “Heart ". Thus, the calculation for knowledge retrieval is followed:

$$\text{Recall} = \frac{No.\ of\ relevant\ \ records\ \ retrieved}{No.\ of\ relevant\ \ records\ \ retrieved\ + No.\ of\ relevant\ \ records\ \ not\ retrieved} \times 100\%$$

$$= \frac{4}{4+1} \times 100\% \ = \ 80\ \%$$

$$\text{Precision} = \frac{No.\ of\ relevant\ \ records\ \ retrieved}{No.\ of\ relevant\ \ records\ \ retrieved\ + No.\ of\ \ irrelevant\ \ records\ \ retrieved} \times 100\%$$

$$= \frac{4}{4+1} \times 100\% \ = \ 80\ \%$$

The results for Recall is 80% and Precision is 80% as shown in query number 2 for sub-theme "Allah knows all that is in the heart " for theme "Unseen" is shows in Table 5.4. Figure 5.1 shows Precision and Recall foe each a keyword.

Table 5.2

Details Calculation of Precision and Recall for Theme "Allah".

No. of query	Theme	Sub-Theme	Sub sub-Theme	Keywords in Search	No. of Verses for the Keyword	No. of Retrieved Verses	No. of Retrieved Correct Verses	Recall (%)	Precision (%)
1	Allah	Knowing	The innate character for mankind.	Innate character	21	20	19	90.4	95
2	Allah	Knowing	The universe and his creation.	Universe	6	5	4	66.6	80
				Creation	17	16	16	94.1	100
3	Allah	Characteristics	Existence.	Existence	15	15	13	86.6	86.6

Table 5.3

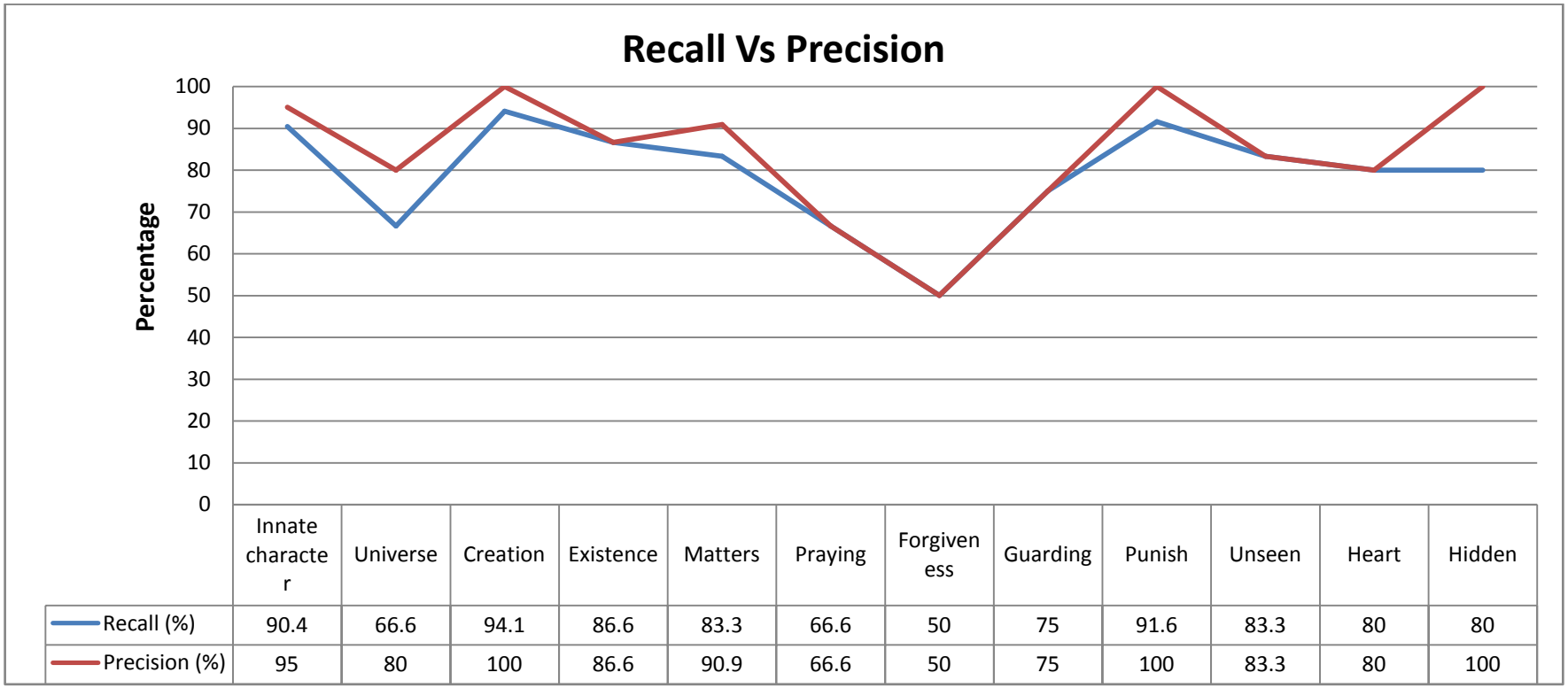
Details Calculation of Precision and Recall for Theme "Angels".

No. of query	Theme	Sub-Theme	Sub sub-Theme	Keywords in Search	No. of Verses for the Keyword	No. of Retrieved Verses	No. of Retrieved Correct Verses	Recall (%)	Precision (%)
1	Angels	The duties	Organize all matters.	Matters	12	11	10	83.3	90.9
2	Angels	The duties	Praying for the Faithful and ask for forgiveness.	Praying	3	3	2	66.6	66.6
				Forgiveness	2	2	1	50	50
3	Angels	The duties	Guarding the hell and punish its occupants.	Guarding	4	4	3	75	75
				Punish	12	11	11	91.6	100

Table 5.4

Details Calculation of Precision and Recall for Theme "Unseen".

No. of query	Theme	Sub-Theme	Sub sub-Theme	Keywords in Search	No. of Verses for the Keyword	No. of Retrieved Verses	No. of Retrieved Correct Verses	Recall (%)	Precision (%)
1	Unseen	Allah knows the keys of unseen.		Unseen	6	6	5	83.3	83.3
2	Unseen	Allah knows all that is in the heart.		Heart	5	5	4	80	80
3	Unseen	Allah knows the affairs of the hidden.		Hidden	5	4	4	80	100



	Innate character	Universe	Creation	Existence	Matters	Praying	Forgiveness	Guarding	Punish	Unseen	Heart	Hidden
Recall (%)	90.4	66.6	94.1	86.6	83.3	66.6	50	75	91.6	83.3	80	80
Precision (%)	95	80	100	86.6	90.9	66.6	50	75	100	83.3	80	100

Figure 5.1. Precision and Recall for each Keyword.

5.5 Discussion

Precision and Recall are the basic measurement used for evaluating the search method. Tables 5.2, 5.2 and 5.3 show the calculation of Precision and Recall for each query in the themes (i.e., Allah, Angels and Unseen). The high accuracy and therefore the good performance measurement ratios for the new searching method are related to the verses in database. This database store contents from the created RDF/OWL file, which is also having a major contribution in improving the searching accuracy.

Each main theme (i.e., Allah, Angels and Unseen) has three queries, so that the total queries are 9. For theme "Allah", query number 1, (table 5.2) show the percentage of Precision is 95% which means that 95% of relevant verses are retrieved. Meanwhile, the percentage of Recall is 90.4%, meaning that 90.4% of relevant verses are retrieved. Query number 2 in theme "Allah" has two keywords (table 5.2) where the percentage of Precision for keyword "Universe" is 80 %, which means that 80% of relevant verses are retrieved. Meanwhile, the percentage of Recall is 66.6%. this means that 66.6% of relevant verses are retrieved. The second keyword in query number 2 is "Creation", where the percentage of Precision for "Creation" keyword is 100% which means that 100%, of relevant verses are retrieved. Meanwhile, the percentage of Recall is 94.1% which means that 94.1% of relevant verses are retrieved.

Query number 3 in theme "Allah" (table 5.2) where the percentage of Precision is 86.6% which means that 86.6% of relevant verses are retrieved. Meanwhile, the percentage of Recall is 86.6% and this means that 86.6% of relevant verses are retrieved.

In theme "Angels", query number 1 in Table 5.3, the percentage of Precision is 90.9% which means that 90.9% of relevant verses are retrieved. Meanwhile, the percentage of Recall is 83.3% this means that 83.3% of relevant verses are retrieved. Query number 2 in theme "Angels" has two keywords in table 5.3, the percentage of Precision for keyword "Praying" is 66.6% which means that 66.6% of relevant verses are retrieved. Meanwhile, the percentage of Recall is 66.6%. this means that 66.6% of relevant verses are retrieved, the second keyword in query number 2 is "Forgiveness", the percentage of precision for keyword "Forgiveness" is 50% which means that 50% of relevant verses are retrieved. Meanwhile, the percentage of Recall is 50% this means that 50% of relevant verses are retrieved, the second keyword in query.

In addition, query number 3 in theme "Angels" has two keywords in Table 5.3, the percentage of Precision for keyword "Guarding" is 75%, where means that 75% of relevant verses are retrieved. Meanwhile, the percentage of Recall is 75%, where means that 75% of relevant verses are retrieved. The second keyword in query number 2 is "Punish", which the percentage of Precision for keyword "Punish" is 100%, which means that 100% of relevant verses are retrieved. Meanwhile, the percentage of Recall is 91.6%, where means that 91.6% of relevant verses are retrieved, the second keyword in query.

In theme "Unseen", query number 1 in Table 5.4, the percentage of Precision is 83.3%, which means that 83.3% of relevant verses are retrieved. Meanwhile, the percentage of Recall is 83.3%, which means that 83.3% of relevant verses were retrieved. Query number 2 in theme "Unseen" (table 5.4) which the percentage of Precision is 80%, which means that 80% of relevant documents are retrieved. Meanwhile, the percentage of Recall is 80%, which means that 80% of relevant verses were retrieved.

Meanwhile, query number 3 in theme "Unseen", the percentage of Precision is 100%, which means that 100% of relevant verses are retrieved. Meanwhile, the percentage of Recall is 80%, which means that 80% of relevant verses were retrieved. The failure to retrieve all the verses is due to the lack of database content, which represents Al-Quran verses which lead to mismatch between user inputs and database contents. To overcome this problem, Verses in the database must be increased so that percentage of Precision and Recall would be higher.

In addition, Tables 5.2, 5.3 and 5.4 show high percentage for both Precision and Recall. A higher Precision number implies that a large percentage of verses are retrieved and only a small number of verses are non-retrieved. Furthermore, a higher Recall number suggests that the information retrieval system was effective in retrieving high percentage of verses, as only a few of the verses are non-retrieved.

In summary, the high percentage of Precision and Recall has described the correctness of the searching method in the Al-Quran ontology. The percentage can be increased if more themes or concepts are used in the experiments. Consequently, the

correctness of the searching results can others facilitate the readers to learn Al-Quran in an efficient way.

5.6 Summary

This chapter presented the validation and evaluation of the ontology and the new searching method in retrieving the knowledge from Al-Quran ontology. The evaluation shows that the new searching method has achieved its objectives. The correctness and accuracy of the searching method is tested and calculated using the Precision and Recall where search results show high percentage on both measures.

CHAPTER SIX

CONCLUSION AND FUTURE WORK

6.1 Introduction

This chapter reviews the works and summarizes the research's overall steps in order to achieve the objectives of this study and also discuss possible future work in this area.

6.2 Conclusion of the Study

Research in the ontology-based approach for knowledge retrieval in Al-Quran has been conducted and the method to search Al-Quran knowledge has been new method. The research has shown the ability to retrieve Al-Quran knowledge with high correctness and accuracy as calculated in Precision and Recall of searching performances.

The first objective is to develop Al-Quran ontology has been achieved. To achieve this goal, the ontology is used to present the content of Al-Quran in a systematic and structured manner. The systematic and structured manner is achieved by mapping the meaning of the themes of the appropriate verses of Al-Quran. The correct meaning of Al-Quran knowledge ontology, is achieved by developing an ontology and this includes defining classes and properties in the knowledge domain. Then, the classes are defined in a taxonomic (subclass–super class) hierarchy, defining properties and

describing allowed values for these properties, and filling in the values for properties for instances.

The second objective is to develop a searching method to retrieve Al- Quran verses based on Al-Quran ontology. This goal is achieved by developing a searching method by using the Jena framework. The searching method search the ontology contents, which was created and achieved in the first objective. The Graphical User Interface (GUI) that is designed for searching the method enables users to select the search criteria and enters the target keyword. After the user submit the inputs searching, the method will list the verses are that related to the inputs.

The third objective is to evaluate the ontology and searching method. To achieve this goal, the ontology is validated through interview with experts in Islamic studies to their opinion about the system-based on ontology. Meanwhile, the searching method is evaluated by using Recall and Precision measurements. The validation and evaluation tasks have shown the success of the new searching method.

6.3 Contribution of the Study

This research contributes towards the theory and practice of using ontology for Al-Quran in information technology. Theoretically, this study adds to literature and provides insight into the methods used. The research presents an integrated Information System (IS) based on ontology and offers a more systematic approach to Islamic studies. Moreover, the research provides a practical contribution by enabling

experts, researchers and readers studying Al-Quran to validate the classification system. Indeed, the research practically contributes to the evaluation of relevance of search and retrieval process related to verses and knowledge contained in Al-Quran. In addition, the research ensure that the usage of Al-Quran for searching in related verses through ontology is easier to users.

In addition, the new search method that enables users to search about certain verses in Al-Quran. The search method check the inputs (main theme, sub-theme, sub sub-theme and keyword) with the database of keywords. If a match exists, the verses related to the entered inputs are listed. The results of the search are listed only if a match exists between the user inputs and database keyword.

Part of the new search method includes the database preparation. Database preparation is the process of translating the RDF/OWL file to the database using Jena framework. The database principally contains the extracted verses from the RDF/OWL file and its location in Al-Quran. Users may utilize this database to search for certain keywords. The search process is actually a question, which is converted to SQL query on the database.

6.4 Recommendations and Future Work

Information retrieval relates to assembling knowledge resources that are relevant to an informational need. Searches can be based on metadata, full-text, or other content-based indexing. The ontology-based approach for knowledge retrieval in Al-Quran has opened some interesting topics for future research in the area of information retrieval. Therefore, the future works are as follows: i) add search by voice feature in

search method, where this feature allows the user to input the target keyword by voice recognition, ii) improve the quality of information retrieval by focusing on contextual retrieval, and iii) increase the accuracy of search method through using the sentences when querying knowledge.

This research provides the foundation of Al-Quran knowledge representation in ontology to facilitate the learning of Al-Quran. Therefore, more applications can be developed by using this research method to help readers learn and understand Al-Quran in easy ways, without neglected the importance of Al-Quran scholars to deliver the truth and accurate knowledge of Al-Quran.

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