Structure and Interpretation of Domain Knowledge with Special Reference to Mineral Deposits in Afghanistan

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Abstract

This study analyzes the structure and interpretations of domain knowledge with general perspectives. It then collects information about mineral deposits recently discovered in Afghanistan and analyzes it for developing a web based system for the purpose of economic development. The main goal of the project is to specify the most appropriate structure for a semantic web representation of mineral deposits in Afghanistan, so that those who are interested in investing in Afghanistan they may get appropriate initial information. The structure will allow a better understanding of how various aspects of mineral deposits such as location of minerals, value of minerals, private versus public control, laws, social norms, people, government, investment climate, transportation and resources are related in a semantic configuration. A sample web site is built using the semantic web technologies. This study suggests that no one knowledge structure is good for all purposes although some structures are better than others for achieving certain goals. A layered structure for domain knowledge representation is reviewed in details for examining consequences.
1. INTRODUCTION

Humans study domain knowledge for various purposes including problem solving, making investment decisions, economic development, social change and so on. It is reasonable to believe that the knowledge is not completely unstructured. As civilizations evolve, the amount of knowledge increases and humans become used to dealing with more knowledge in daily life often with stress. How do we manage our knowledge? How are we able to relate pieces of knowledge? How do we decide what knowledge is relevant for solving a problem? Are there inherent structures of knowledge? What are major consequences of knowledge structure in the web? These are important questions about knowledge structure. The main goal of the project is to describe the appropriate structure and interpretation of domain knowledge and apply them to a semantic web representation of mineral deposits in Afghanistan described in various sources (Simpson 2011; Shroder 2014). A layered structure for domain knowledge representation is reviewed in details for examining consequences.

Knowledge structure has been studied in many different fields including epistemology, psychology, geography, physics, education, economics, natural sciences and so on (BonJour & Sosa 2003; Dufresne, Leonard, & Gerace 1992; Steup 2005). Research articles in this area suggest that there is no one structure for knowledge that fits all settings or situations (Dufresne, Leonard, & Gerace 1992; Dufresne, Mestre, Thaden-Koch, Gerace, & Leonard, 2005; Gerace, 1992; Larkin, 1979). Multiple structures are motivated by different aspects of knowledge. According to an epistemological trend known as foundationalism, knowledge is composed of two components of justified beliefs, a foundation and a superstructure, the latter being supported by the former (Steup 2006). The foundational beliefs are basic whereas beliefs of the
superstructure are non-basic and receive justification from the justified beliefs in the foundation (Bonjour & Sosa 2003). There are viable alternatives that do not make any assumption about these two components. As the internet continues to develop by restructuring knowledge societies, it vigorously impacts creation, dissemination and consumption of knowledge (Castells 1996; Dretske 1981; Ramu 2011). With the emergence of knowledge societies, economists are defining knowledge, information and data as goods, and more specifically, knowledge as expectations (Boisot, MacMillan & Han 2007). Economic importance of knowledge is paramount in modern societies (Leydesdorff 2006). The knowledge of Afghanistan’s mineral deposits would be useful for the benefit of a broad section of the audience, if it presented properly.

In the domain of Physics, experts are believed to have three categories of knowledge in a strongly related manner. These categories are called (a) Conceptual Knowledge, (b) Operational and Procedural Knowledge, and (c) Problem-State Knowledge (Dufresne, Leonard, & Gerace 1992). Progress in relating these categories has been slow. In various models of modern economics the role of knowledge is recognized and well-studied (Leydesdorff 2006). The presentation of various aspects of knowledge in semantic web is a challenge, in addition to other challenges in Afghanistan. Peace, stability and governance are important aspects for national and international considerations. Various aspects of resource development would require improvements in the infrastructure and security in Afghanistan.

1.1 Statement of the Problem
The representation of domain knowledge of mineral deposits in the emerging semantic web is the central problem addressed in this report. The basic assumption is that the representation should be based on the structure of the knowledge. The structure will allow a better understanding of how various aspects of mineral deposits such as location of minerals, value of minerals, private versus public control, laws, social norms, people, government, investment climate, transportation and resources are related in a semantic arrangement. Based on literature review a layered structure for domain knowledge representation is considered along with some other alternatives. One also needs to make software engineering considerations (Pressman 2005; Sommerville 2010) for the design and implementation purposes.
Documents and data are two types of a file that a computer can process. Human can read the documents and data can be represented by using an application to be viewed, searched and combined in many ways by users. The traditional World Wide Web is based mainly on documents written in Hyper Text Markup Language (HTML). In HTML files the data is usually deep down and is not useful in some contexts. The problem of this form of data is that it can not be accessed at a large scale which is hidden in HTML files. Too much information can not be checked entirely by human for specific needed information.

The Semantic Web represents the distributed information across the Web in a machine-interpretable way. The Semantic Web (SW) is publishing in languages designed for data such as Resource Description Framework (RDF), Web Ontology Language (OWL), and Extensible Markup Language (XML). These languages and technologies provide machine-readable description which adds meaning to the contents and describes the structure of the knowledge about the content. In this way the computer can process the knowledge itself similar to human deductive reasoning and inference, obtains meaningful results, and help computes to perform automated information gathering and research. Appropriate analyses of the knowledge of mineral deposits in Afghanistan would attract national and international investments in proper investment climate (Kuo 2007), if appropriate information is available readily and precisely. User interface will play an important role. The website design should meet or exceed the user needs to locate specific information and content quickly through intuitive navigation into information sources. Graphical User Interface is preferable over command based user interface for many information systems (Tidwell 2011, SendPoints 2015). With advancing technology, the programmers and designers create complex GUI designs that work with more efficiency, accuracy and speed.

1.2 Definition of Terms and Acronyms

Acronyms

AI: Artificial Intelligent
AML: Agent Markup Language
DAML: DARPA Agent Markup Language
DB: Database.
2. SEMANTIC WEB

Information dissemination, sharing, access, display, visualization etc. were slow and difficult in the past for ordinary web site users for various reasons (Barners-Lee et al, 2001.) However, rapid changes began with the expansion of the internet starting in 1994, when web browsers started to appear. End users began to participate in information dissemination and retrieval in the fast growing web environment. The web has simplified things for the end users by providing a friendly interface through browsers.
Today, there are lots of ways in which the machines can use data if they can interpret or understand it. For example, if a calendar program can understand dates, it can warn when an appointment is coming up. If the Global Position System (GPS) device understands latitude and longitude, it can show people the way and direction where they want to be. When the address book understands that some string is a phone number or an email address, it can set up communication with a person with a click of a button.

In fact, what users have to do is to laboriously cut and paste details into their address books, and find the date and time themselves. Also, they have to copy the contact details by hand from the web page into their address books, and sort out the address lines and phone numbers manually. For the usage of a GPS system, they need to manually fiddle with its buttons to set up directions and other instructions at the axis of the coordinates to meet. It is similar to the documentation system before the web. In the case of data processing, users are still pre-Web and therefore, the proposed Semantic Web is a good future solution to overcome this issue.

The Semantic Web (Barners-Lee et al, 2001) uses the W3C standards, taking well established ideas, and making them interoperable over the Internet, just like the World Wide Web. The relational models are not invented for the data, query systems, and rule-based systems; they are just webizing. They are just allowed to work together in a decentralized system which does not need a human being to work on the connection.

A time will come when users will click on the web page to attend a meeting, and their computers will know that it is indeed a form of appointment. It will pick up all the necessary information, understand it and send it to all the right applications requesting the information. Most of the time the understanding of plain text contents by a human being is possible in one way or the other. But for a machine or an intelligent agent, it does not work that way. For a machine or computer to understand the text, it should be written in their programming language. Java, for example, is one of the languages used for this purpose (Gaddis, 2009). An applet is a small program of Java language that is part of the web site. There are other languages used for the web development too, such as JavaScript, Perl, PHP, Python, and Ruby. The Semantic Web
uses a language called A Semantic Web Programming Language (Leos, Nov 27, 2006). Its wiki name is SemWebProgrammingLanguage, and is aspl in unix.

A programming language is a language used to write computer programs, the Semantic Web (SW) is an appropriate structure to represent any kind of information which has meaning to the computer or an agent (Berner-Lee et al, 2001). It is structured in a way that a computer can understand its content, process it, and provide it to the users on their quarries. SW uses different technologies to provide useful and meaningful web structure representation to the users. These technologies and their importance are discussed later in the introduction. For further information about the SW, the following information on its history, development, structure, and usage in the past is provided by its inventor, Tim Berners-Lee, his colleagues in W3C, and others in this area.

The Semantic Web is a mesh of information which is linked in away that a machine or intelligent agent can process the data easily on a global scale. It is an efficient way of data representation on the World Wide Web or globally linked database (Berner-Lee et al, 2001). In addition to Tim Berners-Lee’s work and research, a group of dedicated people at the World Wide Web consortium (W3C) are working on the system improvement, extension, and standardization. Already, there are some languages, publications, and tools which are developed for the web. Although its technologies are still in a new stage and its future is bright, there is little consensus on the future of the Semantic Web direction and characteristics.

2.1 Motivation

The rationale for the Semantic Web is about the data and information. In HTML files the data is usually deep down and is not useful in some contexts. The problem of this form of data is that it can not be accessed at a large scale which is hidden in HTML files. An example of such data would be various sites of HTML for displaying the information about sport events, entertainment, television programs, baseball, and volleyball teams. In some contexts, it is difficult to use the data in a way that a user may want to use it, and this is a problem which is addressed by the Semantic Web.
The semantic web elaborates further on the solution. It is being published in languages specifically designed for the data such as RDF, OWL, and XML. HTML describes their links and documents, while the arbitrary things such as people, meetings, and parts can be described by RDF, OWL, and XML.

The Semantic Web in Breadth (Swartz, 2002) is a study which speaks about the different parts of the Semantic Web and how they fit together: the URI, RDF, XML, RDFS schema, and OWL.

Identification is important for understanding the topic or object of a discussion. Identification can be direct or indirect. For instance in the phrase “Shinning Moon,” the identifying object is the moon. Similarly in the phrase “The poor man at the grocery store, “the reader can easily relate to the object or subject of discussion. Other example include: “The really sweet candies that Bob always eats.”, and “jewelries”, “James Watt”, etc (Swartz, 2002).

Identifiers are also used for identifying items on the World Wide Web. Identifiers that are used to identify items on the web are considered “resources”. The World Wide Web uses a uniform system for item identification and therefore, the identifiers are called “Uniform Resource Identifiers” or (URI). Any object on the web can have a URI. For instance, a person, a picture, an object can all have a URI on the web. A URI cannot be replaced because it holds the World Wide Web together.

One important form of URI is the Uniform Resource Locater or URL. A URL allows an internet user to visit a website such as www.cnn.com. When a user types in a website address in a web browser, the URL allows the computer to locate the website or the specific resource the user intended to view. A URL allows the computer to not only identify but also locate the resource. This is a unique distinction with the URL as other types of URI can only identify but not locate the copy of the resource. For instance “mid” or the message id which is another URI can only identify an email message but not locate the actual message copy (Swartz, 2002).
Because of the large nature of the World Wide Web, URIs cannot be centralized. No one organization, government or institution can have the sole responsibility or authority to decide who makes the web, it's use, and limitations. However, there are certain URI schemes that are centralized such as http. HTTP relies on centralized systems such as DNS or domain name systems. Other URIs are completely decentralized such as freenet (Swartz, 2002).

The lack of centralization allows anyone to create a URI. Such freedom allows great flexibility but also presents its own challenges as well. For instance, one a person can create a URI that he/she does not own. On the other hand this freedom can cause duplication because someone else can also create the same URI with similar content. Hence, the user will not know if both the URIs refer to the same exact resource but this is the challenge that users have to deal with in order for the World Wide web to prosper (Swartz, 2002).

Creating a web page is one of the most common ways of creating a URI. A web page for instance describes the object to be identified. The URL of a web page serves as the URI. For instance, the URI (http://logicerror.com/myweavingtheweb) not only represents the physical book but it also represents the web page that describes it. However, there are some discussions about this issue amongst experts in the field. This problem is known as “The Semantic Web Identification Problem (Swartz, 2002).

It's important to note that a URI does not necessarily directs a computer in locating a certain file on the world wide web, although it can do that, it is actually the name of a resource which may or may not exist on the Internet. Furthermore, this resource may not be accessible over the Internet. Instead the computer uses the URL to locate a specific file or resource on the web. A URL also allows the computer to retrieve the resource. Other methods or locating and retrieving a resource on the Internet might come along. A URI serves as a resource identifier and cannot do anything further than that. A URL is needed for retrieving actual information about the resource (Swartz, 2002).

2.2 Tools
Extensible Markup Language (XML) was designed to be a simple way to send documents across the Web. XML enables a user to create his or her own document format. XML is a machine readable format which allows the user to improve the meaning of a document's text and content. It's a great way of creating powerful documents. For instance, using XML a user can add emphasis to a word and the browser will serve that text using special formatting such as Bold or Italic. Similarly, a voice browser will pronounce that word with a different tone or volume. On the other hand, using simple italicized text will only carry over to visual browsers but not voice enabled browsers (Smith, McGuinness & Welty, 2004).

Opening and closing tags are used in XML language. The collection of such tags in a sentence is known as an element. Using the above tag format, a user can provide more information to the computer about the content (Swart, 2002). With using attributes, further information can be provided to the computer. An attribute allows the user to provide a name and a value. Although, if a sentence has an attribute and enough information, user may find a problem sometimes. Common words are used in the sentence and the words such as sentence, person, and animal used in a markup language are common words which can be used by others in their own markup languages in the same way. Some of the same words have different meaning in other languages. How does the computer know to keep these things straight and distinguishable from one another (Swartz, 2002).

To answer the above question and to prevent such confusion, markup elements should be indentified with a Uniform Resource Identifier (URI) in a unique way. So the user should assign a URI to each of the elements and attributes. To do this using XML Namespaces (Swartz, 2002) is very useful. By using XML Namespaces, individuals can make their own tags and mix them with the tags made by others. A part of the Web space can be identified by a namespace which is used to derive the meaning of the names. There is no need to be worry about tag names conflicting, because everyone uses their own URI tag names. Users don't have to type them out each time because XML allows the users to abbreviate and set default URIs whenever they need (Swartz, 2002).
The Resource Description Framework (RDF) is the meat of the Semantic Web. The user can create URIs and talk about them with other web pages. It would be best if a computer can process what users say but it does not. To overcome the different meaning of the same sentence, RDF provides a way to make statements that are machine-processable. Even if the computer can't actually "understand" what is said it can however deal with it in a way that makes sense to it and understand it. An RDF is simple and its statement is like a simple sentence, except that most of their words are URIs. A subject, a predicate and an object are part of each RDF statement. The subject is represented in the first URI. The second URI is the predicate, relating the subjects to the object. The object is represented by the third URI which could be the book or any other object (Swartz, 2002).

According to the above explanation, the RDF statements can say almost anything no matter who says them. This leads to an important RDF ("anything can say anything about anything") principle (Swartz, 2002). This way information is spread across the Web, and people can say contradictory things, the freedom that the Web provides.

The RDF statement is written in N-Triples, a language that enables a person to write simple RDF statements. The official RDF specification is not easy and is a little complex to write the statement; however it provides the same thing. The source of the RDF information is the databases source. There are thousands of databases in the world, most of which contain interesting machine-processable information. The stored database information can be easily retrieved in any form by querying the computer. For publishing the databases to the Web, RDF is ideally suited tool and technology. When the users put the database on the Web, a URI is given to everything in the database, allowing others to talk about it too. Using the available information at this time, the intelligent programs can begin to get the data together and the users can ask questions about all of these databases at once for further information (Swartz, 2002).

The RDF’s schema specification is a declarative representation language influenced by ideas from knowledge representation. The Metadata Activity (MA) group of W3C started work on RDF Schema (RDFS) in the early 1990 as a RDF vocabulary sharing language. It was recommended by W3C in 1999 and the RDFS was recommended in 2004. The Metadata
Activity was replaced by the Semantic Web in 2001. The RDF Schema is comprised of the core classes, core properties for defining relationships, and core properties for restricting properties (Metadata Activity Statement, 2002).

The OWL Web Ontology Language is used for the information contained in documents which needs to be processed by applications. It does a different job compare to a situations where the content only needs to be presented to humans. OWL is used for the representation of the terms’ meaning in vocabularies and the relationship of these terms. Therefore, ontology is the representation of terms and their interrelationships. The facilitating power of OWL in terms of expressing meaning and semantics is more than XML, RDF, and RDF-Schema (RDFS). Hence, OWL goes beyond these languages for its ability to represent machine interpretable content on the Web.

In the USA, the development of DAML was started by DARPA led by James Hendler in 2000 (Hendler, 2000). The joint committee of US and EU on Agent Markup Language (AML) decided to merge DAML with OIL in 2001. The group working on the task was able to develop DAML+OIL as a web ontology language. It was intended to be a thin layer above the RDF Schema based on descriptive logic (DL) with formal semantic. OWL is a research base language revised from DAML+OIL and its aimed is a semantic web.

A set of documents describes the OWL Language, and each of these documents fulfils a different purpose, and has a different audience. A brief roadmap for navigating through this set of documents includes:

- This OWL Overview
- The OWL Guide
- The OWL Reference
- The OWL Semantics and Abstract Syntax
- The OWL Web Ontology Language Test Cases
- The OWL Use Cases and Requirements (McGuinness & Harmelen, 2004.)
The future vision of the Web is the Semantic Web (Berners-Lee et al., 2001). It is a Web which gives explicit meaning to the information, makes it easier for machines to automatically process and integrate available information on the Web. The XML's language ability to define customized tagging schemes and the RDF's flexible approach to representing data will be used in Semantic Web building (the Semantic Web will build on these two.) An ontology language is the first level above RDF required for the Semantic Web which can formally describe the meaning of terminology used in Web documents. The basic semantics of RDF Schema is not enough for machines to expect them for performing useful reasoning tasks on these documents. More details on ontology is provided by the OWL Use Cases and Requirements Document. OWL is an important part of the growing stack of W3C Semantic Web components (McGuinness & Harmelen 2004). Three languages: OWL Lite, OWL DL, and OWL Full are used respectively by communities, members, and implementers according to their needs. (Smith, McGuinness & Welty, 2004).

The semantic web is comprised of the following standards and tool of: XML, XML Schema, RDF, RDF Schema and OWL which are organized in a semantic web stack.

- **XML**, provides a surface syntax for structured documents, without imposing semantic constraints on its meaning. [http://www.w3.org/TR/owl-features/](http://www.w3.org/TR/owl-features/)

- **XML Schema**, is a language that restricts the structure of XML documents and also extends XML with data types.

- **RDF**, provides a simple semantics for the data models and their relation, which can be represented in XML syntax.

- **RDF Schema**, a vocabulary that describes properties and RDF resources classes.

- **OWL**, adds more vocabulary for describing properties and classes and the relations between classes.

- **SPARQL**, the semantic web uses this as a protocol and a query language for the data sources.
- Rule Interchange Format (RIF) is standard format and a rule layer of the Semantic Web Stack which is progressing.

**Tim Berners-Lee version, 2006**

![The Semantic Web Stack](http://www.w3.org/2006/Talks/0718-aaai-tbl/)

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The importance of the traditional Web to the people is that it offers many different things to many different people and the oncoming Semantic Web will multiply this various opportunities even a thousand times more in number. The defining feature of the Semantic Web will ease the PDA, laptop, desktop, server, and the user communication with each other. It will automate the corporate decisions that previously had to be manually processed for other people. It will provide the ability to assess the trustworthiness of documents on the Web as well as the remarkable facilities and abilities to find the answers to the users’ questions. The questions of processing of information by machine which are not answered yet. Regardless of the causes mentioned above, there are enough reasons that almost everyone can find one and agree to support this grand vision of the Semantic Web for themselves and others. Certainly, it will take a
long way from a traditional web transition to the Semantic Web and there is no guarantee that this goal will be achieved but some progress has been already made so far in this field. There are many possibilities to achieve the goal step by step and one by one. The journey has started and hopefully will achieve this rewarding task.

3. **DOMAIN KNOWLEDGE**

The structure and interpretation of the domain knowledge (discovered mineral deposits in Afghanistan) is the study of this report which is represented by a proposed sample Semantic Web. In the beginning, some general information to the past history of the minerals and their usage in the Stone Age, Iron Age, and Industrial Revolution era is reviewed.

Mineral deposits in Afghanistan worth billions of dollars and form the backbone of the economy and are vital to the promotion of other sectors. But the shortage of trained and skilled personnel, proper tools, equipment, technology, and investment in the mining sector has caused to slow down the progress in this sector. If explored, extracted, exported, and used according to the international minerals norms and standards, revenue will be generated, employment will be provided, businesses will be nourished and peace and security will maintained in the country. For the full usage and utilization of the deposits, the private sectors, both national and international should be supported and encouraged to make investment in the mining sector. Private investors play very important role and are welcomed to explore the deposits.

**Definition of Terms and Acronyms**

AGS: Afghanistan Geological Survey

AIMS: Afghan Information Management Service

AISA: Afghanistan Investment Support Agency
AMGPA: Association of Marble and Granite Producers of Afghanistan
ASTER: Advanced Space borne Thermal Emission and Reflection radiometer
BGS: British Geological Survey
EIS: Environmental Impact Statements
EMP: Environmental Management Plans
GGM: German Geological Mission
GGCG: German Geological Consultative Group
GMF: Geological Mission of French
SUM: Soviet Union Mission
USGS: United States Geological Survey

**Definition of Terms** (Schlager, Ed Neil 2002)

ALLOY: A mixture of two or more metals

ATOM: The smallest particle of an element, consisting of protons, neutrons, and electrons. An atom can exist either alone or in combination with other atoms in a molecule

CLEAVAGE: A term referring to the characteristic patterns by which a mineral breaks and specifically to the planes across which breaking occurs

COMPpOUND: A substance made up of atoms of more than one element, chemically bonded to one another

CRYSSTALLINE SOLID: A type of solid in which the constituent parts have a simple and definite geometric arrangement that is repeated in all directions

ELEMENT: A substance made up of only one kind of atom. Unlike compounds, elements cannot be broken chemically into other substances.
HARDNESS: In mineralogy, the ability of one mineral to scratch another. This is measured by the Mohs scale

HYDROCARBON: Any chemical compound whose molecules are made up of nothing but carbon and hydrogen atoms

LUSTER: The appearance of a mineral when light reflects off its surface. Among the terms used in identifying luster are metallic, vitreous (glassy), and dull

MINERAL: A naturally occurring, typically inorganic substance with a specific chemical composition and a crystalline structure. Unknown minerals usually can be identified in terms of specific parameters, such as hardness or luster

METALLURGY: The study of metals

MINERALOGY: The study of minerals, which includes a number of smaller sub-disciplines, such as crystallography

MIXTURE: A substance with a variable composition, meaning that it is composed of molecules or atoms of differing types and in variable proportions

MOHS SCALE: A scale, introduced in 1812 by the German mineralogist Friedrich Mohs (1773–1839), that rates the hardness of minerals from 1 to 10. Ten is equivalent to the hardness of a diamond and 1 that of talc, an extremely soft mineral

NUCLEUS: The center of an atom, a region where protons and neutrons are located and around which electrons spin

ORE: A rock or mineral possessing economic value

PERIODIC TABLE OF ELEMENTS: A chart that shows the elements arranged in order of atomic number, along with the chemical symbol and the average atomic mass for that particular element
PURE SUBSTANCE: A substance, whether an element or compound, that has the same chemical composition throughout Compare with mixture

ROCK: An aggregate of minerals

STRATIGRAPHY: A branch of geology that studies rocks layers and layering

STREAK: The color of the powder produced when one mineral is scratched by another, harder one

TECTONICS (the study of the earth's structural features)

3.1 Past Development of Minerals

Afghanistan is rich in its mineral resources; however they are not effectively developed during the 20th century (Peters et al, 2007). Furthermore, the mineral resources have not been studied through the modern mineral resource assessment methodologies. The available mineral resource information and an estimation of known resources was collected between the early 1950s and about 1985, a time when Afghanistan was provided with technical assistance from the Union of Soviet Socialist Republics (USSR) and its Eastern European allies. Systematic geologic mapping, collection and analysis of rock and sediment samples, airborne geophysical surveys, and systematic mineral exploration are part of mineral resource studies. The libraries of Ministry of Mines (MOM) and the AGS has many maps and reports from this era even though that many were taken to the USSR, Eastern European countries, or elsewhere by the end of Soviet intervention in 1989. USGS gained and collected these materials which provides for the accurate foundation of this preliminary non-fuel mineral resource assessment.

A broad variety of non-fuel mineral resources is identified. This includes deposits of copper, barite, iron, chromium, sulfur, silver, rubies, emeralds, talc, magnesium, salt, mica, marble and lapis lazuli. The Soviet Survey defined the potentially usable deposits of asbestos, nickel, mercury, gold, lead, zinc, fluorspar, bauxite, beryllium, and lithium by 1985 (Peters et al, 2007). The government of Afghanistan was organizing several of these deposits for development
when the Soviet involvement began, thus further development was stopped during the following years of war and civil conflict.

An important and well known deposit is the Haji Gak iron deposit which is located in Bamyan Province, about 90 km west of Kabul. This deposit is located in a 30 km long discontinuous east-trending zone of iron concentrations. The Khaish iron deposit is also part of this discontinuous zone. The magnetite and pyrite, with some chalcopyrite, and which averages more than 60 wt percent iron makes the primary ore. A fraction of the ore is oxidized to some forms of hematite. A total of more than 2 billion metric tons of reserves is identified by the Soviet exploration. This is an amount that is approximately equivalent to the worldwide annual production of iron ore. In 1983, development had begun after a feasibility study was completed (Peters et al, 2007).

The Aynak sediment-hosted copper deposit as well as the smaller Darband and Jawkhar copper deposits are also very important deposits. These deposits are located about 30 to 40 km southeast of Kabul and Logar Provinces. Here, copper has been mined for more than 2,000 years. In 1980s, a drilling program was conducted that identified a minable resource of 240 million metric tons of ore grading about 2.3% copper. In the surround area, there are also more than 30 other occurrences. In about 1985, a mill and a smelter under construction were neglected (Peters et al, 2007).

In the early 1980s, a small amount of chromite ore from was mined A minor amount of chromite ore from two deposits, Mohammad Agha in Logar Province about 30 km south of Kabul and Hesarak in Nangarhar Province about 90 km southeast of Kabul, was mined in the early 1980s. In the surrounding areas, there are also many small chromite deposits are located.

Beginning 1977, the Sangilyn vein barite deposit about 40 km northwest of Heart produces about 12,000 metric tons of barite each year. This deposit not only assets about 1 million metric tons of ore, it also contains small amounts of copper-, lead-, and zinc-bearing sulfide minerals.
Precious and semi-precious gemstones were a major industry in Afghanistan before the Soviet intervention. Afghanistan is still one of the world’s leading sources of lapis lazuli. Other major products include emeralds and rubies. The production of gemstones declined during the civil war. Badakshan and Nuristan provinces in northeastern Afghanistan provide most of the gemstones come from Afghanistan (Peters et al, 2007).

3.2 Stone Age

Humans have long been fascinated by the properties of stone (TACoN, 1988.) Some of the stone qualities such as hardness, durability, color, coarseness, size and situation in larger landscapes are stimulated human imagination and interest to use the stone. Shaping and forming of stone and wood objects had important value to the culture of the society at that time. For example, stone spear-points objects were not seen to be used for its purpose but also as part of their belief system of which they were practicing.

About 6000 years ago, Quartzite was used to make uni-facial and bi-facial stone spear-points. The development of polychrome paintings at sandstone and quartzite sites corresponds to this. They painted stone objects for use in important rituals and ceremonies concerned with life, the after-life or rites of passage. Use of spear-points was a male dominated activity. Stone objects were used by men to promote, extend and create life, a more typically female dominated activity.

In terms of availability of raw material and hardness, quartz and chert would be more effective. Furthermore, quartzite use was linked to the introduction of stone point technology. The changes in tool form, material and manufacture indeed tell us that how much the social, symbolic and aesthetic influences are important and have to be considered. In the Stone Age era, people used to use very basic tools to fulfill their needs and were able to survive with little resources available around them. They used sharp rocks, for example to cut things they needed to cook and eat.

In addition, for lighting and producing fire, the white small size stone were used. Also, people used flat circular and thin shape of rocks for cooking pots and thick rocks for making
wheels. Even today people in rural areas of Afghanistan uses stone wheels for their water-mills (Kooymans, 2000).

As most of the people were living individual life in the caves and deserts, gradually, they realized that life will be not easy on them unless they form the societies and share their scarce resources, skills, knowledge, responsibilities, and other available means at that time for a better future. With the development of science and technologies in the field of industries, medicine, aviation, computer software and hardware technology, and other countless areas, people made a very good progress in very aspect of their lives. They explored ways and means to discover and invent what they needed to use for the betterment of their lives.

3.3 Iron Age

The discovery of the iron metal at the early 18th century caused an industrialization revolution and paved the path for today’s economic development and progress not only in the developed countries but also in underdeveloped countries such as Afghanistan. Natural and political conditions enabled Britain to pioneer the Industrial Revolution during the 18th century (History of Great Britain, n.d).

Naturally, the country has a large amount of three important commodities - water, iron and coal. In the early stages of industrialization, the water from Britain's hilly districts is used to provide the power to drive mills. The rivers were used to form network of canals, from 1761, to assist in the inland transport at the time where there were only rough and nonmetal roads and the sea, not far from any part of Britain. It makes transport of heavy goods easy not only between coastal cities of the country but with other neighbor countries as well (History of Great Britain, n.d).

Iron working had been restricted by a practical consideration until the early 18th century. Because, the smelting of iron required large quantities of charcoal which were expensive, with little result that ironworks were expected to access in the middle of forests.
Abraham Darby who was an ironmaster in 1709, and had a furnace at a place called Coalbrookdale on the river Severn, discovered that coke which were cheaper than charcoal can be used as an alternative to charcoal for the smelting of pig iron, which was used for cast-iron products. Due to Darby efforts and hard work, this Severn region in the early stages of Industrial revolution became Britain's first centre of iron. The Darby family's own construction of the first Iron Bridge is the witness of this achievement, and in the achievements of John Wilkinso (History of Great Britain, n.d).

3.4. A Brief History of Geological Studies in Afghanistan

Afghanistan has been a famous source of precious and semi-precious stones especially lapis lazuli (Lajward), a stone prized throughout history both for jewelry and coloration (Afghanistan Geological Survey).

Despite its important location within the historic trade routes and importance of its gemstones sources, little is known about the ancient mines of Afghanistan and few written records exist. During 1800s, systematic attempts were made to evaluate the “physiography and resources of the region, initially by British military expeditions, followed from time to time by surveys conducted under the auspices of the Geological Survey of India. During the 19th Century and through to the mid-1900s the region various geological expeditions investigated areas along the main caravan routes and later along the arterial motor roads” (Afghanistan Geological Survey). The pioneers C.L. Griesbach, E.W. Vredenburg and H.H. Rayden in these studies were followed by R. Furon and E. Trinkler (428); Mme Cizancourt and H. de Vautrin; K. Brueckl, J. Barthoux, F. Clapp, F. Rives, H. Kirh and A. Drat (292); D.West (440); Abdul-Khan and Hulyam-Ali Khan. The foundation of the present day knowledge of Afghanistan’s geology was laid out by these studies.

When the Government of Afghanistan inaugurated the National Geological Survey in July 1955, a new era of in the study of Afghanistan's geology and mineral resources began. This lead to the beginning of systematic surveys of the geology and mineral resources, which was continued through the next 25 years in the country. During this period, extensive mapping operation was seen by “geological surveys and prospecting of mineral occurrences and more
detailed evaluation of selected prospects” (Afghan Geological Survey). Under the ministry of Mines and Industries, the Afghanistan Geological Survey conducted the work with the help from German, Italian, French, and Soviet geologists. Some assistance was also received by the Geological Survey in its first years of existence from the United Nations organizations.

From April 1959 until 1967, a German geological mission (GGM) and the German Geological Consultative Group (GGCG) conducted studies in Afghanistan and focused more on collecting geological maps. In early 1960s, an Italian expedition published works on the geology of the Western Hindu Kush, Badakhshan and Wakhan. These provide data on igneous complexes, stratigraphy (a branch of geology that studies rocks layers and layering), tectonics (the study of the earth's structural features) and the relationship between Hindu Kush, Pamir, Karakorum and other areas’ structures.

In 1985, a French Geological Mission began work and which was led for many years by G. Mennessier, mainly in western Hindu Kush, Hazarajat, central Afghanistan, the Kabul area and Nuristan. During the years 1968 and 1978, the Afghan Government was assisted by a Soviet Union mission with a systematic geological mapping program of Afghanistan. Their investigation recorded more than 1 254 mineral occurrences. This was carried out first at the Department of Geology and Mines in 1974 and later at the Department of Geological and Mineral Survey. The above mentioned (1968-1978) period was the most important “phase of mineral exploration to date and resulted in the production of a large number of reports on mineral occurrences and prospects” (Afghanistan Geological Survey).

The Russian invasion of Afghanistan in December 1979 slowed down the Geological investigations after the country effectively became closed to western countries’ mining experts and geologists. Before their invasion, the geology of Afghanistan was well known in more detail
in the region than any other region of the Himalaya. The presence and occupation of the Russian
caused the western nations to suspend their interests and the Afghan geological community
became isolated as a result of the disengagement. During that time of military conflict, the
Afghanistan Geological Survey became very weak for more than two decades, and suffered a lot
from lack of security, investment, skills development, and was unable to perform an active
implementation role.

After the withdrawal of the Russian in 1989, the internal fight continued between the
different Mujahideen (freedom fighters against Russian) factions. The AGS office was in the
front line of fighting and was severely damaged. During the entire period of conflict and later
during the Taliban rule, the AGA staff kept and protected documents, maps, and samples, at
great extent of their own and their families’ risks. When the Taleban left Kabul in December
2001 these precious documents were returned to the Survey department by their loyal personnel,
to whom Afghanistan owes a debt of gratitude.

After the fall of the Taliban regime, the Government of the Transitional Islamic State of
Afghanistan, began to formulate a mining sector strategy and policy with the assistance of the
World Bank, In addition to other needs, it recognized the need for the rehabilitation and
restructuring of a modern Afghanistan Geological Survey (AGS) in order to perform and
implement programs of geological mapping and resource assessment utilizing modern
technology, concepts and methods.

In 2004, the United States Geological Survey and the British Geological Survey started
collaborative projects in response to the need, with the Afghanistan Geological Survey and
Ministry of Mines and Industries. The fund for these projects is provided by the Governments of Britain and the United States of America respectively. The implementation will include a comprehensive program of capacity-building, geological mapping, evaluation of mineral and hydro geological resources, the creation of geological and mineral databases, and geographical information systems. An office for the mining cadastre staff will be established. Afghan geologists will be trained in comprehensive training programs (Afghan Geological Survey). Based on the existing understanding of the subject, the Geological observations are made accordingly. Subsequent advance in knowledge, improved methods of interpretation, and better access to sampling locations and the full cooperation of all the stakeholders can affect such observations.

3.5. Categories of Minerals

The minerals are divided into two main categories, Non-silicate and Silicate minerals.

12.1 Non-silicates Minerals:

- Diamond: It is made from pure carbon and the hardest mineral.
- Graphite: It is also made from carbon but is soft compared to diamond.
- Gold: Its Latin name is Aurum (Au) and called Thela (Srehszar) in Afghanistan. It is one of the noble metal. It is discussed later in the report.
- Silver: Its Latin name is Argentu (Ag) and called Thela-user-safeed (Speenzar) and is found together with copper and gold in nature.
- Platinum: It is one of the important industrial metals and was known to Egyptian before AD.
- Copper: Its Latin name is Cuprum (Cu) and was known to the people from very long time. It is discussed later in the report.

- Sulphur: Its symbol is S and is used in matches, medicine and gun powder.

- Halite: Its chemical name is Sodium chloride (NaCl) and used as a salt in food everywhere in the world.

- Pyrite: Its chemical name is Ferrous Sulphide (FeS2). It is used for making H2SO4.

- Hematite: It is called Hajaradam in Arabic and Tha Winoodabara in Pashto languages because of its red color. It is a ferrous oxide (Fe2O3) and is found in Hajigak, Banyan of Afghanistan at huge quantity. It is discussed later in the report.

- Limonite: It has similar structure to Hematite but has more water in its composition. Its chemical formula is (Fe2O3.3H2O) and has color from brownish to yellowish. This is why it is called Limonite.

- Magnesium oxide: It has many oxides as ferrous. Pyrolusite is one of them which make many of its mines in nature.

- Calcite: Its chemical formula is CaCO3, and reflects the light doubly. It is one of the mineral which is found in large quantity after Quartz in sedimentary rocks.

- Gypsum: Its chemical formula is (CaSO4.2H2O) and is found in sedimentary rocks. It is used in molding, coloring and building construction (UNO Education Press, 2003).

12.1.1 Iron

The iron name is an old English word for the metal (Clark, 1993). Iron deposits are found in nearly 100 locations and recorded to date in Afghanistan. Different number of styles and ages of the iron metal are distributed across the country.
The mining exploration was carried out between 1960s and 1970s and it is worth to further review these deposits in the light of modern geological models. Hajigak is one of the largest iron deposits in Afghanistan. Hematite, Limonite, Magnetite, Eliminate, and Siderite are the important minerals of iron.

**Hajigak deposit**

The best known iron-oxide (Hematite) deposit in Afghanistan is located about 100 km west of Kabul in Bamyan province. Other location of this metal has been identified in the east-west belt around 600 km from Herat to the Panjsher River. The formation of iron-bearing is in a sequence of sedimentary and volcanic rocks of Proterozoic age (Afghanistan).

The extension of the deposit covers around 32 km. It contains 16 separate zones, up to 5 km in length, 380 meters wide and extending 550 meters deep. Seven of these have been studied so far in details. The ore occurs in both oxidized and primary states. The primary ore, composing 80% of the deposit, occurs below 100-130 meters and “comprises magnetite and pyrite, with minor other sulfides including chalcopyrite”, and averages 61.3% Ferrous, 5% sulphide and 0.05% P (Afghanistan). The rest, 20%, is oxidized and has three hematitic ore types at 62.8% Ferrous. Russian estimated 1700 metric tons for the entire deposit even though for the oxide ore in the most explored area are 85 metric tons. In 1972, a study by a Franco-German group was undertaken. It included the construction of a blast furnace in the area.
Copper:

The name of copper is derived from Greek "kyprios", of Cyprus, the location of ancient copper mines; Latin "cuprum" (Clark, 1993). Copper is one of the metals which is known to people from very long time. It has many important minerals which are used for the copper extraction such as: cuprites Cu2O), tenverites (CuO), Chalcosite (Cu2S), covelite (CuS), bronite (Cu5FeS4), malkhite CuCO3.Cu(OH), and chalcopyrite (CuFeS2). Aynak is one of the important mine.

The Aynak copper mine is located in Logar province at distance of 30 km to southeast of Kabul, Afghanistan. Since ancient time, this mine has been the focus of copper working. “Numbers of old excavations, pits, and the remainders of smelting furnaces have been
discovered at Aynak, and nearby locations of Darband and Jawkhar” (The Aynak Copper Deposit).

In 1974, Russian geologists prospected and mapped the Kabul area and re-discovered the Aynak, Darband and Jawkhar copper prospects. In 1974–76 and then in 1978–89, the Soviet Geological Mission conducted a detailed exploration of Aynak. In 1989, the work was ceased with the withdrawal of Russian advisors from Afghanistan.

The Aynak anticline, which is asymmetrical and approximately 4 km in length and up to 2.5 km wide, dominates the structure of Aynak. In the central portion of the deposit, the Aynak copper deposit is composed of about 240 million tons of material with a grade of 2.3 % copper. The deposit is located in Logar, about 35 km south of Kabul.

In November 2006, the Ministry of Mines and Industries selected 9 international mining companies for tender. Furthermore, these companies were asked to submit comprehensive technical and financial proposals for the development of the Aynak copper deposit (Afghan Geological Survey, 2006)

The names of the companies were as follows:

• Bahar Consortium of Australia
• Hindalco Industries Ltd. of India
• Hunter Dickinson, Inc. of Canada
• Kazakhmys Corporation LLC of Kazakhstan
• MCC China Metallurgical Group Corporation of China
• Phelps Dodge Corporation of the USA
• Strikeforce Ltd (Soyuz-Metal-Resource) of Russia
• Tyazhpromexport of Russia
• Zijin Mining Group Company Limited of China

These companies were expected to send their representatives to Kabul in the coming future for reviewing the available technical data. They were expected to visit the Aynak site and meet the government officials. The government will evaluate their proposals and calculate the benefits to the people of Afghanistan. Furthermore, companies ability to provide a successful development of the deposits in a long sustainable base will also be evaluate.

Negotiations with the successful bidders will be concluded within the framework of Mineral Rights. The commencement of the development of this world-class copper deposit will bring prosperities and hope to the people.

With the cooperation of Afghan government, Gustavson Associates of Boulder, Colorado and the British Geological Survey have played a key role in providing information on the Aynak deposit to all interested parties or their representatives (Afghanistan Geological Survey).

Figure 3 . Aynak Cooper Deposit, Logar, Afghanistan (G.W. Bowersox, 1985)
Gold

The name of gold is derived from Anglo-Saxon "gold", yellow and its Latin is "aurum" (Clark, 1993). Gold has been used and extracted for centuries in Afghanistan. It has been mined in northern Afghanistan, in Zabul, Takhar, Ghazni and Kandahar provinces in the past. Today, the work of gold is almost solely from the Samti placer deposit in Zabul Province, by groups of artisanal miners.

Throughout Afghanistan, 112 gold occurrences are recorded and still significant geological potential exists for further discovery of the gold mining. Although a number of considerable systematic explorations have been conducted in the past, which led to the discovery of some gold deposits, the country has yet to be evaluated with the help of modern mineral deposit models and improved analytical methods. From a global perspective, its deposits are not explored enough and the potential for the discovery of gold mineralization is at a high level (Afghanistan).
Uranium

The uranium deposit was discovered in 1983. The mountains of Khawaja Rawash, located to the north of Kabul, provided for the production of Uranium. Soviet engineers are also have mined uranium at Koh Mir Daoud, between Herat and Shindand as well as in Kandahar’s Khakriz area. Even though not much information on this work is available, the potential for further discoveries in this field is high in Afghanistan (Export Promotion Agency of Afghanistan).

12.2 Silicates Minerals:

- Olivine: It has a yellowish green color like Olive that why it is named olivine. If it does not have iron in its composition, it looks colorless and very clear. It is formed in the
vacant places of the rocks and is called Chrysolithe (Zaberjed). Zaberjed is use in ornaments.

- Zircon: Its formula is ZrSiO4 and has different colors and used in jewelries.
- Topaz: Its chemical formula is Al2F2SiO4 and has different colors such as yellow, blue, pink, green and colorless. Its yellow color is very common and used in ornaments.
- Brielle: It is used for the production of the Beryllium and its two important types are Emerald (Zamarood) and Aquamarine. It is lighter than Aluminum and a hard metal and used in the airplanes and rockets industries. Its Emerald type which is used in jewelries is discussed later in the report. Aquamarine is also has a common use in ornaments. It is found at the Khenj area of Panjshir province of Afghanistan.
- Quartz: Its chemical formula is SiO2 and has different types such as Rock Crystal, Amethyst, Smokey Quartz, Fine Crystal (Iasper, Agate, Flint, Careol), and Amorphous Quartz (its Opel type which has different color is used in ornaments).
- Feldspar: Plays an important role in the composition of rocks and they are the same rocks which change into soil. Feldspars are divided into different important parts such as Orthoclase and Plagioclase. Kaolin (Chinese Khawra) is one of the plagioclase types when combined with water changes its color into yellowish color and used in making the Chinese’s pots.
- Lazorite (Lajward): Its chemical formula is 3NaAlSiO4 and has different colors such as dark blue, blue, benafsh, and greenish-blue. It is used in ornaments only and found in Sarsang area of Badakhshan province of Afghanistan. Its big mine is 130 km long and 30 km wide.
- Mica (Abrak): It has different types and has taken part in the composition of the majority rocks. Its Muscovite (Speen Abrak) which has different color is used in electrical instruments as insulator (UNO Education Press, 2003).

12.2.1 Marble

Marble, which has different colors, is one of the Metamorphic Rocks. It used for bricks, table top surfaces, and other pots (Bowersox, 1985). Afghanistan has large resources of dimensional rocks such as marble and has the potential to supply and export it to the Middle East and other Asian countries. However, the Afghan marble industry has suffered from a severe lack of investment and poor access to international markets over the past 30 years of war. Through the efforts of marble promotional events held in Dubai in 2007, for example, The Big 5 exhibition and the Afghan Marble Showcase, addresses these problems (Mitchell & Benham, n.d).

The exact size of the Afghan marble industry is not known, the existence of at least 130 factories producing marble, is indicated by the Association of Marble and Granite Producers of Afghanistan (AMGPA). Marble as rough-hewn blocks is exported to Pakistan by individual contractors with the government knowledge and assistance. Usually it is often transported back inside the county from Pakistan and is sold at a higher price after the product is turned to a finished and polished marble.

Due to a lack of proper equipment, the Afghan marble industry has little technical knowledge which can be seen from the uses poor extraction methods. This often degrades the value of the marble. Furthermore, using black powder, extraction is typically carried out by blasting. The black powder is obtained from military munitions, that causes micro fracturing and
thus high levels of wastage during quarrying and processing, resulting. Furthermore, it leads to poor quality of polished marble with a relatively high cost of production (Mitchell & Benham, n.d.).

Afghanistan, especially provinces such as Badakhshan, Balkh, Bamyan, Helmand, Herat, Kabul, Kandahar, Logar, Faryab, Wardak, Nangarhar, Paktia, Parwan and Samangan, is known for the occurrences of marble. Proterozoic age marbles provide one of the best quality marbles with some of the best-known available deposits in markets today.

Lack of enough professional and technical personnel on one hand, and their proper training and skills on the other hand will be one of the first priorities to be considered for the mining industries. For this reason the appropriate training of the personnel which will play an important role includes:

1. How to locate precious stone, gem, and mineral deposits
2. How to evaluate mineral deposits
3. How to operate in mineral mines
4. How to safely operate mines
5. How to use the tools and equipment
6. How to identify and grade the minerals
7. How to increase minerals production
8. How to increase profits with the proper care and handling of minerals
9. How to market raw and finished mineral product
10. How to increase cash flow through improved marketing system (GeoVision, April, 2004.)

With the implementation of the above proposed training activities the existing extraction methods will be improved and will prevent the wastage of the precious and valuable minerals and gemstones.
Emeralds (Zamarood)

The emerald-bearing zone in the Panjsher Valley occupies an area 16 km long by 3 km wide with the deposits at 3,000-4,000 m. The emeralds exhibit a rich green color and can occur in crystals up to 100 carats in weight. They are found in quartz-ankerite veins cutting altered gabbros. Their clarity is similar to that of often rivaling better known Columbian emeralds. The size of the Gem-quality crystals are up to 1 to 1.5 cm long, 2-3 mm thick, and rarely reach up to 5 cm long and 2 cm wide. The production estimated value is about US $8-10 million and its true value is not known. The exportation of the emeralds takes place through Pakistan (Gemstones of Afghanistan).
Rubies (Red Laal)

Rubies are found at Jegdalek- Gandamak in Kabul Province. They are colorless to a deep red, often purplish with strong fluorescence in ultraviolet radiation. True rubies form 15% of the production at Jegdalek; pink sapphires form 75% and blue sapphire 5%. The deposit occurs in a calcite dolomite marble bed 500-2,000 m thick within a regionally metamorphosed marble cut by Oligocene granitic intrusions. It is rare to find clean faceting quality but those that occur are very high in quality and it said it will match those from the very best source of rubies in the world at Mogok in Myanmar (Gemstones of Afghanistan).

Lapis lazuli (Lajwerd)

Lapis lazuli is found in Badakhshan province of Afghanistan which is known to provide the world’s premier source in terms of quantity and quality. Lapis Lazuli is a rock composed of the feldspathoid minerals lazurite, hauyne, nosean, sodalite, calcite and pyrite. On the right bank of the Kokcha River, the Lapis is mined on an area called Blue Mountain. Nests and lenses of the dark blue lapis lazuli rock occur in a wide band of marbles underlain by gneiss (Gemstones of Afghanistan).

The mines has an altitude of 3,300 meters, between the months June and September, the production from the mines is extracted, which has an approximate value of 9,000 kg/y with speculation.

A country very rich in gemstone, Afghanistan still falls at the bottom of the list for the values of its mines and gemstones. Increased security, recent changes to the legal framework for mining and the Afghan Government’s strategy for legitimizing the mining sector will improve
the prospects for investment and will increase standards and productions. Allied to the gradual development of Kabul as a centre for gem trade and the development within Afghanistan of value-added cutting and polishing centers, the country has the potential for a major internationally recognized gemstone industry (Gemstones of Afghanistan).

**Preliminary Non-Fuel Mineral Resource Assessment of Afghanistan**

Afghanistan is full of mineral abundance. Such mineral resources include deposits of copper, iron, barite, sulfur, talc, chromium, magnesium, salt, mica, marble, rubies, emerald, lapis lazuli, asbestos, nickel, mercury, gold and silver, lead, zinc, fluor spar, bauxite, beryllium, and lithium. By using geology-based assessment method, the U.S. Geological Survey and Afghanistan Geological Survey estimated the numbers of undiscovered deposits in Afghanistan. These surveys estimated nearly 60 million metric tons of copper of both known and unknown copper resources. In known deposits, there is 2,200 million metric tons of iron ore. A team of scientists in this assessment collected information about known mineral deposits and assessed the possible occurrence of unknown deposits of all types. For unknown deposits of deposits of copper, mercury, rare-earth elements, sulfur, chromite, asbestos, potash, graphite, and sand and grovel, quantitative probabilistic estimated were made at a depth less than 1 Kilometer. In the report, other deposits type also were considered (U.S. Geological Survey Report, 2007).

**Assessment Methods**

Estimation or an evaluation is known as an assessment. In this case, it is the estimation of the amount of undiscovered mineral resources in Afghanistan that is expected to be present within specific volumes of rock. According to U.S. Geological Survey Report, “resources are materials that are in such form that economic extraction of one or more commodities from the
material is currently or potentially feasible” (2007). If possible, to express the result in numbers, the assessment of non-fuel mineral resources is quantified. The result is presented probabilistically since uncertainty exists in the assessment of the unknown. The government decision makers and potential private investors and explorationists are provided with information on where undiscovered mineral deposits may be located, what kinds of deposits are likely to occur, and the kinds and how much metal or other commodity may exist in them from these mineral resource assessments. Any possible wise management of natural resources can be done with the help of such information.

An assessment of mineral resources can have many forms. A simple form can be a statement such as “Yes, this is a good place to look for minerals” (U.S. Geological Survey Report, 2007). Another form might have a comprehensive inventory of the nature, the location, and amount of known resources. The latter approach for mineral resource would be possible if the area was completely explored and there were no undiscovered deposits remaining. A team of scientists from both USGS and the AGS, using methods described by Singer and Cox (1988) and Singer (1993) which were used in U.S. National Assessment, conducted this preliminary assessment of non-fuel mineral resources of Afghanistan. The geologic map and mineral occurrences data bases were the main data used. Furthermore, mostly the deposit descriptions provided by Abdullah and others were used. In the report, the original references which are often in Russian are cited and referred in this assessment (U.S. Geological Survey Report, 2007).

Assessment Models
There are many models available for the minerals deposits assessment. Grade and tonnage is one of them which is described as:

Grade and Tonnage Models

The data for known deposits were reviewed by the team who were to decide whether or not worldwide models were appropriate for the tract. For the undiscovered deposits, the estimated should be similar in terms of grade and tonnage to known examples. A quantitative estimate can not be made if the models are not appropriate. According to U.S. Geological Survey Report, “many deposit types, these data are available in the form of grade and tonnage models in Cox and Singer (1986), Bliss (1992), and Orris and Bliss (2002)” (2007). Classification of mineral deposits and information about possible value of undiscovered deposits is provided by grade and tonnage models.

The deposits estimated should be consistent with the grade and tonnage model. For example, “if 10 deposits were estimated, 5 of them were considered to be larger than the median tonnage on the grade and tonnage model, and 5 of them are considered to have a higher grade than the median grade on the grade and tonnage model” (U.S. Geological Survey Report, 2007). The number of undiscovered district can be estimated if the grade and tonnage model is based on district data rather than data for individual deposits.

This document focuses on the information gathering of the recently discovered mineral deposits in Afghanistan and their appropriate structure presentation in a sample Semantic Web. The information shall be used as one of the primary resources for investors-public and private sectors, to invest in the trillion dollars industries to benefit themselves and the people of Afghanistan. To enhance the investment opportunities, the government and private sectors have
to arrange meetings, lectures, trade shows, documentaries, and sales events at the national and international level for the promotion of the industries. An important campaign is already started by the government and the ongoing negotiations are undertaken with numerous individual investors, private sectors, interested companies, neighbor countries, donors, and other interested parties.

3.6 Recently Discovered Mineral Deposits in Afghanistan

These recently discovered mineral deposits by the Geological Survey of the United States with collaboration of the government of Afghanistan (Raise, June 14, 2010) are shown in the following graph.

Figure 6. Mineral Deposits Graph
15. The Government’s Role in the Mining Industries

The laws, rules, and regulation for the mining industries in the country are enforced by the government of Afghanistan. Furthermore, the Environmental Protection Department is responsible for the environment protection and its role is defined in the following terms in the draft Minerals Law.

In coordination with other State officials, the Environmental Protection Department is responsible “for the protection of the environment, social welfare, local and indigenous populations and the natural and cultural heritage in connection with Mineral Activities” (Environmental Protection Department). According to the Ministry of mines, the following are the responsibilities of the department:

• “The recommendation and enforcement of Mining Regulations concerning the environmental and social protection with regard to Mineral Activities

• The technical evaluation of Mitigation and Rehabilitation Plan (MRP) submitted for Exploration Licenses

• The technical evaluation of Environmental Impact Statements (EIS) and Environmental Management Plans (EMP) submitted by Applicants for Exploitation Licenses, and

• Monitoring compliance by operators with the environmental and social requirements of the Law, the Mining Regulations and MRPs and EMPs”

Chapter VI of the draft Minerals Law provides further information on Environmental and Social Protection.

Minerals Law

In July 2005, a Minerals Law was passed by Afghanistan. With the aid of the World Bank, the law conforms to current international standards and thus was drafted. Work on
regulations is going to start and will provide more information about the processes of applying for mineral rights. Transitional provisions are contained in the new law which will cover the period before the regulations are publicized.

The Mining Law covers all naturally occurring mineral substances and artificial deposits, such as tailings and waste deposits. However, it does not cover such things as hydrocarbons and water, which are regulated by separate laws and excluded from this legislation.

The Government is responsible to promote an efficient development of the minerals industry by the private sector. Only accordance to the law, any State bodies can participate in mineral activities. The administration and implementation of this law is a responsibility of Ministry of Mines and Industries. To oversee its responsibilities for the mining sector, Mining Cadastre, Mining Inspectorate and Environmental Protection Departments are planned to be created in near future by the Ministry of Mine.

Accepting applications for mineral rights, coordinating their technical and environmental evaluation, processing renewals and collecting application and surface right fees will be a responsibility of The Mining Cadastre Department. Furthermore, they would be responsibility for keeping a national registry of mineral rights and to create and maintain the cadastral map by using GIS technology and modern database. In a transparent and open manner, the Ministry is obligated to apply the law in a first-come first-served principle.

Almost anyone registered in Afghanistan, including foreign citizens who are legally residing and foreign companies with a registered local office, are eligible to apply for mineral rights. Government employees, including members of the arm forces, and civil servants are however, not eligible. Notably, a section on investment security is also included in a section of the Law. It allows the Ministry to guarantee the holder of a mineral right and protect them
against any financial cost that might occur due to changes in legislation. The State is not allowed to seize Mineral Rights without enough reimbursement in accordance with international standards. The Mineral Rights are composed of licenses that are issued for metals, industrial minerals, ornamental rocks, gems and authorizations that are issued for quarry, and construction minerals.

An exploration license is issued for three years and with two renewals of three years. It allows for an extension for up to 250 km. Each renewal requires a 25% reduction in area. Those with exploration rights are automatically allowed to apply for a development license if they discover a profitable deposit. These license holders which can last for about 30 years and with 5-year renewals up to the life of the mine can cover an area of up to 50 km.

The evidence of financial capability and completed feasibility studies; development plans; environmental and social impact assessments; and an environmental management plan including a social mitigation plan, rehabilitation and mine closure plans are conditions for granting of exploitation license (Afghanistan). Exclusive rights to the area covered are given by both licenses. However, they can overlap with quarry authorizations with the holder’s permission.

For small mines and with the use of semi-industrial methods, one can be granted a small-scale exploitation. A surface geological exploration and aerial or remote sensing is called prospecting. Such has to register with Ministry of mines and industries, but does not need a mineral right.

It is non-exclusive and conveys no prior rights to a mineral right. Quarry materials are non-metallic mineral substances that are useful in building, road making, general construction purposes, ceramic clays, lime, cement, and crushed rock (Afghanistan). Quarry authorizations
are needed for exploration, exploitation, temporary exploitation and tailings exploitation. The law provides further details on the extent and duration of these rights.

For artisanal exploitation, authorizations also have to be issued. Such authorization may cover mineral substances including metals and gems. When the producer does not carry out trading and exporting of minerals, authorization from the Ministry of Mines and Industries is needed.

The law includes the rates of mineral royalties which range from 5% of gross revenue for industrial minerals and up to 10% for gemstones. A definition of other fees for applications and surface rights is given in the regulations. For public tenders and mining contracts, a special provision is made. In order to award mineral rights on well known deposits, such as the Aynak copper deposit, the public tenders will be utilized. For larger deposits, mining contracts may also be agreed with mining companies which will add to and not contradict the Minerals Law. Special provisions such as taxation and customs will be allowed by such contracts (Afghanistan).

The Role and Importance of Transportation

Afghanistan is a landlocked country and does not have access to the sea ports directly from its borders. Therefore, the exploration and exportation of the mineral deposits from Afghanistan will be greatly affected by this limitation. The development and promotion of the Transportation and Logistics Sectors will support Afghanistan’s trade with countries in the region and worldwide.

The infrastructure of the highways and roads plays an important role in the development of the mining and transportation industries and their export to international markets. The existing highways and roads mentioned in the following section are not enough for the deposits
transportation because it will be very expensive to transport the minerals and other commercial goods inside the country from one location to another as well as to the neighboring countries and international markets. To overcome this problem one can suggest a railway system to be built with the help of international funding agencies and other donors to connect the neighboring countries with Afghanistan. China is has a great potential for the deposits to invest. It has a common border with Afghanistan and has already invested in copper mining industries. Although, the transportation of the minerals is expensive via the land from Afghanistan to China but is still profitable compare to other countries in the region. Because of its interests and willingness a railway system could be constructed from its border to inside Afghanistan. A budget proposal for the construction of the railway system should be prepared in the near future by both parties.

Roads and Highway Inside the country

As Afghanistan did not have any access to the ocean most of its trades and commerce were taking place either through the land transportation or air. The important roads inside the country which connect different parts and play a vital role in the transportation of agricultural, commercial, industrials and other products and commodities are as follow.

1. The highway between Kabul and Tourkhan is 224 km long and 10 m wide.
2. The Salang highway/ road between Kabul and northern part of the country is 107 km long and has 2762 m long tunnel.
3. The highway between Kabul and Jabelseraj is 77 km long and 10m to 11 m wide.
4. The highway between Dushi district and Shirkhan Bandar (commercial border with Tajikistan) is 214 km long and 10 m wide.
5. The highway among Tourghundi, Herat and Kandahar 678 km long and is 12 m wide.
6. The highway between Herat and Islamqala (a border town with Iran) is 121 km long and.
7. The highway between Kabul and Kandahar is 483 km long and connects Kabul, Kandahar and Speenboldak (a border town with Quetta, Balochistan)
8. The highway between Kabul and Herat was surveyed and its construction was not started at the time when this Geography subject was written.
9. The highway among Pulkhumri (capital city of Baghlan province), Mazardashif (capital city of Balkh province), and Juzjan province is 321 km long (Javed & Saleh, 1977).

16.2 Transport and Logistics Sector

The transport and logistic sector represents a vital supportive industry to other sectors which will give the ability to perform well when upgraded. New and expanding trade routes of Afghanistan are offered to the world community. Both in country and across its borders, Afghanistan’s trade connection is supported by the improvement of its transport infrastructure. A 60% of overland transportation to or from Pakistan, 30% to or from Iran, and a combined 10% through borders with the Central Asian republics is estimated. To its north, in Turkmenistan, Uzbekistan and Tajikistan, there is a flow of goods and commodities on main transit routes south through Afghanistan to Iran, particularly to the ports of Bandar-e ’Abbas and Chah Bahar, and to Pakistan in Gwadar and Karachi. Afghanistan and Tajikistan will link by a planned bridge to the Amu Darya (Oxus) River, carrying large traffic along the borders with Turkmenistan, Uzbekistan and Tajikistan. Within Afghanistan, the country’s key commercial centers such as that Kabul is connected to Kandahar in the South, Herat in the East, and Mazar-e Sharif in the North by main Ring Road. There are other roads that extend to borders crossing Pakistan, Iran, and other counties in the neighbor (Afghanistan Investment Support Agency).
The growing market of Afghanistan’s logistics and transportation services provide new providers with a ground-floor opportunity. Firms of all sizes and origins, both from domestic and foreign, have access to this opportunity. The field is virgin territory for many services even with an increasing investment in the sector. To establish a first mover advantage and customers, this is the right time. Modest start-up costs and quite low expenses are reported by early investors. In addition, large volumes of freight are moved by smaller operators.

A geological-strategic advantage is offered by Afghanistan to investors in the Logistics and Transport Sectors. Afghanistan for centuries has been a center for connecting Asia, Europe and the Middle East. Even today, the location of Afghanistan provides for a strategic gateway and can thus serve landlocked countries to the north and the Iranian and Pakistani seaports to the south (Afghanistan Investment Support Agency). To the Central Asian republics and Russian industrial centers of western Siberia, Afghanistan provides the shortest route. Afghanistan offers Pakistan a main route for trade with Central Asia. Afghanistan shares borders with six different countries: Iran, Turkmenistan, Uzbekistan, Tajikistan, China and Pakistan. Indeed, Afghanistan is known as a land bridge that connects country markets and large trading partners, such as Iran and India. Furthermore, Afghanistan links Middle East to Southern, Central and Southeast Asia, and therefore offers a point of access to an extended regional market of more than 2 billion people.

In Afghanistan, commercial transport is a high-growth sector. The demand for transport services is anticipated to stay strong in the medium and long term among the commercial markets as well as the donor community. There is an immediate and an unlimited demand for both industrial materials and consumer products in Afghanistan. It is expected that transport volumes for commercial goods, which are almost double that of donor material to rise as there is
improvement in Afghanistan’s commercial infrastructure. There is an increase in transshipment of goods through Afghanistan as a result of improvement in infrastructure and security.

Provision of cold transportation and storage facilities, for example cold rooms and refrigerated trucks and containers, are high in demand in the logistics sector. Due to poor packaging, about 20-40% of post-harvest horticulture products are wasted. Throughout Afghanistan, there are less than 50 refrigerated trucks available for cold storage transportation (Afghan Investment Support Agency, Priority Sectors).

17. Three Good Reasons to Invest in the Mineral Deposits (Afghanistan Investment Support Agency)

1. Afghanistan is emerging as an important growing market of mining industries in the world.

   Afghanistan connects Central Asia and the major seaports in South Asia and provides an important transit route for these countries to export their goods to other countries. It also provides land access to markets of other countries as China, India and Pakistan. China has great potential for investing in the mining sector and is a fast growing economy in the world.

2. Afghanistan offers a favorable investments environment to private and pro-business minded investors.

   The constitution has incorporated the free market economy in the law and has emphasized on the growth of the private sector as part of the National Development Strategy. It is focused on the removal of obstacles to private sector development in the constitution.
3. Afghanistan is rich in natural and in mineral resources. More than 1,400 mineral deposits are identified in different part of the country. Iron and copper deposits of world quality, oil, gas and coal are the most important resources. Alabaster, emerald, jade, amethyst, beryl, lapis lazuli, tourmaline, ruby, quartz, sapphire and topaz are known precious and semi-precious stones in Afghanistan. There are great opportunities for investors to invest in the existing mining and hydrocarbon industries. The national privatization program of most of the major state-owned enterprises has made it easier for international tender to get involved (2006-2008, Afghan Investment Support Agency).

4. REQUIREMENTS ANALYSIS

Most software projects starts with Fuzzy requirements (Leffingwell and Widrig, 2003). Requirements are then improved through an iterative process. The purpose of clarity requirements are usually grouped into Functional and Non-Functional Requirements (Pressman 2005; Sommerville 2010).

For a successful project, the requirements should be identified in the initial stage of the project and managed through out the project. A considerable amount of time should be spent during the requirements gathering stage of a project. The level of the requirements details and their understanding often determines the types of software process models such as the lifecycle model (Pressman 2005), Boehm’s spiral model (Boehm 1986) or Agile model (Schwaber 2004). Requirements analysis is used for development and types of techniques to employ in the development process. Requirements will evolve or change during the development process so the developers have to plan for it and make adjustment when required. Requirements analysis provides information, function, and behavior that can be translated to architectural, interface and component-level design (Pressman, 2005).
4.1. Functional Requirements

In order to enable the user to accomplish their tasks, the functional requirements which specify the software functionality, is built into the product by the developers and thus satisfies their business requirements. Functional requirements can sometimes be called behavioral requirements, and have the traditional “shall” statements. What the developer needs to implement can be described by functional requirements.

The top-level requirements for a product that contains multiple subsystems, also known as a system can be described by the term system requirements. A system can be a component of all software or it might also include hardware subsystems in addition to software (Wiegers, 2003).

In software engineering, a function of a software system or its component is defined by a functional requirement. A function is a set of inputs, the behavior, and outputs (Functional Requirements Multimedia Information). Calculations, technical details, data management and processing and other explicit functionality defining what a system is supposed to accomplish is known as functional requirements. They are supported by non-functional requirements, which are known as quality requirements that enforce restrictions on the design and implementation of performance requirements, security, or reliability. The functional and nonfunctional requirements are expressed by the “system shall <do requirement>” and “system shall be <requirement>” respectively.

4.2 Use Cases
Use cases are the most important elements of requirements analysis (Leffingwell and Widrig, 2003). Use cases allow representing important user scenarios. Use case diagrams typically represent use cases in a graphical way.

**Figure 5. A use case diagram for accessing the semantic web**

Actor: User

1. The user starts the program.
2. The system displays user login window.
3. The user enters his or her user ID.
4. The user enters password.
5. The system displays error message.
6. The user re-enters his or her password.
7. The system displays Main menu.
8. The user selects the view details mineral information button.
9. The user generates comments or message.
10. The user selects Exit button.
11. The system exits and ends the program.

4.3 Nonfunctional Requirements

Nonfunctional requirements deal with the essential quality of software. Features such as performance, usability, reliability, supportability etc. are considered under nonfunctional requirements. The following aspects are noted for this project:

- Minimum training shall be provided for the user.
- Additional updated training shall be conducted for System Administrator for managing user information.
- Additional updated training shall be conducted for Database Administrator to manage data.
- An investor or user shall be able to search desired mineral information of five pages within one minute.
- An investor or user shall be able to print or view the file within 20 seconds.
• The Semantic Web system shall be judged by users and investors in terms of its usability compared to traditional web. At least it shall be assessed by 90-95% users.

• The system shall be reliable and 99% of failure should be resolved within twenty-four hours of the reported error.

• The system shall process all viewing and details information within twenty seconds provided that the information is available within three clicks of the mouse button.

• The system shall process five-page information approximately within two minutes including its printing.

• The system shall be able to support the availability of the related information to users without limitation.

• The system development shall use HTML and XML languages at the front end, and SQL Server on the back end as a database management system.

• Provide a logical structure to the information that can be used for displaying in the web.

• The Semantic Web subsystem shall organize information to be used by the user or investor.

• The Semantic Web subsystem shall structure information in a way useful to the user and machine with using the web ontology language.
• All related mineral deposits information should be available to the user within 3 clicks from the main site.
• The Semantic Web subsystem shall accept comments or message from user.
• The Semantic Web subsystem shall allow the user to create, delete, and modify metadata record through a web-based interface
• The Semantic Web subsystem shall allow the user to cut and paste metadata record through a web-based interface
• The Semantic Web subsystem shall allow the user to preview images
• The Semantic Web subsystem shall allow the user to use simple and advanced search options
• The Semantic Web subsystem shall allow the user to display simple and advanced display options
• The Semantic Web subsystem shall provide XML-based mechanism for metadata import and export
• The Semantic Web subsystem shall link to external systems

5. DESIGN

Software design is one of the most challenging tasks that creates the configuration of the software based on the requirements. Often the designer has to creatively construct a complete software architecture based on incomplete requirements. As the requirements evolve and change, the design also changes. The design may also change due to design review and better
understanding of the relations among design elements. Based on the requirements mentioned in Section 2, the design of the knowledge of mineral deposits in Afghanistan is presented below.

The design of the knowledge structure is one of the most important issues in this project. According to the introduction to Aristotle’s logical work there are ten categories of being or existence (Aristotle, 384-322 B.C.)

These ten categories are:

1. Substance (e.g., human, rock)
2. Quantity (e.g., ten feet, five liters)
3. Quality (e.g., blue, obvious)
4. Relation (e.g., double, to the right of)
5. Location (e.g., New York, home plate)
6. Time (e.g., yesterday, four o’clock)
7. Position (e.g., sitting, standing)
8. Possession (e.g., wearing shoes, has a blue coat)
9. Doing (e.g., running, smiling)
10. Undergoing (e.g., being run into, being smiled at)

The Semantic Structure describes the concepts or objects and their relationships which is appropriate for interpretation (by Human or Machine). The understanding of the relations and their representation and interpretation is a challenging task. In linguists’ logic, the structural semantics is the study of relationships between the meanings of terms within a sentence, and the composition of smaller elements that make meaning.
The Semantic Web describes methods and technologies to allow machines or computers to understand the meaning (semantics) of information on the World Wide Web. The agents would be able to perform tasks automatically and locate related information on behalf of the user. Based on the original theory, the automated agents and other software applications users would be able to access the Semantic Web more intelligently if a machine-readable data or metadata is available.

The application of the Aristotle logical structure categories with special reference to the mineral deposits in Afghanistan will take the following form.

<table>
<thead>
<tr>
<th>Aristotle (384–322 B.C.)</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substance (e.g., human, rock)</td>
<td>Minerals (Iron, Copper etc.)</td>
</tr>
<tr>
<td>Quantity (e.g., ten feet, five liters)</td>
<td>Huge, Substantial</td>
</tr>
<tr>
<td>Quality (e.g., blue, obvious)</td>
<td>Excellent, Good</td>
</tr>
<tr>
<td>Relation (e.g., double, to the right of)</td>
<td>Economy, Environment</td>
</tr>
<tr>
<td>Location (e.g., New York, home plate)</td>
<td>Afghanistan Regions</td>
</tr>
<tr>
<td>Time (e.g., yesterday, four o’clock)</td>
<td>Recent, Now</td>
</tr>
<tr>
<td>Position (e.g., sitting, standing)</td>
<td>Underground, Accessible</td>
</tr>
<tr>
<td>Possession (e.g., wearing shoes, has a blue coat)</td>
<td>Variable</td>
</tr>
<tr>
<td>Doing (e.g., running, smiling)</td>
<td>Waiting, Ready</td>
</tr>
<tr>
<td>Undergoing (e.g., being run into, being smiled at)</td>
<td>Being Studied</td>
</tr>
</tbody>
</table>
Layered Knowledge Structure:

The abstraction of knowledge structure is essential for an effective and efficient representation. Elements of knowledge are related in various ways. The most significant relations need to be highlighted. Layered structures are widely used in computer science in various areas. Communication between applications in a network environment is usually shown in seven layers (Cisco Systems 2000). The seven-layer Open System Interconnection includes application layer, presentation layer, session layer, transportation layer, network layer, data-link layer and physical layer. A layer structure allows simplification of a complex system for purposeful generalization of relations among knowledge elements. The architectural, social and cognitive issues associated with the development, implementation and use of information have increasingly attracted the attention of knowledge management researchers.

The Layered knowledge structure is comprised of four layers:

Semantic Layer

Object Layer

Process Layer

Expression Layer

3.3.1 Semantic Layer

This layer forms the backbone of the layered knowledge and is a complex layer. The structure of this layer is shown in figure 7 below.
Figure 7. A Knowledge Structure at Semantic Layer

Object Layer

The object layer establishes the relations among the various objects and their connectivity. The structure of this layer is shown in figure 8 below.
This layer processes the available information in three steps and repeats itself as long as required by the user as shown in figure 9 below.
Figure 9. The Process Layer

Expression Layer

This is a variable layer and could be expressed accordingly due to the circumstances.

System Architecture

The system’s high-level architecture diagram is shown in the following figure. It is comprised of four components:

- View details mineral information
- Generate comments or message
- Manage User Account
- Manage User information
Graphical User Interface

The graphical user interface (GUI) provides several ways to find and used the information provided in the system. When the user wants to access additional information, the user should be able to find some reasonable links.

Detailed Dynamic Model

The following sequence diagram provides an overall picture overview of an interaction diagram and its relation in term of logic and process flow that a user want to generate.
Process Sequence

1. User starts the program and login his or her user ID.
2. User enters his or her password.
3. System validates the user information.
4. User requests information.
5. Administration System requests the database connection.
6. Database System accepts the request and returns the requested information.

7. User views the information.

8. User requests printing information.

9. Database System sends request to Database System.

10. Database System update request and authorize printing.

11. User print information.

12. User selects Exit.

13. System ends program.

6. IMPLEMENTATION STRATEGIES

The software is implemented in a web site using the semantic web strategies. Semantic relations among elements of the knowledge are emphasized. Model-based development is the primary implementation strategy. Various models are built to experiment with the aspects of implementation and then the results are examined. When the results are satisfactory, the implementation is done. A wide variety of tools are used in the implementation, including

Model-view-controller (MVC) is a common design pattern used in software especially in web-based development (Pressman 2005). Use case driven derivation of an instance of the MVC architecture for a specific problem allows efficient and cost effective development of a web-based system. Given the MVC architecture as a general guide, the domain specific aspects are would represented in the Model component. The graphical user interface (GUI) elements would be placed in the View component. The user interactions are done in the Controller. The
statements about what happens when the user presses the submit button would go to the Controller component. Following the preceding logic the architectural design is created and then implemented. It segregates user interface from domain logic. Domain logic entails the mechanisms used for information exchange. The user is presented with views, and through the views, typically interacts with the controller directly. In most implementations the controller is responsible for updating the model while the model updates the view. Other MVC variants utilize the controller to modify both the model and views. The end result is the same however; a logical abstraction of processing, storage, and presentation of domain information.

The model segment of MVC can be considered as the heart of the design as it holds the entirety of domain formation. Models and views are generally manipulated by way of events in most implementations, commonly through user controls. An event signals the controller to update the model, causing dependent views to update as well.

A Model-view-controller representation
7. CONCLUSION

Afghanistan is shaped by its people, history, geography, politics, economy and its international relations with other nations. The domain knowledge of mineral deposits of Afghanistan needs to be understood in the contextual settings. The layer structure of knowledge is found to be useful for representing the domain knowledge of the mineral deposits of Afghanistan. The economy of Afghanistan is primarily related to the development of the mining sector and provides first-mover (or first-come) advantages to investors in this sector and related industries. The role of the mining sector is crucial to the reconstruction and rehabilitation of Afghanistan in a new developmental context. Foreign investment did not take place well in the country due to dominant state control of natural resources and many other factors such as political climate, inter-group conflicts, international relations, infrastructure and so on. Even today many mining and mineral resources remained under the control of unsuccessful state-owned enterprises. Some mining production and extraction activities are conducted mostly illegally on a small-scale basis. Experiences in other countries have shown that private sector operators and investors are more effective and efficient in the exploitation and exploration of natural resources and mining industries.

Some changes are taking place now that may attract new investments. Government tenders hugely dominates new opportunities in mining and related sectors. The investors are encouraged by the government of Afghanistan and request them to contact Afghan Investment Support Agency (AISA) for help in the bidding process and further information. The national privatization program, already undertaken by the government, plays a role in providing more
opportunities for international tender investments within the industry and makes it much easier for them to enter to this private sector. It is hoped that the development of the country’s mineral resources will generate income, employment, help stimulate the economy, and will strengthen the country’s economy like other developing countries in the region (Afghan Investment Support Agency, Priority Sectors). As Afghanistan comes out of long conflicts, disturbances and unrests, it is hoped that a new prosperous nation will emerge based on its potentials in mining and other sectors. Further research may shed new lights on domain knowledge representation for efficient processing and human understanding, and consequently help representing mineral deposits in Afghanistan in an augmented way.

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SendPoints (2015) GUI: Graphical User Interface Design. SendPoints,


Appendix A – Pictures

Figure 10. Map of Afghanistan with Identified Minerals
STRUCTURE AND INTERPRETATION OF DOMAIN KNOWLEDGE

Figure 2. Khenge Emerald mine, Panjsher, Afghanistan (G.W. Bowersox, 1985)

Figure 11. Miners digging the Ruby mine trench using the drills (G.W. Bowersox, 1985)
Figure 14. Rough/raw gems, Pich, Nuristan (G.W. Bowersox, 1985)

Figure 21. Rough Lapis for sales (G.W. Bowersox, 1985)
Figure 24. Kuuzit (By Zia Bahramzi, Aug., 2010)

Figure 25. Lemon Quartz (By Zia Bahramzi, Aug., 2010)
Figure 26. Peridot (By Zia Bahramzi, Aug., 2010)

Figure 27. Aquamarine (By Zia Bahramzi, Aug., 2010)
Figure 28. Tourmaline Green (By Zia Bahramzi, Aug., 2010)

Figure 29. Topaz (By Zia Bahramzi, Aug., 2010)
Figure 30. Emeralds Cut (By Zia Bahramzi, Aug., 2010)

Figure 31. Garnet Pink (By Zia Bahramzi, Aug., 2010)
Figure 32. Sapphires Multi-Color (By Zia Bahramzi, Aug., 2010)

Figure 33. Emeralds Cabushan (By Zia Bahramzi, Aug., 2010)
Figure 34. Tourmaline Pink (By Zia Bahramzi, Aug., 2010)

Figure 35. Amethysts (By Zia Bahramzi, Aug., 2010)
Figure 44. Peridot Jewelry (By Zia Bahramzi, Aug. 2010)

Figure 11. Women sell Traditional Rugs