Semantic-based Multilingual Islamic Finance Thesaurus

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***Abstract*— In this paper, we present an attempt to build a semantic-based multilingual Islamic Finance thesaurus, with the aim of globally standardizing the use of Islamic Finance concepts and providing a rich, semantically sound terminology. We describe a semantic model, which uses international standards such as Simple Knowledge Organization System, a World Wide Web Consortium recommendation designed among others for representation of thesauri, with the aim of enabling easy publication of the thesaurus as part of Linked Data and efficient future use. Finally, we present an Islamic Finance thesaurus collaborative authoring tool, which allows people around the world to contribute in improving the Islamic Finance thesaurus by adding, modifying or deleting concepts, relationships between the concepts or descriptions.**

Keywords-Islamic Finance; Thesaurus; Linked Data; SKOS; RDF

I. INTRODUCTION

Islamic finance and banking institutions worldwide have grown at a remarkable pace for the last three decades. According to a study by the International Monetary Fund (IMF), the number of Islamic finance and banking institutions rose from 75 in 1975 to over 300 in 2005, in more than 75 countries. Total assets worldwide are estimated at $250 billion, and growing at about 15% per annum [1]. Islamic banking and finance concept is also gaining popularity all over the world as highlighted by Ms. Christine Lagarde, director of IMF, who said: "to make (Islamic banking) activities as welcome in Paris as they are in London and elsewhere" [2].

This growth of interest in Islamic Finance and Banking is continuously attracting more stakeholders, but each one uses its own definitions or spellings for core Islamic Finance concepts, creating a lot of ambiguity and misunderstanding within the community. To the best of our knowledge, there exists no standard Islamic Finance thesaurus to refer to; thus, the major objective of this paper is to build such a thesaurus promoting standardization and interoperability in Islamic Finance domain.

Existing financial terminologies are representing knowledge about conventional banking and finance, e.g., the Financial Industry Business Ontology (FIBO) [3]. FIBO

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presents knowledge about financial instruments, business entities, market data and corporate actions in a technology neutral format along with formal definitions and defined business relationships. FIBO standardizes the language of conventional financial contracts and promotes unambiguous shared meaning among all participants in the conventional banking and finance world. In this paper, we aim to complement the existing banking and finance ontologies by considering all the terms specifically used in Islamic finance domain, which include Islam-related terms, Islamic contracts legacy, Islamic scholars, etc.

In order to be widely used around the world, the thesaurus must conform to semantic web standards and would eventually be published as part of the Linked Data (LD) [4]. Linked Data provides a network of interlinked structured data from various sources; it contains as per September 2011 more than 31 billion interlinked pieces of information from different domains (e.g., Health, Economy). We built the Islamic Finance thesaurus using Simple Knowledge Organization System (SKOS) [5], a World Wide Web Consortium (W3C) [6] recommendation designed for representing thesauri, taxonomies, or any other type of structured controlled vocabulary. SKOS is part of the semantic web family of standards built upon Resource Description Framework (RDF) [13], and its main objective is to enable easy publication and use of such vocabularies as Linked Data.

The viability of the thesaurus, i.e., its management and continuous enrichment over the years, is a core aspect [7]. Existing well-established thesauri, ontologies or knowledge bases (e.g., AGROVOC [8], Systematized Nomenclature of Medicine Clinical Terms [9], National Cancer Institute [10]) propose management tools in which the collaborative authoring section is primordial. It allows people around the world to contribute making the terminology a success, for example by adding new descriptions of concepts (e.g., translating a term in another language). An example of such a tool is "VocBench" [11], developed to manage and author AGROVOC knowledge base [12]. Thus, the terminology can continuously be refined, until it eventually caters to the needs of stakeholders from the domain. In this paper, we also propose an Islamic Finance thesaurus tool for browsing the thesaurus as well as collaboratively authoring its content, at first locally then worldwide through the LD.

This work is the result of a broader collaboration started in 2011 with the Institute of Islamic Banking and Finance in Malaysia (IIBF). The collaboration includes the semantic representation of Islamic contracts [17], the semantic representation of Islamic finance terms and an application to automatically generate meaningful questions in different modalities. The modalities investigated are multiple choice questions as well as complex modalities using diagrams to represent the question and semantic similarity to assess free-drawn answers. In this paper, we only focus on presenting the semantic representation of Islamic finance terms as well as the developed collaborative authoring tool.

Section 2 recalls the basics of utilized semantic web standards such as RDF and SKOS. In Section 3, we present the semantic model for the Islamic Finance thesaurus and the followed methodology. Section 4 presents a collaborative authoring tool developed to facilitate the management and enrichment of the thesaurus. The prospects of this work are outlined in Section 5.

II. RDF AND SKOS

A. RDF

RDF provides a common framework for expressing information in order to be processed by applications and exchanged between applications without loss of meaning.

RDF can be used to assign attributes and values to resources and to express relationships between resources. It allows computers to know something about a subject and provides a general method to decompose information into pieces. RDF requires a subject (or resource), predicate (or relationship) and object (or value).

B. SKOS

SKOS provides a standard way to represent knowledge organization systems using RDF. SKOS is a model for expressing the basic structure and content of concept schemes such as thesauri, classification schemes, subject heading lists, taxonomies, folksonomies, and other similar types of controlled vocabularies. SKOS allows concepts to be composed and published on the World Wide Web, linked with data on the Web and integrated into other concept schemes.

The main components of SKOS model are: *Concepts, Labels, Semantic Relationships, Documentary Notes and Concept Schemes*. Below, we present some extracts of the SKOS Primer [5] document explaining briefly the components we are using in the following.

Concepts: Concepts are fundamental elements of the SKOS vocabulary. Concepts are the units of thought—ideas, meanings, or (categories of) objects and events, which underlie many knowledge organization systems [5]. The class *skos:Concept* allows implementers to assert that a given resource is a concept.

Labels: Labels are expressions that are used to refer to the concepts in natural language. SKOS provides three properties to attach labels to conceptual resources: *skos:prefLabel*, *skos:altLabel* and *skos:hiddenLabel*.

Semantic Relationships: In Knowledge Organization System (KOS)'s, semantic relations play a crucial role for defining concepts. The meaning of a concept is defined not just by the natural-language words in its labels but also by its links to other concepts in the vocabulary. Mirroring the fundamental categories of relations that are used in

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vocabularies such as thesauri [14], SKOS supplies three standard properties:

- *skos:broader* and *skos:narrower* enable the representation of hierarchical links, such as the relationship between one genre and its more specific species.
- *skos:related* enables the representation of associative (non-hierarchical) links, such as the relationship between one type of event and a category of entities, which typically participate in it.

Documentary Notes: Concepts sometimes can be further defined using human-readable ("informal") documentation, such as scope notes or definitions. SKOS provides a *skos:note* property for general documentation purposes, which is further specialized into *skos:scopeNote*, *skos:definition*, *skos:example*, and *skos:historyNote* to fit more specific types of documentation.

- *skos:scopeNote* supplies some, possibly partial, information about the intended meaning of a concept.
- *skos:definition* supplies a complete explanation of the intended meaning of a concept.
- *skos:example* supplies an example of the use of a concept.
- *skos:historyNote* describes significant changes to the meaning or the form of a concept.

Collections of concepts: SKOS allows the definition of meaningful groupings or "collections" of concepts. In thesaurus terminology these collections are known as "arrays", and the label that groups the terms in the collection is a "node label". To correctly model such concept collection structures, SKOS introduces a *skos:Collection* class. Instances of this class group specific concepts by means of the *skos:member* property.

III. MODELLING OF ISLAMIC FINANCE THESAURUS

The intention of engineering Islamic Finance using semantic technologies is to build a unique and well established thesaurus for all Islamic Finance users. To the best of our knowledge, there exists no similar work in Islamic Finance field. Another advantage of building a thesaurus for Islamic Finance is to enable users around the world not to start their ontology modelling from scratch. It also promotes interoperability between semantic-based applications using the thesaurus.

Modelling of the Islamic Finance Thesaurus begins with the conceptualization of the Islamic Finance concepts and properties, which are represented as resources using RDF/SKOS formalisms. To model the thesaurus we implemented Spiral Modelling [15] technique, which is usually used for ontology modelling. The requirements are provided by IIBF and the knowledge engineers from MIMOS work closely with the domain experts from IIBF to evaluate the facts. Figure 1 shows the iterative process of getting domain knowledge from experts, modelling this knowledge, verifying it with the help of domain expertise and finally engineering it.

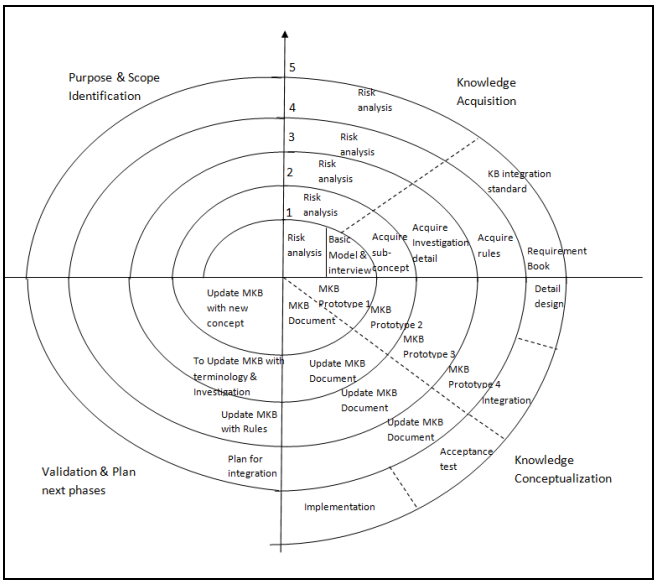

Figure 1. Knowledge Modelling - Spiral Model

We used TopBraidComposer [16] tool for engineering the thesaurus. The SKOS data model of the thesaurus has three concepts at the top level *skos:Collection*, *skos:Concept*, *skos:ConceptScheme*, as shown in Figure 2. All Islamic Finance terms are defined as type of *skos:Concept* class. Islamic Finance concepts that have similar themes are grouped under several categories (e.g., Islamic Sale Contracts), which are defined as type of *skos:Collection*. Finally the whole Islamic Finance thesaurus is defined as type of *skos:ConceptScheme*.

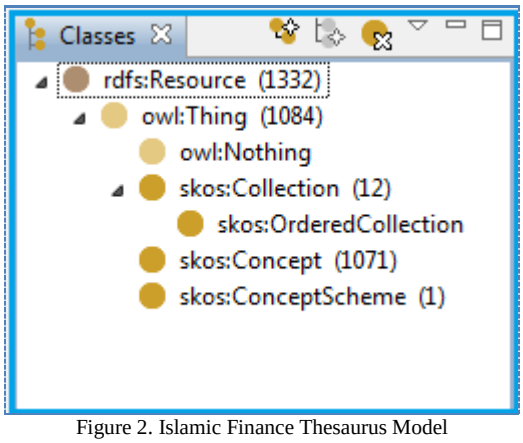

Figure 2. Islamic Finance Thesaurus Model

Each concept is identified by a unique Universal Resource Identifier (URI). Throughout this paper, we will use the prefix “miIFT” to indicate the namespace for

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"http://www.mimos.my/IFT#". For example, the concept "http://www.mimos.my/IFT#Ajr" is shown as *miIFT:Ajr*.

Within this thesaurus, there is a total of 1071 concepts and all the terms are related to Islamic Finance in one way or another. For example, there are different kinds of Islamic Finance contracts such as *miIFT:Murabahah, miIFT:Ijarah, miIFT:Istisna, miIFT:Al-Mudharabah*; different types of financial instruments such as *miIFT:Cash, miIFT:Check*; different Shariah scholars according to whose opinion certain transaction may or not take place such as *miIFT:Abu_Hanifah, miIFT:Abu_Yusuf, miIFT:Ahmad_ ibn_ Hanbal, miIFT:Ibn_Hazm*.

Figure 3 shows the model of the concepts *miIFT:Ajr* and *miIFT:Ajr-un-kareem* in a graph representation.

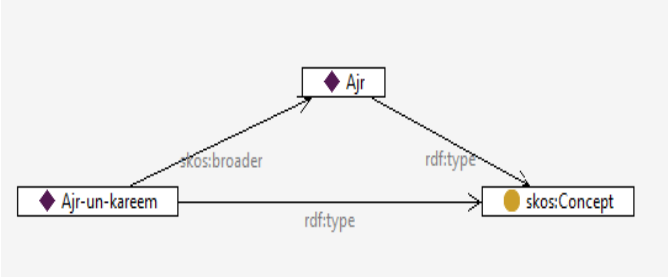

Figure 3. Model of the concepts "*miIFT:Ajr*" and "*miIFT:Ajr-un-kareem*"

Figure 4 shows the modelling of the *miIFT:Murabahah* concept and its related properties. We can see that *miIFT:Murabahah* has broader concept *miIFT:IslamicSaleContract* and it is related to *miIFT:Investment*. All of them are SKOS concepts. It also has several labels (two preferred labels -English and Arabic, two alternate labels and one hidden label), a history note and a definition.

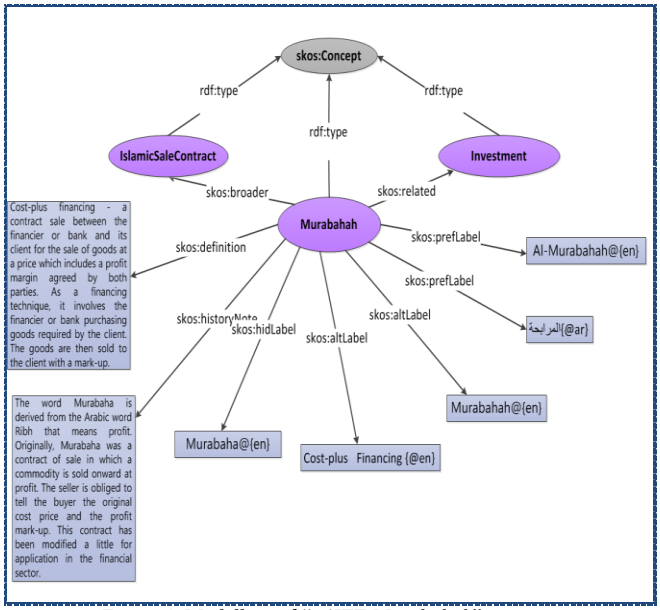

Figure 4. Modelling of "*miIFT:Murabahah*" concept

In the current modelling of the thesaurus, all the terms are in two languages: English and Arabic. But, the system described in the next section is catered to capture any language, because the primary goal of this system is to be able to provide collaborative authoring of its content for users all over the world. Thus one concept can have multiple labels -*skos:prefLabel, skos:altLabel, skos:definition, skos:scopeNote*, in different languages. For example, the word *miIFT:Ajr* has an English preferred label *Wage*{@en} and it has a preferred label in Arabic اجر{@ar} and وجہ{@ur} in Urdu.

As mentioned before, SKOS data model allows to define other kind of spelling of particular term via the use of *skos:altLabel* (alternate label). The primary purpose for *skos:altLabel* is for synonyms, abbreviations, acronyms and different spellings in different languages. For example, for the organization *miIFT:IslamicConferenceFiqhAcademy* it is possible to have all the following alternate labels:

- *OICFA* (acronym*);*
- *OIC Fiqh Academy* (abbreviation)*;*
- *Organization of the Islamic Conference Fiqh Academy* (official name in English);
- مجمع الفقه الإسلامي التابع لمنظمة المؤتمر الإسلامي (official name in Arabic).

This approach provides high flexibility at the lexical level.

Another part of our model uses SKOS ability to create various collections, which are designed to group concepts sharing common features together. For instance all Islamic Finance contracts are member of *miIFT:IslamicFinanceContract* collection; all financial instruments are member of *miIFT:FinancialInstrument* collection and all shariah scholars are member of *miIFT:ShariahScholar* collection. We use the property *skos:member* to create these links.

Figure 5 shows that *miIFT:Ijarah, miIFT:Salam* and *miIFT:Istisna* are all type of SKOS concept and member of *miIFT:IslamicFinanceContract* collection. Similarly for *miIFT:Cash* and *miIFT:Check*, which are members of the collection *miIFT:FinancialInstrument*.

The model has been reviewed by Islamic finance experts from IIBF and knowledge engineers from MIMOS. The process required three iterations/sprints from April 2013 to September 2013, and IFT model has finally been validated and baselined by IIBF on the 26th of September 2013. The content is still under construction and daily updated by research assistants from IIBF with the support of MIMOS.

IV. COLLABORATIVE AUTHORING TOOL

In this section, we present an Islamic Finance thesaurus collaborative authoring tool (called Islamic Finance

Vocabulary –IFV), which allows people around the world to contribute in improving the Islamic Finance thesaurus by adding, modifying or deleting concepts, relationships between the concepts or descriptions.

IFV is a web-based system, which consists of a set of features to assist users in managing the Islamic Finance Thesaurus. These features include navigation, search, authoring, validation, user management and ontology management, which are essential functionalities for knowledge management activities. IFV front-end was built using Adobe Flex/ActionScript 3 and its back-end was based on Java Spring framework on top of a MIMOS platform called the Semantic Technology Platform (STP).

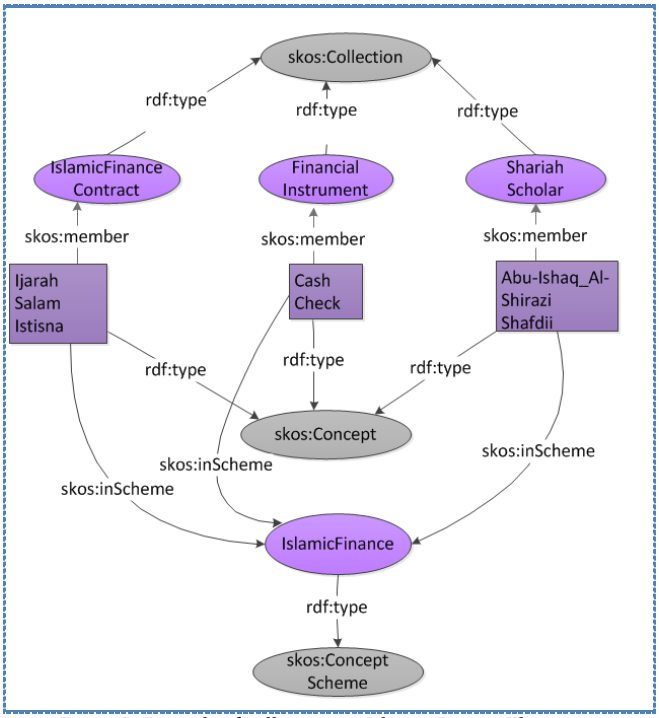

Figure 5. Example of collections in Islamic Finance Thesaurus

Figure 6 shows the IFV overall system architecture. It depicts the web-service components running in the back-end and how they communicate with the Client Application (IFV) GUI. The Service Oriented Architecture (SOA) is adopted as the base technology to ensure scalability. The front-end application is communicating with the back-end components through the core STP web-service components (Delegator, Authenticator and Lookup service). The major function of the Delegator is to distribute all tasks requested by the user from the front-end application to the back-end components and return respective data to front-end application. The front-end application is mainly focused on user interaction and data displaying functionalities.

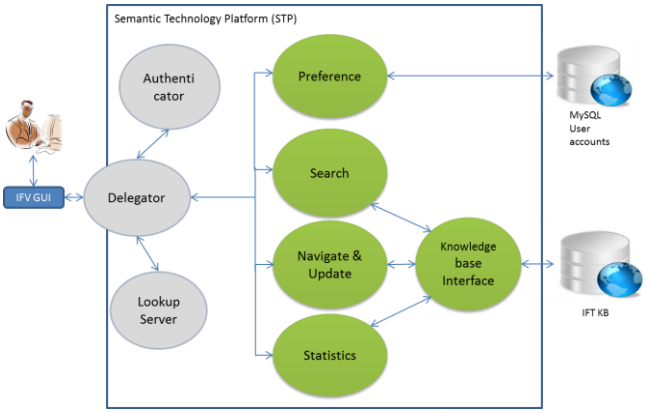

Figure 6. System Architecture of IFV

Apart from the core STP components, the system also includes other web-service components to enable the functional features of IFV, a database and a knowledge base. The features of the components and data sources are described below:

1) IFT knowledge base (IFT KB): contains the Islamic Finance Thesaurus and associated metadata.

2) User account database: contains information about the user details, such as user name, passwords, roles, status etc.

3) Preference: this component is responsible for displaying/modifying the user's profiles and accounts.

4) Search: this component is responsible for receiving queries from IFV GUI and returning the results of the queries.

5) Statistics: this component is responsible for displaying the most discussed, top visited concepts and the top contributors to IFT and their registered places.

6) Navigate and Update: this component is designed for the users to navigate IFT and update its content. The navigation view consists of concepts hierarchy, instances list and details of triples.

The IFV has been reviewed by IIBF on November 2013 and is presently in prototype mode. It is currently in testing phase after the addition of several functionalities such as a search based on Arabic root word.

Figures 8 and 9 are snapshots of the IFV Graphical User Interface. Figure 8 illustrates the landing page.

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Figure 8: Home page of IFV system

Figure 9: Navigation view of IFV system

Figure 9 shows the navigation view allowing users to navigate through IFT by selecting specific collections, concepts and instances.

The chart in Figure 7 illustrates the approval workflow when updating IFT. The workflow is as follows, where the validators are the Islamic finance experts from IIBF:

i. The process starts with the user making a suggestion.
ii. It will go to the validator who will check the suggestion.
iii. If the validator needs more clarifications, the system prompts the user for more clarification and it goes back to Step i).
iv. Else, if no clarification is needed, the process will continue to check if the validator agrees with the suggestion or not.
v. If the validator agrees, then the suggestion is approved and committed to the IFT KB and the process ends.
vi. Otherwise if the validator disagrees, the suggestion is rejected and purged, and the process ends.

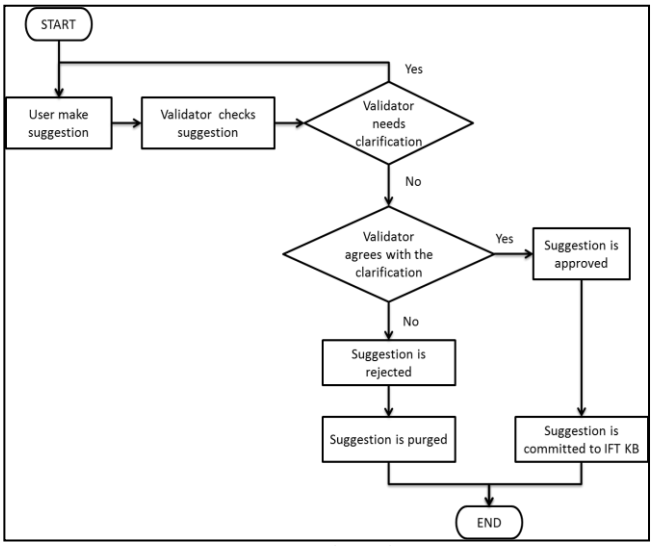

Figure 7: Approval workflow of editing/updating

This workflow has been adopted locally by IIBF, where all the validators are Islamic finance experts from IIBF. We foresee this workflow to be hardly adopted at an international scale, especially if the validators are coming from different Islamic religious groups. A possibility would be to allow the representation of different viewpoints for a single concept, for example by modifying the notion of labels to cover the representation of different school of thoughts, and by categorizing the validators based on their school of thought.

V. CONCLUSION AND FUTURE WORK

In this paper, we presented our work on modelling semantic-based multilingual Islamic Finance Thesaurus. We aim to provide globally standardized use of Islamic Finance concepts as well as providing a rich, semantically sound terminology. To describe Islamic Finance concepts, relations between the concepts and categorization of concepts, we utilized the SKOS data model, a W3C Recommendation designed for representation of thesauri.

We also described a web-based system, the Islamic Finance Vocabulary (IFV), which was developed as a platform to navigate, share and collaboratively author the content of our Islamic Finance Thesaurus among the communities of practice. It serves as a vital tool in the tremendous growth of interest in promoting standardization in Islamic Finance sector.

In the current Islamic Finance thesaurus, most of the information is in the form of annotation. Thus, we plan to transform the representation into an ontology in order to be used for reasoning purpose. We also plan to enhance the multilingual feature of the Islamic Finance thesaurus content to include other languages such as Malay, Mandarin, etc. Finally, to exploit the benefits of the huge Linked Data resources, we want to map the Islamic Finance thesaurus

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concepts to other related knowledge bases within the same domain such as Conventional Banking.

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