A Knowledge Management Approach Based on Ontologies: The Case of Tourism

S. Mouhim¹, A. El aouf², C. Cherkaoui³, H. Douzi⁴, D. Mammass⁵

Laboratoire IRF-SIC, Faculté des sciences & ENCG
B.P.28/S – Agadir – Maroc.
¹mouhimsanaa@yahoo.fr, ²adil@univ-ibnzohr.ac.ma
³ccherkaoui@yahoo.fr, ⁴driss_mammass@yahoo.fr
⁵douzi_h@yahoo.fr

Abstract— The study and the practice of knowledge management have grown rapidly. Tourism, although it is a pioneer industry in electronic commerce and the use of information technology, has unfortunately been slow to adopt this approach. The goal of this paper is to examine the importance of knowledge management and semantic web in tourism. It is in this sense that we will involve ontologies by organizing as a conceptual graph, a set of concepts by semantic relationships. These relationships will allow search engines to target their research and thus make inferences. This paper is aimed primarily to present the concepts of knowledge management, knowledge management systems, semantic web and ontologies. It also provides the importance of knowledge management in tourism, which gave the real benefits to be derived from the use semantic-web based ontologies for travelers. Finally, the last part is devoted to present a tourism ontology for Morocco and an architecture of the KMS we conceived.

Keywords— knowledge management, knowledge management systems, web semantic, ontologies, tourism.

1. Introduction

Internet is an essential tool that allowed a great revolution and a radical change in tourism. It is certain that search engines are probably the most used tools. It is also common for Internet search engines like Google and Yahoo to use Keyword searching [1]. However, the results provided by these tools are mixed, time consuming and essentially locate web pages using the input keywords, without reference to semantics. These results are generally numerous, untargeted and therefore difficult to sort. For consumers, use of long lists of documents is tedious. Others tools like portals, personal websites or blogs are not necessarily negative but must be viewed with caution.

Also, the problems of silence and noise are very common in traditional search engines. Searching by keywords limits the ability of the search engines to make deductions and to expand general queries [1]. As a simple example, the search of the two keywords “accommodation” and “accommodations” that are semantically similar, illustrates a noise we encounter in using traditional search engines. We note that adding an “s” in plural in the query influence the returned result. Another example concerning the search for the expression “scientific tourism” provides a large number of varied results. In contrast, the same search in a semantic search engine like (http://www.sensebot.net/) [2] allows us to deduce a “conference” that makes up a concept semantically related to the expression “scientific tourism”. Another example concerns a tourist who wants to vote in the country where he spent his holidays, if he search for “election” a semantic search engine might retrieve documents containing the words “vote”, “embassy”, “consulate”, “campaigning” and “ballot”, even if the word “election” is not found in the source document.

For tourism, we are not talking only on queries from clients related to hotels, travel, etc.; other important information is required: this is for example the weather forecast, security in a region, risk, etc. Similarly, actors such as tour operators need knowledge about travel, markets, etc. Hotel needs, as we mentioned above, to improve their service quality by enhancing employee’s knowledge about customer’s preferences and the corresponding service procedure.

The use of semantic information can be probably produce meaning-based searches more relevant to traveler’s queries [3]. The semantic web approach appears more than necessary to improve the performance of search engines and to support knowledge management in tourism organisations. Ontology is one of the main technologies used to enhance and to facilitate knowledge representation and semantic searches in Knowledge Management Systems (KMS).

A key principle of a KMS is to improve the search mechanisms of information and knowledge. This is particularly true for public organizations such as universities and research centers, where the sharing and reuse of knowledge plays a central role. This principle is also important for private sector where organisations exploit continuously knowledge to generate new products, applications or services;
which converted into business processes, create value at strategic, tactical and organisational levels.

The aim of this paper is to describe the development of an ontology-based KMS for tourism environments. It is aimed primarily to present some aspects of the main knowledge management concepts, including the notion of knowledge, knowledge management system, semantic web and ontology. It also provides in the section 3 the importance of knowledge management in tourism, which gave the real benefits to be derived from the use semantic-web based ontologies for travellers. Finally, the last section is devoted to present a proposed tourism ontology which we developed using the Protégé’2000 tool.

2. Knowledge Management Concepts

In this section, we briefly present the main paradigms and concepts which are the basis of our work, including the notion of knowledge, knowledge management system, semantic web and ontology.

2.1 The Knowledge Concept

The definition of knowledge is an important issue that has conducted many debates in epistemology. In the domain of knowledge management, several definitions and visions of this concept are available in the literature [4], [5], [6], [7], [8]. As part of our work, we adopt a practical and operational vision of making a distinction between data, information and knowledge according to a hierarchical model.

In this model, data is considered as a raw element completely out of any context. Information is a data set in context. Information is not knowledge, but may become so if it is understood and assimilated by an individual.

To be more precise and to extend what knowledge is, some authors like [4], [5], [9], [10], [11], make an important distinction between tacit and explicit knowledge. In this perspective, tacit knowledge, as opposed to formal or explicit knowledge, can be integrated in people's heads, in their experience and rooted in the action, in the routines, in a specific context. The explicit knowledge is knowledge codified and transmitted in a formal and systematic language (documents, information systems, etc.). Such knowledge is not static; a dynamic process enriches and transforms them persistently.

2.2 Knowledge Management Systems

As we underlined in the previous section, knowledge management is concerned with strategies and practices for supporting capture, creation, representation, storage, usage and evolution of knowledge. KMS refers generally to a system for managing the knowledge within organizations. To build effective KMS technologies, we can say that a KMS could be any of the following:

- **Document based:** It uses technologies that enable the creation, management and sharing of documents such as the Web, distributed databases, document management features, etc;
- **Ontology based:** Knowledge is classified of a set of entities, classes, proprieties and relations. Moreover, a KMS is supporting knowledge sharing and reuse by covering semantic search methods;
- **Semantic Web rooted:** KMS is a ontology based, they can so be used to explicitly represent semantics of semi-structured and textual information on the web;
- **Based on AI technologies:** Artificial Intelligence techniques are introduced for representing and reasoning about knowledge;
- **Service based:** KMS must deploy knowledge management tools for networks of participants of a project;
- **Social computing tools** are being set up to provide an efficient and natural approach to creation of a KM system. It helps knowledge providers to explicit their implicit knowledge and to formalize knowledge in general.

2.3 Semantic Web

The Semantic Web, as was underlined by its creator Tim Berners Lee [12] is a very important initiative affecting the Web [13]. It consists of adding a new semantic layer to the Web to make it readable by humans and machines. Such evolving can be achieved by the simple integration of meta-data, by introducing standard markup languages such as XML, RDF, or by the using ontologies; we particular thanks to the OWL language.

The main objective of this new vision of the Web is to offer new services to users. Thus, for humans, it is to improve the indexing of content, and improve their research. On the other hand, machines and intelligent agents will have great facilities to determine the meaning of a sentence or the nature of content, and therefore to respond to queries put to them.

The semantic web can also easily support efficient and effective KM and focuses on weakly-structured online information sources. It can consequently increase the performance of classical search engines for costumers of organizations.
2.4 Ontologies

An ontology is a formal theory used to explicit knowledge. The primary objective of ontologies is to model knowledge. Indeed, they provide definitions of concepts and terms used to describe a domain, logical and semantic relations between concepts and terms and the constraints of their use. Practical descriptions on ontologies have shown their importance in several respects:

- Ontology involves the factorization of knowledge. Like the oriented object approach, knowledge are not repeated in each instance of a concept [14].
- An ontology provides a unifying framework to reduce, eliminate ambiguities and conceptual and terminological confusion [15].
- Ontology can significantly increase the performance of search engines. Through the semantics provided, ontology can address problems such as noise and silence of the traditional search engines [14].
- Ontology can support the sharing and reuse of knowledge [13]. Indeed, if a group of researchers want to create or extend ontology in a particular field, it can reuse existing ontologies and extending them.
- Ontology implements mechanisms of deductive reasoning, automatic classification, information retrieval, and ensure interoperability between systems.

In the next sections, we will focus our presentation on all of these aspects in the tourism domain. We will particularly explain the importance of KM in the field of tourism; specify the architecture of a KMS and the procedure to acquire and to represent ontology in that domain.

3. Knowledge Management in Tourism

Tourism is viewed as information intensive industry where information and knowledge plays an important role for decision and action making [16]. Indeed, tourism has significant KM elements by nature, and the application of knowledge management tools in this area will bring significant benefits.

Unfortunately, tourism has been slow to adopt the KM approach. In this section we present a background of research in that domain. We present also the importance of knowledge management as well as current needs in the tourism sector.

3.1 Background

Tourism has been slow to adopt the KM approach. Indeed, the number of items in the literature and the issue of applying KM in tourism are poor, and attempts to create KMS in this sector are undergoing questioning research or development. Among these works that supports the idea that tourism has been slow to adopt the approach of knowledge management. There is also other works which treats the subject of scientific research and the interest to be worn by governments to research in the field of tourism.

Among the works that are interested in creating knowledge management systems and are still in the research phase include the Mondeca [17].

3.2 The Importance of KM in tourism

Applying a knowledge management approach to tourism sector delivers a range of significant benefits:

- The management of knowledge: the management of knowledge allows creating organizational memories and tools to access to knowledge which reduces search time and shortens learning curves, permits also easy sharing of knowledge, facilitating new product development and innovation;
- The development of learning ability: an indirect consequence of the establishment of organizational memories and tools in the tourism sector, is that learning is facilitated and accelerated;
- The acquisition and the capture of tacit knowledge: the tacit knowledge can be transformed into explicit knowledge. For example, hotels can improve their service quality by enhancing employee’s knowledge about customer’s preferences and the corresponding service procedure;
- The understanding of processes and practices: such investigations will allow tourism organizations to use knowledge and skills to satisfy customers and exploit market internationally.
- Etc.

In addition to the benefits and facilities provided to customers and hotels, other tourism stakeholders such as travel agencies, tour operators, etc., can also profit in using of the KM approach. Thus travel agencies for example, by using a semantic tool they can exploit new markets, and can know the adapted holiday packages, but not all of the available ones.

To conclude, we say that the important need in the tourism sector is to enable more effective access
to knowledge contained in heterogeneous information environments, Semantic search and ontologies plays an important role in realizing this goal. The next section presents a development of a tourism-oriented ontology for Morocco.

4. The Moroccan Tourism Ontology

The Moroccan Tourism Ontology (MTO) is a positive and a rare project that presents firstly a specific ontology for tourism in our country. In this section, we will present MTO and its rationale. MTO is designed to represent concepts and build relations between entities approaching the tourism domain in Morocco. The main contents of this ontology come from a manual extraction of knowledge from a number of official Web Sites. It is also to provide multicultural semantics.

4.1 Phases in MTO’s development process

In the development of MTO, we have adopted a unified process of modelling ontologies which is composed of five main phases: Analysis of existing ontologies, conceptualization, implementation, verification and utilization.

4.1.1 Analysis of existing ontologies

In the sector of tourism, several researches have focused on the design of ontologies. The example of e-tourism ontology is the Harmonise Ontology [18] which was created within the EU Project Harmonise. It is specialized to address interoperability problems in the area of tourism (e-tourism) focusing on data exchange. The goal of this ontology is to support tourism organizations with exchanging data and information without changing their local data structures and information systems.

Mondeca Tourism Ontology (www.mondeca.com) [17] includes important concepts of the tourism domain which are defined in the WTO thesaurus (www.world-tourism.org) [19] managed by the WTO (World Tourism Organization). The dimensions which are defined within the Mondeca Ontology are tourism object profiling, tourism and cultural objects, tourism packages and tourism multimedia content.

The OnTour project[20] deployed the e-tourism ontology using OWL. This ontology was based on an international standard: The Thesaurus on Tourism & Leisure Activities of the World Tourism Organization [21]. It describes the domain of tourism and it focuses on accommodation and activities.

The several tourism ontologies presented must be considered for reuse, before considering built the new ontology. However, sometimes in different countries or regions around the world, the existing ontologies might not meets the needs to describe regional distinctions for any specific areas. For example, the geographical specificities of Morocco made it a multicultural country, unique in its traditions which are reflected necessarily in the tourism product it offers. Thus, existing ontologies do not cover exactly and completely the concepts related to tourism in Morocco and the creation of a specific ontology to Moroccan tourism is required.

4.1.2 Conceptualization

This step is the most important since it will generate the skeleton of our ontology. It involves the use of different data sources that exist in the field of tourism to keep only the concepts that will constitute the hierarchy of the ontology.

To develop a common vocabulary of tourism, we consulted various resources on the web. We can cite in particular the thesaurus of tourism namely the one provided by the World Tourism Organization, and also the thesaurus of UNESCO [22] which are international standards. We have also consulted various official Web portals such as [23] (http://www.parisinfo.com/), for which we have borrowed some concepts and a categorization of them. These categories are buried in menus offered by the respective sites. For example for the concept "Hotels and Lodging", they include the sub-categories: hotels, residences, home stay, furnished, campsites, handicapped, reservation centers. For the concept "Restaurants and cafes," we found the sub-concepts: haute cuisine, classic restaurants, fast food restaurants, university cafeterias, caterers, etc.

Other social platforms have been examined. These platforms present for example FAQs which contain some questions; the most ones asked by tourists. These issues have enriched our ontology with semantic relations like (is near to, is synonym to, is a kind of, is analogous to, etc.).

We also took into consideration the standards and regulations governed by the law of this sector in Morocco. After collecting the necessary information, the next step was the creation of classes and concepts to form the structure of the ontology. The strategy we adopted in the hierarchy is to go from the most general concepts to more specific concepts. The study, analysis and classification of concepts collected from these different data sources allowed us to divide them into six main classes as shown in Figure 1.

4.1.3 Implementation & Verification

As part of our modeling, the tool we have chosen to create the MTO ontology is Protégé2000 tool [24]. Protégé allows comfortable and intuitive viewing and handling of concepts and relationships that make up the ontology. It also consists of a Java library that can be extended to create real applications of knowledge bases by using an inference engine for reasoning. Protege2000 also allows us to program or to import a large number of "plugins" that can be downloaded directly from its official website. These plug-in add
new features like the ability to edit the ontology with different languages for describing ontologies (RDF(S), OIL, DAML+OIL, OWL).

Protégé also allows different OWL reasoners to be plugged in, the reasoner shipped with Protégé is called Fact++. The ontology can be ‘sent to the reasoner’ to automatically compute the classification hierarchy, and also to check the logical consistency of the ontology. In Protégé the ‘manually constructed’ class hierarchy is called the asserted hierarchy. The class hierarchy that is automatically computed by the reasoner is called the inferred hierarchy. The classification is used as a check so that we can say that we have built our ontology correctly and to detect the smallest defects and inconsistencies in the hierarchy of the ontology.

In order to demonstrate the use of the reasoner in detecting inconsistencies in the ontology take the exemple of a class “Example” that is a subclass of both disjoint classes “Accomodation” and “Event”.

The actual reason that has been detected “Example” to be inconsistent is because its superclasses “Accomodation” and “Event” are disjoint from each other.

After ensuring the consistency of the ontology, the reasoner can be used to query the inferred hierarchy (Figure 1).

4.1.4 Utilization

This phase includes all activities based more or less directly on the layoff of ontology such us the annotation of resources or resolving queries. In the current state the knowledge base should be incorporated into the ontology. In this stage of our development, we have added instances manually to test the system. These instances give us the ability to make a search guided by the ontology.

Instances added concern of some basic information of hotel companies, clubs and amusement centers like telephone numbers, address, services, etc.

4.2 Basic concepts of MTO

In this stage of our work, the ontology we developed is composed by a set of 118 concepts and 75 properties. The study, analysis and classification of concepts collected from different data sources (portals, blogs, ontologies, etc.) allowed us to divide them into seven mother classes (Figure 2, Figure 3):

- Accommodation: This class includes all possibilities offered to accommodate the tourists. The hierarchy of this class follows the standards governed by Moroccan law;
- Transport: class that includes all modes of transportation present in Morocco;
- Attraction: class that defines all the places that a tourist can visit in Morocco. It was difficult to collect all the concepts that can fit into this category for the richness of Moroccan heritage and the diversify of its seascapes, mountains and desert;
- Activity: This class includes all activities that can be practiced;
- Service: defines any additional services that the tourist may need such as hospitals, offices as a guide, pharmacies;
- Restaurant: class that defines all the food services that may exist.
- Cultural heritage: class that describes the cultural characteristics of Morocco.

![Figure 1. An example of queries](image1)

![Figure 2. A short presentation of the MCO Ontology.](image2)
After defining the class hierarchy, the next step was to assign properties to concepts (Figure 4). Our ontology defines both object properties and data-type properties. We also added annotations to enrich our ontology as shown in figure (Figure 5).

Semantic relations can avoid ambiguities in terminology from homonymy. They also allow the introduction of equivalent concepts using synonyms or infer new knowledge using inference rules. Additional properties can be expressed as transitivity, inverse, symmetry, restrictions cardinality, etc.

MTO ontology that we developed contains properties of type object and data-type properties (Figure 3). The properties of the object type used to connect instances to other instances, and properties of data type can link individuals to data values.

An example of the type of object properties expressed in MTO is the property “equipped”. This property links the class "tourist establishment" to "infrastructure" which has the individual swimming pool, golf course, gym, etc. Thus, it is easy to determine tourist establishments equipped with golf course.

The properties of data type cast in MTO are of the form "accept dog", "accepts smoking", "Address", "fax", "has garden", "garage", "disabled facilities", etc. A typed property can be matched to instances. For example, the property "agrees dog" matches to instances of class "tourist establishment" of the type Boolean, representing if the tourist establishment accepts pets. Similarly, the property "class" as an integer matches to instances of the class "tourist establishment" and the class "restaurant" representing the number of stars.

We can also express restrictions on properties. The restriction can be expressed on the cardinality of a property, for example, that the category of a tourist establishment shall not exceed 5.

A View of the Architecture of the KMS

The architecture of the KMS for the integration of ontology MTO is currently under development and finishing. In the present state, only the ontology is developed. This architecture is consists “a priori” of three main modules: the semantic portal, the domain ontology and the reasoning module (Fig. 5).
The semantic portal it is a website that provides a single gateway to a wide range of resources and services focused on the knowledge base. Thus, users will be able to navigate freely on their space and enjoy both the semantics of the knowledge base and other services to senior levels. It should also allow the display of search results as a map or suggestions on better stay for the tourist place in the context.

The domain ontology plays the role of tourism terminology. The language in question, as presented above, is a hierarchical classification of concepts into classes and subclasses mothers linked together by relationships. This terminology is used for indexing resources, reformulation and extension of the user query starting from the general terms to other more specific.

The reasoning module plays a key role in the system. It combines the different search methods to handle the request of the user and allow its extension using the terminology of ontology. The engine must also be able, in addition to these features, the opportunity to propose a route of travel or accommodation for example based on user preferences or their browsing history: tourism resources selected during the research will be combined to propose a trip.

6. Conclusion and Future Works

The need to provide Internet users a semantic web on tourism, to develop the tourism resources of Morocco is obvious. The work we have presented is a first foundation of this building. We have, in effect, created and developed an initial ontology Based on several sources: tourism portals, websites, blogs, existing ontologies, standards, vocabularies, etc.. Then we realized the need to revisit this model given the large interest of the tourist to the Moroccan culture. The next step was to exploit it to meet complex users' queries.

Future work will focus on carrying out a more validation of the MTO ontology. A knowledge validation process must be carried by actors and experts to improve its capability to responding accurately and effectively to queries raised by travelers. This issue can improve information retrieval and international access. Another point to treat is the developing rules to make possible the combination with other existent ontologies, but also a powerful ranking mechanism, which guarantees the best results always staying on the top of the results page.

References


