Implementation of a Knowledge Management Methodology based on Ontologies :Case of Tourism

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***Abstract*—**in this paper, we suggest a methodology of knowledge management that makes use of the new possibilities offered by semantic web technologies and covers the various stages of the project life cycle. In fact, with this new vision of ontologies and semantic web, it is important to provide a strong methodological support in order to develop complex ontology-based systems.

Keywords*-Ontologies; Knowledge management; semantic web, OWL, methdology;*

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I. INTRODUCTION

Up to now, there is no standardized methodological approach that enables ontologists to build large ontologies based on the reuse of distributed and heterogeneous resources which are eventually unstructured. The existing methodologies are composed only of high-level steps. They mainly suffer from a lack of clear instructions for the creation of ontologies using these resources. In addition, they do not cover the complex scenarios in which the reuse and reengineering of ontological and non-ontological resources are necessary.

For that, our goal is to suggest a knowledge management approach in which we integrate the aspects of the different methodologies studied. We put the construction of the ontology in a broader context by carrying out a feasibility study based a priori, with few changes, on CommonKADS [1] and NeON [2] methodologies.

Our approach is mainly characterized by the following:

- The suggestion of methodological aids and software for the construction of an ontology support of knowledge which is reusable, allowing the opening, the accuracy as well as the heterogeneity and the distribution and based on several points of view (expert of the domain, Web resources, forums, News, Questionnaires, etc.),.
- The reengineering of the different sources of the existing knowledge.
- The use of an approach based on linguistic tools of the automatic processing of language.
- The storage and interrogation of ontologies and their bodies.
- The suggestion of a comparative analysis of semantic search engines.
- The application of the results obtained in the field of tourism.

II. Overall vision of the proposed methodology:

The methodology of knowledge management that we support in this paper responds to all the key steps of the process of knowledge management [3], which is to identify, preserve, enhance and update the knowledge.

The first task is to locate the critical knowledge, to identify the sources of skills and to locate the knowledge and expertise. This distributed and heterogeneous knowledge by nature must then be preserved, that is to say modeled, formalized and retained. This stage mainly consists of creating an ontology of domain which constitutes a very powerful tool for the representation of knowledge and its formalization in the languages supported by the community of the semantic web such as RDF and OWL. Once the model of knowledge validated, it must be enhanced in a manner to disseminate, exploit, and possibly combine the knowledge to create new ones. Finally, it is to update this knowledge while taking into account the new requirements of the system and the feedback.

All these stages will be discussed in more detail in the following sections.

A. The identification of critical knowledge:

The identification of critical knowledge is the activity of collection of requirements that the ontology must complete. It is to understand the object, the level of formality and the scope of the ontology, its potential users and the intended uses as well as the needs that it should cover.

The analysis of the state of the art of the ontological engineering reveals that most of the methodologies of construction of ontologies include a specification phase of the requirements of the ontology.

In this regard, we can mention that according to METHONTOLOGY [4], the objective of the specification phase is to produce a document specifying an informal ontology, semi-formal or formal, written in a natural language, using a set of intermediate representations or by using the questions of skills.

This methodology identifies the objectives of the activity of specifying the requirements of the ontology, but does not propose methods to perform the activity.

Other methodologies suggest the identification of questions of competence (QCs) for the establishment of the requirements of the ontology. The QCs are questions in natural language, which the ontology should be able to respond.

The methodology On-To-Knowledge [5] specifies that the questions of competence can be useful in the development of the document of requirements specification. The specifications should lead the engineer of the ontology to decide the inclusion or the exclusion of concepts in the ontology and their hierarchical structure.

Uschold [6] proposes to identify: 1) The purpose of the ontology and, in particular, the identification and characterization of the target users, 2) The scenarios of the uses of the ontology, and 3) The motivations, the questions of competence and the production of a document of the users' needs. Afterwards, the methodology recommends deciding how the formal ontology must be. This decision is largely determined by the users and the purpose of the ontology. Finally, this methodology suggests identifying the scope of the ontology through the creation of detailed scenarios of motivation that are needed in the applications.

Although these methodologies offer methods for the achievement of the specifications of the ontology, they include steps of high level. They do not provide detailed guidelines, which explain how to proceed at each step, which is necessary to obtain a good ORSD, neither instructions of how this document can be later used in the process of development of the ontology.

In what follows, we explain the guidelines that we propose for this phase to particularly help the developers of ontologies in the activity of specifying the requirements of the ontology. These guidelines have been inspired by the study of the existing methodologies specifically the two methodologies NeON and CommonKADS.

We suggest dividing this stage into two main phases:

- The feasibility study: it is in the first place to determine the domain of the ontology. Then, it is necessary to consider and consult the already existing ontologies. Many ontologies are already available in electronic form and can be imported in the development environments. To this end, several libraries of reusable ontologies exist on the Web and in the literature. For example: the library of ontologies Ontolingua 1 or DAML2.
  Then, the limits and gaps raised in the existing systems must be examined. In the field of research of information, we propose to test and evaluate a few engines of semantic search using some of the evaluation criteria [7].
  Another solution is the frequently asked questions. They are lists that make the synthesis of the questions asked in a recurring way on a given subject. The questionnaire is also an effective tool for evaluation and test. It is, through a number of questions addressed to the potential users of the system, to identify the problems encountered in the use of existing systems. It is also to know their expectations vis-a-vis a new solution.
- The choice of scenarios: the construction and the stand of ontologies are highly dependent on the information extracted from the various sources of information.
  The methodology Neon, presents a set of nine possible scenarios to build an ontology. In this work, we support the second scenario in which non-ontological resources are used.
  This categorization includes the different sources of explicit knowledge, which content has not been formalized by an ontology. It is mainly dictionaries, controlled vocabularies, thesaurus, textual records, services, database, web sites, wiki, etc.

In fact, the text is an important source of stabilized and shared knowledge by the communities in practice. It contains linguistic elements such as the candidates words, the semantic classes and the relationships that are very useful for the construction of ontology. In addition, the texts are more easily available than the experts in the field who are involved at the level of the modeling.

In the manual mode, experts in the field rely on conventional techniques of collection of knowledge, through a manual analysis of documents. However, this manual processing of documents is extremely costly in both time and resources. The whole process also poses problems of productivity and quality. In the automatic mode, linguistic tools and statistics such as classification and automatic segmentation are used to analyze the texts and extract from them concepts and semantic relations.

However, the process of construction cannot be fully automatic because the results of the extractors are noisy which requires a permanent intervention of the ontologist in order to provide a subjective judgment at the level of the conceptualization phase.

For these reasons, we will opt for a semi-automatic approach based on the TALN tools to enrich a first nucleus of an ontology of domain built based on a thesaurus of domain.

The choice of scenarios phase also demands making technical choices for the development of the ontology. It is to select, among a wide range of tools and according to the specific needs of the ontologist, software for the implementation of the ontology, for reasoning, computer languages for the representation of knowledge, etc.

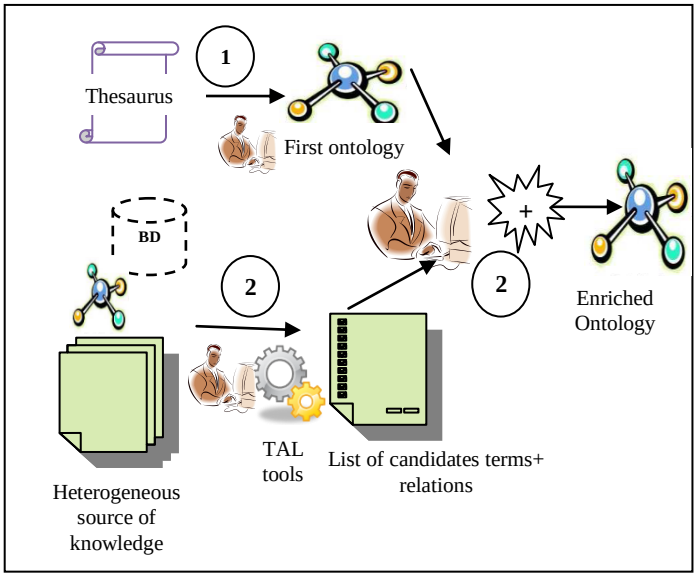

*Figure**1.** the* Adopted approach for the ontology construction

B. Preservation of knowledge:

In our methodology of knowledge management, we use the ontologies for the representation, the formalization and the storage of knowledge. We suggest breaking down the construction of the ontology into two essential phases "Fig.1":

[1]http ://www.ksl.stanford.edu/software/ontolingua
[2]http ://www.daml.org/ontologies

- The first phase consists of manually creating a first structure of the ontology based on the thesaurus of domain.
- The second phase consists of enriching and improving this structure with new concepts and new relationships in a semi-automatic way by using tools of Automatic Treatment of Language (TALN).

The modeling of a domain of knowledge may differ from one person to another and from a need to another. However, before starting a particular approach to design, some basic rules must be met to achieve a consistent and relevant model.
Before starting to build an ontology, the cognitics engineer must take into consideration certain basic rules for the designation of classes, relations and properties.

All these rules are determined on the basis of our personal experiences in the creation of ontologies as well as of the suggestions and recommendations of the W3C.

- Term and concept: the difference between term and concept is at the same time a philosophical and a linguistic problem which has been extensively written about. Since our goal is to describe the objects in the domain so that they allow a reasoning and a manipulation by computer, we have adopted the vision of the semiotic triangle established for the first time by [8].
  In this model, the terminology is based on a tripartite model whose vertices are the object, the notion (concept) and the sign (term). A concept represents a set of objects that share the same properties. While the term includes linguistic variations of the concept and of its synonyms.
- Criteria for names: In order to give a name to a concept or an attribute, there are conventions to follow to avoid errors in modeling. These Conventions can be described as follows:

a) The name depends on the system to use. For example, a case sensitive system will not deal in the same way with a word written in uppercase or in lowercase. Some systems allow commas, spaces, or dashes between names while others do not. Classes, attributes, and the instances may also have the same name.

b) When the name of the concept is composed of several words, these must be delimited. Example: Marine mammal, or MarineMammal, or Marine-mammal. Although there are no mandatory naming conventions for the OWL classes, it is recommended that all class names must begin with an uppercase letter and must not contain spaces.

c) There is no specific requirement regarding the choice of the singular and the plural. If a choice is made, it must be maintained along the modeling. Yet, in language, the meaning of some words can change depending on whether the word is in the singular or in the plural. In this case, the two words are introduced and are reported as different from one another. This criterion is very important, as we will see in what follows in the treatment and the reformulation of the request of the user.

d) The use of prefix and suffix is recommended in the names of the attributes. They are used to differentiate them from the classes. In OWL, it is recommended that the names of the properties begin with a lowercase letter, without space and, when they are composed of several words, the first letter of the latter must be in uppercase. It is also recommended that the properties are prefixed by the word has or followed by isOf. For example hasMother, isMotherOf.

e) Names as class, attribute, slot, property as well as the abbreviations are to be avoided.

- The verification of the consistency: The ontology allows the expression of semantic classes and relations between individuals through properties and restrictions. This allows reasoning and subsequently deducing new knowledge. However, if these properties are poorly expressed or badly managed by the cognitics engineer, errors and inconsistencies can arise. For example, if two classes are declared separated, an individual may not be an instance of two. In this case, an inconsistency is triggered.To limit the inconsistencies in modeling, it is suggested to classify or apply a reasoner throughout the phases of the construction of the ontology. In fact, without reasoner, it is very difficult to keep large ontologies in a maintainable state and logically correct.

C. Enhancement of knowledge:

The enhancement and the updating of knowledge are two steps that are primarily dependent on the exploitation of the ontology. The enhancement requires at first the validation of the ontology. It consists of the verification of the coherence and consistency of the modeling through using the reasoner. Then the role of the experts of the domain comes to verify that the conceptualization expressed in the ontology corresponds to the field of application.

Finally, the ontology is validated by evaluating certain criteria such as the clarity and objectivity, consistency, completeness, the maximization of the monotonous extensibility, the minimum ontological commitment, the principle of ontological distinction, the modularity, the diversification of hierarchies, the minimum semantic distance and the standardization.

D. Knowledge updating:

The last step in the process of knowledge management is the updating of knowledge namely the update of the ontology. As a matter of fact, the life cycle of an ontology is iterative and it requires a follow-up to update the amendments and changes that may exist, as well as for a possible complementarity of the ontology in progress.
In our context, we consider two possible cases for the ontology update:

- An update is deemed necessary by the ontologist or the cognitics engineer. This can be due, for example, to the emergence of a new need which the ontology will have to answer. It may also be a lack raised in particular concepts. In these cases, the update of the ontology is performed by repeating the second step of the preservation of knowledge. New documents dealing with the missing points of the ontology are therefore used to extract new concepts, semantic relations, axioms, rules and instances.
- An update directly linked to the use of the ontology. For example, in the area of research of information, the requests of the users are processed or reformulated on the basis of the concepts of the ontology. The concepts

that are not found can be directly stored in a database. The cognitics engineer in collaboration with the expert of the field will be able to choose those that are appropriate for the enrichment of the ontology.

III. APPLICATION IN TOURISM SECTOR

The choice of tourism as a sector of application is not arbitrary since it is the sector that has benefited the most from the advent of the internet. Indeed, more than one French tourist out of two prepare their trip online and almost one third of internet users book their travels online. Morocco is no exception to the rule.

Moreover, tourism is strongly linked to the internet and the new technologies. The online customer is increasingly aware of the facilities offered by the internet in terms of access to information, offers' comparison, booking, or even planning one's trip. Confronted by these growing demands, the public and private tourism actors' efforts should meet to improve not only the quality and quantity of the information of the tourism offering on the internet, but also to ensure easy access to information.

Tourism is regarded as the industry of intensive information where the information and knowledge play an important role in the action and the decision-making [9]. In fact, tourism has naturally some characteristics of the KM.

Unfortunately, tourism has been slow to adopt the KM approach. The purpose of this section is not to model the tourism sector or its needs, but to show the importance of knowledge management in this area. We particularly present the application of the KM approach, based on the technologies of the WS in the field in question.

A. Identification of crucial knowledge:

In this stage and through a feasibility study then a choice of scenarios, we aim at understanding the object, the need, the level of formality, the scope of the ontology, its possible users and intended uses, implementation languages, resources to use, etc.

a) The feasibility study : In order to show the needs of SGC in tourism, in this part, we deal with the importance of the GC, the needs in the sector (through a conducted survey), the actors and the uses.

- The importance of KM in Tourism:Applying a knowledge management approach to tourism sector offers a range of significant benefits:

The management of knowledge: knowledge management allows the creation of organizational memories and tools to access the knowledge which allows reducing the search time and shortening the learning curves. The knowledge management also allows you to facilitate the sharing of knowledge through facilitating the development of new products and the innovation.

The development of learning capacity: an indirect consequence of the creation of organizational memories and tools in the tourism sector in which 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 employees' knowledge about customers' preferences and the corresponding service procedure.

The understanding of processes and practices of these investigations: such investigations will allow tourism organizations to use the necessary knowledge and skills to satisfy customers and explore international market.

Etc.

In addition to the benefits and facilities granted to customers and hotels, other tourism actors such as travel agencies, tour operators can also benefit from the KM approach. Thus, travel agencies for example can explore, through using a semantic tool, new markets and can know the adapted holiday packages but not all those who are available.

The most important need in the tourism sector is to allow more efficient access to knowledge contained in heterogeneous environments. The semantic search and ontologies play an important role in the achievement of this objective. The following section presents a survey that we conducted to argue its needs.

- Needs in the tourism sector:Through a questionnaire, we asked travelers about the use of internet when preparing for a trip and their satisfaction with the online services. We have also tried to identify the problems encountered when using traditional search engines for information researching as well as the users' expectations from a semantic web for tourism.
  This study is conducted as a representative survey online "https://sites.google.com/site/websemantiqueforourourism/" and by interviews with hotels customers and tourists.

To prepare for their journey, 90% of consumers use internet "Fig.2".Tourism guides and books come second with 23% while travel agencies come last.

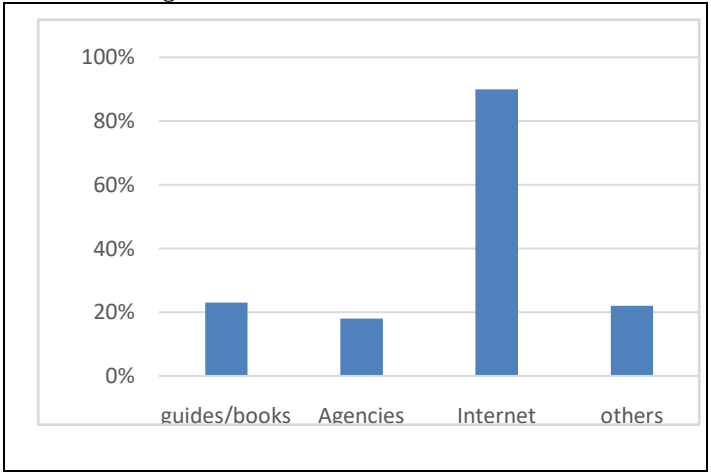

Figure2. Information sources used in the preparation for a trip

The tourist who uses the internet to organize his or her trip is confronted with problems related mainly to the search for information "Fig.3".

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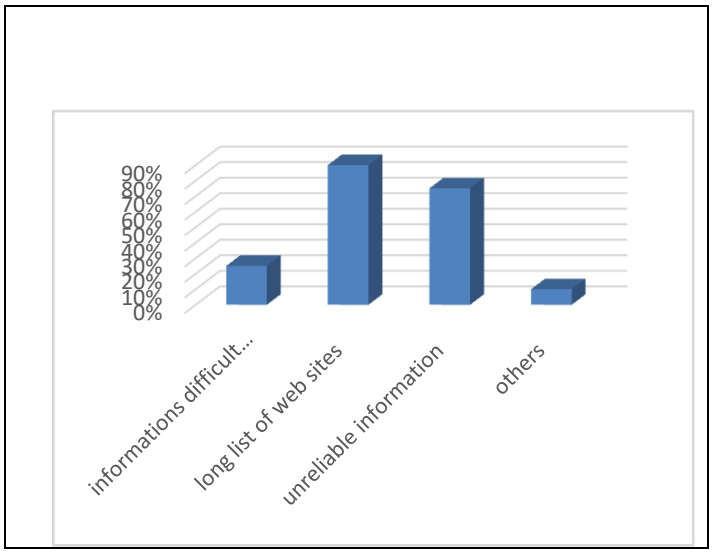
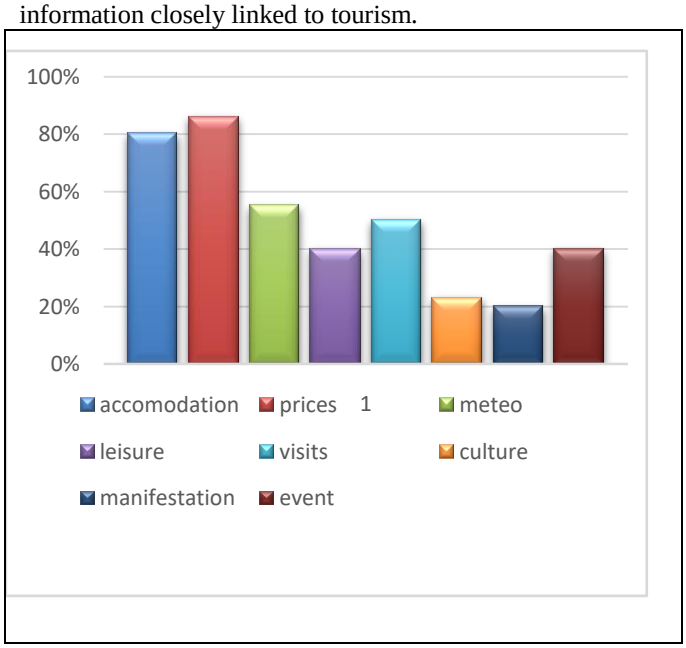


Figure 3. Problems encountered in the preparation for a trip on the internet

In effect, browsing a long list of websites seems tedious for the user who is confronted with a significant number of web pages that he/ she must consult in order to find what he looks for. Thus, information are difficult to find. The problem of the reliability of the information in websites is also encountered.

Regarding the nature of the most searched information, "Fig. 4" shows that users are most interested in prices, accommodation, weather, tours, etc. It is mainly the information closely linked to tourism.



Figue 4.Classification of information sought to prepare for a trip

In term of satisfaction, few users are satisfied with the touristic services available on the internet "Fig.5". Their expectation of intelligent research consists mainly in finding quality information, direct answers and varied offers through a single semantic portal. In terms of service, they want to access to a travel planner and a geographic visualization of the results

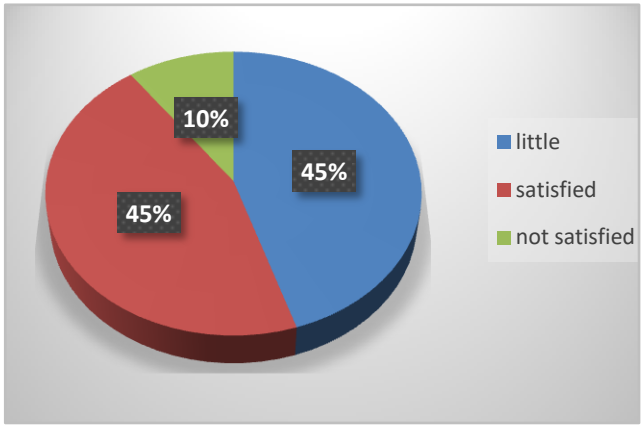


Figure 5. Users satisfaction of touristic services on the internet

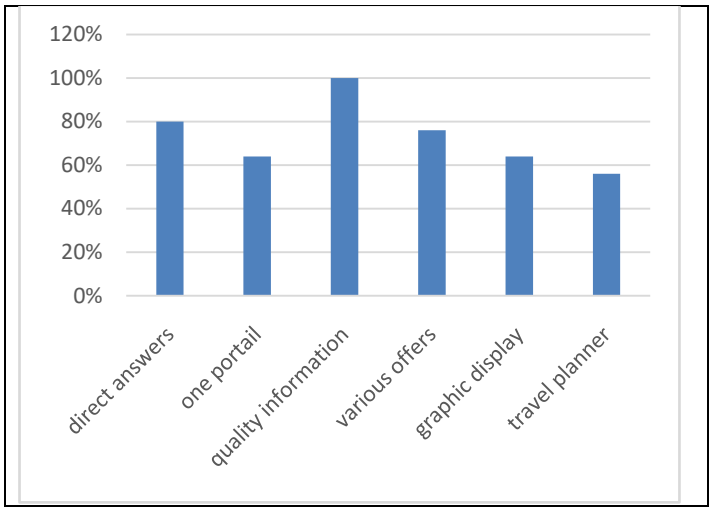


Figure 6.Users' expectations of a smart search on tourism

- Actors in the tourism sector :In this section, we will examine the strategic axes of the different tourism actors involved in the sector and facing the trade or the acquisition of information through the internet.

Transport companies: online booking, streamline the travel process, real-time travel information,

Hotel chains: dissemination of information, online booking, access to distant clients, customer support,

Travel agencies: Product presentation, responsiveness to offers, information media,

The voluntary sector: The voluntary sector represents a group of associations managing holiday villages, family houses, guest houses, etc. a side of some large structures. The voluntary sector has recently become interested in the possibilities offered by the internet. Their sites respond more to a communication-oriented approach and information dissemination.

Territorial bodies: They are the municipalities and the territorial departments of tourism offices. Their mission is the promotion of the touristic offer, the reception and information of the public, and the organization and control of touristic products.

Final consumers: Search for information / comparison of prices and availability, booking of the touristic service and possible modification, real-time information on any changes of

one's journey, loyalty allowing access to discounts, discover destinations , localization of hotels and services, direct interaction through e-mails, sharing and dissemination of travels' experiences, select an offer, etc.

- Background/ study of the existing :In the tourismsector, several ontologies and several systems implementing these ontologies exist. In particular:

The Eiffel3 ontology concerns the touristic offer in its territorial aspects. It is a question of describing in a fine and extensible way the touristic objects: territories, accommodations, heritage, activities, etc. by objective and quantitative elements (location, means of communication and access, prices, schedules ...), elements of classification (categories, labels, keywords ...) and semantic relations (neighborhood, associated activity, enhancement ...) at the same time. But the ontology must also allow integrating these objects and their descriptions in the flow documentaries of indexing and publication. The ontology integrates all these aspects in a uniform format, allowing a total integration of the different components of the Platform Eiffel on the basis of common semantics.

The PICSEL4 ontology is built in the framework of the PICSEL project. The model of the ontology includes a main hierarchy of concepts whose root is the concept product which represents what can be sold in the sector of tourism and which gathers the housing, journeys, rentals of vehicle, internships. In addition, the model includes secondary separated hierarchies describing subdomain object categorizations of the domain of application such as place, leisure, delivery, service, equipment, etc. [10].

Tourism.owl5 is an ontology written in OWL. It is a small ontology consisting of classes such as: attraction, city, state, country, dimension, rental, population. This ontology is also composed of properties of type data and object.

Travel.owl6 is an ontology that contains tourism related concepts. It is available on the web as an OWL file.

Consulting these systems and ontologies allowed us to make the following observations:

European projects that use robust ontologies retain these latter secret. On the web, there is an architecture of the system implementing the ontology as well as an insight of its use. However, consulting the ontology is still not possible.

Ontologies such as travel and tourism are small ontologies written in English. Their scope is very small given the limited number of classes and subclasses they contain. They don't cover the entire tourism sector.

Although these ontologies express properties and restrictions between classes, they suffer from a lack in terms of lexicalization of the concept. They are expressed without taking into consideration their lexicalizations or even their synonyms. This disadvantage can reduce the utility of these ontologies in terms of information search.

*b) Scenarios' selection :*At the choice of scenarios phase, technical choices for the implementation of the ontology are to be made. It consists of choosing an ontology construction tool, a reasoner, the representation languages, the interrogation language, the resources to be used, the appropriate ontology construction methodology, etc.

In the framework of our project, we use Protégé for the ontology implementation, OWL as knowledge representation language, Tree Tagger for the morphosyntactic analysis, Yatea for the extraction of candidates terms, Nooj for the extraction of relations from the morphosyntactic patterns and Terminae for the extraction of transversal relations and for the visualization of results.

For the knowledge representation, the choice of OWL is justified by the fact that it is an XML language designed as an extension of RDF and RDF Schema. OWL allows describing the web ontologies: it is precisely the language of ontologies. OWL incorporate not only the concepts of classes, resources, and properties already present in RDFS, but also tools for comparing properties and classes such as identity, equivalence, the contrary, cardinality, symmetry, transitivity, disjunction, etc.

Thus, OWL provides machines with a greater ability to the interpretation of web content and to reasoning than RDF and RDFS, thanks to a wider vocabulary and true formal semantics.

B. Knowledge preservation :

In this phase, we are interested in the construction of the ontology of tourism that we have named OTM. As already mentioned, the first nucleus of the ontology is created based on a domain thesaurus.

Indeed, there is, in the tourism sector, some controlled vocabulary or thesauri primarily used for indexing and identifying information in documentary resources. We notably refer to "the Tourism and Leisure Thesaurus" of the World Tourism Organization OMT[11].

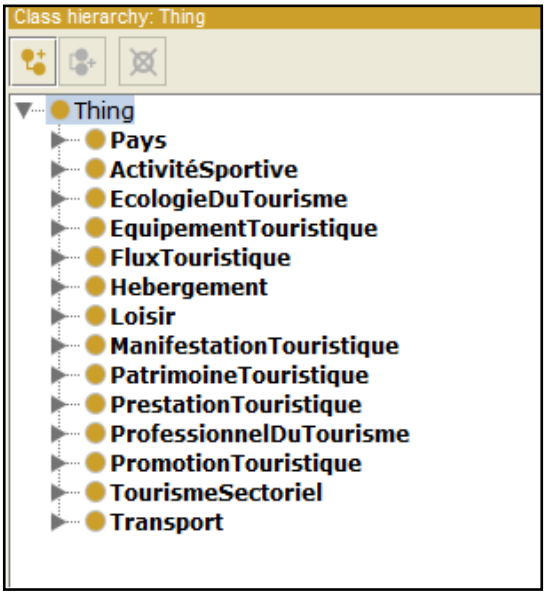


Figure.7 Semantic fields in the tourism ontology

Next, we used TALN tools for the semi-automatic development of the initial ontology [12].

Compared to the presented ontologies travel and tourism, our ontology, as presented in the works is richer in terms of concepts and conceptual relationships. It is also characterized

[3]http://www.projet-eiffel.org/spip.php?article48
[4]https://www.lri.fr/~sais/picsel3/publications.php
[5]http://code.google.com/p/onto/source/browse/trunk/tourism.owl?r=2
[6]http://protege.cim3.net/file/pub/ontologies/travel/travel.owl

by a rich expressiveness of concepts through considering lexicalizations and synonyms. Moreover, it deals with specific aspects of the Moroccan tourism sector.

C. *Enhancement of knowledge :*

The knowledge enhancement consists at first of the validation of the ontology then its use in an appropriate application.

As mentioned in the previous sections, the verification of the ontology consists, on the one hand, in evaluation, i.e. the verification of its conformity and its consistency. On the other hand, in the validation that the semantics expressed in the ontology must be that of the domain considered. As a matter of fact, the verification of the conformity and consistency of our ontology has been done through the reasoner FACT++ available on protege2000 [13]. The application of this reasoner to our ontology allows detecting the smallest anomalies and inconsistencies in the hierarchy of the ontology. The automatically calculated hierarchy by the reasoner is called "inferred hierarchy". It writes in red all classes that show a problem of inconsistency.

The phase of the use of the ontology brings together all activities based more or less directly on the availability of the ontology, for example the annotation of resources or the resolution of queries.

To turn on the ontology of tourism, we have suggested an architecture of GCS that is formed, a priori, of three main modules: The semantic portal, the ontology of domain and the module of reasoning:

- The semantic portal is a website that forms a single gateway to a wide range of resources and services gathered in a knowledge base. Therefore, users will be able to navigate freely on their space and enjoy both the semantics in the knowledge base and other high level services.It should also allow the display of search results in the form of a map or suggestions of stays to better situate the tourist in the context.
- The ontology of domain plays the role of tourism of terminology. The language concerned, as presented above, is a hierarchical classification of concepts into classes and parent subclasses linked together by relationships. This terminology is used for resources indexation, reformulation and extension of the user query starting from general to specific terms. The Ontology of domain is at the heart of the solution of the semantic information systems. It plays the role of terminology of tourism. The language in question is a hierarchical classification of concepts in parent classes and sub-classes linked together by relationships.
- The reasoning module plays a vital role in the system. It combines the different modes of research to address the user's request and allow its extension using the terminology of the ontology. This module must notably be able to manage the problem of multilingualism either during the processing of the requests of users with different nationalities or when translating the presented content. In addition to these features, the engine must be able to offer the possibility of suggesting a travel itinerary or stays based, for example, on the user's preferences or his or her navigation history: the touristic resources selected during the search will be combined to suggest a travel.

IV. Conclusion

In this paper, we have presented an overall view of the knowledge management approach that we have proposed based on ontologies and WS technologies.

In fact, we were confronted with a problem linked to the construction of ontologies in the absence of standard and standardized methodologies since we were using the ontologies for the representation and the preservation. Thus, we focused on the reengineering of the different sources of heterogeneous knowledge while we based ourselves on several points of view.

We have tried to, as much as possible; take into consideration the heterogeneity and the distribution of the knowledge sources. Several standpoints have been taken into account. We have adopted a two phase construction approach of the ontology. At first, a first nucleus needs to be built based on a thesaurus of domain. Afterwards, the initial ontology must be enriched through using the automatic language processing tools.

After providing some basic rules for the naming of classes and properties, we have implemented the proposed approach in the tourism sector which has developed an ontology of domain that we have called OTM.

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