# **Instantiating Web Sites Quality Models: an Ontologies driven Approach**

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#### Abstract

One of the most important steps in a Web site quality evaluation project is the selection of which aspects to consider. In terms of methodology, this means defining a model for the site. In some cases it is possible to use standardized models, such as "syntactic" models, but this is not possible when the evaluation must also consider aspects that have to do with the domain and the specific aims of the site or more generally when the evaluation aims to consider the "semantics" of the site. The process of identifying and adapting a quality model requires, apart from time and resources, the contribution of experts in the domain of the site. In this paper we propose to use ontologies to improve the efficiency of this "instantitation processs". To analyze the feasibility of the approach we have looked at two applications in the tourism sector. The results, while preliminary, are encouraging. Moreover, some critical and delicate points were identified as priorities for future research.

# 1. Introduction

Quality in Web sites is determined by several diverse factors, some of which are general and therefore are considered for all types of site and in all domains. Such features include, for example, the correct functioning of the site, its conformity with standards of language use or of accessibility as described in normatives such as the Web Content Accessibility Guidelines of the W3C (http://www.w3.org/WAI/GL/) or the U.S. Section 508 Guidelines (http://www.section508.gov/), or standards introduced in Italy through the Stanca law in 2004 (http://www.pubbliaccesso.it/biblioteca/documentazione/s tudio\_lineeguida/), which requires these standards for government sites. Other factors or characteristics are more specific and depend on the type as well as the domain of the site. Therefore in cases where it is not possible to use "standard", "syntactic" models - generalMariangela Franch Department of Computer and Management Sciences University of Trento, Italy {mariangela.franch}@unitn.it

purpose and domain-independent - it becomes necessary to develop quality models that take also these features into consideration (among models having a standard version we can look at WebQual [2] and WebQEM [11]; an extensive bibliography of models for Web site quality is available at: http://www.economia.unitn.it/etourism/ risorseQualita.asp). Basically this means defining specialized models that can deal with the unique semantic aspects of a site or sites that will undergo evaluation. The process of definition and instantiation of a model takes time and resources and also the input of experts in the domain. In this paper we propose adopting an approach based on the use of ontologies to support the definition of detailed semantic models. This approach is an extension of a methodology "the Quality Model Factory" described in [9] and successfully applied in the area of tourism. It was applied here to define modular quality models that make it possible to take into account the characteristics of diverse types of tourist destinations. To do this the models were developed using a standard model called the 7Loci meta-model [10]. There are two types of "modules" specialized at two different levels of detail: the first, called the Common module, contains aspects that are common to the sites of all types of tourist destinations, while the second is comprised of Specialized modules that contain specific aspects that are found at different types of destinations. To analyze the feasibility of a methodology based on the use of ontologies to define specialized models for Web site quality evaluation, we looked at the sites of accommodations and of tourist destinations facilities. Both are within the tourism domain and are highly varied given the diversity of types of tourist destination as well as accommodations. Moreover, the decision to look at the tourist sector – a transversal sector that includes numerous actors and activities - made it possible to have a general idea of the difficulties and challenges, as well as the advantages, of using ontologies to define quality evaluation models that are specialized and modular.

Recent years have seen increased interest in the development and application of ontologies. This has

meant firstly the definition of languages and environments to set up ontologies. Examples of languages are DAML (Description Logic Markup Language), OIL (Ontology Interchange Language), RDF (Resource Description Framework) and OWL (Ontology Web Language), a semantic markup language for publishing and sharing ontologies on the World Wide Web (http://www.w3.org/TR/owl-ref/). Among the more numerous applications of ontologies are projects related to the Semantic Web, to obtain "an extension of the current Web in which information is given well-defined meaning, better enabling computers and people to work in cooperation." [3]. An obvious application of ontologies is in Web services; among the most recent works and most frequently downloaded (was in the fifth position of the Top 10 Downloads from ACM's Digital Library in December 2004), we can cite [12]. Also important to note is the use of ontologies for the development of software based on reuse [5] and for the management of multimedia objects in a private and personal environment [7].

The proposal described in this paper differs from these insomuch as it is applied at a different level: it is designed to use ontologies to support the development of quality models that are specialized for Web sites. As such it is a conceptual as well as methodological activity, and is applied at a meta-level with respect to the application of the models themselves.

The paper is structured as follows: the first section gives a general description of ontologies for tourism. Following this we look at the concept of tourist destination, where we present the classification used to apply the "Quality Model Factory" methodology, which we are going to extend to include domain ontologies. The third section puts forth two possible applications for the development of specialized and modular evaluation schemes, respectively for hotel Web sites and for tourist destinations. The conclusion summarizes the preliminary results of these applications, underlining the critical points emerging from the application of the methodology and which require further study.

# 2. Ontologies for tourism

Tourism represents approximately 11% of worldwide GDP, according to the World Travel & Tourism Council (http://www.wttc.org/). Adding to this is the notable growth in the number of tourism-related Internet transactions in recent years (e-commerce). For example, in 2004, 40% of U.S. travelers who use the Internet claimed to make all of their travel purchases online, versus 29% in 2003 (www.tia.org). In this context, the

quality of Web sites becomes a vital strategic factor for all actors involved. Because tourism is a transversal sector – or "umbrella industry" – it has contributions from other sectors, thus an analysis of the sector must have input from different fields such as transport, culture, and sport, to name a few. This fact explains the existence of numerous ontologies for tourism. An exhaustive classification can be found in [1].

Existing ontologies are both general for the tourism sector as well as specific, the latter referring to particular domains. In the first category we have the ontology developed for the Harmonise project, whose goal is to develop an ontology-mediated integration of tourist systems following different standards so that organizations can exchange information without changing their data structures (http://www.harmo-ten.info/). In addition there is the Mondeca's tourism ontology, which includes tourism concepts from the WTO (World Tourism Organization) thesaurus. At this writing this 1000 ontology has concepts that describe accommodations and transportation and a few other secondary elements related to geography, health and immigration (http://www.mondeca.com/).

There are over ten elements on the list of domainspecific ontologies that can be useful for the tourist sector, including geographic ontologies, means of transportation ontologies, gastronomy ontologies, etc. [1].

General – or sometimes called upper – ontologies also exist and aim to gather definitions and concepts that together make up what is known as unspecialized common knowledge. One of the best known of these is WordNet – more appropriately referred to as a lexical reference system (http://www wordnet.princeton.edu/) which was extended from solely English into other languages through the EuroWordNet (http://www.globalwordnet.org/gwa/wordnet table.htm).

Looking at the ontologies for hotels and tourist destinations (the organizations examined for the feasibility analysis of the approach proposed here) the following facts emerged.

Since the concept of hotel is part of common knowledge, the notion is present in WordNet. More specifically, for each concept – in this case *hotel* – WordNet gives information on the generalization, specialization and also on "part of" relationships. A description of the linked concepts is available at Answer.com (www.answer.com). In short, in WordNet, focusing to concepts that are directly linked to *hotel*, thus exploring only relationships represented by arcs going out from the node of hotel, we obtain (see also figure 1):

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hotel is a kind of:
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- building, edifice a structure that has a roof and walls and stands more or less permanently in one place kinds of hotel:
  - hostel, hostelry, inn, lodge a hotel providing overnight lodging for travelers
  - motel, motor hotel, motor inn, motor lodge, tourist court, court – a hotel for motorists; provides direct access from rooms to parking area
  - resort hotel, spa a fashionable hotel
  - Ritz (informal) an ostentatiously elegant hotel
  - ski lodge a hotel at a ski resort
- Parts of hotel:
  - hotel room a bedroom (usually with bath) in a hotel

Furthering the analysis by using the concept of *hotel room*, WordNet gives other information:

kinds of hotel room:

- adjoining room a hotel room that shares a wall with an adjoining room but is not connected by a door
- connecting room a hotel room that shres a wall with an adjoining room and is connected by a private door

hotel room is a kind of:

• bedroom, sleeping room, chamber, bedchamber – a room used primarily for sleeping.

hotel room is a part of:

 hotel – a building where travelers can pay for lodging and meals and other services





The quantity of information about the concept of *hotel* contained in WordNet is exhaustive, an important fact since WordNet is free and has been used in many

projects. Answers.com also provides hypertext definitions (where they exist) found in other sources such as Wikipedia (http://www.wikipedia.org/), which can be useful to integrate with those contained in WordNet, and also their translation into diverse languages.

The more challenging problem is to identify an ontology for tourist destinations, although this difficulty is justified by the complex definition of destination, a concept which, albeit only recently, is assuming an increasingly important role in the tourist sector in general. Basically, the features that identify a tourist destination and distinguish it from what is simply a local offering of a product or service that can be of interest to tourists are:

- a well-defined geographic area with identifiable borders and a territorial identity;
- the presence of numerous operators with different prospectives and objectives that makes it necessary to devise a shared strategy in presenting the offering consisting of attractions and services specifically catering to tourists in the location;
- an understanding of the nature of the potential demand for the tourist products offered;
- awareness of the need to balance tourism's exploitation of resources with ecological, environmental and community stewardship.

A classification of the destinations serving the leisure tourist segment identifies eight distinct types of destination based on the goals for the vacation and the principal attractions present at the destination (table 1) [8]. The table shows key information about the defining features of a destination. Once established, these aspects can then serve as input when determining the requirements and the quality factors for the Web site of the destination.

The definition of tourist destination and the classification of diverse types of destination show how the necessary concepts belong to diverse domains. WordNet gives no treatment to the concept of tourist destination. Numerous ontologies were examined as part of this research, but none proved able to cover all the elements that characterize a destination: it is thus necessary to use different ontologies to describe the geographic area, the different attractions, sports, transport, etc. On the other hand, general ontologies (upper ontologies) contain a lot of information that is not useful because it is related to concepts that differ greatly from those used in the tourism context. In addition, general ontologies for tourism cover only some of the

necessary areas (for example, Mondeca gives good treatment to accommodations and transportation) but not for some indispensable aspects of a destination (examples being cultural, natural and artistic attractions or events).

For this reason we have used WordNet in our feasibility analysis, and the decision as to which concepts to consider was informed by the definition of destination itself and by the table. For example, for alpine destinations we used the concepts of sport, landscape, nature, etc. We were thus able to simulate the nucleus of an ontology for tourist destinations.

 Table 1. Classification of destinations based on their principal attractions

Type of destination	Main reasons for visiting	Well-known examples	Typical attractions found at the destination
Urban	Culture, art, architecture, shopping	Capital cities	Museums, historic buildings, shops
Beach/Sea	Relaxation, enjoyment, socializing, sports, night-life	Rimini, Ibiza, Miami	Beaches, organized activities, amusement parks, discos, bars, pubs
Alpine	Outdoor sports, landscape and environment, nature, traditional events and customs, folklore	Cortina, Chamonix, Aspen	Nature trails, views, ski trails and slopes, ski-lifts
Rural	Get back to nature, local traditions in agriculture and production	Tuscany, Provence	Local food producers and agritours, visits to farms and vineyards Places equipped for health
Wellness	Health treatments, relaxation, diet and exercise programmes, stress relief	Fiuggi, Baden- Baden	and therappeutic treatments, areas for complete relaxation, medium- and high-level accommodations facilities, fitness
Religious	Renewal or deepening of faith, symbolic value of the location, spiritual retreat and introspection, solitude	Lourdes, Fatima	Place of pilgrimage, religious practices and celebrations
Third World	Adventure, discovery of other cultures, understanding of tribal life (rites, traditions, lifestyle) anthropological investigation	Yemen, Madagascar	Cities, historic places, rites, customs, celebrations, guided tours, contact with non-western local cultures
Exotic and Exclusive	Beautiful scenery, isolated locations, far from tourist trek, status symbol and image	Maldives, Seychelles	Villages in traditional style but with all modern conveniences, privacy, untouched natural environments

# **3.** The use of ontologies to define specialized models

### 3.1 The Quality Model Factory

In [9] we described a modular and scalable approach – the Quality Model Factory - to define specialized quality models identifying the specific features of tourist destination Web sites. Its goal was to introduce a systematic way to define a "personalized" evaluation framework. The use of modules derives from the application of reuse of artefacts [13] as a viable practice for definition of evaluation models. Scalability is obtained thanks to the adoption of a general conceptual framework, for Web site quality, the 7Loci meta-model (www.economia.unitn.it/etourism/pubblicazioni.asp). This model introduces seven dimensions used to classify the numerous features of a Web site that can then be

evaluated. The dimensions are *Identity*, *Content*, *Services*, *Location*, *Maintenance*, *Usability* and *Feasibility*. The foundational procedure that serves as the starting

point in developing a modular model for a given class of Web sites is outlined in the steps in table 2.

#### Table 2. Procedure for the quality model factory

{1ST PART: DEVELOPMENT OF COMMON AND SPECIALIZED MODULES}			
IF no model for the class of sites currently exists			
THEN	FOR each of the 7Loci dimensions pertinent to the project		
	Identify the requirements common to all sites in the class and convert them		
	into a question; add the question to the Common module;		
	Identify the specific requirements for the type of site under evaluation and		
	convert them into a question; add the question to the Specialized module;		
ELSE	FOR each dimension of the 7Loci:		
	FOR each question of the existing model		
	IF the question is applied to the type of sites in its current form		
	THEN Add the question to the Common module		
	ELSE IF the question requires only a formal modification		
THEN Modify the question and add it to the Specialized			
module;			
IF the question is inapplicable to the type of site under evaluation			
THEN check whether there is an alternative question and add it to the			
Specialized module			
{2ND PART: COMPLETION OF COMMON AND SPECIALIZED MODULES}			
FOR ea	ch requirement for the type of site under evaluation		
Identify	the 7Loci dimension it refers to		
IF no question exists for it in the Common or Specialized module			
THEN IF the question regards all the sites in the class			
THEN Add a question to the Common module			
I	ELSE Add a question to the Specialized module.		

The procedure has two parts; the first is the instantiation of the 7Loci model, reusing where possible a model already defined for one of the types of site in a class. This step is necessary in order to define the model using requirements as the starting point. In the second part the specific elements for the type of site are identified. When talking about the sites of tourist destinations, this means translating these elements into points (characteristics) within the evaluation model; for example, the unique features of the site for a seaside destination will be converted into points in the model used to evaluate that type of site, while features for another type of destination (religious, for example) may not contain those same points. In our previous work we looked at the aspects in table 1, which in general can be

found in classification schemes of the sites of a specific category. When describing the procedure, for the sake of simplicity we refer to "questions" to insert in the evaluation modules. In reality this is only one way of formulating the points or factors of the evaluation model; besides interrogatives (e.g., in boolean questions) they can also be described in declarative form.

In this paper we want to broaden the approach to be able to develop models for diverse types of sites, and such generalization is conceptually based on the use of ontologies. The steps of the procedure where ontologies can be used are shown in table 2.

The logical architecture of the Quality Model Factory is depicted in figure 2 (a Quality Factory to support "information quality" assessment is described in [4]), where the database "Web site classification" is substituted with a database containing the ontologies.



Figure 2. The Quality Model Factory

From among the different actors in the tourist sector present in the territory we focused on hotels and tourist destinations when studying our approach. For both categories tourism is the core business and the Web site is a strategic tool. For the tourist destination the Web site serves to promote and commercialize the products as well as to support the different actors.

#### 3.2. Models for accommodations facilities

In a previous project we built a model for the comparative evaluation of the Web sites of about 200

hotels. The model consists of 18 questions: four for the dimension *Identity*, nine for *Content*, two for *Services* and one for *Localization*, *Management and Usability*. The model is a useful reference to check the results that can be obtained with the Quality Model Factory which is strengthened through the use of ontologies. In this case we have used the concepts related to *hotel* in WordNet. In addition, for the requirements of the owner and user, we have put together information emerging from the research conducted on the hotels [6]. In this case it meant developing a model more similar to that constructed with the contribution of experts, and also applicable to all hotels. Thus we did not intend to construct different models for different types of hotels.

#### **3.3.** Models for tourist destinations

Applying the Quality Model Factory approach to tourist destination Web sites without using ontologies produced a series of models, each containing about 100 factors that are a reference for evaluating and which can be produced with ontologies [9]. Moreover, we thus obtained important results for the adaption process, where ontologies are necessary to specialize the general-purpose models. Also emerging, in particular, was how the first two dimensions of the 7Loci meta-model depend more on the type of site (with an average of about 80% of specialized factors); about one third are specialized for Services, ten percent for Usability, Maintenance and Localization (related principally to the presence of different target tourist groups). Development of a model for the evaluation of Web site quality for tourist destinations is underway as part of the joint project IFITT/WTO (www.ifitt.org/)sito. The model foresees two levels of assessment: the first looks at general aspects and therefore at requirements that all tourist destination Web sites must satisfy; the second is called Strategy Based Full Web Site Evaluation. A limitation of the IFITT/WTO model is that there is a measurable gap between the two levels. Essentially the first level uses a general model for all destinations while the second must be defined ad hoc. We propose the use of ontologies to specialize the quality models in a systematic way.

## 4. Conclusions

The project is still underway, the results obtained thus far have revealed the following aspects:

- The dimensions of the 7Loci meta-model where the use of ontologies is more straightforward are

those which are more "semantic", thus *Content*, and *Services*; for these dimensions it is possible to use the hierarchies contained in the ontologies as check-lists to identify aspects for which the site must give information or support for services.

- For the dimension *Identity* it is necessary to integrate the ontologies with the aims of the site and be able to connect them to the concepts in the ontology that mainly contribute to the creation of the image of the organization; these concepts are usually specializations of "father" concepts; in the case of hotels, their specialization is for specific target markets, for example motor hotels.
- For all the dimensions of the 7Loci meta-model, the combined use of ontologies, of the standardized version accompanied by a list of the main aims of the site (no more than five elements: e.g., target, business functions, general links), by people with limited experience working in Web site quality (undergraduates students), made it possible to develop "draft" specialized models in a short time and which can be rapidly verified and completed by an expert. On the whole, the methodology proposed makes it possible to notably improve the efficiency of the process of defining specialized models.
- Substantial initial effort is required to identify ontologies for the different domains necessary to cover the tourist sector. Moreover, existing ontologies are heterogeneous with regard to the coverage of the domain they refer to. Nonetheless, they can be reused for numerous categories of operators and entities.
- Statistical analysis of the terms used in sites under analysis provides useful information for the choice of ontology, but principally to choose the concepts to use within the ontology to instantiate the quality models.
- Most existing ontologies are in English language; but it could be necessary to have ontologies in other languages.
- As for their implementation, most ontologies that can be used in the tourism context are written in DAML and some in OWL. This means that if we want to create environments to support the "Quality Model Factory" it is necessary to extract

a version of at least two different types of file that even non-experts can understand.

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