Toward complex academic Web-Sites Quality evaluation method (QEM) framework: quality requirements phase definition and specification

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Abstract

Due to the high dependability on web-based information systems, a great effort has been introduced for increasing acceptability, and decreasing the complexity. However, most of the defined product process model that leverage the effective development, and evaluation process model that promote the website quality assessment and improvement are not being accompanied by that sites growth. This paper presents a general website quality evaluation framework based on a new methodology for organizing the definition and specification of the content.

The main objective of this paper is to introduce the process steps that the evaluators should follow by applying the WEB-QEM that represents the characteristics and attributes for the domain of academic sites in order to produce a quality requirement tree and a descriptive framework to specify them in consideration for the aspects of Quality Requirements phase Definition and Specification (first phase from the four main phases of WEB-QEM Quality Evaluation Method).

A case study on typical academic website is made where more than 70 measurable attributes are outlined and grouped in the quality requirement tree regarding the general visitor view. The methodology results may be useful to understand, control and improve the web artifacts quality in small, medium and large-scale projects.

KEYWORDS: Web-sit QEM, Quantitative Evaluation, LSP, Academic Sites, Quality, Characteristics, Attributes, Metrics.

1. Introduction

The sudden irruption of the Web around the world has marked a quick growth in the developments of Web based information systems. Much defined models that leverage the development and the evaluation activities, mainly in medium and large-scale projects, have not been accompanied by that sites growth. Thus, the need of having an engineering approach to help in the understanding, evaluation, and improvement of Web-based information systems should be considered a mandatory requirement. The evaluation methods fall in the following categories: Testing, Inspection, Inquiry, Analytical Modeling or Simulation.

The Applied Methods and Techniques for the evaluation process could be [17]:

- Quantitative, Qualitative
- Automatics, Semi-automatics or Manuals
- Ranging from Easy to Use to Hard to Use.

Those methods and techniques have many types like:

- Thinking-aloud Protocol,
- Log File Analysis,
- Heuristic Evaluation (as Guideline Review),
- Inspection of Characteristics and Attributes (as Standards Compliant (ISO 9126-1)),
- Interviews, Questionnaires and Cognitive Task Analysis etc.

The quality models were already recognized in the scientific community by the end of the decade of the 70 as described by McCall [1] and Boehm [2,3]. These models describe the quality of the product using a decomposition approach (top-down), where the evaluators are concentrating on the quality key attributes for the software system, in consideration of a user's point of view. Those key attributes are called in the model of McCall, quality factors. However, these factors are still of very high level to be able to be measured directly; therefore, they break down in attributes of lower level called quality criteria. Some times, a level of greater decomposition is required, in which the quality criteria is associated with a set of directly measurable metric. The main drawback in such fixed models in which they assume that all the characteristics (or factors) and other components necessary to evaluate a system.

One objective for Web-site evaluation is to find out the extent that gives information system characteristic or set of characteristics fulfills a selected set of requirements regarding a specific user view, Therefore evaluation implies a logical decision-making process. Even if software evaluation has more than three decades as discipline, the systematic and quantitative quality evaluation of hypermedia information system and particularly of the Web sites is rather a recent and often neglected issue. Most of the recent efforts in this area have introduced some evaluation criteria as richness, consistency, and among others, to evaluate in a qualitative way hypermedia information system. However, this approach is only well suited when the evaluation problem is rather simple and intuitive. In cases with many elementary attributes, it is difficult to evaluate accordingly and it is hard to identify minor differences between similar comparative systems.
In the last years Web-site style guides and design principles have emerged to assist developers in the process and list of guidelines that author should follow in order to make sites more accessible [7]. These guidelines and techniques have brought insight about essential characteristics and attributes and might improve the Web-site designing process but, obviously, do not constitute evaluation methods by themselves. In addition, a need for a broad and engineering-based method as WEB-QEM [15,16,17] will be a result to assess web sites and information systems efforts to meet quality requirements in new web development projects and to evaluate requirements in operational phases. It also helps us to discover absent features or poorly implemented requirements such as interface related design and implementation drawbacks or problems with navigation, accessibility, search mechanisms, content, reliability and performance.

WEB-QEM categorized as an external product feature or characteristic inspection method for quality evaluation where evaluators measure an entity starting from characteristics ending with attributes based on a quality model like ISO/IEC 9126 [10] which can characterize the external quality that ultimately defined as "the result of the combined behavior of the software component or application and the computer system " or it can be defined as "the behavior of the running software in a simulated or operational environment ".

The main contribution of this paper is to introduce a new method for determining and specifying the characteristics and attributes based on common practice in describing software quality in terms of quality characteristics as defined in the ISO/IEC 9126-1 [10] standard. The literature often characterizes quality, cost, or productivity requirements as nonfunctional, and measuring these tangible characteristics directly isn't practical, but assessing them can be done by measuring the product's "lower abstraction attributes". Under defining attributes as measurable properties of an entity (our entity here is the web based information system) a quality model (in the form of quality requirement tree) must be proposed to specify them. In the academic domain, there are mainly three different audiences regarding the visitor view, namely: current and prospective students, academic personnel, and research sponsors. To specify the quality requirement tree for academic domain, the main goal for this evaluation framework must be specified which is "to understand the current level of fulfillment of essential quality characteristics given a set of requirements with regard to prospective and current students’ viewpoint".

The proposed framework of WEB-QEM [15,16,17] is represented in fig(1), it depicts the main evaluation components, which are as follow:

- **Evaluation requirements**: including the specifying for domain, goals, constraints and nonfunctional requirements definition and specification like quality models, attributes and metrics.
- **Data capture**: where specifying what is the data collection techniques (automatic, semiautomatic and manual) that will be used and in which phase.
- **Analysis**: for data interpretation using statistical techniques, graphical visualization etc.
- **Recommendations**: including conclusions reports improvement proposals based on the strengths and weaknesses.

The structure of this paper is as follows: In section 2, presenting the main activities of the proposed framework those evaluators should perform by applying the WEB-QEM. In section 3, the proposed method for representing quality characteristics and attributes through the quality requirement tree regarding student point of view. In section 4 discussion and analysis for Proposed method and finally in section 5, considering the concluding remarks and future work.

### 2- Overview proposed WEB-QEM framework

As stated above the main concern of this paper is to effectively select quality characteristics and attributes considering the site domain, evaluation goals, and different stakeholders' requirements. After considering these steps, the primary objective is to group characteristics and attributes that insight be part of the evaluation and comparison process. So, to get insight of the overall process, outlining and describing the main steps that the evaluators should follow by applying the Web-QEM will be mandatory as depicted in Fig.1 that grouped in the following four major technical phases [15] :

1. Quality Requirements Definition and Specification;
2. Elementary Evaluation (both Design and Implementation stages);
3. Global Evaluation (both Design and Implementation stages);

#### 2.1 Quality Requirements Definition and Specification phase

In this phase, evaluators must clarify the evaluation goals and the intended user viewpoint. They should select a quality model, for instance, the ISO-prescribed characteristics in addition to attributes customized to the Web domain. The relative importance of these components should be identified considering the Web based information systems audience and the extent of the coverage required. Regarding the user profile, at least three abstract evaluation views of quality may be defined, i.e., visitors, developers and managers views. For example, the visitor category can be decomposed in general and expert visitor subcategories. Thus, taking into accounts the domain and product descriptions, the agreed goals, and the selected user view (i.e., the explicit and implicit user needs), characteristics, subcharacteristics and attributes that influence product quality and should be agreed and specified by evaluators according to the quality mixed model approach notion which is simultaneously, pragmatic and flexible.

Part of quality mixed model is a fixed model (in our case, from the quality model ISO 9126) in which it is assumed that all the characteristics necessary to monitor a product quality
evaluation project; are a subgroup of the six characteristics published in the standard. On the other hand, at level of Subcharacteristics (second level) are defined by consensus between evaluators and other intervening parts (possibly constructed in consideration of prescript Subcharacteristics in the standard for each characteristic). As a whole, the remaining mechanism of decomposition is defined, and they agree the Subcharacteristics of lower levels, the attributes and the measurement criteria. Finally, at the end of this phase relations between attributes, Subcharacteristics and characteristics should be assembled and grouped in the quality requirement tree.

2.2 The Elementary Evaluation phase

In this phase, two major stages are defined as depicted in Fig. 1: The design and the implementation of the elementary evaluation. For each measurable attribute Ai from the requirement tree, and associating a variable Xi, which will take a numerical value from a direct or indirect metric. However, the value of this metric will not represent the level of satisfaction of this elementary requirement at all. For that reason, it is necessary to define an elementary criterion function that will result afterwards in an elementary indicator or preference value. For instance, let us consider the Broken Links attribute, which measure (count) links that lead to missing destination pages. A possible indirect metric is:

\[ X = \frac{\#\text{Broken Links}}{\#\text{Total Links of Site}} \]

Now, how to interpret the measured value? What are the best, worst and intermediate preferred values? The next formula represents a possible criterion function to determine the elementary quality preference EP:

\[ EP = \begin{cases} \text{1 (or 100\%)} & \text{if } X = 0; \\ \text{0 (or 0\%)} & \text{if } X \geq X_{\text{max}}; \\ \frac{X_{\text{max}} - X}{X_{\text{max}}} & \text{if } 0 < X < X_{\text{max}} \end{cases} \]

Where \( X_{\text{max}} \) is some agreed upper threshold such as 0.06. Therefore, the elementary quality preference EP is frequently interpreted as the percentage of satisfied requirement for a given attribute, and it is defined in the range between 0, and 100\% [6] (so the scale type and the unit of metrics become normalized). Furthermore, to ease the interpretation of preferences, they are primarily group in three acceptability levels, namely: unsatisfactory (from 0 to 40\%), marginal (from 40 to 60\%), and satisfactory (from 60 to 100\%). In the implementation stage, the selected metrics are applied where some values can be measured observationally, while others can be obtained automatically by using computerized tools.

2.3 The Global Evaluation Phase

The design and the implementation of the partial/global quality evaluation. In the design stage, an aggregation criteria and a scoring model should be selected. The goal of quantitative aggregation and scoring models is to make the evaluation process well structured, accurate, and comprehensible by evaluators. There are at least two types of these models: for example, those based on linear additive scoring models and those based on nonlinear multi-criteria scoring models where different attributes and characteristics relationships can be designed. In both cases, the relative importance of indicators is considered by means of weights. For example, if our procedure is based on a linear additive scoring model the aggregation and computing of partial/global indicators or preferences (P/GP), considering relatives weights (W) is based on the following formula:

\[ P/GP = (W_1 EP_1 + W_2 EP_2 + \ldots + W_n EP_n) \]
Such that if the elementary preference (EP) is in the unitary interval range the following is held:

\[ 0 \leq EP_i \leq 1 \]

or given a percentage scale,

\[ 0 \leq EP_i \leq 100 \]

and the sum of weights must fulfill that

\[ (W_1 + W_2 + \ldots + W_m) = 1 \]

if \( W_i > 0 \); \( i = 1 \ldots m \).

The basic arithmetic aggregation operator for inputs is the plus (+, or A) connector. Formula (1) cannot be used to model simultaneity or replaceability of inputs, among other limitations; they are not useful to express for example simultaneous satisfaction of several requirements as inputs. Additively assumes that insufficient presence of a specific attribute (input) can always be compensated by sufficient presence of any other attribute. Furthermore, additive models are unable to model mandatory requirements; i.e., the total absence of a necessary attribute or subcharacteristic cannot be well compensated by means of the high presence of others. Instead, if using a nonlinear multi-criteria scoring model, dealing with simultaneity, neutrality, replaceability, and other input relationships will be possible using aggregation operators based on the weighted power means mathematical model. This model, so-called Logic Scoring of Preferences (LSP) [5], is a generalization of the additive-scoring model that can be shown in Fig. 2 and can be expressed as follow:

\[
P/GP(r) = (W_1 EP_1^r + W_2 EP_2^r + \ldots + W_m EP_m^r)^{1/r}
\]

Where \(-\infty \leq r \leq +\infty \); \( P/GP(-\infty) = \min (EP_1, EP_2, \ldots, EP_m) \) and; \( P/GP (+\infty) = \max (EP_1, EP_2, \ldots, EP_m) \).

The power \( r \) is a parameter (a real number) selected in order to achieve the desired logical relationship and intensity of polarization of the aggregation function. If \( P/GP(r) \) is closer to the minimum then such a criterion specifies the requirement for the simultaneity of inputs. Conversely, if it is closer to the maximum then it specifies the requirement for the replaceability of inputs.

Formula (2) will be is additive when \( r = 1 \), which models the neutrality relationship; i.e., the formula remains the same as in the first additive model. In addition, (2) is supra-additive for \( r > 1 \) which models the conjunction or replaceability of inputs and it is sub-additive for \( r < 1 \), (with \( r \neq 0 \)) which models the conjunction or simultaneity of inputs. In the intended case study, the use of LSP [5] model was selected. a seventeen-level approach of conjunction-disjunction operators was used, as defined by Dujmovic [5]. Each operator in the model corresponds to a particular value of the \( r \) parameter. When \( r = 1 \) the operator is tagged with A (or the + sign). The C or conjunctive operators range from weak (C-) to strong (C+) quasi-conjunction functions, i.e., from decreasing values of \( r \), starting from \( r < 1 \).

In general, the conjunctive operators imply that, a low quality of an input preference can never be well compensated by a high quality of some other input to output a high quality preference (in other words, a chain is as strong as its weakest link). Conversely, disjunctive operators (D operators) imply that a low quality of an input preference can always be compensated by a high quality of some other input. In order to design the LSP aggregation schema, the following key basic questions (a part of the Global Preference Criteria Definition), should be answered:

1. What is the kind of relationship among this group of related attributes/subcharacteristic, etc.?, is it either a conjunctive, or disjunctive or neutral relationship?
2. What is the level of intensity of the logic operator from a weak to strong conjunctive/disjunctive polarization?
3. What is the relative importance or weight of each element into the group?

Therefore, once a scoring model has been selected, the aggregation process follows the hierarchical structure as defined in the non-functional requirement tree (as the shown in fig.3 and fig.4), from bottom to top. Applying a stepwise aggregation mechanism, a global schema can be obtained in the end. The LSP model allows us to compute partial and global indicators in the implementation stage. The global quality preference represents ultimately the global degree of satisfaction in meeting the stated requirements.
2.4 The Evaluation Conclusion phase

In this phase, the documentation of Web product components, the specification of quality requirements, metrics, criteria, elementary and final results are recorded. The strengths and weaknesses of the assessed product with regard to established goals and user viewpoint can be analyzed and understood by requesters and evaluators depending on the evaluation and comparison process. For each global indicator of the scale from 0 to 100% [6] is obtained, as shown in figure.1 such cardinal rating falls in three categories or preference levels, namely: unsatisfactory (from 0 to 40%), marginal indicates a need for improvement actions (from 40 to 60%), and satisfactory quality of the analyzed feature (from 60 to 100%). The global preference can be approximately interpreted as the degree of satisfied requirements. As a result, in the end of this phase the Recommendations can be suggested and justified.

3- The proposed method for representing Characteristics and Attributes:

In this section, focusing on defining and categorizing a wide set of Web-site quality characteristics and attributes will be handled. Specifically, by applying the last step in the first phase where the evaluators group characteristics and attributes in a requirement hierarchy.

As previously stated, the same conceptual high-level quality characteristics were used as defined in the ISO/IEC 9126-1 [10] standard like usability, Functionality, Reliability, Efficiency, Portability, and Maintainability to follow well-known standards. These characteristics give a conceptual and general description of software quality and provide a baseline for further decomposition.

From these characteristics, sub-characteristics could be derived, and from these, measurable attributes could be specified (all of derivation according to the quality mixed model approach as previously stated). Furthermore, the relative importance of characteristics varies depending on the different users and information system domains. According to this, the three views of quality are defined, namely: visitor view, developer view, and manager view [10].

The visitor category can be decomposed, in turn, in two sub-categories: General visitors and expert visitors. The former represents casual or intentional audience maybe having a general interest and/or minimum domain knowledge; the later represents, a specialist or expert in the domain. In addition, from the visitor viewpoint, quality characteristics such as Maintainability and Portability are not relevant. They are mainly interested in the site ease of use and communicativeness, in its browsing and search mechanisms, in its coherent navigation mechanisms and dependent-domain expected functionality, and also, in the site reliability and efficiency. Thus, in order to assess the Web-site quality, it should be clearly stated the desired combination of characteristics and attributes regarding the intended audience. In the academic domain, there are mainly three different audiences regarding the visitor view, namely: current and prospective students, academic personnel, and research sponsors. Ultimately, the main goal of this study is to evaluate and determine the level of fulfillment of required characteristic such as usability, functionality, reliability, and efficiency, and compare partial and global preferences. This potentially allows us to understand and draw conclusions about the state-of-the-art of the quality of academic sites, from the student’s (current and prospective) point of view.

Particularly, as highlighted at the beginning of this subsection, the very nature of Web based information systems, which are a mixture of information (media) contents, functionalities and services. The six quality characteristics (i.e., Usability, Functionality, Reliability, Efficiency, Portability, and Maintainability) argued that they were not well suited (or not intended) to specify requirements for information quality. As Nielsen [4,11] writes regarding Web contents for informational websites “Ultimately, users visit your website for its contents, everything else is just the backdrop”.

Hence, to follow the thread of our argument, the central issue is how to specify and gauge the quality of Web information contents from the internal and external quality perspectives.

Taking into account some contributions made in the area of information quality [8,9,12,13,14] the Content characteristic have primarily identified with four major subconcepts. The following categories can help to evaluate information quality requirements of Web based information systems:

- **Information Accuracy**: This subcharacteristic addresses the very intrinsic nature of the information quality. It assumes that information has a purpose of its own quality. Accuracy is the extent to which information is correct, unambiguous, authoritative (reputable), objective, and verifiable. If fame to inaccurate information becomes a common belief for a particular piece of information, the website will likely be perceived as having little added value and will result in reduced visits.

- **Information Suitability**: This subcharacteristic addresses the contextual nature of the information quality. It emphasizes the importance of conveying the appropriate information for user-oriented goals and tasks. In other words, it highlights the quality requirement that contents must be considered within the context of use and the intended audience. Therefore, suitability is the extent to which information is appropriate (appropriate coverage for the target audience), complete (relevant amount), concise (shorter is better), and current.

- **Content Accessibility**: It emphasizes the importance of technical aspects of Web based information systems in order to make Web contents more accessible for users with various disabilities (see for instance the WAI initiative [Web content accessibility guidelines 1.0 accessed on 2004]).

- **Legal Compliance**: The capability of the information product to adhere to standards, conventions, and legal norms related to contents and intellectual property rights.

According to the intended user’s profile and goal, the content legal compliance is not relevant to our evaluation process. Besides the above categories, subconcepts of information structure and organization should be addressed. Consequently, in order to represent accordingly quality information requirements to software and mainly to Web based
information systems, proposing to include the Content characteristic into the internal and external quality model of the ISO standard will be mandatory and represents the main contribution in this paper.

A point worth mentioning is that in the spirit of the ISO 9126-1 [10] standard is stated "evaluating product quality in practice requires characteristics beyond the set at hand ..."; and to the requirements for choosing the prescribed characteristics, an ISO excerpt says "To form a set of not more than six to eight characteristics for reasons of clarity and handling". In this section, the quality requirements tree, corresponding to the Web domain of an academic unit will be presented as a university site as a whole rather than on each individual academic unit such as schools, colleges or laboratories.

The later selected universities sites for our process of quality evaluation and comparison in the next phases must embracing regions of different continents where they were published in the web (in the operative phase) from more than three years age. On the other hand, with regard to selected quality characteristics and attributes for assessment purposes, about a hundred and twenty quality characteristics and attributes were taken into account. (This why our academic web sites evaluation framework described as a complex one).

Hence, student-oriented and paper-based questionnaires were conducted to help us in determining the relative importance of characteristics and subcharacteristics. Discussions among involved parties took place (i.e. students, academic personnel, and three evaluators). These gave us feedback to observe, for example, that quality characteristics such as maintainability and portability are not relevant for this audience. Fig. 3 and fig.4 outlines the resulting characteristics and measurable attributes.

In fig.4, Subcharacteristics and attributes derived from the characteristics of higher level named Reliability and Efficiency; also, and according to the standards and approaches previously discussed, in figure 3 Subcharacteristics and attributes derived from the characteristics Usability, Functionality and content are detailed. These prescript characteristics at a high level of abstraction, gives the evaluators a conceptual frame to specify quality requirements providing a firm base for later refinements. Applying the decomposition mechanism description, the characteristics are possible to be disturbed in multiple levels of Subcharacteristics, until arriving at the tree leaves, that is to say, a set of quantifiable attributes. According to this way, the Usability high-level characteristic is decomposed in sub-factors such as Global Site Understandability (implemented by mechanisms that help to understand quickly the structure and contents of the information space of a website like a table of contents, indexes, or a site map), Feedback and Help Features, Interface and Aesthetic Features, and Miscellaneous Features.

The characteristic Functionality is disturbed in two sub-characteristics, quite independent of the domain as searching and retrieving issues (e.g. are the basic and advanced search suitable for the end user? Alternatively, is the basic and advanced search tolerant for misspelled words and accurate in retrieving documents?); Navigation and Browsing issues. In the same way the characteristic Content is disturbed in three sub-characteristics, two quite sub-characteristics dependent of the domain as Information Accuracy, and Information Suitability (Student oriented Domain features) the third one independent, named content accessibility.

Concentrating in Information Suitability (Student oriented Domain features), two basic characteristics are observed Student oriented Basic information and Student oriented contextual information. As the reader can appreciate, in this study there will be evaluated aspects that go from academic units information; inscription information, careers and up to courses; information of academic infrastructure. In addition, a mechanism of similar decomposition was applied for Reliability and Efficiency.

For example, the characteristic Efficiency was divided in to subfactors Performance and Accessibility. In the same way, link and page maturity attributes can be presented, or attributes of deficiencies due to browsers’ compatibility into the Reliability subcharacteristics.

Finally, in consideration of Web domain evaluation process, it could be seen easily that not necessarily all the attributes must exist simultaneously; Site Map, or a Table of Contents could be necessary, or an Index. Moreover, different types of index could be replaceable depending on specific requirements. The indices oriented to thematic or the alphabetical, they could be better in certain circumstances than a chronological index; in addition, may be more than one type of index is specified. (Web-QEM allows modeling replaceability and simultaneity relations taking into account the relative weights and polarization levels and/or using the LSP [5] model). In the same way for the replaceability relation mentioned, it would be possible to model the simultaneity relation; for example, in the subcharacteristic searching and retrieving issue. For a given visitor, it would be possible to require two search types: scoped search and Global Search; that is to say, a scoped search could be necessary to investigate by key words aspects, while also a global search could be necessary to find documents or records that could be in any subsite of the whole Web site.

4- Proposed method discussion and analysis

Web developments are continuous and rapidly growing due to the wide acceptance of Web-based systems for very different audiences. However, this raises issues like how to design for quality and cost-effectiveness taking into account the satisfaction of different users’ needs and behaviors, or how to assess, interpret outcomes, and, ultimately, improve the quality of Web artifacts, and other issues. One effective strategy to face these, is product and process modeling using prescriptive and/or descriptive approaches. Process and product modeling potentially allows us the understanding and communication; the evaluation and improvement; the control and forecasting.

As a result, this paper proposes a quantitative evaluation method to assess and compare the current Web- site quality regarding a user viewpoint. The primary goal was to classify, in a standard-compliant way, quality characteristics and attributes that might be part of a quantitative evaluation, comparison, and ranking process regarding academic visitor. This activity, implies a hierarchical decomposition from the higher level of the tree at
1. Usability

1.1 Global Site Understandability
1.1.1 Global Organization Scheme
1.1.1.1 Site Map
1.1.1.2 Table of Contents
1.1.1.3 Alphabetical Index
1.1.2 Quality of Labeling System
1.1.3 Student-oriented Guided Tour
1.1.4 Image Map (Campus/Buildings)

1.2 Feedback and Help Features
1.2.1 Quality of Help Features
1.2.1.1 Student-oriented Explanatory Help
1.2.1.2 Search Help
1.2.2 Web-site Last Update Indicator
1.2.2.1 Global
1.2.2.2 Scoped (per sub-site or page)
1.2.3 Addresses Directory
1.2.3.1 E-mail Directory
1.2.3.2 Phone-Fax Directory
1.2.3.3 Post mail Directory
1.2.4 FAQ Feature
1.2.5 Form-based Feedback
1.2.5.1 Questionnaire Feature
1.2.5.2 Guest Book
1.2.5.3 Comments

1.3 Interface and Aesthetic Features
1.3.1 Cohesiveness by Grouping Main Control Objects
1.3.2 Presentation Permanence and Stability of Main Controls
1.3.2.1 Direct Controls Permanence
1.3.2.2 Indirect Controls Permanence
1.3.2.3 Stability
1.3.3 Style Issues
1.3.3.1 Link Color Style Uniformity
1.3.3.2 Global Style Uniformity
1.3.3.3 Global Style Guide
1.3.4 Aesthetic Preference

1.4 Miscellaneous Features
1.4.1 Foreign Language Support
1.4.2 What's New Feature
1.4.3 Screen Resolution Indicator

2. Functionality

2.1 Searching and Retrieving Issues
2.1.1 Web-site Search Mechanisms
2.1.1.1 Scoped Search
2.1.1.1.1 People Search
2.1.1.1.2 Course Search
2.1.1.1.3 Academic Unit Search
2.1.1.2 Global Search
2.1.2 Retrieve Mechanisms
2.1.2.1 Level of Retrieving Customization
2.1.2.2 Level of Retrieving Feedback

2.2 Navigation and Browsing Issues
2.2.1 Navigability
2.2.1.1 Orientation
2.2.1.1.1 Indicator of Path
2.2.1.1.2 Label of Current Position
2.2.1.2 Average of Links per Page
2.2.2 Navigational Control Objects
2.2.2.1 Presentation Permanence and Stability of Contextual (sub-site) Controls
2.2.2.1.1 Contextual Controls Permanence
2.2.2.1.2 Contextual Controls Stability
2.2.2.2 Level of Scrolling
2.2.2.2.1 Vertical Scrolling
2.2.2.2.2 Horizontal Scrolling
2.2.3 Navigational Prediction
2.2.3.1 Link Title (link with explanatory help)
2.2.3.2 Quality of Link Phrase

3. Content

3.1 Information Accuracy
3.1.1 On-line Services
3.1.1.1 Grade/Fees on-line Information
3.1.1.2 Web Service
3.1.1.3 FTP Service
3.1.1.4 News Group Service

3.2 Content accessibility
3.2.1.1 Readability by deactivating the Browser Image Feature
3.2.1.2 Image title readability
3.2.2 Support for text-only version

3.3 Information Suitability (Student-oriented Domain Features)
3.3.1 Student oriented Basic information
3.3.1.1 Academic Unit Information
3.3.1.1.1 Academic Unit Index
3.3.1.1.2 Academic Unit Sub-sites
3.3.1.2 Enrollment Information
3.3.1.2.1 Entry Requirement Information
3.3.1.2.2 Form Fill/Download
3.3.1.3 Degree Information
3.3.1.3.1 Degree Index
3.3.1.3.2 Degree Description
3.3.1.3.3 Degree Plan/Course Offering
3.3.1.3.4 Course Description
3.3.1.3.4.1 Comments
3.3.1.3.4.2 Syllabus
3.3.1.3.4.3 Scheduling

3.3.2 Student oriented contextual information
3.3.2.1 Student Services Information
3.3.2.1.1 Services Index
3.3.2.1.2 Healthcare Information
3.3.2.1.3 Scholarship Information
3.3.2.1.4 Housing Information
3.3.2.1.5 Cultural/Sport Information

3.3.2.2 Academic Infrastructure Information
3.3.2.2.1 Library Information
3.3.2.2.2 Laboratory Information
3.3.2.2.3 Research Results Information

Fig.3 Quality requirements Tree for academic sites case of study, specifying three of the five high level characteristics: Usability, Functionality and content
4. Reliability

4.1 NonDeficiency

4.1.1 Link Errors
- 4.1.1.1 Dangling (broken) Links
- 4.1.1.2 Invalid Links
- 4.1.1.3 Unimplemented Links

4.1.2 Errors or Deficiencies Several
- 4.1.2.1 Deficiencies or absent features due to different navigators (browsers)
- 4.1.2.2 Deficiencies or unexpected results (e.g. non-trapped search errors, frame problems, etc.) independent of browsers
- 4.1.2.3 Destination Nodes (unexpectedly) under Construction
- 4.1.2.4 Dead-end Web Nodes

5. Efficiency

5.1 Performance

5.2 Accessibility

Fig.4 Quality requirements Tree for academic sites case of study, specifying two of the high level characteristic: Reliability and Efficiency

Reliability, Efficiency, Portability, and Maintainability) could be argued that they are not well suited (or they were not intended) to specify requirements for information quality. As a result, a new Characteristic related with information named by CONTENTS is suggested to evaluate the website quality through our proposed QEM framework.

Content characteristic has four major subconcepts not covered by the six-prescribed ISO characteristics:

- Information Accuracy is the extent to which information is correct, unambiguous, authoritative (reputable), objective, and verifiable.
- Information Suitability is the extent to which information is appropriate (appropriate coverage for the target audience), complete (relevant amount), concise (shorter is better), and current.
- Accessibility emphasizes the importance of technical aspects of Web Based information systems in order to make Web contents more accessible for users with various disabilities.
- Legal Compliance the capability of the information product to adhere to standards, conventions, and legal norms related to contents and intellectual property rights.

According to the intended user’s profile and intended goal, the content legal compliance is not relevant to our evaluation process. After discussing quantitative evaluation criteria for some elementary attributes, and showing the main method activities, one strength of Web-QEM resides in the modeling of great amount of attributes using the LSP approach where attribute relationships can model simultaneity, replaceability, neutrality, symmetric and asymmetric using logical aggregation operators and at the end of the evaluation and comparison process, obtaining for each selected Web system a global indicator using the scale from 0 to 100% [6]. Such cardinal rating will fall in three acceptability levels, namely: unsatisfactory (from 0 to 40%), marginal (from 40 to 60%), and satisfactory (from 60 to 100%).
5- Concluding Remarks and Future Directions

To improve the quality of Web-based information systems, software engineering methods, models, techniques, and tools should increasingly be used, the proposed expert-driven Web-site QEM methodology, can be a useful approach to assess the quality in the different phases of a Web product lifecycle. Ultimately, the rational utilization of Website QEM should help in reducing subjectivity in the process by providing a quantitative basis for quality assessment. This paper has investigated and discussed the main ideas behind the proposed quantitative evaluation methodology for Web sites (Web-QEM) that:

- Generates elemental, partial, and global indicators or quality preferences that can be easily analyzed, backward and forward traced, justified, and efficiently employed in decision-making activities, the outcomes should be useful to understand, and potentially improve the quality of Web artifacts in medium and large-scale projects.
- Can be employed in assessing and comparing quality requirements in the operative phase of Web sites as well as in early phases of Web development information systems in order to reduce or eliminate the maintenance cost after publishing, where either absent attributes, absent subcharacteristics, or requirements poorly implemented can be discovered.
- Can be used to assess diverse domains according to different user views and evaluation goals. It should be noticed that the definition and the specification of quality requirements are essential activities in the evaluation process.
- Balance the quality factor with management factors such as cost or productivity, because they wish to optimize quality within limited cost, human resources and time frame.
- Establish user quality requirements starting from six standard characteristics that described with minimal overlap, quality evaluated in general by the following characteristics: usability, functionality, reliability, efficiency, portability, and maintainability. Since those high-level characteristics provide a conceptual foundation for further refinement and description of quality, our proposed framework group and categorize Web-site sub-characteristics and attributes in the quality requirement tree. Therefore, in field studies like this, student-oriented meetings, questionnaires, or other techniques has been led to help in determining the requirement tree and the relative importance of the components. Generally, Web site visitors are mainly concerned in using the site, i.e., in its searching and browsing functions, in its specific user-oriented content and functionality, in its reliability, in its performance, in its accessibility mechanisms, in its feedback and aesthetic features, etc.; ultimately, they are interested in quality of its use. Nonetheless, maintainability and portability are rather neglected for this kind of users.
- A new Characteristic related with information named by CONTENTS is suggested to evaluate the website quality through our proposed framework where Users visit any website for its contents and everything else is just the backdrop.

As a result, the meaning of quality is more declared where it is not simple and atomic, but a multi-dimensional and abstract concept. Moreover, the subjectivity can substantially be minimized in the evaluation process but cannot be eliminated at all. Finally, as a future direction running our case study on typical academic sites will performed through the rest phases of web-QEM including the steps for the quality metric validation, both theoretically and empirically, using of the LSP model and all related works. Ultimately, those steps aim to strengthening the evaluation methodology.

References