

# E-COMWEB: A QUALITY MODEL FOR E-COMMERCE WEB SITES

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***Abstract.** This paper introduces a statistical approach to the construction of a new Quality Model for Web Sites (E-COMWEB). A brief overview on Web Sites Quality Models is shown and used top-down and bottom-up approaches are introduced. This approach to the construction of E-COMWEB is different from most of the current ones: exploiting the considerable number of available Web Sites, it uses statistical analysis for validating the relations between variables in a traditional Quality Model and finding new ones. The process for constructing such a newly conceived model and its composition is presented and discussed, and examples of its application are shown.*

***Keywords:** Quality, Quality Models, Web Sites Quality Evaluation, E-commerce*

## 1. INTRODUCTION AND BACKGROUND

Websites are assuming greater importance to announce anything publicly, from one's ideas, beliefs and experiences, to news broadcasting and commenting, to ways to provide a variety of services. Their communicative nature is at user service, and the user wishes to find exhaustive and updated information besides accessible and rich contents in brief time and without too many obstacles. Very important is therefore to evaluate websites quality: the quality of a Web Site (WS) is strongly linked to the relationship between the expected goals of the WS and the degree of achievement of such goals. To investigate this topic, we adopted the definition of quality by Standard ISO 8402 [14] according to which quality is "The totality of features and characteristics of a product, process of service that bear on its ability to satisfy stated or implied needs". Besides it is opportune to distinguish the type of quality we want to refer to, or, following the perspective adopted by Standard ISO/IEC 9126 [16], Internal Quality, External Quality and Quality in use. The type of quality we are interested in a Website is the quality perceived by the site's user, namely "quality in use". Nevertheless, since the quality positively perceived by the user is hardly achieved without a good code quality and good performances, we considered suitable that these three aspects of quality were equally evaluated.

Any attempt to evaluate the quality implies, implicitly or explicitly, a Quality Model (QM), including QMs for QMs [20], [23]. The study of the quality characteristics of software products and their relationships has been absorbing an impressive amount of effort that can be dated back to the 1970's [3], [8], [10] [21] [25], but in spite of the huge research work spent over decades, no practically (industrially) satisfying solutions have been reported up to our days [1].

In different communities (e-government, cultural, research and commercial environments), Quality Models have been proposed in terms of hierarchical sets of aspects, or characteristics, capable of capturing and expressing the quality concept. Abstract models have been proposed that produce complex, time-consuming manual evaluation methods and partially tool-aided approaches. As an

alternative, several commercial/prototypal tools are also available, whose declared performance has little explicit relationship with all the various dimensions of the quality concept (yet, a sort of implicit quality expectation hides behind the set of data provided by automated analyses). Broadly speaking, we can distinguish between two trends: one where an evaluation process is defined on the grounds of a quality model structured into hierarchical characteristics; another one where unidentified quality aspects represent a target against which the information collected by raw-data analysis should be checked. Our purpose was to define an evaluation process to appraise the websites quality that, by conciliating these two orthogonal approaches, uses a working QM to build a statistically tested QM.

The System and Software Evaluation Centre (SSEC) of the National Research Council in Pisa (CNR) has been working for a couple of decades in 3rd party software product and process assessment/improvement. The experience of SSEC with software lifecycle process definition, started in 1993 with the SPICE project to support the ISO/IEC 15504 standard development [17] and continued with tens of process assessments [9]. After providing two decades of independent evaluation service to public administration and industries, the SSEC of CNR is planning to extend its activity and to spend some investigative effort considering that investigating website quality, with the purpose of coming out with an evaluation service, can reflect an explicit / implicit request from web users.

This paper will describe an approach to WS' quality evaluation. The approach has been developed through four temporally subsequent steps: examining some Websites QM, building a general, theoretic, common-sense compliant QM, submitting the theoretic QM to WS sample and detecting relationships between variables, finally defining the QM as reorganisation and re-definition of its components. In the Section 2 a short survey of Websites QM, proposed in the last years, is presented. The survey covers various points of view observing, gauging and finally evaluating a Website, in order to point out similarities and novelties proposed by each QM and to compare their characteristics. In Section 3 the process for generating our theoretic QM is described; particularly, the choice of e-commerce area and the top-down and bottom-up approaches to detect characteristics, sub – characteristics and variables are presented. In Section 4 the analysis and its results are summarized and in Section 5 the new QM, E - Commerce Web Sites Quality Model (E-COMWEB QM) is presented: procedures for the application and expected results. In Section 6 some conclusions are drawn and Section 7 contains a list of references.

## **2. QUALITY MODELS: DISCUSSION ON SIMILARITIS AND DIFFERENCES**

### ***2.1 Different Quality Models for different Web Site Typologies***

For evaluating Websites quality, some approaches found in literature [5], [6], [19], [22], [26], [27], [29], [30], [33], [35], [39], consider general criteria, or criteria adaptable to different kinds of web sites, while others are focused on different criteria regarding to different typologies of web sites to appraise, such as Public Administration web sites, Cultural web sites, Commercial web sites, medical Information web sites, etc. The second approach is obviously very focused on the type of service that the web site wants to offer and among its criteria. The most important are those that have an interactive nature rather than a technical one.

Nevertheless, some evaluation criteria are common to both approaches and then they may reveal to be important and essential for any type of web site aspects. For example, in order to obtain a more usable and accessible web site, several usability guidelines have been proposed, especially by W3C

(World Wide Web Consortium) in the project Web Accessibility Initiative (WAI) [36]. They pointed out a number of recommendations and guidelines to promote web accessibility: "Web Content Accessibility Guidelines 1.0" (WAI 1999).

Consequently, a short survey of web sites Quality Models will be presented. We will not focus on the type of web site for which these models were built, but emphasize their similarities and differences in web site quality evaluating and we will compare their characteristics. We then will derive a model for working purposes, that will be used for developing our approach and testing it in action.

## 2.2 *Quality Models: a brief overview*

Before introducing Website QMs, we mean to underline the importance of Standard for software product quality **ISO/IEC 9126** [16] and also **ISO/IEC 25010** [18] in the construction of a QM. Their usefulness can be found in their attempt to reduce the product quality predicate to a limited number of independent characteristics, and, as above mentioned, to have developed the notion of various levels of qualities ("internal", "external" and "in-use"). The standard proposes independent quality characteristics for software products along with metrics for their evaluation. In order to evaluate the internal and the external quality characteristics of a software product, we recall that the standard has defined six higher-level quality characteristics (*Functionality, Reliability, Usability, Efficiency, Maintainability and Portability*) plus four characteristics representing the point of view of software users (*Effectiveness, Productivity, Safety and Satisfaction*). This model and its associated metrics, in spite of scarce practical results [1], has deeply influenced the models for website quality presented in the following, because it introduces a concept of quality that is structured in a set of characteristics.

In the **Web-site Quality Evaluation Method (QEM)** [29] proposed by Olsina and Rossi, a set of Websites Quality Characteristics and Attributes is defined and categorized. The high-level Characteristics are the same of the ISO/IEC 9126 [16], but a premise is fundamental: the importance of characteristics varies depending on the users typology and application domains. Then three views of quality are defined: visitor, developer, and manager views. From the point of view of general visitors, maintainability and portability will not be necessary to be evaluated, then Web-site Quality Evaluation Method (QEM) is focused on *Usability, Functionality, Reliability, Efficiency*. Analogously to ISO/IEC 9126, these characteristics are decomposed in sub-characteristics or sub-factors, and, at the lower level, into more than sixty measurable attributes.

The **Web Quality Model (WQM)** [4], [5], [32] proposed by Calero, Piattini and Ruiz considers three properties of web site quality evaluation along with 385 web metrics. They define a cube structure composed of aspects, or dimensions, to be taken into account in the evaluation of web site quality and which can be considered orthogonal: *web features dimension* (including content, presentation and navigation), *Quality Characteristics dimension* (including Functionality, Reliability, Usability, Efficiency, Portability, Maintainability) and *life-cycle processes dimension* (including the diverse processes of the web site life cycle). The model is quite interesting and presents a systematic view of website quality that also includes aspects of the development process, an approach closer to our experience.

**Minerva** (Ministerial NETwork for Valorizing Activities in Digitization) [27], is an important initiative for Websites Quality, and its principles, although mainly refer to cultural Websites, as museums, libraries, archives and other cultural institutions, can be applied to almost any Website. Minerva offers also a set of criteria and a checklist that is based on the criteria itself.

The high-level principles expressed in this model are *Transparency* (reducing user confusion and uncertainty "the sooner possible"); *Effectiveness* (the content must be appropriately selected and relevant, valid and correct, accompanied by appropriate commentary and supporting information; besides the user must be able to easily navigate the site); *Maintenance and Update, Accessibility* (a quality Website must be accessible to all users, irrespective of the technology they use or their disabilities, including navigation, content, and interactive element); *User-centered* (taking into account the needs of users, ensuring relevance and ease of use through responding to evaluation and feedback); *Responsive* (the Website must be allowed the user to contact the site and receive an appropriate reply; where appropriate, it is also opportune to encourage questions and to share information with and among the users); *Multi-lingual* (providing a minimum level of access in more than one language); *Interoperable* (a quality Website must be committed to being interoperable within cultural networks to enable users to easily locate the content and services that meet their needs); *Managed* (a quality Website must be managed to accomplish legal and privacy issues, and clearly state the terms and conditions on which the Website and its contents may be used) and *Preserved* (it is required to adopt strategies and standards to ensure that the Website and its content can be preserved for the long-term).

The **Comprehensive Model for Websites Quality** [33] has been proposed by O. Signore with the aim of identifying a set of user perceived characteristics and relating them to internal code features to identify possible points of weakness. This websites QM offers 5 quality dimensions: *Correctness* (a technical and internal aspect which can be easily checked by several tools); *Presentation* (aspects referred to a single page and including page layout, text presentation, multimedia presentation and link presentation); *Content* (aspects considering the readability, the information architecture, the information structure, the distinction between author and webmaster, and the indication of currency of content, i.e. last update date); *Navigation* (a dimension that consider the navigation bar, the site structure and the horizontal, vertical, mixed navigation); *Interaction* (aspects considering the transparency, the recovery and the help and the hints). The model was presented to cover a possible automated process, using pages and page components as evaluation items. Its criteria can objectively be estimated and measured, to help connecting the external quality to the internal quality.

The **Meta-Model 2QCV3Q or 7-loci** [26] from the initials of the Ciceronian loci of classical rhetoric, has been proposed by L. Mich, M. Franch and G. Cilione. It is a structure or reference theoretical frame which identifies 7 dimensions or *loci* for evaluating website quality: *Identity* (*Who*, the image that the organization projects); *Content* (*What*, available information for the users); *Services* (*Why*, services available for the users); *Location* (*Where*, visibility of a website and ability of the website to offer a space where users can communicate with each other and with the organization); *Maintenance* (*When*, all activities that guarantee proper functioning and operability of the site); *Usability* (*How*, it determines how efficiently and effectively the site's content and services are available to the user), *Feasibility* (*With what means*, it includes all aspects related to project management). This model captures the general idea of quality but suffers of measurability problems. Through the 7 loci it is possible to identify the main dimensions of a Website, since they constitutes a general structure of the QM, independently from the site under analysis.

A **Web Site Quality Model** has been developed by Ping Zhang and Gisela von Dran [39] as an application of the Kano Model<sup>1</sup>. The objective of the researchers was building a theoretical framework for evaluating web site quality from an user satisfaction perspective. To such purpose

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<sup>1</sup> Kano, Noriaki, Seraku, N., Takahashi, F., and Tsuji, S. (1984), "Attractive and Normal Quality," *Quality*, (14:2)

they developed a quality model based on Kano's Model, a Japanese management consultant and researcher. Kano defined three levels of customer expectations for product and service quality: Basic, Performance and Exciting. On this structure two important variables change the perception of the quality: the time and the imitation by others. The Kano's Model assumes that with time and imitation by others, exciting quality features turn into normal expectations, and normal quality features migrate towards basic expectations. Concurrently with the three levels of satisfaction of the customer, the present model hypothesizes that the features of the scheduling of sites web can be defined in three types of quality that go towards three needs of quality: *Basic Features*, which support the expected needs of user; *Performance Features*, which contribute to performance quality of the Web site, *Exciting Features* which delights the user and may generate user loyalty. The authors defined a list of seventy-four features in the web environment, and for every feature a average score has been calculated. This model addresses an interesting aspect (exciting feature) for web sites that is indeed difficult to decompose and measure.

In the Italian Public Administration, CENSIS<sup>2</sup>, through the method ARPA (Analysis of the Public Administrations Nets), developed a Web Sites Evaluation Model defined **Pentagon of the Quality** [6]. An analysis of thirty-two Italian Public Administration web sites has been carried out, measuring, for everyone, the values of sixty-three different indicators; such indicators are related to different aspects and include technical characteristics, functionalities, contents and available services. The indicators, since they make reference to very different phenomena, are brought back then, through the parametric analysis, to homogeneous values, and from these are drawn the values of five thematic indices to be appraised: *Accessibility* (the ability of the Website to make attainable to all own contents and services); *Usability* (easiness of using web site); *Institutional Characterization* (institutional recognizability of the web sites); *Administrative Transparency* (the possibility, compliant to the normative principles, including privacy, to publish information in totally automatic way and to make it available to the public in real time); *Availability of the Services* (the possibility to interact directly with the Public Corporation through its Website). For each indice a value is associated, defining the evaluated web site profile. Such profile is graphically express through a polygonal graphics representation. The distance of the vertexes from the center represents the value of every thematic index. By the average of the five thematic indices it is possible to obtain the index that determines the total web site quality.

In the Italian Public Administration, another web site QM is the **Heptagon of the quality** [19], developed by Institute of Communication of the Free University of Languages and Communication (IULM) in Milan, in collaboration and on behalf of the Province of Milan. This model considers that the general quality of a Public Administration web site is articulated on three main dimensions and seven correlated factors: *Technical* dimension with *Accessibility* and *Usability* factors, *Communicative* Dimension with *Communicative Style* and *Graphical System* factors and *Institutional* dimension with *Bi-directionality*, *Wealth of Contents* and *Service Valence* factors. Through measured values on each of the indices, an heptagon having center in "0" and axis the value of the weighed indices, was constructed so it may assume inclusive values among 0 and 10. Therefore, the heptagon of Quality allows to display graphically the qualitative level of Web sites and the distance between the real and the ideal quality.

R. Polillo presented a **web site QM** [30] that considers the actions of the design, implementation and management of a web site, in addition to the various types of involved actors. The individuated macro-characteristics to estimate the web sites Quality are: *Informative architecture of the site*

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<sup>2</sup> Centro Studi Investimenti Sociali

(structure according to the contents), *Communication* (relationship that is established with the users), *Functionality* (all the functions that the web site offer), *Contents* (reliability, updating, understanding of the language), *Management* (guarantee of the correct operativeness of the web site), *Accessibility* (possibility for all to quickly enter and without problems to the web site) and *Usability* (easiness of using web site). To evaluating web sites Quality, it is possible to attribute a score to every characteristic (from 0 = very bad to 4 = very good) and to display the web site quality profile through a star diagram. For the complexity of the macro-characteristics, a good quality of themodel requires the decomposition of every characteristic in sub- characteristics. Characteristics and sub- characteristics do not have the same importance: according to the purposes of the web site, it is assigned to each sub-characteristic a weight that expresses its importance in the evaluation, and the vote of every characteristic can be calculated as "weighed mean" of the votes assigned to each sub- characteristic.

B. Leporini and F. Paternò proposed a set of usability criteria in order to improve **usability of accessibility** [22] in web sites. Their criteria can be used to support both design and evaluation. The authors determined a set of 16 criteria that were grouped in three sub-sets on effectiveness (5 criteria), efficiency (9 criteria) and satisfaction (3 criteria) principles; then they catalogued them depending on their type of impact on the user interface. For each criterion more checkpoints, as specific fragment of code, are proposed in order to indicate how it can be applied and to facilitate developer's tasks. The effectiveness criteria are: Logical partition of information, Proper link text, Loading of proper style sheets, Messages and dynamic data management and Terminological Consistency and layout. The efficiency criteria are: Number of links and frames, Proper name of the frames, Location of the navigation bar, Importance levels of elements, Assignment of hot keys, Proper formatting of forms,. "Last update" section, Indexing of contents and Navigation links. The satisfaction criteria are: Addition of a short sound, Colour of text and background, Magnifying at passing by mouse.

For web pages evaluation, University of the California "Berkeley" recommends to adopt two approaches: **Techniques to Apply & Questions to Ask** [35]. The Techniques can help to quickly find what we need to know about web pages; asking questions can help to decide if and how reliable is a web page. Some techniques are: *Before you click on anything written in the page web, glean all you can from the URLs of each page, and Choose pages most likely to be reliable and authentic, or Look for the date "last updated", or also Look up the author's name in Google or Yahoo, and Be sensitive to the possibility that you are the victim of irony, spoof, fraud, or other falsehood, etc.* Some Questions are: *Is it somebody's personal page? Who wrote the page? Is it current enough? Are sources documented with footnotes or links?, etc.*

### 2.3 Discussion on web site QMs

The above overview of the wide plethora of proposals allows us to draw some considerations. If we try to abstract the high level concepts which the characteristics of the presented QMs refer to, it seems possible to identify few concepts for several characteristics: Usability, Accessibility, Contents, Navigability, Management and Relationality. Defining these concepts, can help us understand similarities and differences among characteristics. Usability is "The effectiveness, efficiency and satisfaction with which specified users achieve specified goals in particular environments" [15]; then, this concept is recurrent when the authors make implicit or explicit reference to an efficient, effective and satisfactory use of the web site. In the W3C culture [36], the Accessibility is the opportunity, equal for all, to access to the Web whatever their hardware, software, language, culture, location, or physical or mental ability. Content is considered as a

component that identifies what is contained in the site; Navigability is used to underline the ability to exploit relationships among the elements (pages, images,...) which compose a web site. The concept of Management recalls the set of the activities that allow full operability of the site and that include its maintenance finalized to stability and evolution, and its good operation of the site, including protection of privacy and security. Relationality is related to the process through which two or more entities act to reciprocally modifying their state, and is used as Identification and as Interactivity.

These concepts encompass the mentioned characteristics which probably are not totally mutually independent; it is possible in fact that some characteristics, though presented with different denominations, have similar meaning or recall the same concept; in a web sites QM, *Maintenance* and *Feasibility* [26] are elements which could recall the concept of “Management”, like also *Managed* and *Preserved* in [27]. *Wealth of the Contents* [19] can be considered an attribute of the concept of “Content” which is common to [26], [30] and [33]. “Content” is a rare example where different QMs use the same terms for semantically equivalent characteristics: probably only the “Content” characteristic is a sort of agreed one, maybe probably because its meaning is less controversial. *Multi-lingual* in [27] can be recognized as a specific aspect of a broader “Accessibility” concept: a web site in fact should be able to be accessible by different nationality users. *Responsive* in [27], *Location* in [26], *Communication* in [30], and *Interaction* in [33], could recall the concept of “Relationality”. Besides, *Identity* in [26], *Institutional Characterization* in [6], *Communicative Style and Graphical System* in [19] recall the concept of the “Relationality”, because they presuppose two subjects which, in the same time, interact. A *basic feature* as “Indication of the user's location within the Website” [39] and an *exciting feature* as “The users have the control of the site” [39] both make reference to the concept of “Navigability”. *User-centered* in [27] can be understood as an aspect of “usability”.

Some of the above introduced web sites QMs that cover various points of view in observing, gauging and evaluating a web site are summarized in Table I; besides, the concepts which seem to refer to the characteristic by each model are summarized; some concepts are common to most QMs and contain characteristics with different labels:

Model ID	Accessibility	Usability	Contents	Navigability	Management	Relationality
2QCV3Q –Meta Model [26]		X	X		X	X
A Comprehensive Model [33]	X	X	X	X		X
Web Site Quality Model [39]		X	X	X	X	X
Minerva [27]	X	X	X	X	X	X
QEM [29]	X	X	X	X		X

**Table 1** Examples of web site QMs and Related Concepts

This study allowed us to define some important points in the construction of a QM; in fact a QM should have the following requirements:

- Defined goals
- To be structurable: to be defined through a list of characteristics
- To have *independent, comprehensible, adoptable, and measurable* checklists.

- To have defined objects/stakeholders or a set of objects/stakeholders as reference.

Every identified characteristic should have a unique and accepted definition. Every characteristic should be associated to specific checklists that allow to estimate the degree of presence of the characteristic they refer to in the evaluated Web site. For this purpose, each checklists should be independent from the others, comprehensible for all, adoptable and measurable. These points, even though not fully achieved, should be ideal targets to be pursued.

From observation of QMs, it is therefore possible to hypothesize the presence of a set of concepts that frequently occur. Hypothesizing the construction of a new web site's QM, these concepts may be the fundamental criteria to evaluate web sites, and, in our QM we have adopted these concepts, plus the Correctness of the source code, are the high-level characteristics. The Correctness of the source code was defined as adherence to the source markup language (markup language) used; it is very important because, despite its technical nature, purpose of this study is to identify some user perceived characteristic and relate them to the internal code features.

### 3. OBJECTS, PROCEDURES AND INSTRUMENTS

#### 3.1 *Supplying Web Sites Certification Service in the e - commerce area*

After providing two decades of independent evaluation service to public administration and industries, the System and Software Evaluation Centre (SSEC) of the National Research Council (CNR) in Pisa would extend its activity investigating web site quality, with the purpose of coming out with a self-sustainable and well-reputed evaluation service, which can reflect an explicit/implicit request by web users and also developers, owners and evaluators.

As providers of an external service, we suppose that our best category target is among commercial sites. In this context, sale-oriented Web Sites could represent the natural business area of the web sites Evaluation Service we intend to establish.

E-commerce B2c (Business to consumer) web Sites constitute a particular category: specific quality criteria, as efficiency, usability, navigability, etc., determine the success of the Web Site and then the return of economic investment; B2c e-commerce also collects the interest of developers, owners and consumers, and among these stakeholders, the evaluation service could gather more support. Ideally, the supplier wants the site to be able to perform the transfer of maximum perception of the value of the goods or services offered, possibly enhancing it.

To this scope, the service should respond to a list of requirements:

- *Specificity*: the service should address to specific categories of e-commerce web sites.
- *Cost effectiveness*: costs undertaken to provide the service should kept as low as possible
- *Efficiency*: the service should consume the minimum amount of resources that allow reaching its goal.
- *Independency*: the service should be independent of site owners and developers.
- *Reliability*: the service should not give users erroneous results.

Similarly to any requirements sets, also these requirements are not totally independent of each other and claim for resolution of some trade-offs (typically, cost effectiveness versus reliability).

The results of an evaluation can be expressed as a global score and a *quality profile* composed of a set of rating values corresponding to the characteristics of the reference QM. The evaluation activity should consist, in practice, in providing a comparison between the quality profile derived from the ratings obtained by evaluation and the expected (target) profile. While the measured profile can be



obtained following a process that uses opportune evaluation techniques, the expected profile is usually aligned to the maximum scores provided.

As there is no widely accepted standard for measuring quality characteristics, not for a QM itself (the ISO/IEC 9126 should be considered just as a methodological reference), the ability of the service to determine a *relative score* between different websites or different stages in a website lifecycle can be used for benchmarking purposes.

### **3.2 Working Procedures**

To establish a QM based evaluation, a set of characteristics must be defined in order to capture the notion of quality, and a set of actions in order to find in the web site under examination, evidence of the desired quality profile. If the characteristics are typically organized as belonging to higher abstraction levels, the actions include procedures execution that in turn may be objective measurements that can be automated and some human intervention or subjective judgments that can not. Basic requirement for an evaluation process is to be able to quantitatively determine the degree of presence of each quality characteristic of the model in the web site under analysis. Most of the approaches, referred to *top-down approaches*, try to decompose the characteristics down to final elements, which are able in some way to capture aspects of the structural essence expressible in meaningfully quantitative terms [10]. However, what is more easily measurable is a number of lower-level characteristics, as *Broken Links &/or Unavailable Pages, Average Download Time per Page, number of Slow/Large/Old Pages, Average Links per Page, etc.*; following a *bottom-up approach*, from these elements, whose values are obtained using commercial tools, it can be expected to go up in the abstraction scale from the low-level measures towards high-level characteristics they refer to; in fact these elements, which seem to be totally dependent of an internal quality evaluation, indeed might strongly influence the web site usage as well as the satisfaction level of the user.

#### **3.2.1 Adopting Top - Down and Bottom - Up approaches to investigate the relations between characteristics**

*Top-down* approach is based on the decomposition of the quality concept in a structured set of possibly independent characteristics that represent the different aspects on which to evaluate the web site quality; every characteristic is then decomposed in sub-characteristics and these can be measured by opportune metrics that indirectly measure the characteristics they belong to. The informative parts of the Standard ISO/IEC 9126 [16] can be considered a typical example of the adoption of this approach. In a *bottom-up* approach, existing tools for web site analysis indeed provide objective and structural measures, as *Average Bytes per Page, Broken Links per Page, Off-site Links, reports for every measure and metrics as Size, HTML Elements, Frames, Hyper Links, Hidden Fields*. Both approaches present important advantages and significant limitations, as shown in the following table:

<i>Approaches</i>	<b>Advantages</b>	<b>Limitations</b>
<b>Top-down</b>	Decomposability	Difficulty of measuring
	Structuring of the Quality Concept in Characteristics or Dimensions	Difficulty to ensure Independence between the Characteristics
	Proximity to common Concept of Quality	Difficulty to attribute a shared semantic Identity to the Characteristics
		Difficulty of Integration with the bottom-up Approach
		Excessive expenditure of resources for to constitute replicable Evaluation Processes
		Temporal Ineffectiveness for the Assessments
<b>Bottom-up</b>	Measurability	Difficulty to establish shared indication relationship between Measures, Characteristics and Quality
	Easiness of Composition and Integration	Difficult semantic Coverage of Characteristics by the Measures
	Automatization	Difficulty of Integration with the top-down Approach
	Possibility of repetitive Processes	

**Table 2 Top-down and Bottom-up Approaches: Advantages and Limitations**

In order to build a new QM for our e-commerce web site evaluation service, we have chosen to integrate the two approaches shown before so that a greater trust in the evaluation of web sites quality can be achieved.

Conciliating the two approaches can take advantage from the capability of the tool based bottom-up approach to evaluate, through composition, some sub-characteristics, and the possibility of decomposing all characteristics down to measurable elements. Our strategy is to extend the scope of bottom-up approach in order to get quantitative evaluations of sub-characteristics, and, at the same time, to precisely relate these sub-characteristics to higher level quality characteristics by means of the top-down approach. The two approaches are not equivalent in terms of effort required and results achieved, in particular, the bottom-up one is easier and quicker than the other, and from that we have started. Having collected many technical measures as *Broken Links per Page*, *Slow/Large/Old Pages Visited*, *Off-site Links*, etc. by a commercial tool, e-Valid [38], we have performed some evaluations about the measures produced by the tool by ascending from the low-level measures towards high-level characteristics they refer to. In this process, among the others, two possible high-level Characteristics have been identified: *Update* and *Absence of malfunctions*. The *Old Pages Visited* were considered indicators of the web sites Update level; *Broken Links &/or Unavailable Pages* were considered indicators of the absence of malfunctions. Nevertheless, we believe that the measures do not provide total semantic coverage to the characteristics to which they relate; in fact, for example, the *Old pages* may be indicator of *Update*, but web site *Update* is even more...; *Broken Links &/or Unavailable Pages* may be indicator of *absence of malfunctions* but *absence of malfunctions* recalls characteristics of *Efficiency* or *Usability* that are larger and

comprise other aspects. Then, those possible characteristics could be considered sub-characteristics of other higher characteristics as Management and Usability.

Being aware of the difficulty, following only a bottom-up approach, of a wide semantic coverage of some important characteristics by the measures, we have planned the construction of a *theoretical* QM that previewed identified by tools and detected by human intervention elements. This theoretical QM will be introduced in the following section, but now we consider important to explain *how* and *why* we have chosen to build it.

### ***3.2.2 Construction of a theoretical QM and introduction to the analysis***

The theoretical QM is born within a top-down work approach and it presupposes relations between characteristics and sub-characteristics so that the last can semantically cover the characteristics to which respective they refer. The working approach that has been followed was to consider a theoretical QM as a basis for conducting a defined set of experiments, using the availability of web sites and statistical methods to investigate if there were non-causal relationships among the elements collected by bottom-up and top-down methods; the theoretical QM in fact includes elements both identified by tools and detected by human intervention, and it was built on the basis of three important observations: the study of existing literature and standards for traditional software products and for the web site themselves, the long experience (both of authors themselves and of the state-of-art) in software product quality, and evident objectives and goals of e-commerce web sites.

Our aim was to investigate if there were non-causal relationships among the elements coming from different approaches, to define a new QM resulting as a reorganisation and re-definition of such elements. The relationships among the elements of such new QM class would allow deriving a measuring framework to be used to evaluate quality aspects of web sites.

To do that, we have collected, through the theoretical QM, many data, and defined and populated a database; the unit of analysis was the e-commerce web site and the sample was constituted by 110 italian<sup>3</sup> e-commerce web sites, selected through the Quota Sampling Method [7]. To identify the e-commerce web sites we adopted the definition adopted by WTO for the purposes of the work programme; where e-commerce is "the production, distribution, marketing, sale or delivery of goods and services by electronic means" (WTO document WT/L/274) [37]. When the database was populated, we performed statistical analysis to find if whether or not non-casual relationships existed between collected data. The results of the analysis influenced the construction of new QM and then the Evaluation Service.

For statistical analysis, we used some techniques for exploration purposes, to bring into light hidden structures among the characteristics on the basis of the discovered frequencies and levels. Descriptive statistics and Factor Analysis [2], [24], [34] a technique that assumes that all collected data on different attributes can be reduced down to a few main dimensions, were used. This

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<sup>3</sup> The authors have considered only sales that were made by web sites that belong to companies based in Italy (even if they belong to international groups)

multivariate technique can be used to analyze interrelationships among a large number of variables and to explain these variables in terms of their common underlying dimensions (factors), since this kind of analysis isolates the underlying factors that explain the data. An additional knowledge obtained is the information on the different “loading” with which each variable is correlated to the underlying dimensions (factors) identified. Particularly, “Factor analysis allows one to use statistical relations between several lower-level variables as empirical evidence for or against the establishment of a semantic relationship of indication between these variables and an abstract concept” [24].

### **3.3 *The theoretical Quality Model***

Table 3 shows the theoretical QM. It is structured in a set of elements (Characteristics, sub-characteristics and Variables) attributed to the Quality concept, organized in abstraction levels. The characteristics are closer to those commonly perceived: they can be subjectively perceived and estimated by human effort; the sub-characteristics are the products of the decomposition of each characteristic, and are individuated for their supposed indication relationship with the single parts of characteristic they are referable to. The variables are measurable elements that can be determined directly by human intervention or indirectly through automated tools. The variables that can be noticed by tools are indicated with different colours. The used tools are: W3C Markup validator [11], that checks the markup validity of Web documents in HTML, XHTML, etc., W3C CSS Validator [12], that checks the CSS Stylesheets, Functional Accessibility Evaluator 1.0.3 [13], that evaluates the functional accessibility of web pages, and e-Valid [38], a commercial tool for web site analysis that can browse through a web site, collecting technical data; as each page is delivered to e-Valid, it is checked for broken links and detailed page statistics: download time, page age and size, existence of specified strings and, finally, several reports are generated. The difference between e-Valid and the other tools results is that e-Valid analysis results refer to the whole analyzed web site instead of the Homepage only. Nevertheless, in a web site quality evaluation service, every page should be analyzed for its correctness and accessibility.

CHARACTERISTICS	SUB-CHARACTERISTICS	VARIABLES
<b>Correctness</b>	MARKUP Validation	Presence of valid HTML in the homepage
	CSS Validation	Presence of valid CSS in the homepage
<b>Accessibility</b>	Implementation W3C WCAG and Section 508 standards in the homepage	Functional Accessibility Evaluator: Navigation & Orientation in the HP
		Functional Accessibility Evaluator: Text Equivalents in the HP
		Functional Accessibility Evaluator: Scripting in the HP
		Functional Accessibility Evaluator: Styling in the HP
	Multilinguality	Availability of website consultation in more than one language
<b>Usability</b>	Efficiency	Average Download Time per Page
		Large Size pages
		Slow Pages
		Presence of cart
	Facility to obtain information	Presence of Help and/or on line guide keys
		Presence of a internal search engine
		Presence of RSS content
	Information Completeness	Presence of a larger image of the product
		Tourist or not tourist website
		Presence of detailed information on costs/rates
		Exact indication of the additional prices for costs of shipping and/or charges on customer
		Specification of waiting time for the shipping
	Absence of malfunctions	Absence of extraneous to the websites objectives pop-up/layers
Number of Broken Links &/or Unavailable Pages (%)		
<b>Contents</b>	Information Wealth	Presence of a selection of homogeneous to website's objectives links
		Presence of skilled studies and/or market researches on the subject website
	Updating	Presence of a "news" section
		Presence of a "news" section that reports the date of last update of this section
<b>Navigability</b>	Easy Navigation	Presence of the link to the Sitemap in the HP
		Presence of the navigator bar in the HP
	Traceability of the trail	Availability of a link which through specific wording (home / beginning ..) or home icon, send back to homepage
		Availability of a link to immediately return to the previous level
		Availability of a breadcrumb trail
<b>Management</b>	Privacy and Information Security	Availability of information for the user about possible uses that will be made of their personal data through the publication on the site of the relevant information in compliance with applicable laws
		Offer of guarantee of reservation of the information and respect of privacy, through at least the quotation of the normative source
		Availability of a SLL system for the sure commercial transactions
		Request of a password with specification of number and typology of characters to access to the services
		Off Site links
	Update and Information Maintenance	Old Pages
		Presence, in the homepage, of the date of the last updating of the website
		Availability to pay by credit card
		Availability to pay cash on delivery
		Availability to pay by credit transfer
		Availability to pay by paypal
<b>Relationality</b>	Identification	Availability of the homepage as the first visible page of the website
		Availability of information about the identity of the website's owner (registered name, etc)
		Presence, in the homepage, of a descriptive title of the corporation
		Indication of the registered office and/or of the operative office if this is different from the registered office

		Presence of telephone/fax numbers and/or email addresses to communicate with the website's owner
		Presence, in the homepage, of a link to the website's objectives (Mission..)
	Interactivity	Presence of a forum
		Presence of a moderator in the forum
		Presence of chat (Skype/Messenger...)
		Presence of a "Guest Book/About Us /Press.."
		Possibility to download catalogues / forms / documents / announcements...
		Presence of a Customer Satisfaction Service
		Presence of a "Frequently Asked Questions" (FAQ) section
		Availability of forms to be compiled to propose claims, suggestions, protests
		Possibility to enroll and receive a newsletter
		Presence of specified methods for cancelling him from the mailing list of the newsletter

**Table 3 The theoretical Quality Model**

Legend:

**Brown:** <http://validator.w3.org/> [11]

**Blue:** <http://jigsaw.w3.org/css-validator/> [12]

**Green:** <http://fae.cita.uiuc.edu/> [13]

**Red:** e-Valid [38]

**Black:** manual evaluation

## 4. THE ANALYSIS

### 4.1 Information about the Sample

As above specified, we intended to investigate if there were non-causal relationships between the variables that were identified in the theoretical Quality Model, and if, behind the variables, there were underlying factors that could coincide with the identified characteristics. For this purpose, we followed a statistical approach: we have constructed a sample, and the unit of analysis was the e-commerce B2c Web Site; as above stated, to identify the e-commerce Web Sites we adopted the definition on e-commerce that was adopted by the WTO in WTO document WT/L/274 [37].

The Sample consisted of 110 e-commerce Web Sites [in appendix], selected through the non-probability Quota Sampling method [7] which we adopted for exploratory purposes. The sample is proportional stratified for sectors of activity and the Web Sites are selected no randomly according to some fixed quotas. For B2c e-commerce Web Sites, the quotas have been fixed according to the entity of the volumes of sales for every sector of activity. In Italy the role and the evolution of B2c e-commerce are monitored by Netcomm (The Consortium of Italian Electronics Commerce) – School of Management of the Polytechnic of Milan B2c Observatory, and the 2007 Report Netcomm [28] shows a such distribution of the sales for sector of activity: 49% Tourism, 9% Informatics and Electronics, 8% Insurances, 3% Book Industry, Music and Audio, 3% Clothing, 1% Grocery and 27% Other. We have adopted these quotas for our sample; then it consists of 54 tourist Web Sites, 10 Informatics and electronics Web Sites, 9 Insurances Web Sites, 3 Book Industry, Music and Audio Web Sites, 3 Clothing Web Sites, 1 Grocery and 30 other Web Sites.

## 4.2 Methodology

To collect and to store data, two methods have been used: in fact some identified variables could be detected by automated tools [11], [12], [13], [38], while some variables could be detected by the human inspection; with the collected data, we have defined and have populated a database.

The variables that were considered in the analysis are 55 plus 2 after added, “Presence of cart” and “Tourist or no tourist web site”, that are introduced in collect data phase; in fact, during data collection, different problems relating to web site tourist aspect emerged.

To analyze the collected data, the SPSS software was used. We chose to use descriptive statistics and Factor Analysis; through application of this multivariate technique we wanted to analyze interrelationships among a large number of variables and to explain these variables in terms of their common underlying dimensions: the factors. Such factors are not directly measurable (latent) dimensions, but they summarize the relationship among an original set of variables that were measured and they bring out a semantic relationship of indication between the many variables and a more abstract concept, identified as factor. The aim of this step of our work is to notice if the relationships between variables that were supposed in the theoretical QM with characteristics, sub-characteristics and variables return through the statistical experiment; the additional knowledge that we obtain is the information on the different loading with which each variable is correlated to the factors identified.

Before applying this technique, the range of variability of the variables was checked, and, through the frequency distributions, some of them that showed narrow range of variation have been excluded from the subsequent analysis (but not from the new QM under construction). By the analysis we also obtained, for each variable, a coefficient of saturation (*loading*) that shows the correlation between the variable and each factor: since a 0,300 cut-off value was chosen for the loadings, the variables with loading lower than this threshold are considered poorly correlated with the identified factors and therefore irrelevant for them; thus, only variables well correlated with the identified factors have been preferred. We believe that none of the variables should remain outside the e-commerce web site Quality Model as all of them are useful in some way.

Furthermore, as some variables that were identified in the theoretical QM cannot be applicable for tourist web sites (for example, *Presence of a larger image of the product*, *Specification of waiting time for the shipping*, etc.): it was decided to divide the sample into two sub-samples, 54 tourist web sites (sub-sample A) and 56 non-tourist web sites (sub-sample B). The factor analysis was applied to each sub-sample, selecting the most appropriate variables in each case.

Regarding the number of factors to extract, the criterion was adopted that a percentage of reproduced variance equal to 75% of the total variance is considered a reasonable level [34]; thus, 8 factors were extracted (Extraction method: Principal Components Analysis, Rotation method: Varimax with Kaiser normalization [2], [24], [34]). In this way we believe that a somewhat good-motivated grouping of the variables into factors has been achieved.

## 4.3 Results of the factor analysis

As above introduced, applying the factor analysis, 8 factors were extracted for each sub-sample. Naming the factors is an arbitrary procedure, and in fact usually the name comes from the variables that have the highest loadings. In a characteristic, more factors can coexist, bringing out a semantic relationship of indication between the many variables and a more abstract characteristic: for example, the characteristic “Management” and the factors “Privacy, Information Security...”, or

the characteristic “Usability” and the factors “Availability of Payments Methods, Fast Search, Offer of personalization, etc”, or finally the characteristic “Relationality” and the factors “Direct Communication, Possibility of Contact, etc”.

Besides, some factors, as Availability of Payments Methods, Easy of Navigability, Privacy, are common to both sample, but, in the sample B, there is a new factor, Information Completeness, that is specific for not tourist e-commerce web sites, because it collects not detectable in tourist web sites information.

In the identified factors, whether in the sample A or in the sample B, we can trace some of the characteristics that have been identified in the theoretical Quality Model, such as Navigability (Easy of Navigability), Management (Privacy, Security...), Usability (Availability of Payments Methods, Fast Search, Offer of personalization...), Relationality (Direct Communication, Possibility of Contact...).

The factors, for each sub-sample, are below:

Sub-sample A	Sub-sample B
Availability of Payments Methods	Availability of Payments Methods
Easy of Navigability	Information Completeness
Privacy	Easy of Navigability
Information Security	Privacy
Possibility of Contact	Security Search
Support to Knowledge	Ways of Interaction
Direct Communication	Possibility of Identification
Offer of Personalization	Fast Search

**Table 4 Factors for Sub-Samples**

We noticed that, in most cases, the relationships between variables that were supposed in the theoretical QM return through the statistical experiment; the additional knowledge that we obtain is the information on the different loading with which each variable is correlated to the factors identified.

Below we report the variables divided by reference factors, and each variable with its factor loadings, in order to make clear the variable-factor correspondence and the consistence of each variable in relation to its factor.



Sub-sample A		
Factors	Variables	Loadings
Availability of Payments Methods	Availability to pay by credit card	,979
	Availability to pay by credit transfer	,978
	Availability to pay by Pay Pal	,978
Easy of Navigability	Availability of a link to immediately return to the previous level	,908
	Availability of a breadcrumb trail	,891
	Availability of a link which through specific wording (home / beginning ..) or home icon, send back to homepage	,578
	Presence of the link to the Sitemap in the homepage	,301
Privacy	Offer of guarantee of reservation of the information and respect of the privacy, through at least the quotation of the normative source	,843
	Availability of information for the user about possible uses that will be made of their personal data through the publication on the site of the relevant information in compliance with applicable laws	,830
Information Security	Presence of a "Frequently Asked Questions" (FAQ) section	,663
	Availability of information about the identity of the website's owner	,638
	Presence of detailed information on cost/rates	,596
	Availability of a SLL system for the sure commercial transactions	,830
Possibility of Contact	Presence of telephone numbers, fax numbers and/or email addresses to communicate with the website's owner	,839
	Indication of the registered office and/or of the operative office if this is different from the registered office	,820
Support to Knowledge	Presence of Help and/or on line guide keys	,700
	Presence, in the homepage, of a descriptive title of the corporation	,667
	Availability of website consultation in more than one language	,612
Direct Communication	Possibility to download catalogues/forms/documents/announcements	,682
	Presence of chat (Skype/Messenger/Call Center...)	,675
	Off site links (%)	,697
Offer of Personalization	Request of a password	,802
	Average Download Time per Page	,625

**Table 5 Factors, variables and factor loadings in Sub-sample A**

Sub-sample B		
Factors	Variables	Loadings
Availability of Payments Methods	Availability to pay by credit card	,995
	Availability to pay by credit transfer	,995
	Availability to pay by Pay Pal	,995
	Availability to pay cash on delivery	,995
Information Completeness	Presence of a larger image of the product	,851
	Specification of waiting time for the shipping	,822
	Exact indication of the additional prices for costs of shipping and/or charges on customer	,756
	Presence of a internal search engine	,669
	Presence of cart	,636
Easy of Navigability	Availability of a link to immediately return to the previous level	,810

	Availability of a link which through specific wording (home/beginning ..) or home icon, send back to homepage	,788
	Availability of a breadcrumb trail	,768
Privacy	Offer of guarantee of reservation of the information and respect of the privacy, through at least the quotation of the normative source	,894
	Availability of information for the user about possible uses that will be made of their personal data through the publication on the site of the relevant information in compliance with applicable laws	,854
Security Search	Availability of a SLL system for the sure commercial transactions	,754
	Availability of forms to be compiled to propose claims, suggestions, protests	,707
	Presence of the navigator bar in the homepage	,452
Ways of Interaction	Presence of chat (Skype/Messenger/Call Center...)	,823
	Presence of a "Frequently Asked Questions" (FAQ) section	,382
Possibility of Identification	Availability of information about the identity of the website's owner	,777
	Presence of telephone numbers, fax numbers and/or email addresses to communicate with the website's owner	,691
Fast Search	Average Download Time per Page	,661
	Presence of Help and/or on line guide keys	,554
	Possibility to download catalogues/forms/documents/announcements	,534
	Presence of detailed information on cost/rates	,455

**Table 6 Factors, variables and factor loadings in Sub-sample B**

## 5. THE E - COMMERCE WEB SITES QUALITY MODEL (E-COMWEB QM)

On the basis of the general results that analysis showed, three groups of variables can be distinguished:

1. The variables with narrow range of variation and then excluded from the factor analysis
2. The variables that have been included in the factor analysis
3. The variables with too low factor loadings or similar in most factor loadings

All variables are the measurable expressions of the identified factors and high level characteristics. In a characteristic, more factors can coexist, bringing out a semantic relationship of indication between the many variables and a more abstract concept, and, for this reason, in our new QM the factors become the sub-characteristics.

We also believe that none of the variables should remain outside the our e-commerce web site QM, as all of them are useful in some way (even variables that would have constant values across all web sites can be part of a QM), so we thought of grouping the variables into three *components*. The *first component*, identified as Technical Quality Component (TQC), includes the variables that have a more *technical nature* and not subjected to factor analysis; for their nature, these variables are independent by the type of considered web site; this component can be assessed by the following characteristics: *Correctness*, *Accessibility* and *Usability*, detected through measures of Efficiency; between these variables, there are those that have a narrow range of variation or too low factor loadings or factor loadings similar in most factors. The *second component*, identified as In Use Quality Component (IUQC), includes the variables that have been considered in the factor analysis; this component can be assessed by the following characteristics: *Management* (Privacy, Security), *Navigability*, *Content* as Information Completeness, *Relationality* (Possibility of Contact, Direct Communication) and again *Usability*, but designed as Fast Search, Offer of Personalization,

Availability of Methods of Payment. The *third* component, defined as Plus Quality Component (PQC), includes the *no technical nature* variables, with narrow range of variation, too low factor loadings or factor loadings similar in most factors; this component can be assessed by the following characteristics: *Management*, designed as Update and Information Maintenance, *Relationality* as Identification and Interactivity, *Content* as Information Wealth, and *Usability* which is designed, in this case, as Facility to obtain information and Absence of bottlenecks to the good functioning. The three components form the structure of the E - Commerce Websites Quality Model (E-COMWEB QM).

If we compared the results of statistical experiment without focusing only on the factors but looking to the relationships, we notice that in most cases relationships between variables that were supposed in the theoretical QM, through the statistical approach, return; more news (signed in red) are detected among some variables related to the Usability and Contents:

<i>Characteristics</i>	TQC	
	VARIABLES PRE-ANALYSIS	VARIABLES POST-ANALYSIS
<b>Correctness</b>	Presence of valid HTML in the homepage	Presence of valid HTML in the homepage
	Presence of valid CSS in the homepage	Presence of valid CSS in the homepage
<b>Accessibility</b>	FAE: Navigation & Orientation in the HP	FAE Navigation & Orientation in the HP
	FAE: Text Equivalents in the HP	FAE: Text Equivalents in the HP
	FAE: Scripting in the HP	FAE: Scripting in the HP
	FAE: Styling in the HP	FAE: Styling in the HP
	Availability of website consultation in more than one language	-
	<b>Usability</b>	Broken Links &/or Unavailable Pages (%)
Large Size pages		Large Size pages
Slow Pages		Slow Pages
-		Old Pages

**Table 7 – a Variables per Characteristics Pre and Post - Analysis: TQC**

<i>Characteristics</i>	IUQC (TOURIST WEBSITES)	
	VARIABLES PRE-ANALYSIS	VARIABLES POST-ANALYSIS
<b>Usability</b>	Presence of Help and/or on line guide keys	Presence of Help and/or on line guide keys
	Average Download Time per Page	Average Download Time per Page
	Presence of a internal search engine	-
	Presence of a larger image of the product	-
	Presence of detailed information on costs/rates	-
	Exact indication of the additional prices for costs of shipping and/or charges on customer	-
	Specification of waiting time for the shipping	-
	Presence of cart	-
	-	Availability to pay by credit card
	-	Availability to pay by credit transfer
	-	Availability to pay by paypal
	-	Availability of website consultation in more than one language
	-	Presence, in the HP, of a descriptive title of the corporation
	-	Request of a password with specification of number and typology of characters to access to the services
<b>Navigability</b>	Availability of a link which through specific wording	Availability of a link which through specific wording

	(home / beginning ..) or home icon, send back to HP	(home / beginning ..) or home icon, send back to HP
	Availability of a link to immediately return to the previous level	Availability of a link to immediately return to the previous level
	Availability of a breadcrumb trail	Availability of a breadcrumb trail
	Presence of the link to the Sitemap in the HP	Presence of the link to the Sitemap in the HP
	Presence of the navigator bar in the HP	-
<b>Management</b>	Availability of information for the user about possible uses that will be made of their personal data through the publication on the site of the relevant information in compliance with applicable laws	Availability of information for the user about possible uses that will be made of their personal data through the publication on the site of the relevant information in compliance with applicable laws
	Offer of guarantee of reservation of the information and respect of the privacy, through at least the quotation of the normative source	Offer of guarantee of reservation of the information and respect of the privacy, through at least the quotation of the normative source
	Availability of a SLL system for the sure commercial transactions	Availability of a SLL system for the sure commercial transactions
	Request of a password with specification of number and typology of characters to access to the services	-
	Off Site Links	-
	Presence, in the HP, of the date of the last updating of the website	-
	Availability to pay by credit card	-
	Availability to pay cash on delivery	-
	Availability to pay by credit transfer	-
	Availability to pay by paypal	-
	-	Availability of information about the identity of the website's owner (registered name, etc)
	-	Presence of a "FAQ" section
-	Presence of detailed information on cost/rates	
<b>Relationality</b>	Indication of the registered office and/or of the operative office if this is different from the registered office	Indication of the registered office and/or of the operative office if this is different from the registered office
	Presence of telephone numbers, fax numbers and/or email addresses to communicate with the website's owner	Presence of telephone numbers, fax numbers and/or email addresses to communicate with the website's owner
	Presence of chat (Skype/Messenger...)	Presence of chat (Skype/Messenger...)
	Possibility to download catalogues / forms / documents / announcements...	Possibility to download catalogues / forms / documents / announcements...

**Table 7 – b – 1 Variables per Characteristics Pre - and Post - Analysis: IUQC in Tourist web sites**

<i>Characteristics</i>	<b>IUQC (NO TOURIST WEBSITE)</b>	
	<b>VARIABLES PRE-ANALYSIS</b>	<b>VARIABLES POST-ANALYSIS</b>
<b>Usability</b>	Presence of Help and/or on line guide keys	Presence of Help and/or on line guide keys
	Average Download Time per Page	Average Download Time per Page
	Presence of a internal search engine	-
	Presence of a larger image of the product	-
	Presence of detailed information on costs/rates	Presence of detailed information on costs/rates
	Exact indication of the additional prices for costs of shipping and/or charges on customer	-
	Specification of waiting time for the shipping	-
	Presence of cart	-
	-	Availability to pay by credit card
	-	Availability to pay by credit transfer

	-	Availability to pay by paypal
	-	Availability to pay cash on delivery
	-	Possibility to download catalogues/forms/documents/announcements...
<b>Contents</b>	-	Presence of a larger image of the product
	-	Presence of cart
	-	Specification of waiting time for the shipping
	-	Presence of a internal search engine
	-	Exact indication of the additional prices for costs of shipping and/or charges on customer
<b>Navigability</b>	Availability of a link which through specific wording (home / beginning ..) or home icon, send back to HP	Availability of a link which through specific wording (home / beginning ..) or home icon, send back to HP
	Availability of a link to immediately return to the previous level	Availability of a link to immediately return to the previous
	Availability of a breadcrumb trail	Availability of a breadcrumb trail
	Presence of the link to the Sitemap in the HP	-
	Presence of the navigator bar in the HP	-
<b>Management</b>	Availability of information for the user about possible uses that will be made of their personal data through the publication on the site of the relevant information in compliance with applicable laws	Availability of information for the user about possible uses that will be made of their personal data through the publication on the site of the relevant information in compliance with applicable laws
	Offer of guarantee of reservation of the information and respect of the privacy, through at least the quotation of the normative source	Offer of guarantee of reservation of the information and respect of the privacy, through at least the quotation of the normative source
	Availability of a SLL system for the sure commercial transactions	Availability of a SLL system for the sure commercial transactions
	Request of a password with specification of number and typology of characters to access to the services	-
	Old Pages	-
	Presence, in the HP, of the date of the last updating of the website	-
	Availability to pay by credit card	-
	Availability to pay cash on delivery	-
	Availability to pay by credit transfer	-
	Availability to pay by paypal	-
	-	Availability of forms to be compiled to propose claims, suggestions, protests
	-	Presence of the navigator bar in the HP
	<b>Relationality</b>	Availability of information about the identity of the website's owner (registered name, etc)
Presence of telephone numbers, fax numbers and/or email addresses to communicate with the website's owner		Presence of telephone numbers, fax numbers and/or email addresses to communicate with the website's owner
Presence of chat (Skype/Messenger...)		Presence of chat (Skype/Messenger...)
Presence of a "FAQ" section		Presence of a "FAQ" section

**Table 7 – b - 2 Variables per Characteristics Pre and Post - Analysis: IUQC in No Tourist web sites**

<i>Characteristics</i>	<b>PQC</b>	
	<b>VARIABLES PRE-ANALYSIS</b>	<b>VARIABLES POST-ANALYSIS</b>
<b>Usability</b>	Presence of RSS content	Presence of RSS content
	Absence of extraneous to the websites objectives pop-up/layers	Absence of extraneous to the websites objectives pop-up/layers
<b>Contents</b>	Presence of a selection of homogeneous to website's objectives links	Presence of a selection of homogeneous to website's objectives links
	Presence of skilled studies and/or market researches on the subject website	Presence of skilled studies and/or market researches on the subject website
	Presence of a "news" section	Presence of a "news" section
	Presence of a "news" section that reports the date of last update of this section	Presence of a "news" section that reports the date of last update of this section
<b>Management</b>	Presence, in the HP, of the date of the last updating of the website	Presence, in the HP, of the date of the last updating of the website
<b>Relationality</b>	Presence, in the HP, of a link to the website's objectives (Mission..)	Presence, in the HP, of a link to the website's objectives (Mission..)
	Presence of a "Guest Book/Press Review."	Presence of a "Guest Book/Press Review"
	Availability of the HP as the first visible page of the website	Availability of the HP as the first visible page of the website
	Presence of a forum	Presence of a forum
	Presence of a moderator in the forum	Presence of a moderator in the forum
	Presence of a Customer Satisfaction Service	Presence of a Customer Satisfaction Service
	Possibility to enroll and receive a newsletter	Possibility to enroll and receive a newsletter
	Presence of specified methods for cancelling him from the mailing list of the newsletter	Presence of specified methods for cancelling him from the mailing list of the newsletter

**Table 7 - c Variables per Characteristics Pre and Post - Analysis: PQC**

### 5.1 The Components of E-COMWEB QM

The three components (TQC, IUQC and PQC) of E - Commerce Websites Quality Model (E-COMWEB QM) are different for QM application procedure, methods of assessment and assessment outputs: the procedure of application of QM in TQC and PQC is same for all web sites, regardless of tourist or no tourist nature of evaluable web site, but it is different in IUQC. The TQC is detected by automated tools, instead the IUQC and the PQC are detected by the human intervention; besides, the three components are different for outputs of their analysis: IUQC and PQC produce scores, but TQC produces also important and detailed reports.

<b>E – COMWEB QM</b>			
<b>COMPONENTS</b>	<b>QM APPLICATION PROCEDURE</b>	<b>METHODS OF ASSESSMENT</b>	<b>ASSESSMENT OUTPUTS</b>
<b>TQC</b>	Same for all web sites	Automated Tools	Report and Score
<b>IUQC</b>	Different for tourist or no tourist web sites	Human Intervention	Score
<b>PQC</b>	Same for all web sites	Human Intervention	Score

**Table 8 E-COMWEB QM: application procedure, methods of survey and outputs of analysis per components**

E-COMWEB QM observes seven characteristics: Correctness, Accessibility, Usability, Navigability, Content, Management and Relationality. Within every of three component there are aspects of quality related to these characteristics, but, except Usability, not all characteristics are present in every component, because the nature of every Component is different; some characteristics are considered in more components because they recall “technical” or “in use” or “plus” aspects of the Website Quality; in these cases, the characteristics are evaluated through different sub-characteristics and variables.

The Technical Quality Component (TQC), regards Correctness, Accessibility, and Usability; in this component, Markup and CSS Validation, implementation W3C WCAG and Section 508 Standards, and the website Efficiency are very important, then the variables that were checked are Presence of valid HTML and valid CSS, number of Slow/Large/Old Pages Visited, Broken Links &/or Unavailable Pages, etc. For to analyze the web site Accessibility was adopted Functional Accessibility Evaluator [13], which organizes the analysis of documents based on the following categories: *Navigation & Orientation, Text Equivalents, Scripting, Styling and HTML Standards*. Correctness and Accessibility were analyzed only in the Home Pages because the analysis in the all pages would have required too much for time, but in service phase for all pages these characteristics to be evaluated. The In Use Quality Component (IUQC) has two versions, one for tourist websites and one for not tourist websites; the IUQC for tourist websites regards Usability, Navigability, Management and Relationality, instead for not tourist website regards over these characteristics, also the Content. For both the typologies of websites, very important are Methods of Payment, Offer of Personalization, Privacy, Easy Navigability, Possibility of Contact, etc, and thus the variables that were checked are Availability to pay by credit card/ credit transfer/ PayPal, Request of a password with specification of number and typology of characters to access to the services, Average Download Time per Page, Availability of a SLL system for the sure commercial transactions, Presence of Help and/or on line guide keys, Availability of a breadcrumb trail, Presence of the link to the Sitemap in the Homepage, etc. Over these variables, in not tourist web site, were checked variable as *Presence of a larger image of the product, Specification of waiting time for the shipping, etc.*

In the Plus Quality Component (PQC) some characteristics return but to observe different aspects, or sub-characteristics, as Information Wealth, Update and Information Maintenance, Identification and Interactivity, etc... In this component, the variables that were checked are *Presence of a "news section", Presence, in the homepage, of the date of the last updating of the website, Presence of a forum, Possibility to enroll and receive a newsletter, etc.*

The characteristics are assigned to every component as below:

E – COMWEB QM								
COMPONENTS		CHARACTERISTICS						
		CORRECTNESS	ACCESSIBILITY	USABILITY	NAVIGABILITY	CONTENT	MANAGEMENT	RELATIONALITY
TQC		X	X	X	-	-	-	-
IUQC	TOURIST WEBSITE	-	-	X	X	-	X	X
	NOT TOURIST WEBSITE	-	-	X	X	X	X	X
PQC		-	-	X	-	X	X	X

**Table 9E-COMWEB QM: Characteristics per Components**

Every component consists of characteristics, sub-characteristics and variables: in the Quality evaluation, the Technical Quality Component and the Plus Quality Component have the same composition for tourist or no tourist web sites, whereas the In Use Quality Component has two versions: one for tourist websites and one for not tourist websites, because, as was above explained, it was found that some variables are necessarily required in e-commerce web sites, but are not detectable in tourist websites.

## 5.2 Procedures for the E-COMWEB QM application: attribution of scores, weights and weighted scores.

The application of the E-COMWEB QM requires the attribution of *weighted scores*: this is done by multiplying the score obtained by measuring a variable by its *weight*. The score is obtained after collecting data and reveals the current state of a web site on every variable. In general, the score may be 0 (if the required object was not found within 3 minutes from the beginning of the search), 1 (if the required object was found after 3 minutes from the beginning of the search, while other objects were being found) or 2 (if the required object was found within 3 minutes from the beginning of the search); thus, two elements are assessed in attributing the score: the presence of the considered property and the average time required by the assessors to find it. Specifically, there are some exceptions, especially among the technical variables: when the state of variable is an output of a tool, the average time is a different concept, and then, in TQC, the attribution of scores is differently distributed (the indicated ranges are the products of previous processing around average values); there are exceptions also in IUQC and PQC.

COMPONENTS	VARIABLES	SCORES
TQC	Presence of valid HTML in the homepage	Absence/There has been no validation/Errors don't be noticed because stylesheets have not been individualized = 0 Presence = 2
	Presence of valid CSS in the homepage	
	FAE: Navigation & Orientation in the homepage	Not applicable/Not implemented = 0 Partially Implemented = 1 Almost Complete/ Complete = 2
	FAE: Text Equivalent in the homepage	
	FAE: Scripting in the homepage	
	FAE: Styling in the homepage	
	Slow Pages Visited (Pages loading slower than 3000 msec)	Over 10,0% = 0 5,1% - 10,0% = 1 Up to 5,0% = 2
	Large Size Pages Visited (Pages larger than 1024 bytes)	Over 66,0% = 0 33,1% - 66,0% = 1 Up to 33,0% = 2
	Old Pages Visited (Pages older than 1 day)	Over 66,0% = 0 33,1% - 66,0% = 1 Up to 33,0% = 2
Broken Links &/or Unavailable Pages (%)	Over 10,0% = 0 5,1% - 10,0% = 1 Up to 5,0% = 2	
IUQC	Off Site links (%)	Over 66% = 0 33% - 66% = 1 Up to 33% = 2
	Average Download Time per Page	Over 8000,00 = 0 3000,00 – 8000,00 = 1



		Up to 3000,00 msec (3 sec) = 2
PQC	Availability of the homepage as the first visible page of the website	Not= 0 Yes= 2
	Absence of extraneous to the websites objectives pop-up/layers	Presence = 0 Absence = 2

**Table 10 Exceptions in attribution of scores**

Below are showed, for every component, the evaluation tables that adequately should be compiled. The TQC and PQC tables present characteristics, sub-characteristics, variables and weight for variable; the IUQC present characteristics, sub-characteristics, variables, weight for variable and weight for sub-characteristic. After observing data, by frequency distribution we found that the range of variation for some variables was not sufficiently extensive and by factor analysis, some variables had too low or similar loadings in most factors. These variables, for their importance could not be excluded from the QM, and thus they are left in TQC and in the PQC with a same value for all weights, and this value is, respectively, 0.10 in TQC and 0.05 in PQC.

In IUQC, the weights for variable are the Factor Score Coefficients: the *loadings* in fact represent the dependence of the latent identified factors by the manifest variables, so it is more correct to calculate the appropriate weights, denominated Factor Score Coefficients. Besides, the weight for the eighth sub-characteristic is the percentage of Variance Explained by every factor: we just recall that the Total Variance is practically redistributed among the principal factors; because in our new QM the factors become the sub-characteristics, then the percentage of Variance Explained by every factor constitutes the weight for sub-characteristic.

CHARACTERISTICS	SCORE	SUB-CHARACTERISTICS	VARIABLES	SCORE	WEIGHT	WEIGHTED SCORE
<b>Correctness</b>		MARKUP Validation	Presence of valid HTML in the homepage		0,10	
		CSS Validation	Presence of valid CSS in the homepage		0,10	
<b>Accessibility</b>		Implementation W3C WCAG and Section 508 Standards in the Homepage	FAE: Navigation & Orientation in the homepage		0,10	
			FAE: Text Equivalentents in the homepage		0,10	
			FAE: Scripting in the homepage		0,10	
			FAE:Styling in the homepage		0,10	
<b>Usability</b>		Efficiency	Slow Pages Visited (%)		0,10	
			Large Size Pages Visited (%)		0,10	
			Old Pages Visited (%)		0,10	
			Broken Links &/or Unavailable Pages (%)		0,10	

**Table 11 Evaluation Table for TQC**

CHARACTERISTICS	SCORE	SUB-CHARACTERISTICS	WEIGHT	WEIGHTED SCORE	VARIABLES	SCORE	WEIGHT	WEIGHTED SCORE
Usability		Methods of Payment	0,21		Availability to pay by credit card		0,29	
					Availability to pay by credit transfer		0,29	
					Availability to pay by PayPal		0,29	
		Offer of Personalization	0,10		Request of a password with specification of number and typology of characters to access to the services		0,52	
					Average Download Time per Page		0,36	
		Support to Knowledge	0,09		Presence, in the homepage, of a descriptive title of the corporation		0,52	
					Presence of Help and/or on line guide keys		0,46	
Availability of website consultation in more than one language					0,32			
Management		Privacy	0,14		Offer of guarantee of reservation of the information and respect of the privacy, through at least the quotation of the normative source		0,41	
					Availability of information for the user about possible uses that will be made of their personal data through the publication on the site of the relevant information in compliance with applicable laws		0,36	
		Information Security	0,12		Availability of a SLL system for the sure commercial transactions		0,42	
					Availability of information about the identity of the website's owner (registered name, etc)		0,25	
					Presence of a "Frequently Asked Questions" (FAQ) section		0,32	
					Presence of detailed information on cost/rates		0,32	
Navigability		Navigability	0,13		Availability of a link to immediately return to the previous level		0,41	
					Availability of a breadcrumb trail		0,41	
					Availability of a link which through specific wording (home / beginning ..) or home icon, send back to homepage		0,27	
					Presence of the link to the Sitemap in the Homepage		0,11	
Relationality		Possibility of Contact	0,11		Presence of telephone/fax numbers and/or email addresses to communicate with the website's owner		0,47	
					Indication of the registered office and/or of the operative office if this is different from the registered office		0,45	
		Direct Communication	0,10		Presence of chat (Skype/Messenger/Call Center...)		0,39	
					Possibility to download catalogues / forms / documents / announcements...		0,38	
					Off Site Links (%)		0,46	

**Table 12 Evaluation Table for IUQC – Tourist web sites**

CHARACTERISTICS	SCORE	SUB-CHARACTERISTICS	WEIGHT	WEIGHTED SCORE	VARIABLES	SCORE	WEIGHT	WEIGHTED SCORE	
Usability		Methods of Payment	0,23		Availability to pay by credit card		0,24		
					Availability to pay by credit transfer		0,24		
					Availability to pay by paypal		0,24		
					Availability to pay cash on delivery		0,24		
		Fast Search	0,07			Average Download Time per Page		0,51	
						Possibility to download catalogues / forms / documents / announcements...		0,39	
						Presence of Help and/or on line guide keys		0,37	
						Presence of detailed information on cost/rates		0,28	
Content		Information Completeness	0,20		Presence of a larger image of the product		0,26		
					Presence of cart		0,25		
					Specification of waiting time for the shipping		0,20		
					Presence of a internal search engine		0,20		
					Exact indication of the additional prices for costs of shipping and/or charges on customer		0,17		
Navigability		Navigability	0,13		Availability of a link which through specific wording (home / beginning ..) or home icon, send back to homepage		0,39		
					Availability of a link to immediately return to the previous level		0,36		
					Availability of a breadcrumb trail		0,31		
Management		Privacy	0,10		Offer of guarantee of reservation of the information and respect of the privacy, through at least the quotation of the normative source		0,53		
					Availability of information for the user about possible uses that will be made of their personal data through the publication on the site of the relevant information in compliance with applicable laws		0,50		
		Security Search	0,09			Availability of forms to be compiled to propose claims, suggestions, protests		0,49	
						Availability of a SLL system for the sure commercial transactions		0,42	
						Presence of the navigator bar in the homepage		0,30	
Relationality		Ways of Interaction	0,10		Presence of chat (Skype/Messenger/Call Center...)		0,45		
					Presence of a "Frequently Asked Questions" (FAQ) section		0,30		
		Possibility of Identification	0,08			Availability of information about the identity of the website's owner (registered name, etc)		0,56	
						Presence of telephone/fax numbers and/or email addresses to communicate with the website's owner		0,46	

**Table 13 Evaluation Table for IUQC – No Tourist web sites**

CHARACTERISTICS	SCORE	SUB-CHARACTERISTICS	PLUS VARIABLES	SCORE	WEIGHT	WEIGHTED SCORE
Usability		Easyness to obtain information	Presence of RSS content		0,05	
		Absence of bottlenecks	Absence of extraneous to the websites objectives pop-up/layers		0,05	
Content		Information Wealth	Presence of a selection of homogeneous to website's objectives links		0,05	
			Presence of a "news/novità" section		0,05	
			Presence of a news section that reports the date of last update of this section		0,05	
			Presence of skilled studies and/or market researches on the subject website		0,05	
Management		Update and Information Maintenance	Presence, in the homepage, of the date of the last updating of the website		0,05	
Relationality		Identification and Interactivity	Presence, in the homepage, of a link to the website's objectives (Mission..)		0,05	
			Presence of a "Guest Book/libro degli ospiti/ Dicono di noi/Rassegna stampa.."		0,05	
			Availability of the homepage as the first visible page of the website		0,05	
			Presence of a forum		0,05	
			Presence of a moderator in the forum		0,05	
			Presence of a Customer Satisfaction Service		0,05	
			Possibility to enroll and receive a newsletter		0,05	
			Presence of specified methods for cancelling him from the mailing list of the newsletter		<b>0,05</b>	

**Table 14 Evaluation Table for PQC**

The application of the E-COMWEB QM for evaluating the web sites quality requires two different procedures, one for TQC and PQC and one for IUQC. In TQC and in PQC, the sum of weighted scores for each variable gives the weighted score of the characteristic to which those variables refer, and the sum of weighted scores for each characteristic gives the weighted score of the component. In the IUQC, the sum of weighted scores for each variable should be multiplied for the weight of each sub-characteristic to which those variables refer, and then the sum of weighted scores for each sub-characteristic gives the score of the characteristic to which those sub-characteristics refer. Finally, the sum of weighted scores for each characteristic gives the weighted score of the component.

We consider:

S = score

W = weight

WS = Weighted Score

Var = variable

Chr = Characteristic

Sub-Chr = Sub-characteristic

Cmp = Component

WSGQ = Web Site Global Quality

In all components, it is necessary to obtain a weighted score of each variable, and this is achieved multiplying the score for its weight:

$$S \times W = WS$$

In the TQC and in the PQC, the sum of weighted scores for each variable gives the weighted score of the characteristic to which those variables refer, and the sum of weighted scores for each characteristic gives the weighted score of the component.

$$S \times W = WS$$

$$WS (\text{Var } 1) + WS (\text{Var } 2) + \dots + WS (\text{Var } n) = WS (\text{Chr})$$

$$WS (\text{Chr } 1) + WS (\text{Chr } 2) + \dots + WS (\text{Chr } n) = WS (\text{Cmp})$$

In the IUQC, the sum of weighted scores for each variable should be multiplied for the weight of each sub - characteristic to which those variables refer, and then the sum of weighted scores for each sub – characteristic gives the score of the characteristic to which those sub-characteristics refer. Finally, the sum of weighted scores for each characteristic gives the weighted score of the component.

$$S \times W = WS$$

$$\left( \sum_{\text{var}=1}^n WS_{\text{var}} \right) \times W (\text{sub-chr } n) = WS (\text{sub-chr } n)$$

$$WS (\text{sub-chr } 1) + WS (\text{sub-chr } 2) + \dots + WS (\text{sub-chr } n) = WS (\text{Chr})$$

$$WS (\text{Chr } 1) + WS (\text{chr } 2) + \dots + WS (\text{chr } n) = WS (\text{Cmp})$$

For the Web Site Global Quality Score:

$$WS (\text{cmp } 1) + WS (\text{cmp } 2) + WS (\text{cmp } 3) = WSGQ$$

The min and the max scores for every component and for the Web Site Global Quality are presented below:

CHARACTERISTICS	COMPONENTS									
	TQC		IUQC				PQC		WEB SITE GLOBAL QUALITY	
	All Web Sites		Tourist Web Sites		No Tourist Web Sites		All Web Sites		Tourist Web Sites	Non Tourist Web Sites
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX		
CORRECTNESS	0	0,4	-	-	-	-	-	-	0,4	0,4
ACCESSIBILITY	0	0,8	-	-	-	-	-	-	0,8	0,8
USABILITY	0	0,8	0	0,8	0	0,6	0	0,2	1,8	1,6
NAVIGABILITY	-	-	0	0,3	0	0,3	-	-	0,3	0,3
CONTENT	-	-	-	-	0	0,4	0	0,4	0,4	0,8
MANAGEMENT	-	-	0	0,5	0	0,4	0	0,1	0,6	0,5
RELATIONALITY	-	-	0	0,4	0	0,3	0	0,8	1,2	1,1
	<b>0</b>	<b>2,0</b>	<b>0</b>	<b>2,0</b>	<b>0</b>	<b>2,0</b>	<b>0</b>	<b>1,5</b>	<b>5,5</b>	<b>5,5</b>

**Table 15 Characteristics Per Components: Min and Max Scores**

### **5.3 The expected results: assessments, reports and recommendations to web site improvement.**

The e-commerce web site quality analysis by the E-COMWEB QM produces quantitative and qualitative results that are important both for the web site global quality and for its components quality. The quantitative results are available for IUQC and PQC, and they are constituted of scores which are obtained for each component and for each characteristic that is present in every components, thus, if we have a set of target results, we can see where is necessary to improve the website; in the TQC analysis, to obtain the scores of the variables and characteristics, it is necessary to submit the analyzed Web Site to automated tools that produce reports; so we can obtain scores and detailed informative reports. These reports show the errors found while checking the Markup of website's Homepage and number and typology of errors and warnings found during CSS validation. By the Implementation W3C WCAG and Section 508 Standards check, we can obtain detailed reports which show evaluation results by Best Practices in categories as Navigation & Orientation, Text Equivalent, Scripting, Styling and HTML Standards. Finally, very interesting reports are produced by using a commercial tool, e-Valid: the data collected in these reports may be considered measures of website's efficiency because we can find number, URL and Download Time for slow pages, number, URL and size per large pages, number, URL and age per old pages,

also number, URL and HTML Status Code for Broken Links &/or Unavailable Pages; besides, we can make a web site analysis by changing the settings for slow/large/old pages and for level's depth to be achieved.

By partitioning the possible global score range according to opportune criteria for to obtain equal ranges, it is possible to determine a Web Site global quality score, through which we can give a final evaluation to the analyzed website , as below it is showed:

Web Site Global Quality Score	Final Evaluation
SCORE < 1	SERIOUSLY INSUFFICIENT
SCORE 1 – 1,9	INSUFFICIENT
SCORE 2 – 2,9	SUFFICIENT
SCORE 3 – 3,9	GOOD
SCORE 4 – 4,9	VERY GOOD
SCORE ≥ 5	EXCELLENT

**Table 16 Website Global Quality Score and Final Evaluation**

Two examples of application of the E-COMWEB QM are below shown: for each web site, we can see the difference between possible max scores which are above presented for characteristics and components, and the real scores that are derived by analysis; the tables show the overall results for each analyzed web site.

CHARACTERISTICS	WEB SITE 1			
	TQC	IUQC	PQC	WEB SITE GLOBAL QUALITY
CORRECTNESS	0	-	-	0
ACCESSIBILITY	0,1	-	-	0,1
USABILITY	0,5	0,4	0,2	1,1
NAVIGABILITY	-	0,1	-	0,1
CONTENT	-	-	0,1	0,1
MANAGEMENT	-	0,4	0	0,4
RELATIONALITY	-	0,4	0,3	0,7
	0,6	1,3	0,6	2,5

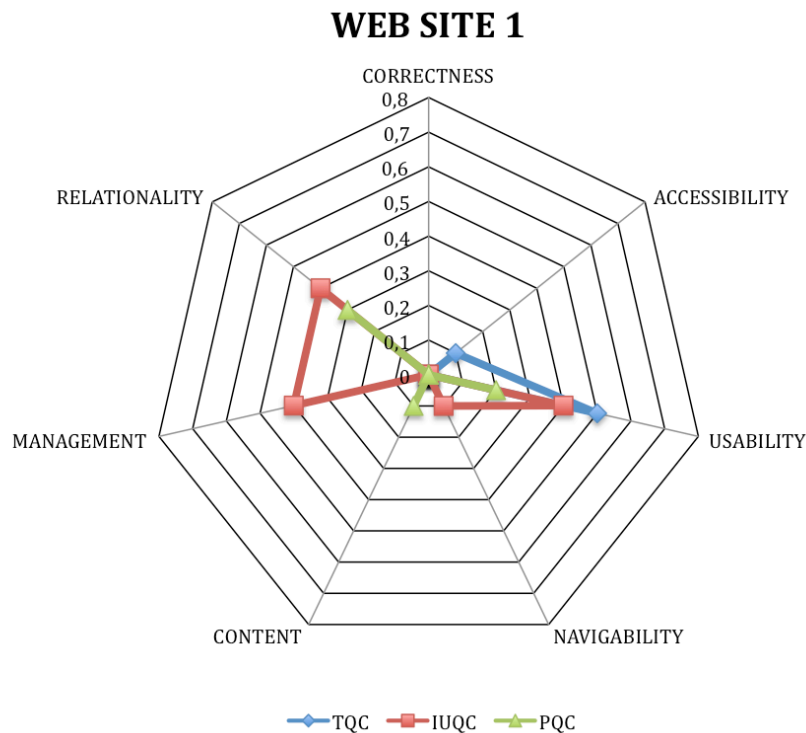
**Table 17 Web Site 1 Quality Profile**

CHARACTERISTICS	WEB SITE 2			
	TQC	IUQC	PQC	WEB SITE GLOBAL QUALITY
CORRECTNESS	0,2	-	-	0,2
ACCESSIBILITY	0,5	-	-	0,5
USABILITY	0,3	0,3	0,1	0,7
NAVIGABILITY	-	0,1	-	0,1
CONTENT	-	-	0,2	0,2
MANAGEMENT	-	0,2	0,1	0,3
RELATIONALITY	-	0,2	0,2	0,4
	1	0,8	0,6	2,4

**Table 18 Web Site 2 Quality Profile**

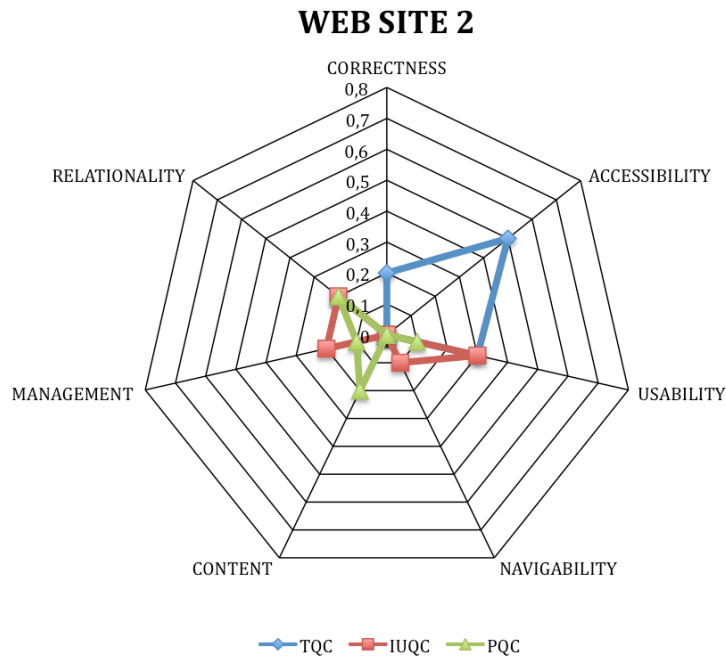
In the first example, the web site global quality can be scored as "sufficient" (its score is 2,5) and also the global quality of web site 2 is "sufficient" (its score is 2,4), but its strong points are in the TQC and its weak points in the IUQC, instead in the Web Site 1, the situation is opposite. On these results, it seems clear that the first Web Site, though technically not very functional, is more oriented to attract its visitors than the second one. Instead the second Web Site is more technically functional.

These results are evident in the figures below:



**Figure 1 Example of the E-COMWEB QM application: Web Site 1**





**Figure 2 Example of the E-COMWEB QM application: Web Site 2**

## 6. CONCLUSIONS

An approach to the definition of a Quality Model for Web Sites was presented, and a brief overview on web sites QMs and on used top-down and bottom-up approaches was introduced. A procedure for the adoption of the new Quality Model for quality measure was defined and its main features presented, with two examples.

The process, which has led to define the new QM, called as E-COMWEB QM, started with the definition of a traditional, multileveled structure of characteristics, that was taken as a reference for data collection and analysis. During a period of a few months, the authors have analyzed a sample of the 110 e-commerce Web Sites to individuate significant aspects, in terms of measurable attributes, and to investigate on their mutual relationships. A particular, yet significant, category of web sites has been chosen, that is e-commerce web sites; in this category, specific quality criteria, as efficiency, usability, navigability, etc., determine the success of the Web Site and then the return of economic investment; B2c (Business to consumer) e-commerce also collects the interests of developers, owners and consumers, and among these stakeholders, the evaluation service could gather more support. Descriptive analysis and factor analysis across the set of reference variables were performed on the sampled data. The results allowed recognizing some groupings of variables into factors corresponding to traditional Quality Models' sub-characteristics, and some groupings of variables into new factors, so that a more complete and reliable Quality Model could be constructed. Besides, the results of the same analysis suggested adoption of a weighting technique in the structure of the attributes.

More work has still to be done to further validate the QM and to enrich it with other characteristics and others variables. Moreover, families of QMs could be defined to capture the differences in the quality objectives: for instance, considering also those web sites that provide public services.

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## Appendix

The sample of 110 Web Sites:

1. <http://www.yoox.com/>
2. [www.esselunga.it](http://www.esselunga.it)
3. <http://www.bol.it>
4. [www.das.it](http://www.das.it)
5. [www.genialloyd.it](http://www.genialloyd.it)
6. [www.eprice.it](http://www.eprice.it)
7. [www.bow.it](http://www.bow.it)
8. [www.totomondo.it](http://www.totomondo.it)
9. [www.itwg.it](http://www.itwg.it)
10. [www.edreams.it](http://www.edreams.it)
11. [www.hotels.it](http://www.hotels.it)
12. [www.alitalia.it](http://www.alitalia.it)
13. [www.msccrociere.it](http://www.msccrociere.it)
14. [www.europcar.it](http://www.europcar.it)
15. [www.borsaviaggi.it](http://www.borsaviaggi.it)
16. [www.hot-els.it](http://www.hot-els.it)
17. <http://www.boxol.it>
18. [www.lacompagniadeltatavolati.it](http://www.lacompagniadeltatavolati.it)
19. <http://www.ferraristore.com>
20. <http://www.ticketone.it>
21. [www.devitofiori.it](http://www.devitofiori.it)
22. [www.factotus.it](http://www.factotus.it)
23. <http://www.tiebreak.it>
24. <http://www.internetbookshop.it>
25. <http://www.linear.it>
26. [www.ingdirect.it](http://www.ingdirect.it)
27. <http://www.mrprice.it>
28. [www.olidata.it](http://www.olidata.it)
29. [www.tui.it](http://www.tui.it)
30. [www.octopustravel.it](http://www.octopustravel.it)
31. [www.prenotazioni.alberghi.it](http://www.prenotazioni.alberghi.it)
32. [www.trenitalia.it](http://www.trenitalia.it)
33. [www.costacrociere.it](http://www.costacrociere.it)

34. [www.ttlines.it](http://www.ttlines.it)
35. [www.busweb.it](http://www.busweb.it)
36. [www.prenotazione-bedandbreakfast.com](http://www.prenotazione-bedandbreakfast.com)
37. [www.architetturaeviaggi.it](http://www.architetturaeviaggi.it)
38. <http://www.viaggiareperilmondo.com>
39. <http://www.esperya.it>
40. <http://www.italianflora.it>
41. <http://www.wineshop.it>
42. [www.cittadelsole.it](http://www.cittadelsole.it)
43. [www.concerteria.it](http://www.concerteria.it)
44. [www.greenticket.it](http://www.greenticket.it)
45. [www.freemoda.net](http://www.freemoda.net)
46. [www.zuritel.it](http://www.zuritel.it)
47. [www.genertel.it](http://www.genertel.it)
48. [www.monclick.it](http://www.monclick.it)
49. [www.nomatica.it](http://www.nomatica.it)
50. [www.expedia.it](http://www.expedia.it)
51. [www.venere.it](http://www.venere.it)
52. [www.hotelsitalia.biz](http://www.hotelsitalia.biz)
53. [www.otelio.com](http://www.otelio.com)
54. [www.meridiana.it](http://www.meridiana.it)
55. [www.myair.com](http://www.myair.com)
56. [www.corsicaferries.com](http://www.corsicaferries.com)
57. [www.toremair.it](http://www.toremair.it)
58. [www.bus.it](http://www.bus.it)
59. <http://www.bb-italia.it>
60. [www.vacanzeserene.it](http://www.vacanzeserene.it)
61. <http://www.bestticket.it>
62. <http://www.buycentral.it>
63. [www.Vivaticket.it](http://www.Vivaticket.it)
64. [www.bestoutlet.it](http://www.bestoutlet.it)
65. [www.gioie.it](http://www.gioie.it)
66. <http://www.lemercerie.it>
67. <http://www.panini.it>
68. <http://www.dialogo.it>
69. [www.chl.it](http://www.chl.it)
70. <http://compraonline.mediaworld.it>

71. [www.lastminute.com](http://www.lastminute.com)
72. [www.opodo.it](http://www.opodo.it)
73. [www.alberghitalia.com](http://www.alberghitalia.com)
74. [www.viaggiaedormi.it](http://www.viaggiaedormi.it)
75. [www.volawindjet.it](http://www.volawindjet.it)
76. [www.moby.it](http://www.moby.it)
77. [www.orariautobus.it](http://www.orariautobus.it)
78. [www.bbplanet.it](http://www.bbplanet.it)
79. [www.migliori-offerte-viaggi.it](http://www.migliori-offerte-viaggi.it)
80. [www.teorematour.it](http://www.teorematour.it)
81. <http://www.fulltravel.it>
82. <http://www.bimdvd.it>
83. [www.buy.it](http://www.buy.it)
84. <http://www.dmail.it>
85. <http://www.saninforma.it>
86. [www.acquisti-ok.it](http://www.acquisti-ok.it)
87. [www.efo.it](http://www.efo.it)
88. [www.modellismo.it](http://www.modellismo.it)
89. <http://www.6sicuro.it>
90. <http://www.directline.it/>
91. <http://shoponline.euronics.it/>
92. <http://www.pixmania.com>
93. [www.booking.it](http://www.booking.it)
94. [www.initalia.it](http://www.initalia.it)
95. [www.ospitando.com](http://www.ospitando.com)
96. [www.reserver.it](http://www.reserver.it)
97. <http://www.emmeti.it/>
98. [www.flyairone.it](http://www.flyairone.it)
99. [www.snav.it](http://www.snav.it)
100. [www.tirrenia.it](http://www.tirrenia.it)
101. [www.ibus.it](http://www.ibus.it)
102. [www.hertz.it](http://www.hertz.it)
103. [www.hotelexpert.it](http://www.hotelexpert.it)
104. [www.hotelopia.it](http://www.hotelopia.it)
105. [www.mmalberghi.it](http://www.mmalberghi.it)
106. [www.ciao.it](http://www.ciao.it)
107. <http://www.gioielloro.it>

108. [www.100asa.it](http://www.100asa.it)

109. [www.bottegaverde.it](http://www.bottegaverde.it)

110. [www.gioiadellacasa.it](http://www.gioiadellacasa.it)