Assessing Corporate Web Sites: Quality Model and Methodology

Daniela Fogli and Giovanni Guida

Dipartimento di Ingegneria dell'Informazione
Università degli Studi di Brescia
Via Branze 38, 25123 Brescia, Italy
{fogli,guida}@ing.unibs.it

Abstract. The paper presents a new quality model for corporate web sites based on three fundamental concepts: ultimate quality, external quality, and internal quality. External quality is defined in detail through a suitable set of characteristics and sub-characteristics and covers a comprehensive spectrum of the properties a good web site should show. A practical assessment methodology for external quality is finally proposed, which employs expert evaluators instead of actual users, in order to make the evaluation less costly and faster.

Keywords: quality model, ultimate quality, external quality, quality assessment.

1 Introduction

Corporate web sites are more and more pervasive in today economic world and play a crucial role for success in the marketplace. Notwithstanding the variety of good methodologies that have been proposed over the years for the design of web sites, it often happens that users' needs are not satisfied and site owners do not obtain adequate return on their investment. Failure and low effectiveness of many corporate web sites can be related to their poor quality [20].

Quality is a fundamental indicator of the expected success of a web site and therefore its assessment is an important activity all during its life cycle. Assessment can be carried out during the design and development phases in order to identify and correct emerging problems as soon as possible; but quality should also be monitored during the overall operation phase of a web site, in order to guarantee its continuous improvement. Several quality models for web sites have been proposed in literature. Inspired to ISO/IEC 9126 [8] and to the more recent ISO/IEC 25010 [10], such quality models identify sets of characteristics and sub-characteristics that are specific for assessing the quality of web sites (see for example: [3], [15-18], [21-27]). However, some important limitations affect existing quality models:

- The goals of the site owner are not sufficiently considered, if not neglected at all. Indeed, the success of a corporate web site depends not only on the satisfaction of users' needs, but also on the achievement of company goals.

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- The usability dimension is overestimated. For example, while all models include usability as a basic quality characteristic, less or no emphasis is given to aesthetics and how it influences user perception of usability, as demonstrated in [2], [11], [13]. Also the usefulness of the contents offered by a website is often neglected.
- The user point of view is prevailing. Usability, aesthetics and usefulness all contribute to the satisfaction of final users, who are, however, only an intermediate target for a web site, whose ultimate goal is a positive impact on the company and its performance.
- There are overlappings among characteristics and sub-characteristics. This happens both in the models inspired to software quality standards (e.g., [22], [26]) and in those based on the web site development model [23] or on the stakeholder organization [24].
- Several models are not scalable. Most models are too complex to be applied to the typical web sites of small and medium enterprises; the possibility to focus only on some quality characteristics, neglecting the others, is generally not considered.
- Applying a quality model is always a complex and time-consuming activity. Quality models are generally not supported by a specific application methodology that allows keeping the evaluation process within precise time and budget limits; their implementation is left to the evaluators who must make all relevant decisions.

The work described in this paper emerges from a long practical experience in the evaluation of corporate web sites, aimed at identifying the causes that led to failures, poor performance or unsatisfactory results [1]. The paper thus analyzes the concept of quality for corporate web sites and proposes a new quality model, which aims at overcoming some of the limitations mentioned above and which can be easily tailored to a variety of cases of practical interest. The model focuses in particular on external quality and proposes a methodology for assessing corporate web sites. The model and the methodology are being tested in a set of real case studies that will be discussed in a future work.

The paper is organized as follows: Section 2 proposes a concept of quality that evolves the definitions provided in quality standards and literature work; Section 3 illustrates the proposed quality model, focusing on external quality characteristics; Section 4 describes the main features of the relevant assessment methodology; Section 5 provides some comparisons with literature work and hints for future work.

2 Defining Quality

According to ISO-8402 [5] *quality* is defined as “the set of characteristics of an entity that give that entity the ability to satisfy expressed and implicit needs”. A similar concept is later assumed also in ISO-9000 [9] that defines quality as “the ability of a set of intrinsic characteristics to satisfy requirements”.

In the specific case of software products, ISO/IEC 25010 [10] introduces a *product quality* model that encompasses both *internal qualities* and *external qualities* of the system and a distinct *quality in use* model that refers to “the impact that the product has on stakeholders”.

As pointed out in [3], [22], [24], there are good reasons that support the need for a different quality model for web sites. In fact, web sites feature a set of peculiarities

that make them different from ordinary software products and call for a specific approach to quality and quality assessment. In the following we present a definition of quality partially coherent with most literature approaches, but better specified according to a large practical experience in web site assessment.

First of all, the concept of quality of a web site refers to the goals of its *owner*, namely the company that pays for its construction and expects to obtain concrete benefits from its use, for example, increasing online sales, improving customer care, exploiting brand reputation, disseminating product knowledge. We call this type of quality **ultimate quality**, since it refers to the final objectives that the web site should satisfy or, in other words, to its effectiveness in the target context.

Apparently, this concept of quality shares several aspects with the notion of *quality in use* recalled above, since both generically refer to the impact of the system on the target environment when it is actually used in a specific context. However, differently from quality in use, ultimate quality focuses just on the owner of a web site, and not on all possible stakeholders, who encompass a large variety of actors including, among others, the users. Moreover, our concept of ultimate quality is based on a set of characteristics that strictly depend on the specific company considered and on its goals, and that cannot be of general validity; while a company might focus on increasing sales, another might aim at collecting user feedback to improve product design, and still another might be interested in promoting relationships with the stakeholders. Quality in use, instead, assumes a fixed set of characteristics (namely, effectiveness, efficiency, satisfaction, safety, and usability) [10] of general validity and mostly company independent.

Ultimate quality, while being in a sense the most important aspect of quality, does not allow, however, identification of weak and strong points of a web site, thus failing to provide useful hints about where and in what directions it could be improved. Moreover, it can be noted that a web site is a very particular type of software product, which, in order to be effective, requires the collaboration of users, who exploit the contents it offers and, this way, contribute to the achievement of the goals of the owner. As a further step, we can then define a second type of quality, called – as widely accepted in literature [24] – **external quality**. External quality captures the properties of a web site, which make it attractive, useful and rewarding, thus ensuring a large set of satisfied visitors and then supporting its effectiveness. External quality can be articulated through a suitable set of characteristics (and sub-characteristics) that are of general validity but of course can be more or less important for a specific web site. External quality is clearly a necessary condition for success and therefore we can assume it as a reasonable gauge of ultimate quality.

Turning now to the methods for assessing external quality, it is important to distinguish between two approaches. From a strict theoretical perspective, assessing external quality requires experimentation with suitable samples of users in a suitable test setting. We call external quality measured through user experiments **actual quality** since it represents the quality actually experimented by web site users in a real interaction context. Measuring actual quality is however a complex, time consuming and costly task. Even a single experiment about an aspect of usability – say for example, learnability – can require tens of users, a wide collection of test cases, a number of experimental sessions, and a complex framework for collecting and processing data. Therefore, we introduce a second approach to assessing external

quality based on experimentation and analysis of a web site by an evaluator or a panel of evaluators. We call this type of quality **expected quality**, since it represents an estimate of actual quality, possibly less reliable but definitely much simpler and less costly to assess. This difference between actual and expected quality introduces a distinction generally not considered in literature and often neglected in practice, thus introducing imprecision and sometimes even misunderstanding in the assessment. However, expected quality cannot be assimilated to – or confused with – actual quality: they are different concepts and must be considered differently. Asserting that a given web site features a low usability is poorly meaningful if one does not specify whether it has been assessed by users or by web site evaluators.

Finally, if the assessment of external quality reveals weak points or even critical aspects in a web site, it is then important to identify how it might be improved. To this purpose, we must assume the point of view of the designer and assess quality under this new perspective. This brings to the definition of a third type of quality, usually called **internal quality**, which accounts for the reasons behind the external behavior of the web site and points out what is right and what is wrong in its internal structure and operation. Internal quality depends on a variety of design choices – from information architecture to graphics, from page layout to the use of colors – and can be considered as the end-point of a progressive refinement of the concept of quality, from the goals of the owner to the deep technical reasons that can make them satisfied to a certain degree. Clearly, a set of general characteristics for internal quality might be defined, but this issue is outside the scope of the present research.

The concept of quality illustrated above is summarized in Figure 1.

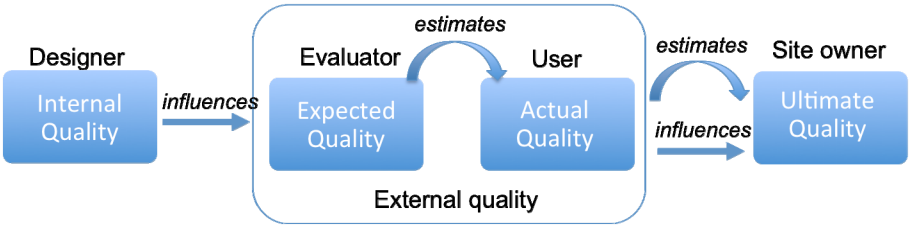

Fig. 1. The concept of quality

In this paper we focus on the quality model behind external quality (Section 3) and we propose a methodology for assessing expected quality (Section 4).

3 The Quality Model

3.1 The Requirements

In the essence, a quality model is made up of a structured system of **quality characteristics** and **sub-characteristics** that a web site is expected to satisfy to a certain degree. The quality model for external quality proposed in this paper is based on three main requirements:

- The model should provide a credible estimate of ultimate quality, that is of the effectiveness of a web site for the purposes of the owner. A quality model that cannot account for this aspect is practically useless and would not be applied outside the research laboratory.
- The model should be simple, both to understand and to apply. Too generic and abstract models cannot be directly applied; whilst, highly refined but complex models are not suitable for mass application, as it is required in the present situation, where almost all companies might largely benefit from an assessment of their web site that can be used as a concrete basis for improvement.
- The model should be tailorable to a variety of different contexts and assessment objectives, and especially to a wide range of companies, from large enterprises to small-medium ones. In particular, one must be free to focus on the characteristics (or sub-characteristics) that are considered more important discarding the others.

Our model for external quality comprises five characteristics, namely **operation**, **accessibility, usability, impact** and **usefulness**. These characteristics and their sub-characteristics have been derived from literature and practical experience gathered in the assessment of corporate web sites. They are defined in detail in the following, along with example tests that may be carried out to assess each sub-characteristic, which include heuristics, metrics, and checklists, depending on the relevant type.

3.2 Operation

Operation comprises five sub-characteristics as shown in Table 1.

Table 1. Operation

Sub-characteristic	Description	Test
Availability	Does the web site regularly respond to requests from web clients?	Number of failures in a given time interval, average duration of failures, mean time between failures, total time of unavailability
Reachability	Can a search engine easily find the web site?	Page rank with a variety of search terms and search engines
Compatibility	Does the web site operate correctly with a variety of devices?	Correct operation with a variety of web browsers, user agents, assistive devices
Functionality	Does the web site perform correctly?	Corrupted pages, broken or wrong links, navigation errors, correctness of application services, response time
Security	Is the web site able to protect the privacy of the user?	Web site certificates, reputation of site owner

Operation is intended to capture a set of basic properties of a web site whose satisfaction – at least to a minimal degree – is a prerequisite for external quality. It would be pointless analyzing the quality of a system that is frequently not available, not easily reachable in the web, or that might cause damages to the user. Operation is therefore the first and fundamental characteristic of external quality and should be assessed first. It is largely user independent and concerns the behavior of hardware and software infrastructure where the web site is hosted and of some of the technical features of the web site structure.

3.3 Accessibility

Accessibility concerns the possibility for a generic user – independently of his/her personal abilities – to easily and naturally access the web site and its contents.

The sub-characteristics of accessibility (Table 2) are derived from those defined by W3C Web Content Accessibility Guidelines (WCAG) [28]. However, in this context they do not specifically refer to possible user disabilities, but we assume a wider point of view where accessibility is understood as a necessary property for all users, without any exception. The sub-characteristics of accessibility belong to the perceptual ("perceivability"), cognitive ("understandability") and pragmatic ("operability") spheres of an individual. Accordingly, "robustness", which is mentioned in [28], is not present here since it is a technical, user-independent property; it pertains to the concept of "operation" and therefore it has been included in its definition under the name "compatibility".

Table 2. Accessibility

Sub-characteristic	Description	Test
Perceivability	Can users easily perceive the contents displayed?	Text font and point size, size of icons and pictures, use of colors, page layout, use of audio channel
Understandability	Can users easily understand the contents presented?	Foreign language versions, use of appropriate language, context, explanations
Operability	Does the web site support easy operation by the users?	Ease of navigation, search engine performance (precision, recall), interaction with links and other web controls, use of site map, personalization tools

3.4 Usability

Usability is one of the pervading concepts of user-centered design and it is traditionally defined as the property of a web site to be easy to use according to a specified set of criteria [6-7], [19]. The sub-characteristics of usability (Table 3) are derived from the original work of J. Nielsen [19] with minor adjustments. All of them belong to the cognitive and pragmatic sphere of an individual. Coherently, "satisfaction", which is present in Nielsen's proposal, is not included here since it pertains to the emotional sphere and therefore it is classified as a sub-characteristic of "impact", as defined in Table 4.

Table 3. Usability

Sub-characteristic	Description	Test
Learnability	Can users easily accomplish basic tasks the first time they approach the web site?	Time to accomplish a set of sample tasks the first time users approach the web site
Efficiency	Can users proficiently accomplish their tasks after having learned the system?	Time to accomplish a set of sample tasks after suitable training
Memorability	Can users easily re-establish proficiency when they return to system after a period of not using it?	Time to accomplish a set of sample tasks after a period of not using the web site
Robustness	Does the web site support users in avoiding errors or in recovering from the errors occurred?	Number of errors incurred in a given time period, ratio of successes to failures, time spent on recovering from errors

3.5 Impact

Impact is aimed at capturing into a single, coherent concept the main aspects of a web site that pertain to the emotional sphere of an individual (Table 4). These largely depend on cultural and psychological elements and have a primary role for acceptance and loyalty of a web site. These aspects also exert an important effect on user persuasion and decisions [29].

Table 4. Impact

Sub-characteristic	Description	Test
Simplicity	Do users perceive the web site as simple?	Organization of layout, essentiality of information, minimalism of presentation
Aesthetics	Do users consider the web site beautiful?	Just ask the user their subjective opinion
Affectivity	Does the web site generate a positive sentiment in the users?	Classify and count emotions, analyse the relationships between emotions and web site objects, check the evolution of emotions into a stable sentiment
Satisfaction	Do users feel the web site as pleasant and rewarding?	Just ask the user their subjective opinion

The sub-characteristic “simplicity” is inspired to the work of J. Maeda [14], who has shown with clear and convincing arguments the importance of being simple and has proposed a concept of simplicity that perfectly applies to web sites. Simplicity is different from any other property and is perceived in an immediate and natural way by any user, independently of his/her background, culture, and personal profile. “Aesthetics” of web sites has been deeply studied in [11]; this work considers aesthetics as consisting of two main dimensions, namely “classical aesthetics” and

"expressive aesthetics", the former emphasizing orderly and clear design, the latter related to designers' creativity and originality. "Affectivity" is a characteristics related to the system's efficacy in stimulating emotions in a user [4]. "Satisfaction" is derived from [19] and shares several traits with the concept of "user experience" [12].

3.6 Usefulness

Usefulness (Table 5) is the characteristic of a web site that accounts for the quality of its content (both information and application services). It belongs to the practical sphere, since content is specifically aimed at satisfying users' needs and at meeting their expectations. Usefulness deeply influences the relationships between the user and the web site in a problem solving perspective.

Table 5. Usefulness

Sub-characteristic	Description	Test
Correctness	Are the contents offered by the web site correct?	Correctness and accuracy of information, correctness of application services, time correctness
Pertinence	Are all the contents offered by the web site relevant to its purpose?	Any immaterial or misleading information or application service present?
Completeness	Does the web site offer to the users all contents relevant to its purpose?	Any key or important information or application service missing?
Reliability	Can users rely on the contents offered by the web site?	Authority of the web site owner, reputation of authors and designers, presence of time marks

4 Assessing Expected Quality: A Methodology

4.1 When and Why to Assess a Web Site

The assessment of expected quality is an important tool to support iterative development of a web site. After each iteration, an evaluation session can greatly help down-stream analysis, both to diagnose design errors and to keep the evolution of the web site strictly focused on the stated quality requirements. Formal evaluation sessions with quality experts must be preferred to informal sessions with users, since the assessment of actual quality is long and costly and cannot be repeated several times during development. The evaluation of expected quality can thus be regarded as a predictive method, playing the same role that heuristic evaluation and cognitive walkthrough play in usability engineering [19]. The evaluation of actual quality with real users may instead be very useful towards the end of the development cycle, when the web site has already been extensively tested and its expected quality is satisfactory. In this case, actual quality can provide further hints for final refinements

and also serve as a last field test before go-live. In addition, expected quality should be assessed periodically during the operational life of a web site, especially in case of unsatisfactory ultimate quality. It can reveal strong and weak points of the web site and suggest the priority directions for improvement.

4.2 A Practical Approach

The basic issue in approching the assessment of the quality of a web site concerns whether to assume an absolute or relative point of view. For example, if the assessment of the sub-characteristic *robustness* is *excellent*, does it mean that robustness is achieved to the highest possible degree (absolute judgment) or that it fully meets the stated requirements for the specific web site at hand (relative judgment)? In order to implement an approach that allows clearly distinguishing between absolute and relative assessment, two scales of values must be introduced:

- A first scale is necessary to express absolute evaluations about each one of the sub-characteristics of external quality. We assume here a qualitative scale, made of a finite, total ordered set of labels that we call the **absolute scale** or **a-scale**. For example, a1={*insufficient, poor, fair, good, excellent*} or a2={*seriously insufficient, insufficient, very poor, poor, acceptable, sufficient, fair, moderately good, good, very good, excellent*}, where each value has an intuitive meaning. Of course finer or coarser a-scales may be adopted, according to the precision desired.
- A second scale is then needed to represent the degree to which each sub-characteristic meets stated requirements. We assume again a qualitative scale, called the **relative scale** or **r-scale**. For example, r1={*seriously failed, failed, met, largely met*}.

It is reasonable to assume that the lenght of the r-scale is less or equal than the lenght of the a-scale; in fact, the former has only to represent the degree to which a requirement is satisfied, while the latter must be fine enough to allow an assessment as far as possibile precise and detailed according to the features of the specific case at hand. Of course, before assessment starts, the requirements for each sub-characteristic must be stated. These should be defined according to the goals of the web site owner and to the specific features of the web site. We assume that **requirements** are stated using only the positive values of the a-scale, that is the values above sufficiency; for example, considering the a-scale a1 introduced above, the positive values are {*fair, good, excellent*}. The notation *req(x) = a,* where *a* belongs to a given a-scale, means that the requirement of the sub-characteristic *x* is *a*. Note that it would be inappropriate in general to assume for each sub-characteristic a target value corresponding to the maximum of the a-scale: depending on the case at hand, some characteristics are definitely less important than others and this should be reflected in the requirements.

Moreover, it is necessary to define a suitable mapping between the value *a-val(x)* assigned on the a-scale to a given sub-characteristic *x*, the requirement r*eq(x)*, and the value *r-val(x)* that should be assigned to *x* on the r-scale. That is, considering again the above example, if the evaluation of *robustness* yields *a-val(robustness) = poor* and *req(robustness) = good*, how should this be mapped onto the r-scale? Intuitively,

one might expect that being *poor* a far worst value than *good*, the final relative assessment of *robustness* should be *r-val(robustness)= seriously failed*. We call this relation **AR mapping** and clearly we have: AR: a-scale × a-scale →r-scale. The definition of the AR mapping must of course comply with the goal of representing the degree at which a stated requirement about a quality sub-characterstic is met. For example, considering the a-scale a1 and the r-scale r1 introduced above, we might assume the following definition of AR:

IF *a-val(x) - req(x)= y* THEN *r-val(x)=met + y*

where (a) the difference operator "-" denotes the positional distance between a pair of elements of a-scale, and (b) in case the sum *met + y* exceeds the limits of the r-scale, the left- or right-most value is assumed respectively.

So, resuming the example introduced above, we have

y = a-val(robustness) - req(robustness) = (poor – good) = -2
r-val(roustness) = met + y = met - 2 = seriously failed

Based on the above concepts, the **assessment procedure** we propose is then organized in two steps:

1. **Step-1:** for each sub-characteristic *x*, evaluate the degree to which it is satisfied in absolute terms and assign to it a value *a-val(x)* on the a-scale.
2. **Step-2:** for each sub-characteristic *x*, compute its final relative assessment *r-val(x)* on the basis of *a-val(x)*, the stated requirement *req(x)* and the assigned AR mapping.

Now a last point has to be faced, which concerns the eventual aggregation of the evaluations assigned to each individual sub-characteristic into an overall evaluation of the relevant characteristic and, then, the eventual aggregation of the evaluations assigned to each characteristic into a global evaluation of external quality. This aggregation process is clearly possibile through the application of a suitable mean-value operation defined on the a-scale or on the r-scale. However, we stress that if on one side aggregating values into global scores can provide a useful one-shot representation of the quality of a web site, on the other hand it hides much of the details that are necessary to deepen the analysis and to identify concrete actions for quality improvement.

5 Discussion and Conclusion

In this paper, we have presented a new quality model for corporate web sites, which takes explicitly into consideration the goals and expectations of the site owner. The concept that we have called here "ultimate quality" is not encompassed in existing literature and standards, which prefer either defining general models including characteristics for internal quality, external quality and quality in use [17], [24], [27], or focusing on quality in use only [3], [22]. General models are usually very articulated and thus difficult to apply, whilst models focused on quality in use do not consider important characteristics that affect ultimate quality.

In addition, we have proposed a pragmatic approach to quality assessment, based on the concept of expected (external) quality. Condidering quality from the perspective of expert evaluators – instead of that of the users – allows adapting the assessment to the specific development phase of a web site, to the available time and budget, and to the accuracy one desires to achieve. As proposed in [8] and [10], problems identified through the assessment of external quality can then be recognized as dependent from problems in the internal quality, and thus require the intervention of designers.

Furthermore, our quality model is not based on the web site development phases and on the actors involved in such phases as proposed for example in [24], but considers quality itself as having different meanings for the different stakeholders, namely site owner, evaluators, users, and designers. In our opinion, this makes the model and assessment methodology more natural and easier to understand and apply.

Finally, we stress that while some literature works are more oriented towards a specific type of web sites – such as e-commerce sites [25], [26] or web 2.0 sites [24] – the model proposed in this paper, and the relevant assessment methodology, can be tailored to the type of web site at hand, to the needs of the site owner, and to the preferences of the evaluators.

The prototype of an interactive tool for supporting the evaluator in assessing expected quality has been developed and is presently being tested. Moreover, an extended experimentation of the proposed quality model and methodology in concrete cases and the assessment of its adequacy, effectiveness, and ease to use are ongoing; the results of this experimentation will be the subject of a forthcoming paper.

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