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Classifying web metrics using the web quality model

Coral Calero, Julián Ruiz and Mario Piattini
ALARCOS Research Group, Computer Science Department, University of Castilla-La Mancha, Ciudad Real, Spain

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Abstract

Purpose – The purpose of this paper is to classify the most important metrics proposed for web information systems, with the aim of offering the user a global vision of the state of the research within this area.

Design/methodology/approach – WQM distinguishes three dimensions related to web features, lifecycle processes and quality characteristics. A range of recently published (1992-2004) works that include web metrics definitions have been studied and classified within this model.

Findings – In this work, a global vision of web metrics is provided. Concretely, it was found that about 44 percent of metrics are related to "presentation" and that most metrics (48 percent) are usability metrics. Regarding the life cycle, the majority of metrics are related to operation and maintenance processes. Nevertheless, focusing on metrics validation, it was found that there is not too much work done, with only 3 percent of metrics validated theoretically and 37 percent of metrics validated empirically.

Practical implications – The classification presented tries to facilitate the use and application of web metrics for different kinds of stakeholders (developers, maintainers, etc.) as well as to clarify where web metric definition efforts are centred, and thus where it is necessary to focus future works.

Originality/value – This work tries to cover a deficiency in the web metrics field, where many proposals have been stated but without any kind of rigour and order. Consequently, the application of the proposed metrics is difficult and risky, and it is dangerous to base decisions on their values.

Keywords Worldwide web, Quality, Measurement

Paper type Research paper

Introduction

Web engineering aims to address and resolve the multifaceted problems of web-based systems development, and usually its main focus is the establishment and use of sound scientific and engineering management principles, as well as systematic approaches to the successful development, deployment and maintenance of high-quality web-based systems and applications (Heuser, 2004). Web applications are generally considered to be among the most difficult software constructs to size and cost (Umbers and Miles, 2004).

Web Information Systems Engineering (WISE) differs from traditional information systems because of its unique technological platform and design philosophy (Oinas-Kukkonnen *et al.*, 2001). In addition, with the quality-assurance process being a challenging one for the new discipline of web engineering (Deshpandé *et al.*, 2002), the

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fact that WISE can provide realistic estimates early in a web application's life cycle allows project managers and development organizations to manage resources effectively (Mendes *et al.*, 2001).

WISE aims to improve the quality of web sites, since according to Offutt (2002), high quality is the only mechanism that brings repeat users to web sites. Quality, however, is not always assured (Abrahão and Pastor, 2003; Cutter Consortium, 2000), perhaps because it is not universally definable and measurable (Ciancarini and Moretti, 2003). As stated in Kappel *et al.* (2004), a survey conducted by the Cutter Consortium (2000) found that the main problem areas of large-scale web application projects were failure to meet business needs (84 percent), project schedule delays (79 percent), budget overrun (63 percent), lack of required functionality (53 percent), and poor quality of deliverables (52 percent). This can be explained by the fact that web applications usually present disordered architectures, poor or non-existing documentation, and can only be analyzed, comprehended and modified with considerable effort (Di Lucca *et al.*, 2004).

In recent years, several experts have worked on different proposals to improve web quality, including methodologies (Castro *et al.*, 2004; Ceri *et al.*, 2000, 2004; Gómez *et al.*, 2001; Hennicker and Koch, 2000; Olsina *et al.*, 2001), quality frameworks (Donaldson and Cowderoy, 1997; Katterattanakul and Siau, 2001), estimation models (Mendes *et al.*, 2001), criteria (W3C WWW Consortium, 1999), usability guidelines (Krug, 2000; Nielsen, 2000), assessment methods (Schubert, 2003), and metrics.

In fact, web metrics is a particularly valuable area of ongoing, commercially relevant research (Ruhe *et al.*, 2003a, b). Since the 1990s, a wide ranging set of metrics has been proposed for quantifying web quality attributes (Abrahão *et al.*, 2003; Alves de Silva and Ponti de Mattos Fortes, 2001; Bajaj and Krishnan, 1999; Baresi *et al.*, 2003; Botafogo *et al.*, 1992; Costagliola *et al.*, 2004; Dhyani *et al.*, 2002; Di Lucca *et al.*, 2004; Fink, 2001; Herder, 2002; Henzinger, 2001; Ivory 2001, 2003; Ivory and Hearst, 2001; Ivory *et al.*, 2001; Lafuente *et al.*, 2001; Mendes and Counsell, 2000; Mendes *et al.*, 2001, 2002a, b, 2003; Morisio *et al.*, 1999; Olsina, 2000; Olsina *et al.*, 2001, 2003; Olsina and Rossi, 2002; Reifer, 2000, 2002a, b; Rivlin *et al.*, 1994; Rollo, 2000; Ruhe *et al.*, 2003a; Umbers and Miles, 2004; Warren *et al.*, 2001). Nevertheless, these metrics are sometimes not well defined and nor are they empirically or theoretically validated, and hence they can confuse interested users instead of helping them.

Recently, Dhyani *et al.* (2002) have proposed a web classification framework to try to determine how the classified metrics can be applied to improve web information access and use. However, they have discarded important dimensions such as life-cycle processes and web features, losing very important information about metrics.

With the aim of classifying metrics in a broad manner, we have elaborated the Web Quality Model (WQM), which distinguishes three dimensions related to web features, life-cycle processes and quality characteristics (Ruiz *et al.*, 2003).

The first version of our model was developed in 2003 and was refined in a survey (Calero *et al.*, 2004) by using it in the classification of 326 web metrics. The last version of our model has been refined in this paper by including organizational life-cycle processes, in order to make possible the classification of metrics related to effort and reuse – an essential element for the provision of competitive bids and for the maintenance of success in the marketplace ((Ruhe *et al.*, 2003a).

In the following section, we present the WQM model, explaining each of its dimensions. In the subsequent section, we summarize the result of the classification of the most relevant web metrics. Conclusions and future work are dealt with in the last section.

The Web Quality Model (WQM)

Ramler *et al.* (2002) defined a cube structure in which they considered three basic aspects when testing a web site. Following on from this idea, we proposed (Ruiz *et al.*, 2003) another "cube", composed of those aspects to be taken into account in the evaluation of web site quality: features, life-cycle processes and quality aspects, which can be considered orthogonal. The model was reviewed by basing the features dimension on aspects relevant to the web found in the literature (Calero *et al.*, 2004). Using this version of WQM, we classified 326 web metrics. In the current version, we have included changes in the life-cycle processes dimension by adding the organizational processes to the existing ones. In this section, we summarize the previous version of WQM, which is shown in Figure 1.

Web features dimension

In this dimension, we include the three "classic" web aspects: content, presentation and navigation (Baresi *et al.*, 2003; Fraternali, 1999; Gómez *et al.*, 2001). Navigation is an important design element, allowing users to acquire most of the information they are seeking and making that information easier to find. Presentation and content are prime components in making the page easier to use (Palmer, 2002).

In content, we have included not only data such as text, figures, images, video clips, and so on, but also programs and applications that provide functionalities like scripts, CGI programs, Java programs, and others. Content also deals with structure and representation issues. Because of the close intertwining of functions and data, the border between them is not clearly drawn, and we consider them to be the same feature.

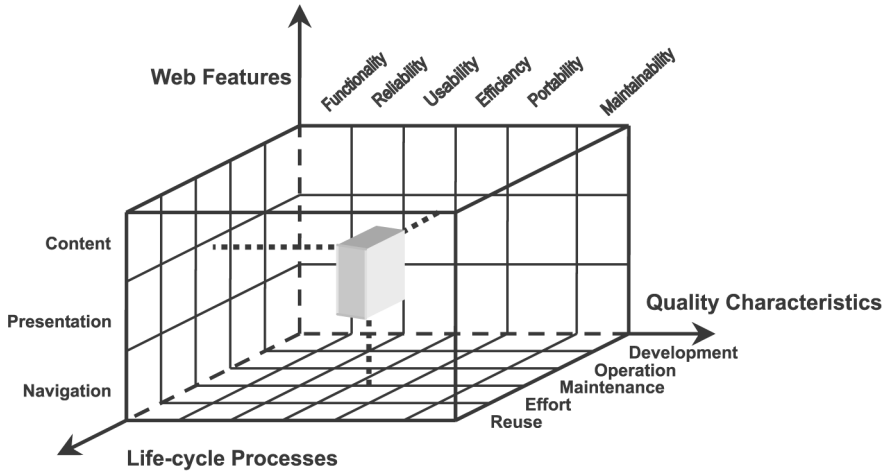

Figure 1.
The Web Quality Model cube

Navigation is concerned with the facilities for accessing information as well as moving around the web.

Presentation is related to the way in which content and navigation are presented to the user.

Quality characteristics dimension

For the description of this dimension we use the Quint2 model (Niessink, 2002), based on the ISO 9126 standard, as a foundation (ISO/IEC, 2001). We have decided to use Quint2 instead of the standard because this model extends the ISO standard with new characteristics that are most appropriate for web products. Quint2 is a hierarchical model that fixes six basic characteristics, each of them with a set of sub-characteristics, to which a set of attributes is connected. These are the basic elements. The list below shows the characteristics of Quint2, indicating, where necessary, those sub-characteristics added or removed with respect to ISO 9126:

(1) *Functionality* – a set of attributes that bear on the existence of a set of functions and their specified properties. The functions are those that satisfy stated or implied needs:
   - suitability – attribute of software that bears on the presence and appropriateness of a set of functions for specified tasks;
   - accuracy – attributes of software that bear on the provision of right or agreed results or effects;
   - interoperability – attributes of software that bear on its ability to interact with specified systems;
   - security – attributes of software that bear on its ability to prevent unauthorized access, whether accidental or deliberate, to programs or data; and
   - traceability (Quint2) – attributes of software that bear on the effort needed to verify correctness of data processing on required points.

(2) *Reliability* – a set of attributes that bear on the capability of software to maintain its level of performance under stated conditions for a stated period of time:
   - maturity – attributes of software that bear on the frequency of failure by faults in the software;
   - fault tolerance – attributes of software that bear on its ability to maintain a specified level of performance in cases of software faults or of infringements of its specified interface.
   - recoverability – attributes of software that bear on the capability to re-establish its level of performance and recover the data directly affected in case of a failure, and on the time and effort needed for it;
   - availability (Quint2) – attributes of software that bear on the amount of time the product is available to the user at the time it is needed; and
   - degradability (Quint2) – attributes of software that bear on the effort needed to re-establish the essential functionality after a breakdown.

(3) *Usability* – a set of attributes that bear on the effort needed for use, and on the individual assessment of such use, by a stated or implied set of users:
   - understandability – attributes of software that bear on the users' effort for recognising the logical concept and its applicability;
   - learnability – attributes of software that bear on the users' effort for learning its application (for example, control, input, output);
   - operability – attributes of software that bear on the users' effort for operation and operation control;
   - explicitness (Quint2) – Attributes of software that bear on the software product with regard to its status (progression bars, etc.);
   - attractivity (attractiveness in Quint2) – attributes of software that bear on the satisfaction of latent user desires and preferences, through services, behaviour and presentation beyond actual demand;
   - customisability (Quint2) – attributes of software that enable the software to be customized by the user to reduce the effort required for use and increase satisfaction with the software;
   - clarity (Quint2) – attributes of software that bear on the clarity of making the user aware of the functions it can perform;
   - helpfulness (Quint2) – attributes of software that bear on the availability of instructions for the user on how to interact with it; and
   - user-friendliness (Quint2) – attributes of software that bear on the users' satisfaction.

(4) *Efficiency* – a set of attributes that bear on the relationship between the level of performance of the software and the amount of resources used, under stated conditions:
   - time behaviour – attributes of software that bear on response and processing times and on throughput rates in performing its function; and
   - resource behaviour – attributes of software that bear on the amount of resources used and the duration of such use in performing its function.

(5) *Portability* – a set of attributes that bear on the ability of the software to be transformed from one environment to another:
   - adaptability – attributes of software that bear on the opportunity for its adaptation to different specified environments without applying other actions or means than those provided for this purpose for the software in question;
   - installability – attributes of software that bear on the effort needed to install the software in a specified environment;
   - replaceability – attributes of software that bear on the opportunity and effort of using it in the place of specified other software in the environment of that software; and
   - co-existence (not included in Quint2) – the capability of the software to co-exist with other independent software in a common environment sharing common resources.

(6) *Maintainability* – a set of attributes that bear on the effort needed to make specified modifications:
   - analysability – attributes of software that bear on the effort needed for diagnosis of deficiencies or causes of failures, or for identification of parts to be modified;
   - changeability – attributes of software that bear on the effort needed for modification, fault removal or for environmental change;
   - stability – attributes of software that bear on the risk of unexpected effect of modifications;
   - testability – attributes of software that bear on the effort needed for validating the (modified) software;
   - manageability (Quint2) – attributes of software that bear on the effort needed to (re)establish its running status; and
   - reusability (Quint2) – attributes of software that bear on its potential for complete or partial reuse in another software product.

There is also a compliance sub-characteristic for all characteristics (attributes of software that make each characteristic adhere to application-related standards, conventions in law and similar prescriptions).

Life-cycle processes dimension

By introducing this dimension, we believe that we are also taking into consideration the different stakeholders involved in web development, who have different skills and therefore different priorities and attitudes (Mich *et al.*, 2003). For example, the developer's interests are considered in the development process.

Hence, in this dimension we include the diverse processes of the web site life cycle, following the ISO 12207 standard (ISO/IEC, 1995; ISO, 2002). In the current version of the model we have considered both primary and organizational processes. As primary processes, we have included the development process, the operation process (which includes the operative support for users), and the maintenance process (which includes the evolution that the web site undergoes).

As organizational processes, we have considered the project-management process (in order to classify estimation metrics), and the reuse program-management process (for classifying the reuse metrics).

It is important to emphasize that the activities of these processes must not be developed sequentially, since, because of the characteristics of web development, it will be necessary to use more iterative models and even more flexible developments without following formal methodologies (Avison and Fitzgerald, 2003).

Web metrics classification

For the present study, we have extended the survey recorded in Calero *et al.* (2004), reviewing 60 papers from 1992 to 2004. From these, we have selected 40 where metric proposals (considered useful for classification purposes in WQM) were included.

Furthermore, we have discarded those metrics that were outside the scope of our model (e.g. process metrics). We have also discarded metrics that did not provide any relevant information, as well as repeated metrics (proposed by more than one author),

so that each metric is included only once. At the end of the selection, we had 385 metrics that were classified by the WQM. These metrics are listed in the Appendix.

With regard to the classification itself, it should be noted that it is not a simple task, and we are conscious that some of the assignments may be arguable. In fact, some of the classifications from the survey conducted by Calero *et al.* (2004) have been changed in this version because of the inclusion of new values in the life-cycle processes dimension.

Although the model does not restrict the number of cells that can be assigned to a given metric, we tried to minimize this number by assigning the metrics to the cells where they would be most useful.

For the quality dimension, we show only the quality characteristic assigned, instead of the precise sub-characteristic, in order to make interpretation easier.

For the assignment to a life-cycle process, we gave special consideration to operation and maintenance. In the web world, where the typical development timeline is 3-6 months (Reifer, 2000), it is difficult to distinguish when an operation finishes and maintenance begins. In case of doubt, we have classified metrics in both processes.

Interpreting results

The assignment of metrics to cells can be found in the Appendix, and the main figures of our classification are shown in Table I. The "% Absolute" row in Table I shows the percentage of metrics classified in each value dimension, and the sum of these values is greater than 100 percent since, as we have already explained, a metric can be classified in more than one cell in the cube. Because of this fact, we have extracted pro-rated (normalized) values, which are shown in the "% Pro-rated" row.

Figure 2 shows metric distribution over the three dimensions of the model: web features, quality characteristics, and life-cycle processes, using pro-rated figures.

Web features dimension. The results obtained in this dimension (about 44 percent of the metrics studied are "presentation" metrics) confirm the tendency in the web world to give presentation the greatest importance, making sites as attractive as possible for the end user.

However, it is convenient to remark that there is usually confusion between presentation and navigation (Baresi *et al.*, 2003). Therefore, there is the possibility that the results of navigation may vary depending on the person who carries out the classification.

Quality characteristics dimension. About half of the metrics considered (48 percent) are usability metrics. We have to take into account that this data is pro-rated, because if we examine absolute data (Table I) we can see that 77 percent of metrics are related to usability. Again, this value confirms the end-user focus of trying to design usable web sites that attract users.

But, it is curious that only 5 percent of metrics focus on reliability, when this characteristic is also extremely important for customer acceptance of web sites.

In the end, we think that the diffusion of new devices (such as PDA, mobile phones, and so on) will encourage the definition of new portability metrics (currently only 8 percent of metrics).

Life-cycle processes dimension. With respect to life cycle, operation (43 percent) and maintenance (30 percent) processes have the most metrics. These results can be justified by taking into account the evolutionary nature of the web. The fact that there

Table I.
Classification of metrics

	Web features				Quality characteristics					Lifecycle processes				
										Non-organizational			Organizational	
	Content	Presentation	Navigation	Functionality	Reliability	Usability	Efficiency	Portability	Maintainability	Development	Operation	Maintenance	Effort	Reuse
Total	150	184	85	82	31	298	51	47	115	101	254	176	45	11
% Absolute	39.0	47.8	22.1	21.3	8.1	77.4	13.2	12.2	29.9	26.2	66.0	45.7	11.7	2.9
% Pro-rated	35.8	43.9	20.3	13.1	5.0	47.8	8.2	7.5	18.4	17.2	43.2	30.0	7.7	1.9

	Granularity level				
	Web site	Web page	Theoretical validation	Empirical validation	Auto
Total	171	214	13	144	258
Percentage	44.42	55.58	3.38	37.40	87.01

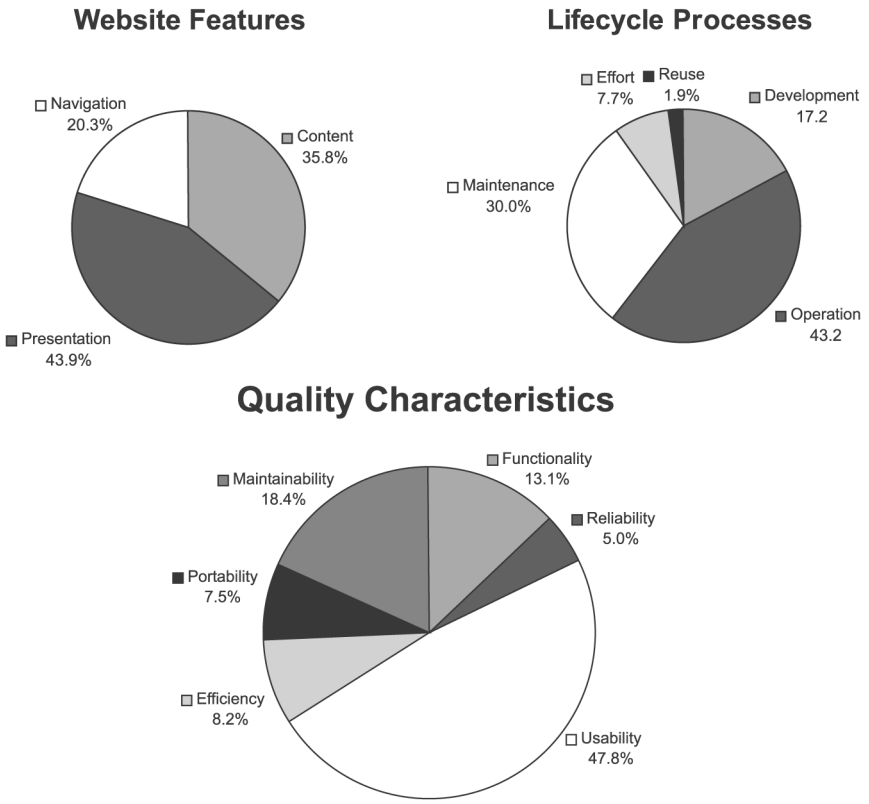

Figure 2.
Metric distribution across the model dimensions

are not too many metrics defined for the development process (17 percent) can be explained by the fact that for companies doing business on the web, putting their software into the marketplace is the top priority. And so, rather than developing software from requirements through the waterfall development model, web development companies try to use rapid-application development methods and continuous prototyping (Reifer, 2000).

Finally, we must indicate that there are only 10 percent of metrics for the organizational process (effort 8 percent and reuse 2 percent). We think that this result is not due to the unimportance of this process, but to the lack of research effort surrounding it (reflected in the low number of works found and considered for classification).

Cell distribution. In this section, we show the results obtained from the triplets point of view in order to discover in which cells of the cube we can find many metrics defined. In Table II, the values obtained for each triplet of the cube are shown. As can be seen, the triplets where more metrics were found are the ones with usability as a quality sub-characteristic. Among them, the triplet (usability, operation, presentation) with 149 metrics, and the triplet (usability, maintenance, presentation) with 93 metrics are the most populated triplets of the cube. Moreover, the triplet (maintainability, maintenance, content) with 38 metrics, the triplets (functionality, development, content)

Quality characteristic	Lifecycle process	Web feature	No. of metrics
Functionality	Development	Content	34
Functionality	Development	Presentation	7
Functionality	Development	Navigation	10
Functionality	Operation	Content	8
Functionality	Operation	Presentation	13
Functionality	Operation	Navigation	10
Functionality	Maintenance	Content	11
Functionality	Maintenance	Presentation	5
Functionality	Maintenance	Navigation	4
Functionality	Effort	Content	34
Functionality	Effort	Presentation	12
Functionality	Effort	Navigation	6
Functionality	Reuse	Content	3
Functionality	Reuse	Presentation	0
Functionality	Reuse	Navigation	0
Reliability	Development	Content	9
Reliability	Development	Presentation	5
Reliability	Development	Navigation	6
Reliability	Operation	Content	3
Reliability	Operation	Presentation	12
Reliability	Operation	Navigation	0
Reliability	Maintenance	Content	5
Reliability	Maintenance	Presentation	10
Reliability	Maintenance	Navigation	11
Reliability	Effort	Content	7
Reliability	Effort	Presentation	5
Reliability	Effort	Navigation	6
Reliability	Reuse	Content	2
Reliability	Reuse	Presentation	0
Reliability	Reuse	Navigation	0
Usability	Development	Content	31
Usability	Development	Presentation	26
Usability	Development	Navigation	42
Usability	Operation	Content	47
Usability	Operation	Presentation	149
Usability	Operation	Navigation	39
Usability	Maintenance	Content	31
Usability	Maintenance	Presentation	93
Usability	Maintenance	Navigation	27
Usability	Effort	Content	31
Usability	Effort	Presentation	32
Usability	Effort	Navigation	9
Usability	Reuse	Content	0
Usability	Reuse	Presentation	0
Usability	Reuse	Navigation	0
Efficiency	Development	Content	9
Efficiency	Development	Presentation	7
Efficiency	Development	Navigation	5
Efficiency	Operation	Content	15

(*continued*)

Table II.
Values obtained for every triplet of the cube

Quality characteristic	Lifecycle process	Web feature	No. of metrics
Efficiency	Operation	Presentation	32
Efficiency	Operation	Navigation	0
Efficiency	Maintenance	Content	5
Efficiency	Maintenance	Presentation	20
Efficiency	Maintenance	Navigation	3
Efficiency	Effort	Content	6
Efficiency	Effort	Presentation	4
Efficiency	Effort	Navigation	4
Efficiency	Reuse	Content	0
Efficiency	Reuse	Presentation	0
Efficiency	Reuse	Navigation	0
Portability	Development	Content	6
Portability	Development	Presentation	7
Portability	Development	Navigation	6
Portability	Operation	Content	19
Portability	Operation	Presentation	20
Portability	Operation	Navigation	5
Portability	Maintenance	Content	15
Portability	Maintenance	Presentation	14
Portability	Maintenance	Navigation	5
Portability	Effort	Content	6
Portability	Effort	Presentation	16
Portability	Effort	Navigation	4
Portability	Reuse	Content	0
Portability	Reuse	Presentation	0
Portability	Reuse	Navigation	0
Maintainability	Development	Content	17
Maintainability	Development	Presentation	4
Maintainability	Development	Navigation	27
Maintainability	Operation	Content	17
Maintainability	Operation	Presentation	16
Maintainability	Operation	Navigation	0
Maintainability	Maintenance	Content	38
Maintainability	Maintenance	Presentation	14
Maintainability	Maintenance	Navigation	24
Maintainability	Effort	Content	7
Maintainability	Effort	Presentation	4
Maintainability	Effort	Navigation	4
Maintainability	Reuse	Content	8
Maintainability	Reuse	Presentation	0
Maintainability	Reuse	Navigation	0

Table II.

and (functionality, effort, content) with 34 metrics, as well as the triplet (efficiency, operation, presentation) with 32 metrics, deserve to be mentioned.

On the other hand, it is important to observe that the cells related to reuse have few metrics, and some of them even have no defined metrics. In addition, the cells including effort have not received much attention in terms of metrics definition. This may be because of the fact that, until now, the only factor considered important for web quality was usability. From our point of view, however, things are changing, and metrics researchers are conscious of the importance of defining metrics for reuse and effort.

Other characteristics of the Web metrics

Once metrics have been classified we can use them according to their concrete utility. However, it is necessary to have some other information about a metric to know not only what it can be used for, but also other characteristics such as, among others, its validation or its application level. In this section, we summarize the aspects we have considered together with the results obtained.

We have considered the following properties (Calero *et al.*, 2001):

- granularity level, depending on whether the metric focuses on a single web page or on a web site as a whole;
- theoretical validation helps us to know when and how to apply metrics, and their scale;
- empirical validation, with the objective of proving the practical utility of the proposed metrics; and
- automated support, i.e. whether or not there is a support tool that facilitates the calculation of the metrics.

The results of this evaluation are shown in Table I together with the quality classification.

As can be seen, there is a balanced distribution of metrics defined for web pages (44.42 percent) and web sites (55.58 percent).

The results of the validation confirm that, unfortunately, web metric validation is not considered a major issue – especially theoretical validation (3 percent), but also empirical validation (37 percent).

A large number of metrics are automated (67 percent). This is very important if we want to incorporate metrics into web development and maintenance projects.

Conclusions and further work

Web technologies and applications are becoming increasingly important in the information systems world. One of the main problems of web developments is their short life cycle, which can result in a lack of quality. Taking into account the importance of the web, however, this situation must be avoided as much as possible.

A good mechanism for controlling the quality of a software product (and hence of a web site) is the use of metrics. But, at this point there are also some problems. In the literature, it is possible to find hundreds of web metrics, but no guidelines for their use. This chaotic situation makes the use of the defined metrics dangerous and difficult.

In response to this chaos, in this paper we have presented the web metrics classification that we have performed with 385 metrics using WQM, a three-dimensional web quality model. As a result of this classification, we found that the triplet (usability, operation, presentation) with 149 metrics and the triplet (usability, maintenance, presentation) with 93 metrics are those with more defined metrics, and that most of the triplets that include reuse have no defined metrics.

Regarding the metrics classified in this study, we do not claim that this survey is complete. It would be necessary to make an even more exhaustive study of the state of the art. We intend to define new metrics in those cells in which the non-existence of metrics is detected. We are interested in those cells that we think are, or will be, important for web technology. One of our priorities is the portability characteristic, which we think is particularly important when taking into account the new kinds of devices available.

It is also necessary to clarify that the classification will vary depending on the moment in which it is carried out, since the web is continually changing. For example, as mentioned previously, although the end user is the main priority in any case, the fact that new web applications are necessary for mobile devices could result in a change in web tendencies, which will be reflected in the classification. Besides, other kinds of factors can be influential. For instance, some years ago the most important aspect of a web site was usability, but now accessibility plays a very important role. These tendencies influence research and therefore the result of the classification.

The final goal of our model is to determine, for each cell of the cube, the most useful metrics. To do so, we plan to apply techniques such as main-component analysis. After attaining the right set of metrics in each cell of the cube, we will be able to use them for constructing a "total web quality" expression by combining all the cells of the cube. This expression could be used to calculate the quality of a given web site.

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Appendix

	Metric	Ref	WQM Quality Characteristic						WQM Lifecycle Process					WQM WebSite Feature			Granular Level	Theo Valid	Emp. Valid	Auto
			Fun	Rel	Usa	Effic	Port	Main	Dev	Ope	Maint	Organizational Effort	Organizational Reuse	Cont	Pres	Nav				
1	Distance	24			X				X		X			X		X	Web		X	X
2	Depth	24			X			X	X	X						X	Web		X	X
3	Breadth (Width)	24			X			X	X	X						X	Web		X	X
4	Diameter	24			X				X							X	Web		X	X
5	Radius	24			X				X							X	Web		X	X
6	Average Connected Distance	24			X				X							X	Web		X	X
7	Converted Out Distance (COD)	7			X			X	X		X					X	Web Page		X	X
8	Converted In Distance (CID)	7			X			X	X		X					X	Web Page		X	X
9	Converted Distance (CD)	7			X			X	X		X					X	Web Page		X	X
10	Relative Out Centrality (ROC)	7			X			X	X		X					X	Web Page		X	X
11	Relative In Centrality (RIC)	7			X			X	X		X					X	Web Page		X	X
12	Compactness	7			X			X	X		X					X	Web		X	X
13	Stratum	7			X			X	X		X					X	Web		X	X
14	Prestige	7			X			X	X		X					X	Web Page		X	X
15	Status	7			X			X	X		X					X	Web Page		X	X
16	Contrastatus	7			X			X	X		X					X	Web Page		X	X
17	Absolute Depth Imbalance	7			X				X		X					X	Web Page			
18	Absolute Child Imbalance	7			X				X		X					X	Web Page			
19	Impurity Tree	3			X			X	X		X					X	Web		X	X
20	Number IN Links (NIL)	3			X			X	X	X						X	Web		X	X
21	Number OUT Links (NOL)	3			X			X	X	X						X	Web		X	X
22	Connectivity Density	39	X		X			X	X	X						X	Web		X	X
23	Structure	39			X	X		X	X	X						X	Web		X	
24	Total Link Count (NL)	49			X		X	X	X	X						X	Web		X	X
25	Number Broken Links (NBL)	49		X	X			X		X	X					X	Web		X	X
26	% Broken Links (%BL)	37		X	X			X		X	X					X	Web		X	X
27	Number of Different Links	37			X			X	X	X						X	Web			X
28	% Different Links	37			X			X	X	X						X	Web			X
29	Number of Different Broken Link	37		X				X		X	X					X	Web		X	X
30	% Different Broken Links	37		X				X		X	X					X	Web		X	X
31	Images Count	49	X		X		X		X	X				X			Web		X	X
32	Link Image Count	3			X					X						X	Web Page		X	X
33	Surface of Images	3			X					X					X		Web Page		X	X
34	Different Image Count	37			X				X		X				X		Web			X
35	% Image Redundancy	37			X			X			X				X		Web			X
36	Images ALT Text	37		X	X			X		X					X		Web			X
37	% Images ALT Text	37		X	X			X		X					X		Web			X
38	Page Count	39			X		X	X		X	X			X			Web		X	X
39	Media Count	39	X		X		X	X	X		X			X			Web		X	X
40	Page Complexity	39			X					X					X		Web Page		X	X
41	Media Duration	39				X				X					X		Web			X
42	Quick Access Pages	49			X	X				X						X	Web Page			X
43	Program Count	39	X	X	X		X	X		X	X			X	X		Web		X	X
44	Page Allocation	39				X				X				X			Web Page		X	X
45	Total Page Allocation	39			X		X			X				X			Web		X	X
46	Total Media Allocation	39				X				X				X			Web		X	X
47	Total Code Length	39				X		X		X				X			Web		X	X
48	Media Allocation	39				X				X				X	X		Web		X	X
49	Audio Complexity	39			X	X	X		X					X	X		Web		X	X
50	Video Complexity	39			X	X	X		X					X	X		Web		X	X
51	Animation Complexity	39			X	X	X		X	X				X	X		Web		X	X
52	Code Length (LOC)	39	X				X	X	X					X			Web		X	X
53	Code Comment Length	39	X					X			X			X			Web		X	X
54	Reused Media Count	39						X					X	X			Web		X	
55	Reused Program Count	39						X					X	X			Web		X	
56	Total Reused Media Allocation	39						X					X	X			Web		X	
57	Total Reused Code Length	39						X					X	X			Web		X	
58	Reused Code Length	39						X					X	X			Web		X	
59	Reused Comment Length	39						X					X	X			Web		X	
60	Total Page Complexity	39						X		X	X			X			Web		X	X
61	Cyclomatic Complexity	39	X		X				X							X	Web		X	X
62	Graphic Complexity	39			X		X			X					X		Web Page		X	X
63	Suitable Information	20			X					X				X			Web		X	
64	Updated Information	20			X			X		X				X			Web		X	
65	Reused Web Pages	38		X				X					X	X			Web		X	X
66	Reused Docs	38		X				X					X	X			Web		X	X
67	Num. Panes Regarding Frames	49			X	X				X					X		Web Page			X
68	Images per Page	49			X	X	X			X					X		Web Page			X

(*continued*)

Table AI.
Metrics classification

	Metric	Ref	WQM Quality Characteristic						WQM Lifecycle Process					WQM WebSite Feature			Granular Level	Theo Valid	Emp. Valid	Auto
			Fun	Rel	Usa	Effic	Port	Main	Dev	Ope	Maint	Organizational Effort	Organizational Reuse	Cont	Pres	Nav				
69	Local Coherence due to Relationship between Information Chunks (LCRIC)	5			X				X					X			Web			
70	Local Coherence due to Short Term Memory (LCSTM)	5			X				X					X			Web			
71	Global Coherence due to Hyperlink Within Application (GCHLWA)	5			X				X					X			Web			
72	Global Coherence due to Cognitive Jumps (GCCJ)	5			X				X					X			Web			
73	Cognitive Overhead due to Consistency (COC)	5			X				X					X			Web			
74	Cohesion (COH)	5			X				X					X			Web			
75	Coupling (COU)	5			X				X					X			Web			
76	Download Time	5			X	X	X			X					X		Web Page			X
77	Invalid Links Count	49		X						X	X				X		Web			X
78	Unimplemented Link Count	49		X						X	X				X		Web			X
79	Spelling Errors	49		X				X		X	X				X		Web			X
80	Deficiencies or absent features due to different browsers	49		X				X		X	X				X		Web			X
81	Deficiencies or unexpected results independent of browsers	49		X				X		X	X				X		Web			X
82	% Dead-end Web Pages	50		X				X		X	X					X	Web			X
83	Destination Nodes Under Construction	49		X	X			X		X	X					X	Web			X
84	Support for Text-Only Version	49				X				X					X		Web			X
85	Image Title	49			X	X		X		X					X		Web			X
86	Global Readability (without browsing Images)	49				X				X					X		Web			X
87	NON-Frame Version	49				X				X					X		Web			X
88	Table of Contents	49			X				X	X					X		Web			X
89	Site Map	49			X				X	X					X	X	Web			X
90	Subject Index	49			X				X	X					X		Web			X
91	Alphabetical Index	49			X				X	X					X		Web			X
92	Chronological Index	49			X				X	X					X		Web			X
93	Geographical Index	49			X				X	X					X		Web			X
94	Other indexes (audience, format,etc.	49			X				X	X					X		Web			X
95	Quality Labeling System	49			X				X	X					X		Web			X
96	Audience-Oriented Guided Tour	49			X					X					X		Web			X
97	Conventional Tour	49			X					X					X	X	Web			X
98	VR Tour	49			X					X					X	X	Web			X
99	Global Help	49			X				X	X					X		Web			X
100	Specific Help	49			X				X	X					X		Web			X
101	E-mail Directory	49			X					X	X			X			Web			X
102	Phone-Fax Directory	49			X					X	X			X			Web			X
103	Post mail Directory	49			X					X	X			X			Web			X
104	FAQ Feature	49			X					X	X			X			Web			X
105	What's New Feature	49			X					X	X			X			Web			X
106	Questionnaire Feature	49			X					X					X		Web			X
107	Comments/Suggestions	49			X					X					X		Web			X
108	Subject-Oriented Feedback	49			X					X					X		Web			X
109	Guest Book	49			X					X					X		Web			X
110	Cohesiveness by Grouping Main Control	49			X					X					X		Web			
111	Direct Control Permanence	49			X					X					X		Web			
112	Indirect Control Permanence	49			X					X					X		Web			
113	Stability	49			X					X					X		Web			
114	Link Color Style Uniformity	49			X				X						X		Web			
115	Global Style Uniformity	49			X				X						X		Web			
116	Foreign Language Support	49			X				X	X	X			X	X		Web			X
117	Last Update Indicator Global	49			X					X	X				X		Web			X
118	Last Update Indicator Scoped (sub-site or page)	49			X					X	X				X		Web Page			X
119	Screen Resolution Indicator	49			X					X	X				X		Web			X
120	Global Search	49	X							X					X		Web			X
121	Scoped Search	49	X							X					X		Web			X
122	Level of Retrieving Customization	49	X							X					X		Web			X
123	Level of Retrieving Feedback	49	X							X					X		Web			X
124	Indication of Path	49	X							X						X	Web			X
125	Label of Current Position	49	X							X						X	Web			X
126	Contextual Permanence Controls	49	X							X						X	Web			X
127	Contextual Stability Controls	49	X							X						X	Web			X
128	Vertical Scrolling	49	X							X					X		Web			X
129	Horizontal Scrolling	49	X							X					X		Web			X
130	Link Title (with explanatory help)	49	X							X						X	Web			X

Table AI.

(*continued*)

	Metric	Ref	WQM Quality Characteristic						WQM Lifecycle Process					WQM WebSite Feature			Granular Level	Theo Valid	Emp. Valid	Auto
			Fun	Rel	Usa	Effic	Port	Main	Dev	Ope	Maint	Organizational Effort	Organizational Reuse	Cont	Pres	Nav				
131	Quality of Link Phrase	49	X							X						X	Web			X
132	Quick Browse Controls	49	X							X					X	X	Web			X
133	Number Navigational Contexts	1			X			X		X						X	Web	X	X	
134	Number of Navigational Links	1			X	X		X		X						X	Web	X	X	
135	Density of a Navigational Map	1			X			X		X						X	Web	X	X	
136	Depth of a Navigational Map	1			X			X		X						X	Web	X	X	
137	Breadth of a Navigational Map	1			X			X		X						X	Web	X	X	
138	Minimum Path Between Navigational Contexts	1			X			X		X						X	Web	X	X	
139	Number of Paths Between Navigational Contexts	1			X			X		X						X	Web	X	X	
140	Compactness of a Navigational Map	1		X	X	X		X		X	X					X	Web	X	X	
141	Fan-In of a Navigational Context	1			X			X		X						X	Web	X	X	
142	Fan-Out of a Navigational Context	1			X			X		X						X	Web	X	X	
143	Number of Navigational Classes	1			X			X			X					X	Web	X	X	
144	Number of Attributes	1	X					X			X					X	Web	X	X	
145	Number of Methods	1	X				X	X			X					X	Web	X	X	
146	Web Building Blocks	55	X	X			X	X	X		X			X			Web			X
147	Number of COTS Components	55		X			X	X	X		X			X			Web			X
148	Number of Object or Applicat. Points	55	X					X	X					X			Web			X
149	Number of XML, SGML, HTML and Query Language Lines	55	X					X		X					X		Web			X
150	Number of Web Components	55	X		X		X	X		X	X			X	X		Web			X
151	Number of Scripts (Visual Language, Audio, Motion)	55	X		X	X		X		X	X				X		Web			X
152	Number of Web Objects	55	X		X		X	X		X	X			X			Web			X
153	Function Points	44	X						X			X		X			Web		X	
154	Object-Oriented Function Points	44	X						X			X		X			Web		X	
155	Reuse Level LOCs	44	X										X	X			Web		X	
156	Reuse Level OOFPs	44	X										X	X			Web		X	
157	Total Number Flash Animations	42			X	X				X					X		Web		X	
158	Total Number of Icons/Buttons	42	X		X				X			X			X		Web Page		X	
159	Average Length Audio Clips	42			X	X	X			X					X		Web		X	
160	Average Length Video Clips	42			X	X	X			X					X		Web		X	
161	Total Embedded Code Length	41	X					X			X			X			Web		X	
162	Size CFSU	41	X					X				X		X			Web		X	
163	Number of Entities	6	X					X	X					X			Web		X	
164	Number of Components	6	X		X			X	X					X			Web		X	
165	Number of InfoSlots	6	X		X			X	X					X			Web		X	
166	Slots Semantic Association	6	X		X				X					X			Web		X	
167	Slots Collection Center	6	X		X				X					X			Web		X	
168	Components Entity	6	X					X	X					X			Web		X	
169	Slots Components	6	X						X					X			Web		X	
170	Semantics Associations	6	X						X					X			Web		X	
171	Semantics Association Centers	6	X		X				X					X			Web		X	
172	Segments	6	X						X				X	X			Web		X	
173	Nodes	6	X		X		X	X	X							X	Web		X	
174	Navigational Slots	6	X		X				X							X	Web		X	
175	Nodes Cluster	6			X			X	X							X	Web		X	
176	Slots Node	6			X				X							X	Web		X	
177	Clusters	6			X				X							X	Web		X	
178	Publishing Units	6	X						X						X		Web		X	
179	Sections	6			X				X						X		Web		X	
180	Word Count	32			X	X	X			X	X			X	X		Web Page		X	X
181	Page Title Word Count	32						X		X	X			X			Web Page			X
182	Overall Page Title Word Count	32						X		X	X			X			Web Page			X
183	Invisible Word Count	32		X	X					X	X					X	Web Page			X
184	Meta Tag Word Count	32						X		X	X			X			Web Page			X
185	Body Word Count	32			X	X	X			X	X			X	X		Web Page		X	X
186	Display Word Count	32			X					X	X				X		Web Page			X
187	Display Link Word Count	32			X					X	X				X		Web Page			X
188	Link Word Count	32			X					X	X					X	Web Page			X
189	Average Link Words	32			X					X	X				X		Web Page			X
190	Graphic Word Count	32			X	X				X	X			X	X		Web Page			X
191	Ad Word Count	32			X	X				X	X				X		Web Page			X
192	Exclamation Point Count	32			X					X	X				X		Web Page			X

(*continued*)

Table AI.

	Metric	Ref	WQM Quality Characteristic						WQM Lifecycle Process					WQM WebSite Feature			Granular Level	Theo Valid	Emp. Valid	Auto
			Fun	Rel	Usa	Effic	Port	Main	Dev	Ope	Maint	Organizational Effort	Organizational Reuse	Cont	Pres	Nav				
193	Spelling Error Count	32		X	X			X		X	X				X		Web Page			X
194	Good Word Count	32			X					X	X			X			Web Page			X
195	Good Body Word Count	32			X					X	X			X			Web Page			X
196	Good Display Word Count	32			X					X	X			X			Web Page			X
197	Good Display Link Word Count	32			X					X	X			X			Web Page			X
198	Good Link Word Count	32			X					X	X			X			Web Page			X
199	Average Good Kin Words	32			X					X	X			X			Web Page			X
200	Good Graphic Word Count	32			X					X	X			X			Web Page			X
201	Good Page Title Word Count	32			X					X	X			X			Web Page			X
202	Overall Good Page Title Word Count	32			X					X	X			X			Web Page			X
203	Good Meta Tag Word Count	32			X					X	X			X			Web Page			X
204	Reading Complexity	32			X					X				X			Web Page			X
205	Overall Reading Complexity	32			X					X				X			Web Page			X
206	Fog Word Count	32			X					X				X			Web Page			X
207	Fog Big Word Count	32			X					X				X			Web Page			X
208	Overall Fog Big Word Count	32			X					X				X			Web Page			X
209	Fog Sentence Count	32			X					X				X			Web Page			X
210	Overall Fog Sentence Count	32			X					X				X			Web Page			X
211	Text Link Count	32			X					X						X	Web Page			X
212	Page Link Count	32			X					X						X	Web Page			X
213	Redundant Link Count	32			X					X						X	Web Page			X
214	Redundant Graphic Count	32				X		X			X				X		Web Page			X
215	Graphic Ad Count	32			X		X			X	X				X	X	Web Page			X
216	Animated Graphic Ad Count	32			X		X			X	X				X	X	Web Page			X
217	Emphasized Body Word Count	32			X					X	X				X		Web Page		X	X
218	Bolded Body Word Count	32			X					X	X				X		Web Page			X
219	Capitalized Body Word Count	32			X					X	X				X		Web Page			X
220	Colored Body Word Count	32			X					X	X				X		Web Page			X
221	Exclaimed Body Word Count	32			X					X	X				X		Web Page			X
222	Italicized Body Word Count	32			X					X	X				X		Web Page			X
223	Underlined Word Count	32			X					X					X		Web Page			X
224	Serif Word Count	32			X					X					X		Web Page			X
225	Sans Serif Word Count	32			X					X					X		Web Page			X
226	Undeter. Font Style Word Count	32			X					X					X		Web Page			X
227	Font Style	32			X					X					X		Web Page			X
228	Minimum Font Size	32			X					X					X		Web Page			X
229	Maximum Font Size	32			X					X					X		Web Page			X
230	Average Font Size	32			X					X					X		Web Page			X
231	Body Color Count	32			X					X					X		Web Page			X
232	Display Color Count	32			X					X					X		Web Page			X
233	Text Positioning Count	32			X					X					X		Web Page		X	X
234	Text Column Count	32			X					X					X		Web Page			X
235	Text Cluster Count	32			X					X					X		Web Page		X	X
236	Link Text Cluster Count	32			X					X					X		Web Page			X
237	Border Cluster Count	32			X					X					X		Web Page			X
238	Color Cluster Count	32			X					X					X		Web Page			X
239	List Cluster Count	32			X					X					X		Web Page			X
240	Rule Cluster Count	32			X					X					X		Web Page			X
241	Non-Underlined Text Links	32			X					X	X				X		Web Page			X
242	Link Color Count	32			X					X	X				X		Web Page			X
243	Standard Link Color Count	32			X					X	X				X		Web Page			X
244	Minimum Graphic Height	32			X	X	X			X	X				X		Web			X
245	Maximum Graphic Height	32			X	X	X			X	X				X		Web			X
246	Average Graphic Height	32			X	X	X			X	X				X		Web			X
247	Minimum Graphic Wide	32			X	X	X			X	X				X		Web			X
248	Maximum Graphic Wide	32			X	X	X			X	X				X		Web			X
249	Average Graphic Wide	32			X	X	X			X	X				X		Web			X
250	Color Count	32			X					X	X				X		Web Page		X	X
251	Minimum Color Use	32			X					X	X				X		Web Page			X
252	Browser-Safe Color Count	32			X					X	X				X		Web Page			X
253	Good Text Color Combination	32			X					X	X				X		Web Page			X
254	Neutral Text Color Combination	32			X					X	X				X		Web Page			X
255	Bad Text Color Combination	32			X					X	X				X		Web Page			X
256	Good Panel Color Combinations	32			X					X	X				X		Web Page			X
257	Neutral Panel Color Combinations	32			X					X	X				X		Web Page			X
258	Bad Panel Color Combinations	32			X					X	X				X		Web Page			X
259	Font Count	32			X					X	X				X		Web Page		X	X
260	Serif Font Count	32			X					X	X				X		Web Page			X
261	Sans Serif Font Count	32			X					X	X				X		Web Page			X
262	Undetermined Font Style Count	32			X					X	X				X		Web Page			X
263	Page Height	32			X	X				X	X				X		Web Page			X

Table AI.

(*continued*)

	Metric	Ref	WQM Quality Characteristic						WQM Lifecycle Process					WQM WebSite Feature			Granular Level	Theo Valid	Emp. Valid	Auto
			Fun	Rel	Usa	Effic	Port	Main	Dev	Ope	Maint	Organizational Effort	Organizational Reuse	Cont	Pres	Nav				
264	Page Width	32			X	X				X	X				X		Web Page			X
265	Page Pixels	32			X	X				X	X				X		Web Page			X
266	Vertical Scrolls	32			X	X				X	X				X		Web Page			X
267	Horizontal Scrolls	32			X	X				X	X				X		Web Page			X
268	Interactive Element Count	32	X		X		X	X		X	X			X			Web Page			X
269	Search Element Count	32	X		X		X	X		X	X			X			Web Page			X
270	External Stylesheet Use	32			X			X		X	X				X		Web Page			X
271	Internal Stylesheet Use	32			X			X		X	X				X		Web Page			X
272	Fixed Page Width Use	32			X			X		X	X				X		Web Page			X
273	Page Depth	32			X					X	X					X	Web Page			X
274	Page Type	32			X					X	X				X		Web Page			X
275	Self Containment	32			X					X	X			X			Web Page			X
276	Spamming Use	32			X	X				X	X				X		Web Page			X
277	Table Count	32			X					X				X	X		Web Page			X
278	Graphic bytes	39			X		X			X				X			Web Page			X
279	Script File Count	32			X	X	X			X				X			Web Page			X
280	Script Bytes	32			X	X	X			X				X			Web Page			X
281	Object File Count	32			X	X	X			X				X			Web Page			X
282	Object Bytes	32			X	X	X			X				X			Web Page			X
283	Object Count	32			X	X	X			X				X			Web Page			X
284	Bobby Approved	32			X					X					X		Web Page			X
285	Bobby Priority 1 Errors	32			X					X					X		Web Page			X
286	Bobby Priority 2 Errors	32			X					X					X		Web Page			X
287	Bobby Priority 3 Errors	32			X					X					X		Web Page			X
288	Bobby Browser Errors	32			X					X					X		Web Page			X
289	Weblink Errors	32		X	X					X	X				X	X	Web Page			X
290	Visible Page Text Terms	32			X					X	X				X		Web Page			X
291	Visible Unique Page Text Terms	32			X					X	X				X		Web Page			X
292	Visible Page Text Hits	32			X					X	X				X		Web Page			X
293	Visible Page Text Score	32			X					X	X				X		Web Page			X
294	All Page Text Terms	32			X					X	X				X		Web Page			X
295	All Unique Page Text Terms	32			X					X	X				X		Web Page			X
296	All Page Text Hits	32			X					X	X				X		Web Page			X
297	All Page Text Score	32			X					X	X				X		Web Page			X
298	Visible Link Text Terms	32			X					X	X				X		Web Page			X
299	Visible Unique Link Text Terms	32			X					X	X				X		Web Page			X
300	Visible Link Text Hits	32			X					X	X				X		Web Page			X
301	Visible Link Text Score	32			X					X	X				X		Web Page			X
302	All Link Text Term	32			X					X	X				X		Web Page			X
303	All Unique Link Text Term	32			X					X	X				X		Web Page			X
304	All Link Text Hits	32			X					X	X				X		Web Page			X
305	All Link Text Score	32			X					X	X				X		Web Page			X
306	Page Title Terms	32			X					X	X				X		Web Page			X
307	Unique Page Title Terms	32			X					X	X				X		Web Page			X
308	Page Title Hits	32			X					X	X				X		Web Page			X
309	Page Title score	32			X					X	X				X		Web Page			X
310	Text Element Variation	32			X					X	X				X		Web Page			X
311	Page Title Variation	32			X					X	X				X		Web Page			X
312	Link Element Variation	32			X					X	X				X		Web Page			X
313	Graphic Element Variation	32			X					X	X				X		Web Page			X
314	Text Formatting Variation	32			X					X	X				X		Web Page			X
315	Link Formatting Variation	32			X					X	X				X		Web Page			X
316	Graphic Formatting Variation	32			X					X	X				X		Web Page			X
317	Page Formatting Variation	32			X					X	X				X		Web Page			X
318	Page Performance Variation	32			X					X	X				X		Web Page			X
319	Overall Element variation	32			X					X	X				X		Web			X
320	Overall Formatting Variation	32			X					X	X				X		Web			X
321	Overall Variation	32			X					X	X				X		Web			X
322	Median Page Breadth	32			X					X						X	Web			X
323	Information Effort	6	X						X			X		X			Web		X	
324	Navigation Effort	6	X		X				X			X				X	Web		X	
325	Total Effort (Design)	6	X	X	X	X	X	X	X			X		X	X	X	Web		X	
326	Development Effort Person/Hour	60	X						X			X		X	X	X	Web		X	
327	Peak Staff	60	X						X			X		X			Web		X	
328	Structuring Effort	39			X				X			X		X			Web		X	
329	Interlinking Effort	39			X				X			X				X	Web		X	
330	Interface Planning	39			X				X			X			X		Web		X	
331	Interface Building	39			X				X			X			X		Web		X	
332	Link-Testing Effort	39		X	X				X			X				X	Web		X	
333	Media-Testing Effort	39		X	X				X			X		X	X		Web		X	
334	Total Effort (Design&Auth)	39	X	X	X	X	X	X	X			X		X	X	X	Web		X	
335	Text Effort	39	X		X				X			X		X			Web Page		X	
336	Page Linking Effort	39		X	X				X			X				X	Web Page		X	
337	Page Structuring Effort	39			X				X			X		X		X	Web Page		X	
338	Total Page Effort	39	X	X	X	X	X	X	X			X		X			Web Page		X	
339	Media Effort	39	X		X				X			X		X			Web		X	
340	Media Digitizing Effort	39			X				X			X		X			Web		X	
341	Total Media Effort	39	X	X	X	X	X	X	X			X		X			Web		X	

(*continued*)

Table AI.

	Metric	Ref	WQM Quality Characteristic						WQM Lifecycle Process					WQM WebSite Feature			Granular Level	Theo Valid	Emp. Valid	Auto
			Fun	Rel	Usa	Effic	Port	Main	Dev	Ope	Maint	Organizational Effort	Organizational Reuse	Cont	Pres	Nav				
342	Program Effort	39	X						X			X		X			Web		X	
343	Experience	39	X	X	X	X	X	X	X	X	X	X		X	X	X	Web		X	
344	Tool Type	39	X	X	X	X	X	X	X	X	X	X		X	X	X	Web		X	
345	Total Number of Images Provided by Customer	42	X		X							X		X			Web		X	
346	Total Number of Photos Provided by Customer	42	X		X							X		X			Web		X	
347	Total Number of Text Pages Provided by Customer	42	X		X							X		X			Web		X	
348	Total Number of Products to Sell	42	X		X							X		X			Web		X	
349	Total Number of Photos from a Library	42	X		X							X		X			Web		X	
350	Total Number of Images from a Library	42	X		X							X		X			Web		X	
351	Total Number of Audio Clips	42	X		X							X		X			Web		X	
352	Total Number of Video Clips	42	X		X							X		X			Web		X	
353	Total Number of Photos to Scan	42	X		X							X		X			Web		X	
354	Total Number of Images to Scan	42	X		X							X		X			Web		X	
355	Total Number of Gif Animations	42	X		X							X		X			Web		X	
356	Total Number of Photos to Process/Create	42	X		X							X		X			Web		X	
357	Total Number of Images to Process/Create	42	X		X							X		X			Web		X	
358	Total Number of Text Pages to Type	42	X		X							X		X			Web		X	
359	Total Number of Text Pages to Scan	42	X		X							X		X			Web		X	
360	Total Number of Existing Components to Add	42	X		X							X		X			Web		X	
361	Total Number of Docs (pdf, .doc, etc) to Download	42	X		X							X		X			Web		X	
362	Total Amount of Graphics per Product	42	X		X							X		X			Web		X	
363	How much Text Necessary to Each Product	42	X		X							X		X	X		Web		X	
364	Total Web Pages	18			X		X	X			X			X			Web			
365	Total LOC	18					X	X			X			X			Web			
366	Server Scripts	18						X			X			X			Web			
367	Client Scripts	18						X			X			X			Web			
368	Interface Objects	18						X			X			X			Web			
369	Total Data	18						X			X			X			Web			
370	I/O Field	18						X			X			X			Web			
371	Total Connectivity	18						X	X	X				X		X	Web			
372	Total Languages	18						X			X			X			Web			
373	Web Page Tag	18						X			X			X			Web Page			
374	Web Page Scripts	18						X			X			X			Web Page			
375	Web Page Web Objects	18						X		X	X			X			Web Page			
376	Web Page Relationships	18						X			X			X		X	Web Page			
377	Page Code Size	18						X			X			X			Web Page			
378	Page Interface	18						X			X			X			Web Page			
379	Web Object Size	18						X		X	X			X			Web Page			
380	Web Page Data	18						X			X			X			Web Page			
381	Web Page Data Coupling	18						X			X			X			Web Page			
382	Inner Components	18						X			X			X			Web Page			
383	Web Page Control Structures	18						X	X		X			X			Web Page			
384	Page Language	18						X			X			X			Web Page			
385	Script Size	18						X			X			X			Web Page			

Table AI.