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Comparing different quality models for portals

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Abstract

Purpose – The purpose of this research is to present a brief overview of some proposals for portal quality models. In addition, a comparative study is carried out to determine the similarities and differences of these models.

Design/methodology/approach – In order to compare the different portal quality models, their main characteristics were analysed as well as the different dimensions proposed in each model.

Findings – As a result, several similarities and differences have been established among the portal quality models. For example, the dimensions present in all the models are navigation, representation, personalization and intrinsic data quality. This means that, as expected, it was found that researchers pay special attention to visual aspects.

Practical implications – The comparison attempts to determine which aspects are important for the quality of a web portal, and also to clarify which proposal is the most broadly relevant. The paper also identifies, where necessary, what features must be added in order to ensure that all aspects related to web portal quality are considered.

Originality/value – This work tries to identify a portal quality model that can be used to gauge portal quality levels. The model could also be used where there is a low quality level for a particular dimension, giving some guidelines for improving the weaker aspects.

Keywords Portals, Worldwide web, Quality

Paper type Research paper

Introduction

Web portals are Internet-based applications that enable access to different sources (providers) through a single interface (Mahdavi *et al.*, 2004). They provide personalization, single sign-on and content aggregation from different sources (Java Community Process, 2003). Moreover, they can help users to find the information, service or product desired from among a large number of providers without having to navigate through them all one-by-one (Mahdavi *et al.*, 2004).

A web portal is defined as "... a Web site or service that offers a broad array of resources and services, such as e-mail, forums, search engines, and on-line shopping malls." (Webopedia, 2005). As yet, however, the concept of "portal" is not well defined, and its use, even within the industry, remains problematic (Smith, 2004). Initially the objective of web portals was to provide access to the web, but this objective has evolved over time, and more services are now provided. In addition, the primary

objective for the development of portals may vary from one organization to another (Hazra, 2002), although in general, it is to create a working environment where users can easily and quickly navigate, to find the information they require for operational and strategic purposes, and for decision-making (Collins, 2001).

Usually, the software functions included in a portal are:

- *Data points and integration*. Including the ability to access information from a wide range of internal and external information sources, and to display the resulting information at the single point-of-access desktop.

- *Taxonomy*. Including the organization-specific categories that reflect and support the organization's business.

- *Search capabilities*. The search element provides several services for corporate users and needs to support searches across the company.

- *Help features*. The help element provides assistance.

- *Content management*. The publishing and distribution element supports content creation, authorization, and inclusion in (or exclusion from) corporate portal content collections.

- *Process and action*. The process and action element enables the corporate portal user to initiate and participate in the organization's business processes.

- *Collaboration and communication*. The collaboration and communication element facilitates discussion, the sharing of innovative ideas and resourceful solutions.

- *Personalization*. The personalization element is a critical component in creating a working environment that is organized and configured specifically to each employee in the organization.

- *Presentation*: the presentation element provides the knowledge desktop and visual experience to the corporate portal user, encapsulating all of the corporate portal's functionality.

- *Administration*. The administration element provides two services. The first is the deployment and maintenance activities or tasks associated with the corporate portal system. The second is what can be configured by an administrator, uniquely, for the corporate portal system as well as by each user through corporate portal personalization.

- *Security*. This provides a description of the levels of access appropriate for each user or groups of users for each portal application and software function included in the corporate portal (Collins, 2001).

According to Lim *et al.* (2002) web portals offer several recognized advantages to their users. Firstly, well-categorized web resources enable users to sift out large volumes of unwanted information, and focus on relevant material. Secondly, web portals often provide some search engine capability to enable their indexed resources to be queried.

These features, however, are not enough. For a portal to survive today, users must be able to access it frequently. Some authors are of the opinion, that the only feature that makes users return to a portal, is high quality (Offutt, 2002). There is an obvious need, therefore, for quality models to focus on portals, which seek to improve their overall quality.

Several quality models, aimed specifically at portals, have been published, which identify different portal features to be considered in an evaluation exercise. However, these models do not all take into account the same portal characteristics; for this reason, a comparative study of these has been carried out.

This paper is structured as follows: the first section presents a brief overview of the different quality models for portals. The next section compares the different models, along with the conclusions obtained from this comparative study. The last section summarizes the paper.

Quality models for portals
PQM: a Portal Quality Model – Moraga et al. *(2004)*
In Moraga *et al.* (2004), we propose a generic quality model for portals, namely PQM (Portal Quality Model). This model has been devised using as a basis the SERVQUAL model, proposed by Parasuraman *et al.* (1998) and the GQM (Goal Question Metric) method (Basili *et al.*, 1994).

We adapted the different dimensions of the SERVQUAL model to the portal context and split some of them up into sub-dimensions, in order to create a more specific model. As a result, the dimensions identified for the PQM model were:

(1) *Tangibility*. This dimension indicates if "the portal contains all the software and hardware infrastructures needed according to its functionality".

(2) *Reliability*. "Ability of the portal to perform its functionality accurately". In addition, this dimension will be affected by:

  • *Availability*. The portal must always be operative.

  • *Search quality*. The results provided by the portal when making a search must be appropriate to the request made by the user.

(3) *Responsiveness*. "Willingness of the portal to help and to provide its functionality in an immediate form to the users". In this dimension, we distinguish the following sub-dimensions:

  • *Scalability*. This refers to the ability of the portal to adapt smoothly to increasing workloads which come about as the result of additional users, an increase in traffic volume or the execution of more complex transactions (Gurugé, 2003).

  • *Speed*. This relates to the response times experienced by portal users (Gurugé, 2003).

(4) *Assurance*. "Ability of the portal to convey trust and confidence". This dimension will be affected by:

  • *Confidentiality*. Ability to protect the privacy of the users.

(5) *Empathy*. We define this dimension as the "ability of the portal to provide caring and individual attention". In this dimension, we highlight the following sub-dimensions:

  • *Navigation*. The portal must provide a simple and intuitive navigation for users.

  • *Presentation*. The portal must have a clear, uniform interface.

- *Integration.* All the components of the portal must be integrated into a coherent form.
- *Personalization.* The portal must be capable of adapting to the user's priorities.

(6) *Data quality* (DQ). This dimension is defined as "quality of the data contained in the portal". According to Dedeke and Kahn (2002), we can observe four sub-dimensions:

- *Intrinsic DQ.* What degree of care was taken in the creation and preparation of information?
- *Representation DQ.* What degree of care was taken in the presentation and organization of information for users?
- *Accessibility DQ.* What degree of freedom do users have to use data, define and/or refine the manner in which information is inputted, processed or presented to them?
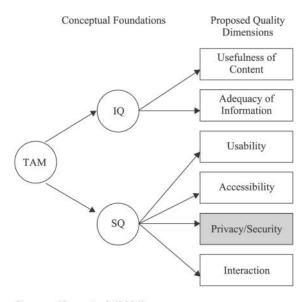- *Contextual DQ.* To what degree does the information provided meet the needs of the users?

Once the model was defined, it was applied to a specific portal (www.castillalamancha. es, the portal of a Spanish region, whose objective is to provide information and online services to its users), aiming to discover the portal quality level from the developers' point of view. To collect this information, a questionnaire containing 42 items was devised. This questionnaire was evaluated by a small group of users who evaluated it for clarity and ease of understanding. It was then completed by all the Castilla-La Mancha portal developers. We found that the reliability coefficient of the survey was 0.9 (this coefficient can vary from 0 to 1, where 1 means the maximum reliability). As a result, we were able to identify the features which needed to be improved in order to increase the portal quality, and to decide on the appropriate corrective actions.

An instrument to measure user-perceived service quality – Yang et al. *(2004)*
The objective of Yang *et al.* (2004) is to develop and validate an instrument to measure user-perceived overall service quality of IP web portals (Information Presenting web portal). This information is useful for researchers and for portal managers.

This instrument focuses on a specific type of portal, namely, IP web portals. According to Eisenmann and Pothen (2000), an IP web portal is "... a site that provides users with online information and information-related services, such as search functions, community building features, commerce offerings, personal productivity applications, and a channel of communication with the site owner and peer users". This kind of portal is directed specifically at creating an effective channel of communication between organizations and their users. For potential customers, IP web portals are a platform that enables them to become acquainted with an organization, to explore its goods and services, and to make enquiries. For existing customers, IP web portals are a place to become more familiar with the organization, to obtain product and service-related information, to request services, and to exchange information with peer users of the same goods and services (Yang *et al.*, 2004). Moreover, they facilitate communication with other stakeholders, such as shareholders, the public, and the government.

In this work, several conceptual methods are integrated, in order to identify main service quality dimensions related to IP web portals. To be specific, the authors adopt the technology adoption model (TAM) and consider that an IP web portal is an information system (IS). For these reasons, the following conceptual foundations are taken into account (Figure 1):

(1) *Information quality (IQ)*. Web-based information is defined as "users' perception of the quality of information presented on a Web site". Under this point, the dimensions are classified into:

- *Usefulness of content*. Value, reliability, currency, and accuracy of information.
- *Adequacy of information*. Extent of completeness of information.

(2) *System quality (SQ)*. This refers to customers' perception of a web site's performance in information retrieval and delivery. Factors are categorized into four dimensions:

- *Usability*. This is related to user-friendliness. Here, various factors have been identified: content layout and classification, website structure, user interface, website appearance and visual design, intuitiveness, readability/comprehension/clarity, search facilities, and ease of navigation.
- *Accessibility*. Customers expect the web-based services to be available at all times and they also desire speedy log-on access, search and web page download. This dimension involves two aspects: availability and responsiveness.
- *Privacy/security*. Some frequently-used measures are the inclusion of vendor guarantees of protection of personal information, confidence resulting from promises on the site, and the reputation of the organization.

Source: Yang *et al.* (2004)

Figure 1.
Proposed conceptual foundations and quality dimensions of information presenting web portals

- *Interaction*. Although using an IP web portal is primarily a self-service process, users may still expect to receive personalized or customized services from a knowledgeable, responsive, and caring contact person.

In order to validate the quality instrument, a questionnaire was drafted by Yang et al. As a first step, a pilot study was conducted to analyse the correlation of the questionnaire and its reliability. As a result, ten items with the lowest reliability were deleted, and the final questionnaire contained 37 items.

The final questionnaire was sent to 10,000 portal subscribers, who were chosen through a simple random sampling technique, but only 1992 questionnaires were completed correctly.

The authors conducted a principal component factor analysis with a varimax rotation, using half of the responses. As a result, they eliminated six items from the questionnaire, and the security/privacy dimension was merged with the usability dimension. The end result was that the service quality dimensions perceived by users of an IP web portal were: usability, usefulness of content, adequacy of information, accessibility and interaction.

To test the factor structure more rigorously, the authors conducted confirmatory factor analyses using the other half of the responses. The results led to two items on the questionnaire being deleted; a second-order factor measurement model was developed to confirm that a second-order factor existed. In Figure 1 we can see, in white, the final dimensions of the model, and, in grey, the dimension which has been deleted.

As the next step, the authors verified that the reliability and validity of the test (convergent, discriminant, criterion-related and nomological validity) were acceptable.

A flexible evaluation framework for web portals – Sampson and Manouselis (2004)
Sampson and Manouselis(2004) present an evaluation framework for addressing the multiple dimensions of web portals that can affect user satisfaction.

Initially, the authors defined several dimensions related to the main satisfaction factors, namely: web portal content, web portal design, web portal personalization and web portal community support. For each one of these, different dimensions were identified.

For the "web portal content" factor, the dimensions were:

- *Satisfaction from content organization*. This aspect refers to the categorization of information to enable efficient search and retrieval.

- *Satisfaction from content creditability*. This aspect refers to the trust and reliability of the information and the content provider, and has multiple facets, such as the accuracy and clarity of the content and the trustworthiness, recognition and reputation of the content author or provider.

- *Satisfaction from content usefulness*. This aspect concerns the focus of the content, the use of appropriate language, and the usefulness of information according to the needs of the audience to whom it is directed.

- *Satisfaction from content integration*. This aspect concerns all content services related with the integration of external sources of information and the provision of links to external resources.

The following dimensions were observed for the factor "design of a web portal":

- *Satisfaction from information architecture*. This is closely related to the organization of content. In this context, however, it is approached from the system design perspective, and it can therefore be considered independent.
- *Satisfaction from usability*. Addresses all issues related to the interaction and navigation of the user in the portal.
- *Satisfaction from graphical design*. The web portal design should be subject to periodical revisions and re-designs from time to time, with the minimum possible impact on the portal operation.
- *Satisfaction from technical integrity/performance*. The dimension concerned with proper operation of the web portal services and the satisfactory performance of the overall services.

The identified dimensions for the "personalization" factor were:

- *Satisfaction from the personalization of navigation*. All issues related to the adjustment of the navigation mechanism and functions to the needs of individual users.
- *Satisfaction from the personalization of information/content*: all issues related to notifying users about new relevant content and providing them with information tailored to their needs and preferences.
- *Satisfaction from the personalization of interface*. All issues related to the adaptation of the interface to the needs and preferences of the users and the properties of their equipment.

Finally, the "community support" factor was analysed and the following dimensions were observed:

- *Satisfaction from the communication support*. This refers to tools and services related to communication between the members of a virtual community.
- *Satisfaction from the collaboration support*. Related to the tools and services allowing effective and efficient collaboration between users.

The authors then presented a methodology to assess the strong and weak points of a web portal. This methodology comprises three steps: firstly, a set of criteria and sub-criteria are defined, against which to measure the different dimensions of user satisfaction from a web portal; secondly, integration of the results collected is carried out and partial satisfaction indicators are obtained; and thirdly, techniques for the analysis of the results of the evaluation are put into operation. Subsequently, the authors presented an evaluation process in order to integrate this methodology into a generic evaluation procedure. As a result, a framework was formulated.

Finally, the framework was applied to the Go-Digital portal, whose objective is to provide a set of web-based services that support e-business training and awareness of vSMEs (very Small and Medium Enterprises). A questionnaire was developed, and two different groups, one composed of end users and the other of portal experts, specified their level of satisfaction with each portal service. The framework was subsequently used for analysing and comparing the results obtained, and the distribution of responses for the higher-level criteria; the partial and global utility indicators were also calculated.

Drivers of web portal use – Telang and Mukhopadhyay (2004)
Telang and Mukhopadhyay (2004) tried to explore how Internet users choose portals. In order to do so, the authors relied on the cognitive psychology and human computer interaction (HCI) literature, along with marketing literature, in an attempt to understand the drivers of web portal use.

Firstly, the authors affirmed that a successful portal needs users who repeatedly come back to the same portal on a frequent basis, for extended periods of use. This is because portal services are given away for free, and users have access to multiple providers. Three measures of portal use were defined:

(1) repeat use: no portal can be financially viable without a significant proportion of its users coming back to the site repeatedly;

(2) stickiness: portal site operators want the users to spend more time per visit; and

(3) frequency: users must return to the site frequently to increase the viability of the portal business model.

Secondly, they developed a conceptual model of portal use made up of three components:

(1) a model of repeat use: examines the effect of repeated use, demographics and other variables on portal choice;

(2) a model of stickiness: concerns the length of user visits; and

(3) a model of use frequency: examines the frequency of portal use.

For each one of the previous models, a set of independent and dependent variables was defined (Table I).

The authors then assessed each one of the models using:

(1) multinomial logic for estimating the repeat use model;

(2) fixed effect OLS regression for estimating the stickiness model; and

(3) negative binomial regression for estimating the frequency model.

Model	Dependent variable	Independent variables
Repeat use model	Choice variable (1 for the portal visited, 0 for others)	Repeat use (RU), advertisement (Ad), cumulative negative experience (CNE), demographic variables (Demo), five portal level dummies. They create three RU variables for each task, RU_S (for search), RU_I (for information) and RU_PS (for personal)
Stickiness model	Number of minutes spent on a portal	Repeat use (RU), cumulative negative experience (CNE), demographic variables (Demo), six portal level dummies. They create three dummy variables (one for each task) and S (for search), I (for information) and PS (for personal)
Frequency model	Count of number of visits to all portals in a week. Count of number of visits to all portals in a week for each task	Repeat use (RU), trend (T), previous week's count (Count_Lag), demographic variables (Demo). They add three lag variables, one for each task. Lag_S (Lag of search task), Lag_I (Lag of Information task), Lag_PS (Lag of Personal task)

Table I.
Independent and dependent variables in each model

To evaluate these models, the authors collected Internet navigation data for 102 demographically diverse internet users for six major portals, over a period of one year. They analyzed the results and found that a connection existed between the selection of a particular portal and use of information and personal services, and the quality of the search services.

Comparative study

In this section, we attempt to compare the models presented previously. Table II shows the main characteristics of the models set out in the previous section.

From the previous table, the following main conclusions can be inferred. Firstly, the Telang and Mukhopadhyay (2004) proposal focuses on studying how different factors (search, information and personal devices) affect portal use. The authors do not, however, study portal quality, which is the main objective of the other models. As a consequence, a comparative study between this model and the others cannot be carried out. Secondly, the instrument developed by Yang *et al.* (2004) focuses on IP web portals, and as such is not a generic model. Thirdly, the Sampson and Manouselis(2004) proposal has not been validated. Finally, the PQM model has not yet developed defined measures.

The features identified in each model are one of the most important characteristics to be compared. In Table II, however, we have only specified the number of features observed in each model. As a result, in order to perform a more complete study of the relative differences, we must compare the features and sub-categories of the different models.

In doing so, we observe that PQM has taken into account more portal features than the others. As a result, we compare the dimensions of the other models with those proposed in the PQM model. In Table III we compare the features identified by Yang *et al.* (2004) with PQM features. The first column shows the different features identified by Yang *et al.* (2004); the second column displays the equivalent feature(s) in PQM.

Looking at Table III, we observe that PQM takes into account all the dimensions of the model proposed by Yang *et al.*(2004) as well as the following ones: tangibility, scalability, integration, personalization (from the point of view of the portal), representation, data quality, and accessibility (although there is a dimension called accessibility, the meaning of this term is different). In Table IV, the dimensions proposed by Sampson and Manouselis (2004) and the corresponding ones in the PQM model are shown.

We can see that some features are repeated in the second column - dimensions for the PQM model. This is because PQM includes several aspects in a single dimension, and this is why, although Sampson and Manouselis(2004) identify more dimensions than PQM, all the aspects which they consider, are considered in PQM as well. This can be more easily understood through an example. One of the features identified in PQM is personalization, which comprises all the issues related to the personalization of a portal. Nevertheless, Sampson and Manouselis(2004) identify the following features in order to meet all the personalization needs: satisfaction from the personalization of navigation, from the personalization of information/content, from the personalization of interface, from the communication support and finally, satisfaction from the collaboration support only notes the personalization dimension.

| Characteristics | Model | | | |
	PQM	Yang	Sampson	Telang
Objective	Develop and validate a portal quality model	Develop and validate an instrument to measure user perceived overall service quality of IP web portals	Develop an evaluation framework for addressing the multiple dimensions of web portals that can affect users' satisfaction	Try to explore how Internet users choose portals
Background	SERVQUAL model	The technology adoption model (TAM)	(Winkler, 2001), (Nielsen, 2000) (Lacher et al., 2001), etc.	Cognitive psychology and human computer interaction literature along with marketing literature
Type of portal	All types	IP web portals	All portals	All portals
Number of dimensions	Six	Six	Thirteen	None
Methodology	GQM	Methodology proposed by Churchill (1979)	No	No
Measures	No	No	Yes	Repeat use, stickiness and frequency
Validation	No	They conducted a principal component factor analysis, and a confirmatory factor analysis	No	It is based on Internet navigation data of 102 demographically diverse users for six major portals over a period of one year
Application	It has been applied to a Spanish regional portal	It has been applied to a IP web portal of Hong Kong	It has been applied to the Go-Digital Portal	No
Tools	No	No	No	No

Table II.
A comparative study of the different models

Dimensions proposed by Yang et al. (2004)	PQM dimensions
Usefulness of content	Contextual data quality
Adequacy of information	Intrinsic data quality
Usability	Navigation, presentation, confidentiality
Accessibility	Availability, speed
Interaction	Personalization

Table III.
Dimensions proposed by Yang et al. (2004) v. dimensions of PQM

Dimensions proposed by Sampson and Manouselis (2004)	PQM dimensions
Satisfaction from content organization	Representation
Satisfaction from content credibility	Intrinsic data quality
Satisfaction from content usefulness	Intrinsic data quality
Satisfaction from content integration	Integration
Satisfaction from information architecture	Representation
Satisfaction from usability	Navigation
Satisfaction from graphical design	Presentation
Satisfaction from technical integrity/performance	Integration
Satisfaction from the personalization of navigation	Personalization
Satisfaction from the personalization of information/content	Personalization
Satisfaction from the personalization of interface	Personalization
Satisfaction from the communication support	Personalization
Satisfaction from the collaboration support	Personalization

Table IV.
Dimensions proposed by
Sampson and Manouselis
(2004) v. dimensions of
PQM

We can also see that in PQM the following dimensions exist, which are not in the model proposed by Sampson and Manouselis (2004): tangibility, availability, search quality, scalability, speed and confidentiality.

Thus we can infer from the previous tables, that the features which have been set out in all models, are: navigation, presentation, personalization and intrinsic data quality. Researchers, clearly, give special attention to the empathy sub-dimensions (i.e. navigation, presentation, integration and personalization), and to the intrinsic data quality (related to the creation and presentation of information for users). To this end, all models attach great importance to visual aspects.

In particular, the Sampson and Manouselis (2004) proposal takes into account all the empathy sub-dimensions and the Intrinsic and Representation sub-dimensions of the data quality dimension. As a result, this proposal looks primarily at the visual aspects of the portal (in spite of the fact that the authors have identified a large number of dimensions). However, although it is obvious that portals focus on the end-user, a quality model cannot focus on the visual aspects alone.

The Yang et al. (2004) proposal considers more portal aspects than the previous model. In particular, it includes the following aspects: portal availability, its speed, the user's confidentiality and the contextual sub-dimension of the data quality dimension (dimensions which are not considered in the previous model). PQM, however, in addition to these dimensions, has highlighted the following:

- *Tangibility*.

- *Search quality*. This sub-dimension is important because, according to Telang and Mukhopadhyay (2004), higher dissatisfaction with search results lowers the future use of the portal.

- *Scalability*. When a portal grows and becomes increasingly popular, its scalability is an important issue. The portal must adapt smoothly to increasing workloads, whether these new situations arise as a result of additional users, an increase in traffic volumes, or the execution of more complex transactions (Gurugé, 2003).

- *Integration*. According to Davidov (2002), a portal is a doorway to the cyberworld of information; it is not a product sold by a vendor, but a goal to be

achieved through the integration of multiple products from multiple vendors; it is a concept of a unification platform, that enables several application services to work together to facilitate access to that world of information. This dimension must be considered, therefore, because all the portal's components must be integrated into a coherent form.

- *Representation*. The usability of the portal desktop depends on users' acceptance of the interface (Collins, 2001); the presentation and organization of information for users is, therefore, very relevant.

- *Accessibility*. According to Mahdavi *et al.* (2004), using web portals can help users to find the desired information effectively, and it is therefore important that the information provided by the portal, meets the needs of the users.

It is worth mentioning that the dimensions, which have been considered in PQM only, are: tangibility, search quality, scalability and accessibility. The importance of these dimensions has been proved in the previous paragraph.

Conclusions

As a response to the intense growth in the importance of portals, different portal quality models have emerged. This paper attempts to contribute to the literature, by presenting a brief overview and comparison of the different models.

A comparative study has been conducted, in order to present the main characteristics of the different models. We have discovered firstly, that the Telang and Mukhopadhyay (2004) proposal studies the different factors affecting portal use, but not portal quality. It is, therefore, not possible to carry out a comparative study with the rest of the models. Secondly, the instrument developed by Yang *et al.* (2004), looks at a specific type of portal, namely IP web portals, and so is not a generic model. Thirdly, the Sampson and Manouselis (2004) proposal has not been validated. Finally, the PQM model has not yet developed defined measures.

With the above results in mind, we carried out a comparative study of the dimensions of the different models with respect to the PQM dimensions. The main conclusions from this comparison have been:

- The features, which have been observed in all models, are: navigation, representation, personalization and intrinsic data quality. Researchers give special attention to the empathy dimension and to the intrinsic data quality (related to the creation and presentation of information for users); with this in mind, all models attach great importance to visual aspects.

- The Sampson and Manouselis (2004) proposal focuses mainly on visual aspects of the portal, and although it is obvious that portals are directed towards the end-user, a quality model cannot focus on visual aspects alone.

- The Yang *et al.* (2004) proposal considers more portal aspects than the previous model, but it does not take into account the following PQM dimensions: tangibility, search quality, scalability, integration, representation and accessibility. In section three the importance of these dimensions has been proved.

- The dimensions which have been considered in PQM alone are: tangibility, search quality, scalability and accessibility.

In future work, it will be necessary to apply the models presented to different kinds of portals, with the aim of improving them and continuing research into portal quality.

Moreover, it is necessary to define measures for each of the features. The aim of these measures is to assess the quality level of a portal, taking into account the measure values for the different features. Once a set of well-defined measures has been identified, the next step is to develop a tool, which will automatically assess the values of the measures. These values are useful for detecting any weaknesses in the portal. When the need arises, therefore, corrective action can be taken to counteract the weaknesses, and as a result, there should be an improvement in portal quality.

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