

EVALUATION OF ENVIRONMENTS FOR PORTALS DEVELOPMENT: A CASE STUDY

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With the growing application of the Internet, business portal software is becoming increasingly complex given the wide variety of technologies it must integrate. It is therefore most important to have development environments that enable this type of software to be built efficiently. This justifies the need to evaluate the quality of business portal development environments.

The objective of this article is to propose the definition of a quality model for business portal development environments, based on ISO/IEC 9126, with the appropriate metrics for estimating quality. The estimation model was evaluated through a case study using a commercial business portal development environment. The rational unified process (RUP) methodology was chosen to build a business portal prototype.

ONE OF THE PROBLEMS THAT SOFTWARE engineering faces today is software quality, due to the growing number of products and services on the market and the consequent increase in competition. There is a worldwide trend toward quality, and software is no exception. The subject has been a cause of much concern to software researchers,¹⁻⁶ who tend to focus on two main objectives: how to get quality software and how to estimate its quality.

This article analyzes the quality of a business portal development environment (BPDE). To do so, a quality model has been proposed. It contains a series of selection cri-

teria based on metrics for estimating the quality of a particular development environment. Additionally, an evaluation of the model is presented through a case study where it was applied to a commercial BPDE. This measurement was possible thanks to the implementation of a business portal prototype. It should be noted that the portal was developed using the rational unified process (RUP)⁷ methodology and evaluated in accordance with ISO/IEC 14598-5⁸ as the software evaluation methodology applied.

One of the main advantages of the solution is that it puts forward a quality model for each BPDE. Furthermore, any organization

Any organization interested in implementing this kind of development environment can evaluate it within the framework of a quality model based on ISO/IEC 9126 so that it can be applied worldwide.

interested in implementing this kind of development environment can evaluate it within the framework of a quality model based on an international standard — ISO/IEC 9126⁴ — so it can be applied worldwide.

The work undertaken is covered in the following sections, beginning with a brief description of what business portals (BP), ISO/IEC 9126,⁴ and ISO/IEC 14598-5⁸ are. Next, following the process suggested by ISO/IEC 14598-5,⁸ the evaluation model proposed and the application of the RUP to develop the portal are presented. The article concludes by showing the results obtained when estimating portal quality using the model proposed and then the conclusions.

BUSINESS PORTALS

According to Holland,⁹ “a BP is a single input of data, generally based on access through a browser, which can be used to navigate and examine internal and external data through the Web, while receiving information fed to it on a regular basis.” The idea behind the BPs is similar to the one behind Internet portals, the only difference being that Internet portals only give information on one company. The goal is to have a central location that can easily be accessed by all the firm’s employees, customers, partners, and suppliers, which would be an incentive for them to use it in their day-to-day activities and make them genuinely interested in increasing it. According to Schlam,¹⁰ BP software is very complex due to the large number of functions it must satisfy because it is not merely a Web page with a series of links to interesting sites, but a page that shows users both structured and unstructured source data.

BPs must⁹:

- Provide customization, flexibility, and scalability
- Allow the rapid creation and logical development of the business
- Deliver a unified, standards-based architecture
- Be deeply integrated with the existing applications and data
- Be continuously available

Because BPs are batch processing oriented applications, there must be some way of disconnecting the requirement for a user to be able to do additional processing. It is precisely there that event integration is important and it becomes a functional requirement that must

be provided by the environment supporting the development of this kind of portal.

A further advantage of BPs is that once the firm’s staff has become accustomed to using the information available and to adding to it the information they create each day, only one more step has to be taken to set up the enterprise knowledge base.

Another advantage of BPs is that staff can organize and customize information from different sources on their computers, making it their navigation board. These sources could range from their favorite Internet pages to ERP, databases, e-mail, news servers, text files lost on their hard disks, video or TV signals, etc.⁹

BPs must include the following technologies:¹ (1) content management servers, (2) search tools, (3) automated classification mechanisms, (d) content catalogues, (4) directories, and (5) XML.

BPs are complex applications that integrate many back-end systems and technologies, so their application calls for a development environment capable of handling this integration. A development environment is software that provides all the facilities to enable a programmer to develop other programs.¹² However, not just any BPDE is suitable for creating a business portal.

ISO/IEC 9126

ISO/IEC 9126⁴ is an international evaluation standard that analyzes a system’s suitability according to its degree of compliance with the application for which it was designed, which was why this standard was considered capable of guiding the evaluation of a BPDE.⁶

The scope of this international standard defines six characteristics that describe software quality, with a minimum amount of overlap. They provide a baseline for additional refining and description of software quality characteristics.⁴ These characteristics and the corresponding subcharacteristics are shown in [Exhibit 1](#).

The primary objective sought by this research was to determine which characteristics, based on ISO/IEC 9126, a BPDE should have to generate a quality business portal from the developer’s point of view. However, ISO/IEC 9126 is not sufficient to ensure the implementation of this objective, because it does not state exactly how it should be done. The method is given in ISO/IEC 14598-5.⁸

EXHIBIT 1 ISO/IEC 9126 Characteristics and Subcharacteristics

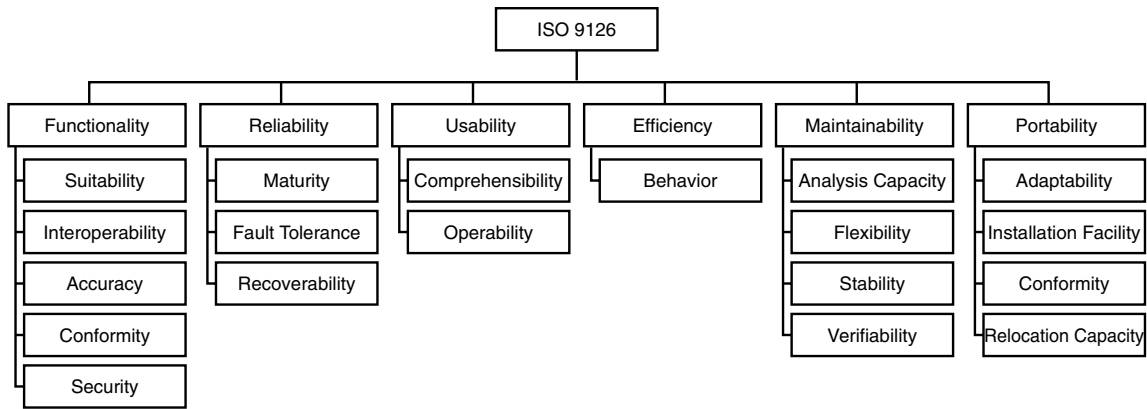
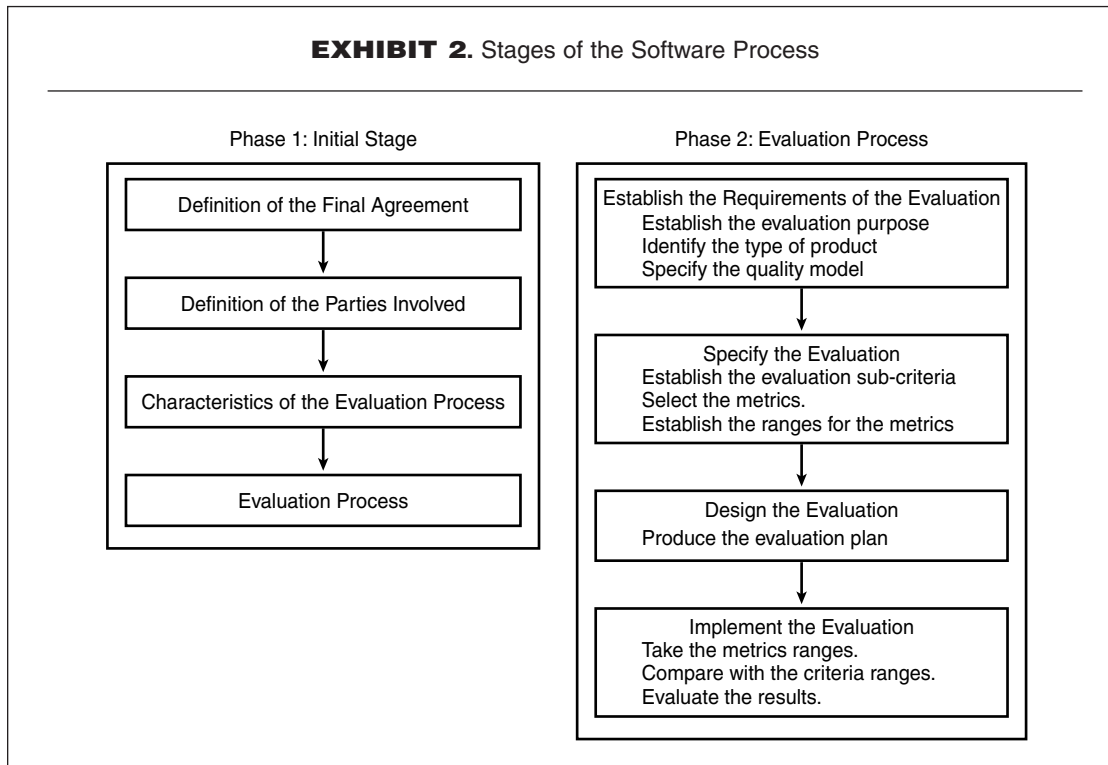


EXHIBIT 2. Stages of the Software Process



ISO/IEC 14598-5

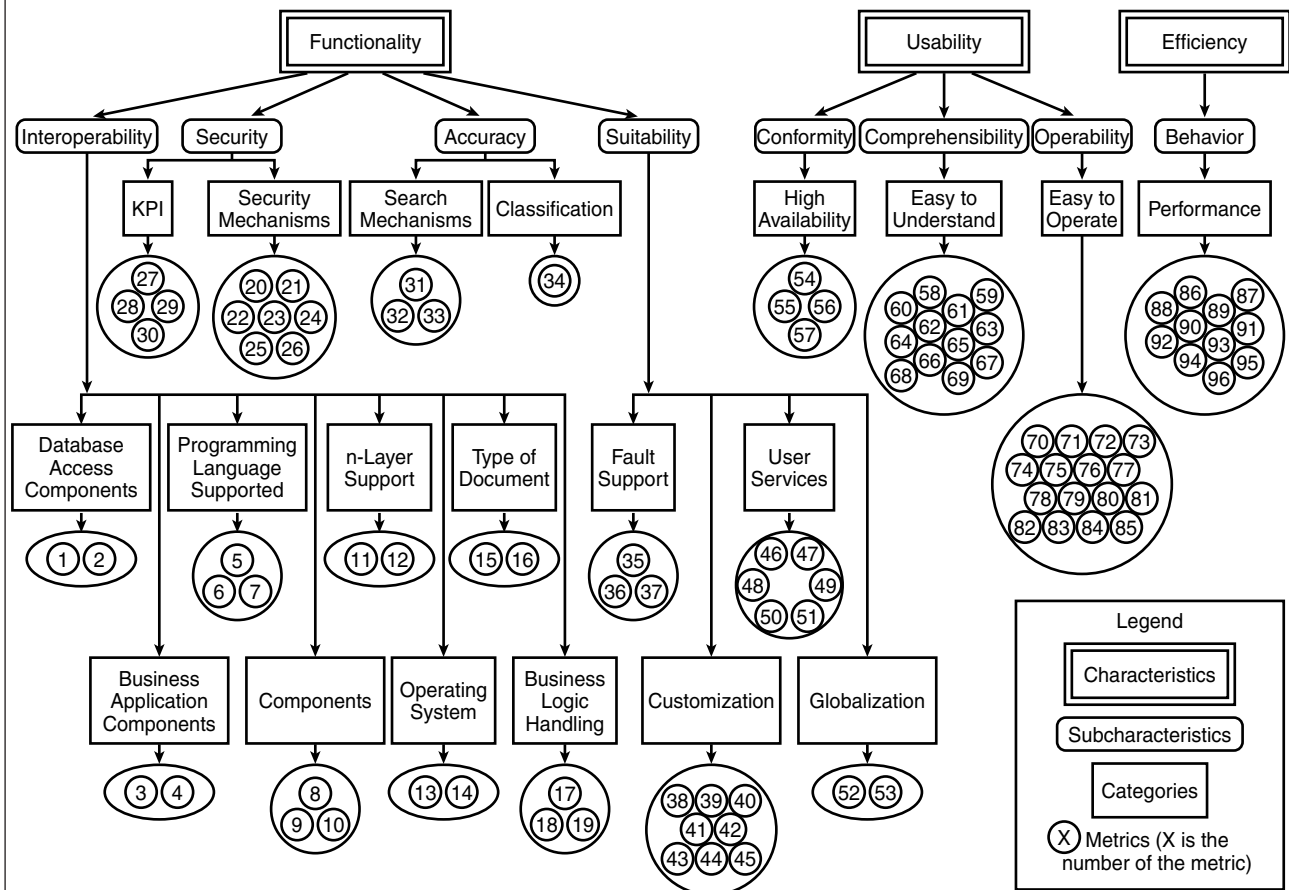
ISO/IEC 14598-5, in an expanded version of the ISO/IEC 14598 standard, indicates that a phase prior to the evaluation process is necessary. The stages are: definition of the initial agreement, definition of the parties involved in the evaluation, characteristics of the evaluation process, and then continuation of the development phase. On the basis of this standard, the phases of the software product evaluation process used in this research are shown in [Exhibit 2](#).

ESTABLISHING THE EVALUATION REQUIREMENTS: QUALITY MODEL FOR BUSINESS PORTAL DEVELOPMENT ENVIRONMENTS

One of the activities undertaken to meet the objectives, based on ISO/IEC 14598-5, involved developing a quality model for BPDEs. This model was applied to a commercial BPDE, through the development of the business portal prototype for a Venezuelan company, used as support for the estimation.

[Exhibit 3](#) shows the quality model proposed for the BPDE, indicating the software

EXHIBIT 3 Quality Model for BPDE



quality characteristics and subcharacteristics, as well as the classification and number of metrics defined in order to apply the Model.

The quality model for evaluating BPDE was expressed in terms of the ISO/IEC 9126 quality characteristics and from the point of view of a developer who is its user. So the factor that determined the choice of the characteristics was the interest in generating quality in the final product, as follows.

Characteristics
Functionality

A BPDE must support the construction of the basic functionalities a portal should provide: availability of a central information location; sufficient integration with existing systems that include *databases, mainframe systems, packaged applications, and middleware applications*; provision of a central management system; and transaction reliability, because companies are connecting their data and vital business processes to an ever-increasing number of con-

sumers of this information. BPs must also facilitate rapid and reliable access to information.

The environment must support the management of BPs, contributing to their efficiency. Because they can gather numerous sources of information in a centrally managed system, final users must have a quick and flexible way of obtaining day-to-day corporate data. That is, the environment must enable an efficient search service to be built.

The BPs must be portable. The very nature of the Internet poses the need for systems executed on this technology to be capable of operating in different environments and on different platforms. BPs must also provide flexibility and scalability because they must ensure continued availability; hence, multi-level scalability is the basis of a portal's predictable operation and of its availability. Therefore, the environment must facilitate the construction of BPs with these capacities, in addition to being able to handle large amounts of traffic.

Usability

A BPDE must reduce the effort needed to use it; that is, BP developers must shorten the learning curve to increase productivity.

Efficiency

A BPDE must use resources efficiently and ensure a quick response time for its operations. Such efficiency is vital to the development of a portal because one of the functionalities that has to exist in a BPDE is integration with existing systems (mainframes, databases, etc.). This is why the use of resources must be optimized.

Subcharacteristics

The following subcharacteristics were chosen based on the characteristics described in the previous section (see [Exhibit 3](#)).

□ Functionality

—*Interoperability*: The BPs must be able to be integrated with the existing systems in the company, which include databases, mainframe systems, applications, and middleware. An environment that supports the development of these kinds of portals must provide elements that will facilitate such integration.

—*Security*: BPDE must also provide the mechanisms needed to guarantee security in the portal. Security for each user's authentication is necessary when accessing information. These portals must also support transaction handling, because they support E-business and E-commerce which require security policy definition for customers, suppliers, and partners.

—*Accuracy*: Within the technologies that a BPDE must support are search tools, automated classification mechanisms, and directory handling. These technologies would be no good without a high level of accuracy.

—*Suitability*: This includes all the attributes that ensure the presence of and compliance with a series of functions for the tasks at hand. A BPDE must support portal reliability, because a basic requirement of BPs is *continuous availability*. Another functionality that the environment must provide is the series of elements related to customization, help, functions for handling, such as customer relationship management (CRM), and those functions that ensure that users can interact naturally with the portal.

□ Usability

—*Comprehensibility*: A BPDE must have attributes that minimize developers' efforts to recognize the logical concept of the environment and its applicability.

—*Operability*: After the business portal is up and running, it then has to be managed; so the environment must offer a central management system that ranges from the insertion of users and roles for these users to the definition of new security policies or the improvement of existing ones, handling of centralized transactions, etc.

□ Efficiency

—*Behavior over time*: The proper and optimum use of the resources of the machine where the portal is being developed is a vital indicator for appreciating the behavior and performance of the development environment, as well as the response time of such resources for transactions, queries, and operations undertaken for portal configuration.

SPECIFYING THE EVALUATION

Ninety-six metrics were defined for the characteristics and subcharacteristics selected. However, for reasons of summary, they cannot all be presented in this article. [Exhibit 4](#) gives a sample of the product obtained from the selection of metrics and the assignment of the respective ranges.

DESIGNING THE EVALUATION

Once the metrics have been selected, the next step is to produce the evaluation plan that was based on ISO/IEC 14598-5. The steps are as follows:

1. Streamlining of the values of the metrics ranges through the conversion of a common scale for all the ranges proposed. A scale from 1 to 5 is a general and complete way of including the ranges selected for each metric (see [Exhibit 4](#)).
2. Determination as to whether the metric is acceptable. The value of the metric is considered: if it is higher than or equal to 3, then the metric is acceptable. If it is lower than 3, then the metric is not met.
3. Decision as to the whether the category of a subcharacteristic is present. This will only occur if 50 percent or more of the metrics are acceptable. A subcharacteristic might have no categories, in which case this step would not apply.

EXHIBIT 4 Example of Metrics and Ranges Established

Characteristics of the Quality Model: Functionality

Subcharacteristics of the Quality Model: Interoperability

Classification	Metrics	Ranges for the Metrics				
		5	4	3	2	1
Database access components	Number of database access components	≥ 8	5–7	3–4	1–2	0
	Degree to which company is satisfied with the database access components	100%–81%	80%–61%	60%–41%	40%–21%	20%–0%
Application integration components	Number of application integration components	≥ 6	5–4	3–2	12	0
	Degree to which company is satisfied with the application integration components	100%–81%	80%–61%	60%–41%	40%–21%	20%–0%
Programming language supported	Does it enable XML language to be used?	Yes				No
	Does it allow Java/JavaScript language to be used?	Yes				No
	Does it enable C++ language to be used?	Yes				No
Components	Does it enable components (COM, CORBA, DCOM, EJB) to be created?	Yes				No
	Does it allow components belonging to the logic inherited from the business to be used?	Yes				No
	Company's degree of satisfaction with the type of components that can integrate the environment	100%–81%	80%–61%	60%–41%	40%–21%	20%–0%
Support n-layers	Does it allow the creation of 2-layer applications?	Yes				No
	Does it allow the creation of 3-layer applications?	Yes				No
Operating systems	Number of operating systems supported by the environment?	≥ 5	4	3–2	1	0
	Degree to which the company is satisfied with the support system.	100%–81%	80%–61%	60%–41%	40%–21%	20%–0%
Type of documents	Degree to which the company is satisfied with the type of documents that can be imported	100%–81%	80%–61%	60%–41%	40%–21%	20%–0%
Business logic handling	Does it permit distributed handling of transactions?	Yes				No
	Does it enable the workflow belonging to the business logic to be handled?	Yes				No
	Does it enable events to be handled?	Yes				No

EXHIBIT 5 Classification of a Development Environment According to the Quality Model Proposed

Number of Characteristics Present	Number of Characteristics Absent	Classification of the Environment
3		Excellent
2	1	Good
1	2	Average
	3	Not recommended

- Decision as to whether the subcharacteristics are acceptable. The same criterion is followed. If 50 percent or more of the categories of the subcharacteristics are acceptable, the subcharacteristic will be deemed acceptable.
- Decision as to whether the characteristic of the quality model is acceptable. A percentage of importance will be assigned to each subcharacteristic. Hence, a characteristic of the quality model is acceptable if the sum of the percentage exceeds 50 percent. To assign the percentages to each subcharacteristic, experts were surveyed (“expert opinion”).

- Finally, a qualification is assigned to the tool according to [Exhibit 5](#). With this result the environment is classified and the appropriate business decisions can be made.

CONSTRUCTION OF A PORTAL PROTOTYPE

To develop this portal a case-driven and object-oriented approach was chosen, and therefore the construction was based on the rational unified process (RUP) model.⁷ The following views were determined: use case, logic, implementation, and deployment, based on Kruchten’s proposal for RUP methodology.

The view of portal use cases developed is shown in [Exhibit 6](#).

The logical view includes the navigation map associated with this solution, which is shown in [Exhibit 7](#).

The characteristics of the BP were aimed at client/server architecture. The interface or presentation, first layer, is represented by the navigator or Web browser, through which the user interacts with the portal. The logic, second layer, contains the business logic and the communication interface with the company’s systems. This layer is located in the portal’s serv-

EXHIBIT 6 Use Case Model of the Venezuelan Company BP

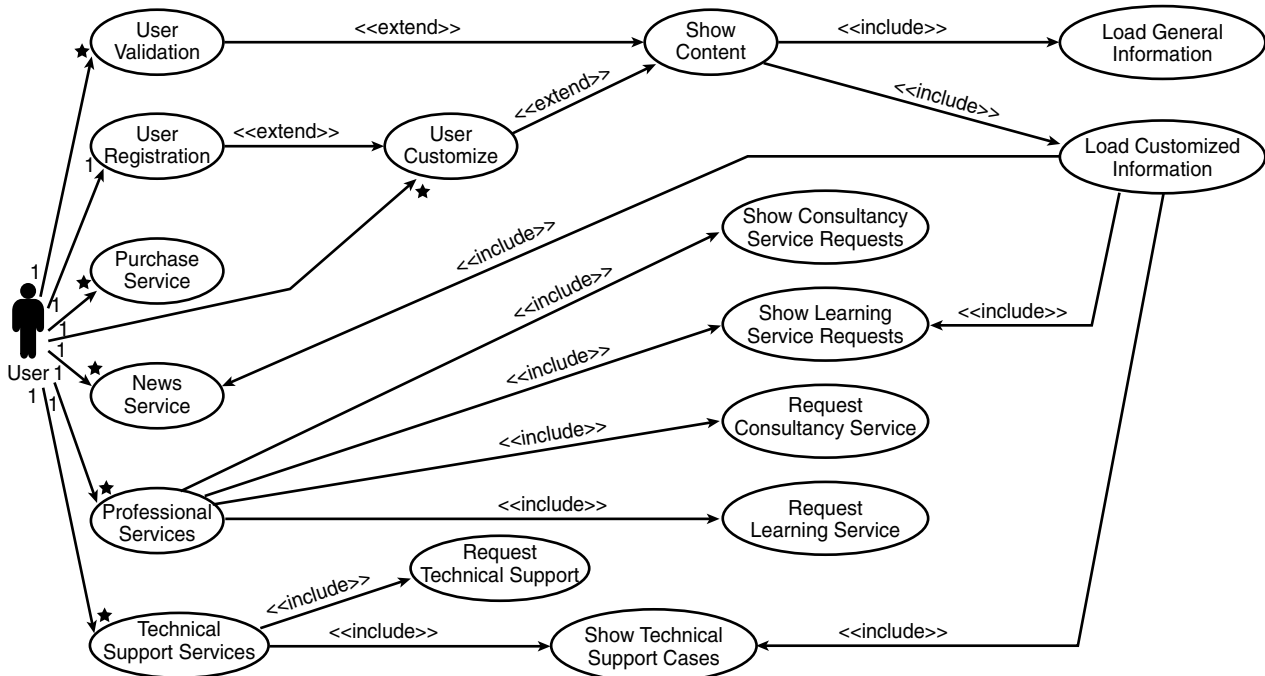
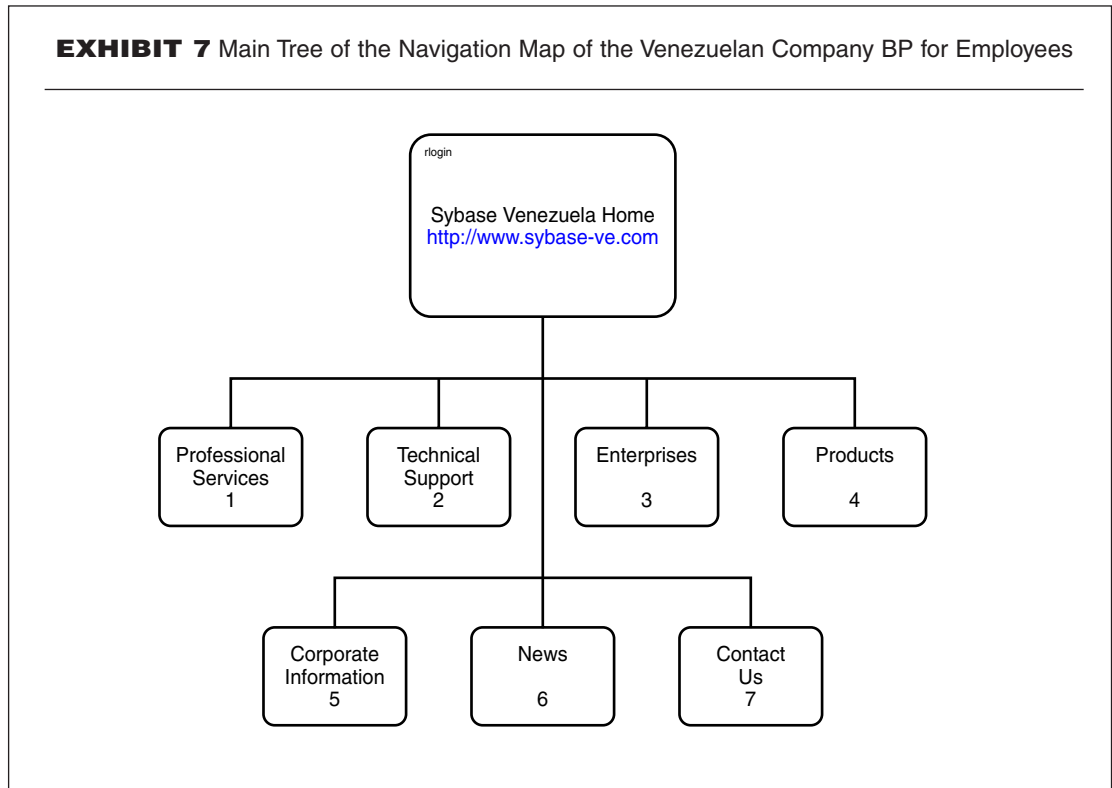


EXHIBIT 7 Main Tree of the Navigation Map of the Venezuelan Company BP for Employees



er. The third and last layer, the data, is the database and the applications existing in the company; this layer is in the company's server. The deployment view associated with the solution is shown in [Exhibit 8](#).

[Exhibits 9](#) and [10](#) show two interfaces of the Venezuelan company BP. Note how the option menu (left-hand side of the figure) changes, depending on the type of user.

During the development of this solution, the set of metrics proposed by the quality model described above was measured.

IMPLEMENTATION OF THE EVALUATION: EVALUATION OF THE BUSINESS PORTAL DEVELOPMENT ENVIRONMENT

Having taken the values of the metrics during the process of developing the prototype mentioned above, the quality of the environment was evaluated. Each step in the implementation of the method is explained below.

1. Standardization of the values of the ranges of the metrics

Once the ranges are proposed and the metrics taken, the value for each metric was converted to the scale of 1 to 5, according to the range proposed (see [Exhibit 4](#)).

2. Decide whether the metric is acceptable

To make this decision, the criterion described above must be followed. There are several metrics that, due to the nature of the development, could not be measured. In those metrics it states that the evaluation does not apply.

3. Decide whether the category is acceptable

The accepted metrics for each subcharacteristic were counted and the result shown as a percentage in [Exhibits 11](#), [12](#), and [13](#). Categories

EXHIBIT 8 Three-Layer Architecture of the Sybase de Venezuela Business Portal

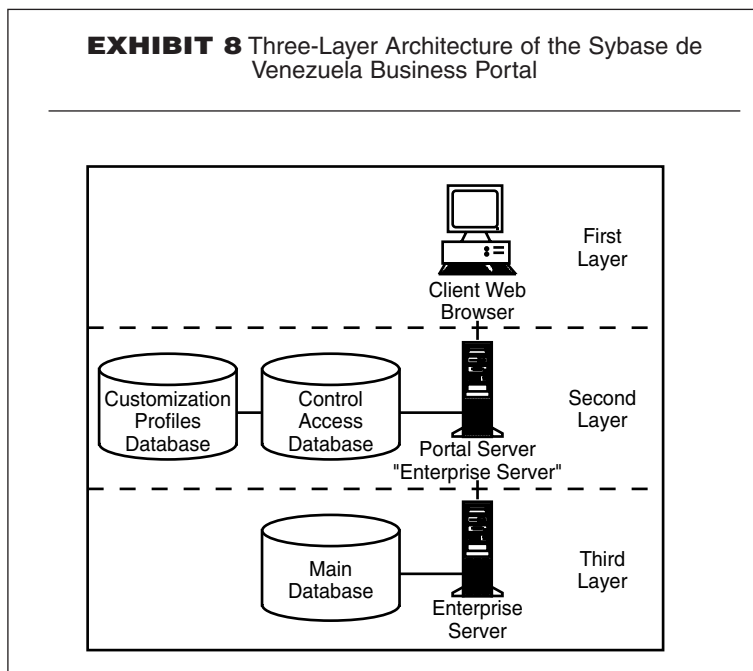


EXHIBIT 9 Customer Welcome Interface



EXHIBIT 10 Learning Service Employee Welcome Interface



with percentages above 50 percent were classified as acceptable. Exhibits 11, 12, and 13 show that all the categories of the subcharacteristics were considered acceptable.

4. Decide whether the subcharacteristics are acceptable

If the same criterion is followed, that is, if 50 percent or more of the categories of the subcharacteristics are acceptable, then the subcharacteristic will be deemed acceptable. Exhibit 14 shows the sum total of the percentages and the subcharacteristics that are acceptable within the characteristics.

Exhibit 15 shows that all the subcharacteristics of the *functionality* of the quality model are considered acceptable, as they all exceed 50 percent.

In the functionality characteristic, the suitability followed by the interoperability are seen to a lesser degree, because there are only two operating systems under which Sybase® Enterprise Portal could work, that affect the interoperability (see Exhibit 16).

The development environment cannot offer the user an opportunity to design his own interface and this reduced the suitability of the system (see Exhibit 17).

Exhibit 18 shows that the subcharacteristic that most affects usability is comprehensibility and this is because the environment is not highly intuitive and training is greatly needed before it is used.

The efficiency is not subdivided into several subcharacteristics. The only subcharacteristic evaluated was “behavior,” which obtained a pondered 100 percent.

EXHIBIT 11. Percentages of Metrics Present in Each Category of the Functionality Subcharacteristics

Subcharacteristic	Category	Percentage Obtained
Interoperability	Database access components	100
	Application integration components	100
	Programming languages supported	100
	Components	100
	Operating systems supported	50.0
	Type of documents supported	100
	n-layer support	100
	Business logic handling	100
Security	KPI	100
	Security mechanisms	100
Accuracy	Search mechanisms	100
	Classification	N/A
Suitability	Fault support	100
	Customization	62.5
	User services	100
	Globalization	100
Conformity	High level of availability	100

EXHIBIT 12 Percentages of Metrics Present in Each Category of the Usability Subcharacteristics

Subcharacteristic	Category	Percentage Obtained
Comprehensibility	Easy to understand	66.7
Operability	Easy to operate	93.3

EXHIBIT 13 Percentages of Metrics Present in Each Category of the Efficiency Subcharacteristics

Subcharacteristic	Category	Percentage Obtained
Behavior	Performance	100

EXHIBIT 14 Percentages of each Subcharacteristic of the Characteristics

Characteristic	Subcharacteristic	Percentage Obtained
Functionality	Interoperability	94.4
	Security	100
	Accuracy	100
	Suitability	90.6
	Conformity	100
Usability	Comprehensibility	76.7
	Operability	96.0
Efficiency	Behavior	100

5. Presence of the characteristics of the quality model

For this, a percentage of importance was assigned to each subcharacteristic through “expert opinion” type surveys. The value of the percentages was obtained by averaging the percentages proposed by the experts for each of the subcharacteristics shown in Exhibits 19 and 20. The survey was not conducted for the efficiency characteristic because it only has one subcharacteristic.

Once the percentages of appreciation by the experts were obtained, they were compared with the percentages obtained in the evaluation. Exhibits 21, 22, and 23 show each subcharacteristic’s difference compared with the expected behavior. As expected, the suitability and the interoperability were the subcharacteristics of the functionality that had a lower rate than the one proposed by the experts. However, there is only a slight difference (see Exhibit 21).

For the usability, comprehensibility was the subcharacteristic in the comparison that seems to be the most affected (see Exhibit 22). However, the experts determined that it was not this subcharacteristic that was the most important; additionally, the difference between the percentage obtained in the evaluation and the percentage assigned by the experts is not significant enough for this subcharacteristic to be classified as absent.

Efficiency is the most pondered characteristic because it has only one subcharacteristic that was entirely present during the evaluation (see Exhibit 23).

Once the percentages with which each subcharacteristic were known, they were summed up and the result had to be greater than 50 percent to conclude that a characteristic was present. Exhibit 24 shows the participation of the three characteristics of the quality model.

The greatest differential, which is not very significant for the evaluation, is presented by the **Usability** characteristic. This, as mentioned earlier, is because a sound introduction to the handling of this tool is needed. It is important to stress that efficiency seems to be the most pondered characteristic because it obtained a 100 percent presence; however, it is the characteristic with the greatest number of metrics (a total of four) that “do not apply” in the evaluation; this might warrant a subsequent evaluation, although there are not so many of them that they might affect the result of this evaluation.

6. Count of the characteristics of the quality model proposed and assignment of the classification

The characteristics fulfilled were checked and the result compared with Exhibit 5 to determine the evaluation of the tool. As seen in the previous step, the three characteristics of the quality model are fulfilled in the BPDE evaluated, which leads to their classification as “Excellent.”

EXHIBIT 15 Participation of the Functionality Subcharacteristics

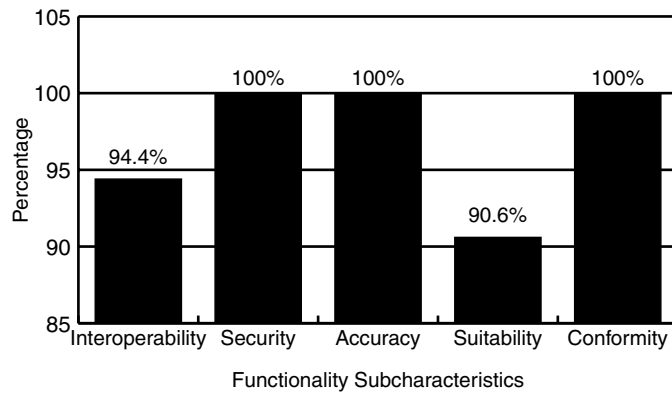


EXHIBIT 16 Participation of the Interoperability Categories

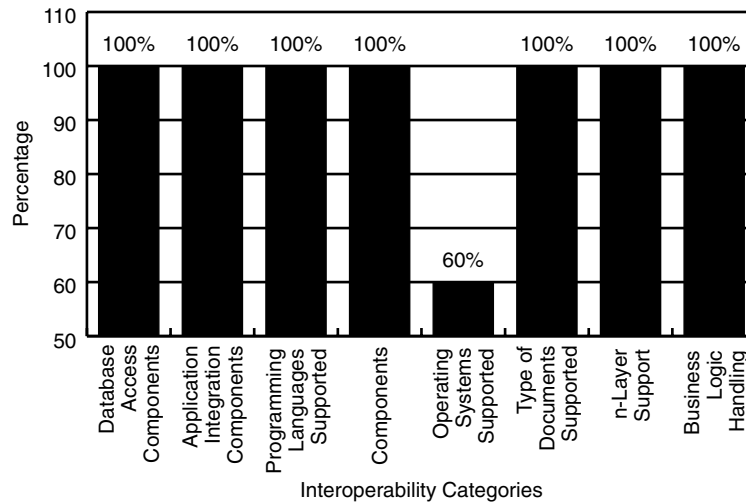


EXHIBIT 17 Participation of the Suitability Categories

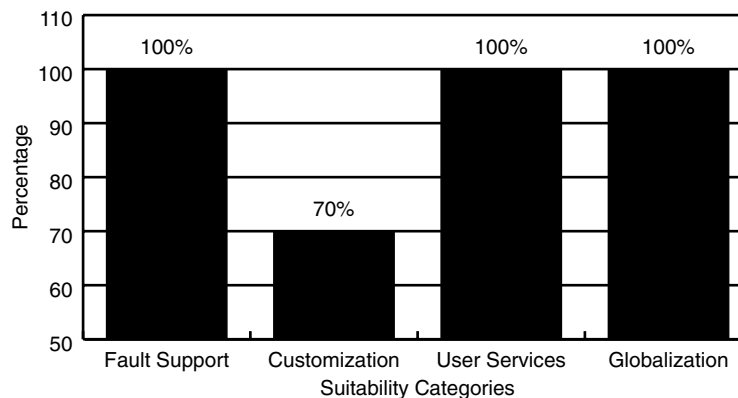


EXHIBIT 18 Participation of the Usability Subcharacteristics

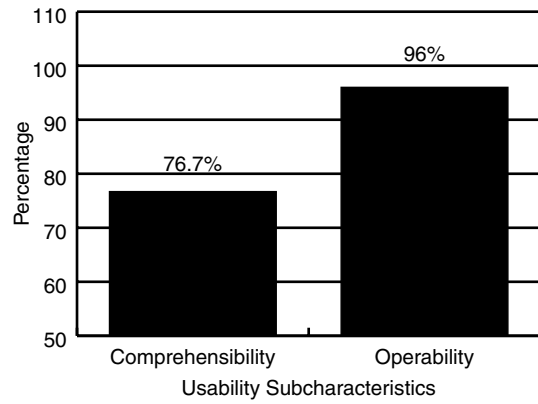


EXHIBIT 19 Results of the Expert Opinion (Functionality)

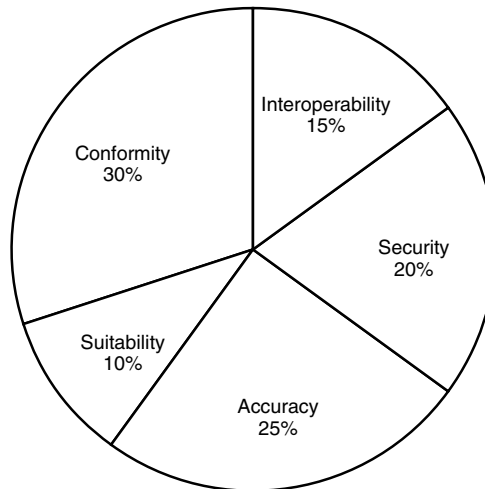


EXHIBIT 20 Results of the Expert Opinion (Usability)

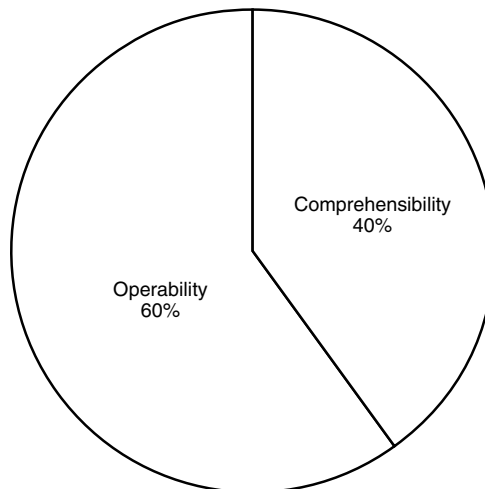


EXHIBIT 21 Comparison of the Percentages of the Functionality Subcharacteristics Assigned by the Experts with Those Obtained in the Evaluation

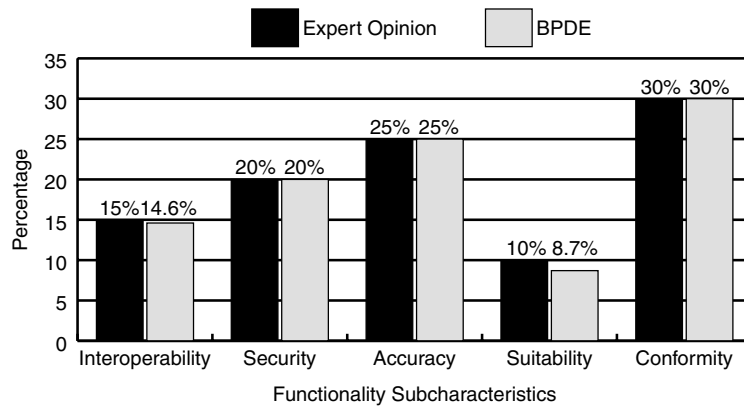


EXHIBIT 22 Comparison of the Percentages of Usability Subcharacteristics Assigned by One of the Experts with Those Obtained in the Evaluation

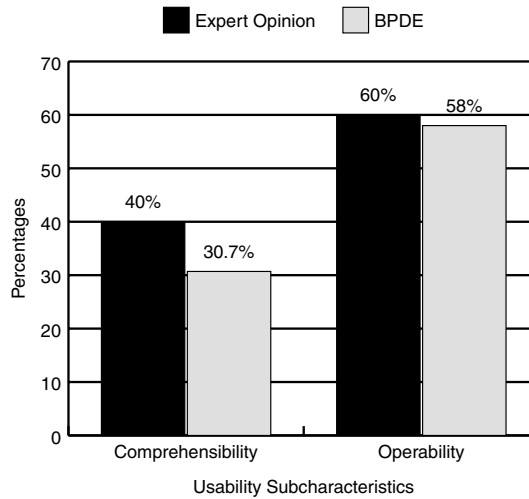


EXHIBIT 23 Comparison of the Percentages of the Efficiency Subcharacteristics Assigned by the Experts with Those Obtained in the Evaluation

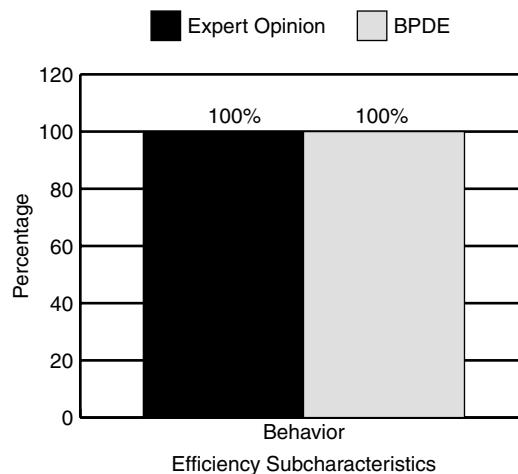
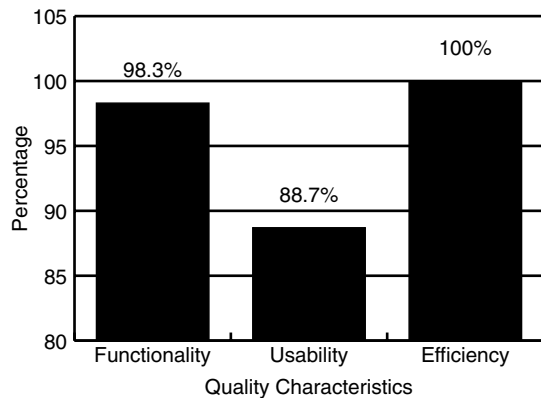


EXHIBIT 24 Percentages of the Quality Characteristics in the Evaluation

CONCLUSIONS AND RECOMMENDATIONS

The BPs integrate all the business environments of a company — process, applications, and data — to present them on the Web and thereby have a centralized location that can be accessed by customers, employees, suppliers, and trading partners alike.

The quality model for the evaluation of the BPDE used in this research was developed on the basis of ISO/IEC 9126. This model is extremely useful for orienting developers in the selection of BPDE.

The commercial BPDE was evaluated using the methodology established by ISO/IEC 14598-5.

To test the quality model proposed, a case study was applied, which consisted in the development of a prototype at the functional level of a BP using the ratified unified process (RUP) methodology. Use of the RUP made it possible to generate a generic model of use cases for the development of a BP that enables the metrics proposed here to be identified and applied.

The commercial BPDE used in this article satisfies the quality model proposed. This environment offers all the functionalities for developing a quality BP; and as a develop-

ment environment, it was a highly efficient one and easy to use once proper training had been given.

It is suggested that new metrics be put forward to complement the quality model proposed and to apply it to others BPDEs so that the model proposed can be refined. ▲

Acknowledgments

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