

Efficiency and portability: guidelines to develop websites

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Abstract— The use of the Internet as a means of ensuring greater visibility for products, services and information offered by companies is gaining strength in recent decades. However, it is known that to ensure satisfaction and subsequent virtual customer loyalty, it is necessary to guarantee the quality of the websites, allowing indiscriminate access regardless of the resources used, as well as rapid responses to possible requests. In order to assist this process, this paper presents a set of guidelines for the development of websites having quality characteristics, efficiency and portability as per ISO 9126 norms. An observational analysis of e-commerce websites was done which showed that they are inadequate as to the proposed guidelines, making them difficult to access available content. Therefore, the adoption of the proposed guidelines can greatly contribute to increasing the quality of websites and, consequently, enable quick and effective access regardless of the resources used.

Keywords - *websites quality assurance; websites development guidelines; efficiency and portability characteristics*

I. INTRODUCTION

Internet use has grown amazingly and is increasing in the number of new users. This has encouraged many companies to migrate the publicity of their products and services to the Internet, seeking access to a larger public. However, this entails the need to guarantee the users indiscriminate access to documents, products and services, regardless of where they are and the device used. With this scenario, it is necessary to develop new techniques to help the process of quality assurance, since the websites have unique features not offered by traditional software engineering.

This article then presents a set of guidelines that contributes to the creation of websites with emphasis on quality characteristics of efficiency and portability, as defined in ISO / IEC 9126 [1], including the need to ensure agility and indiscriminate access to information.

This article is organized as follows: section 2 presents related work in software quality; section 3 presents the guidelines established in this work; section 4 presents the results of an observational analysis undertaken in the context of Brazilian e-commerce websites in relation to proposed guidelines; and finally section 5 presents the conclusion.

II. RELATED WORK

Quality is an important factor for any software, regardless of their characteristics and restrictions. The ISO / IEC 9126 [1] established a standard of quality characteristics to be measured against during the development of software systems.

However, the Web environment is an even greater challenge because of its unique characteristics, spawning various works ([2] [3] [4] [5] [6] [7]) which seek to establish elements that will ensure the quality of a website project. In this context, it is observed that quality efficiency and portability represent key aspects in websites, since their quality and interaction experience may be jeopardized by various factors, such as access device, means of access and implementation of specific features present in websites.

Works related to efficiency usually focus on usability, i.e., although important, efficiency is often not dealt with explicitly in works that cover the quality theme in websites ([8] [9] [10], [11]). The use of mobile devices to access websites makes it necessary to adapt the websites to the hardware characteristics of those devices [10]. Thus, the work related to portability seeks to minimize such problems ([12], [13], [14],[15]), often caused by lack of concern for quality when websites are developed.

Because of the above, this paper focuses on providing a set of guidelines in order to direct the development of quality websites, with emphasis on efficiency and portability characteristics, as defined in ISO / IEC 9126 [1]. With this, it is possible to improve the quality of websites, helping to ensure user satisfaction and guarantee indiscriminate access to information.

III. GUIDELINES FOR DEVELOPING WEBSITES

Creating quality websites is a challenge to designers and developers. To define the guidelines presented in this study, current information regarding the use of websites was gathered in order to assist the developers in the creation, with available resources, of a website with quality that meets today's demands. In this context, we emphasize that today, although it is possible to access the Web through various types of networks and different connection speeds, the Internet speed available to most of the population is less than 56 Kbps [9]. In Brazil, the newest CETIC [16] research points out that about 34% of the population has an Internet connection of up to 256 Kbps, a fact that causes a number of problems to access some websites, because it can create a barrier between the user and application, substantially hindering access to useful information. Against this scenario, in establishing guidelines, this study considered only three speed levels: below 256 kbps; from 256 kbps to 1 Mbps; and above 1Mbps.

The presentation of each of the proposed guidelines was conducted according to a defined set of relevant information in

order to facilitate their understanding and use. This combination is shown schematically in Figure 1 and detailed below. It should be noted that for a given category, different guidelines can be established.

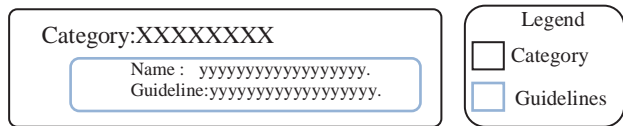


Figure 1 Structure of the guidelines.

Category: reflects the group that belongs to the established guideline(s).

Name: assigns a unique identifier for the corresponding guideline, based on the context of the metric considered as a basis [3].

Guideline: defines rules to guide the design of websites as a way to contribute to the production of results that meet the requirements of portability and efficiency.

In the following subsections, the guidelines established to aid in the development of websites following the proposed structure are presented.

3.1 Category: Media

The use of media to interact with the user in the form of tutorials or newsletters has been an element used in websites as a means of assisting users in the performance of a task.

a) Name: Duration.

Guideline: Due to the high volatility of Internet users, videos should not be too long, i.e., the recommended duration should be between two and ten minutes [17], to ensure effective execution and portability to different access devices.

b) Name: Response time.

Guideline: As to efficiency, the size of the videos and audios can be defined by taking into account three factors: the first is that a user needs to receive a response from the website up to one second after the click [6], i.e., the user must be able initiate the execution of video or audio until one second; the second factor is the use of streaming data, which is the ability to play media while downloading the rest of the file; finally, the last factor is to consider the connection speed of the user. Thus, in order to provide a satisfactory interaction with the user, it is necessary that the download of a new second of media be possible for each second done. Therefore, the media size is defined by the equation 1:

$$\text{Average size} = \text{download per second} \times \text{display time} \quad (1)$$

In this context, based on a time range of two to ten minutes from the previous guideline and the proposed levels of access speed considered in this work, you can establish the following maximum size of videos and audios described in Table 1. In the item portability, it should be noted that most mobile devices that are used to access videos and audios do not have great processing power and storage capacity. Cell phones, for instance, seldom have an internal memory size greater than 100 MB. Thus, the adoption of media to support the use of a

website should be done with caution so as to always consider the size of such media related to desired portability.

Table 1. Maximum size of videos and audios

Speed	Media	
	2 minutes	10 Minutes
up to 256 kbps	up to 3,840 KB	up to 19,200 KB
between 256 kbps and 1 Mbps	between 3,840 KB and 17,520 KB	between 19,200 KB and 87,600 KB
above 1 Mbps	from 17,520 KB	from 87,600 KB

c) Name: Image.

Guideline: Whereas a user can access information from a website from a mobile device, more precisely with less processing power such as cell phones, some precautions should be taken in relation to the use of images. Therefore, to improve the portability of the website, we suggest the preferred use of JPEG and GIF in an attempt to ensure a better user experience. To improve efficiency, we recommend that the resolution be set correctly inside the tags, specifying the value of the image that is loaded by the browser to prevent the resizing of images loaded by the browser [17]. As an example of the effectiveness of this policy, considering the use of HTML, the implementation could be done by adding the width and height attributes within the HTML image tag, as follows:

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The use of actual image values of width and height helps the browser to build the page properly, improving aspects of portability and efficiency of websites related to different devices and thus improving user experience.

3.2 Category: Maximum access time

The access time to a website represents an element that will be part of the quality evaluation of the user, directly influencing the user's decision about whether or not to continue using that website.

Name: Loading rate

Guideline: The metrics considered in this guideline are heavily dependent on the maximum download time that the user is willing to wait to see the website or any additional element. An additional feature is defined as being any external component from the page the user wants to see, for example, downloading a text file, an image with higher resolution, etc. Nielsen [11] defines ten seconds as being the maximum time users will wait before they decide to choose another page. Taking into account this time and the download speed, it is possible to calculate what the recommended size of a page or additional element of the website should be. The page size is the sum of all the sizes of each element that composes it, or is the sum of all images, texts, scripts, animations, and other elements that make up the website page. You can calculate the maximum size with the following equation 2:

$$\text{Maximum Size} = \text{download speed} \times \text{maximum waiting time} \quad (2)$$

There are videos that do not need a complete loading when opening a page, since the total size of the video can be accessed by streaming if the user so wishes. Therefore, the size of the videos only represents the size of the application that will play them. In developing websites focused entirely on

mobile phones, it is recommended that pages have sizes of up to 20 KB [15]. As for the other devices, based on levels of access speed considered in this work, you can establish the following maximum sizes for a page described on Table 2:

Table 2. Maximum size for a page

Speed	Size
up to 256 kbps	up to 320 KB
between 256 kbps and 1 Mbps	between 320 KB and 1,280 KB
above 1 Mbps	from 1,280 KB

3.3 Category: Interface

The quality of the interface of a website aims to facilitate its use by the user through the organization of its established features.

a) Name: Text.

Guideline: It is recommended that websites be developed to make available a version where the images are not loaded by the browser whenever the user so wishes. This guideline is motivated by two factors: the first is the inability of some browsers to display the images and the second is to reduce the amount of downloaded data, thus reducing the access time to websites [18]. Moreover, it is necessary to allow the user to browse the page without any loss, even without viewing the images. As an example of how to put this guideline into effect, considering the use of HTML, the implementation of a text-only version could be done by adding the alt image tag within the HTML, as follows:

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<img alt="Name of the picture" ...>
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With this, instead of viewing the image, the user will only see the information according to the tag. This is a feature that provides benefits to access websites via mobile devices, since it reduces the amount of information to be accessed, and consequently stored, without affecting the usability of the website.

b) Name: Title.

Guideline: The use of titles for all images of the website helps the overall readability of the site and its use is recommended.

c) Name: Reading.

Guideline: The overall reading of the site is the user's ability to understand the information contained in it. The overall readability of the site, even when it is not displaying images, should remain unchanged. Therefore, the guidelines related to the text-only version and inclusion of titles in the images must be implemented, so that the user has no trouble in understanding the information even when not viewing the images.

d) Name: Compactness.

Guideline: The navigation map is a representation in the form of a tree structure of possible paths to be followed in a website. Map compacting considers the number of levels required to gain access to pages that have the desired information. It is known that the less effort made by the user to access the information he wants, better will be the compactness of the navigational map. Therefore, the amount of levels established in this guideline for the maximum size of the navigational map, takes into account that the pages have

used the maximum loading rate proposed in the maximum access time guideline. In addition, three other facts were considered: 1) studies show that users should be able to perform simple tasks within a website in one minute [10], 2) the time visiting a website lasts from one to two minutes, so the user must be able to reach the target website within that time or he will give up [19], 3) a user would spend, on more than 50% of the times, at least ten seconds to see each page of the website [19]. Therefore, considering that of the two minutes (average maximum time of one visit) the user can use up to one minute to perform the proposed task, we can then calculate the maximum amount of pages that can be visited before reaching the last one through the following equation 3:

$$(3)$$

The remaining time is the time of the visit less the time spent performing the task the user wants to accomplish. With that, the maximum use of up to three pages is indicated for the desired task to be accomplished. The high compactness of the navigational map contributes to the ease of access to websites through mobile devices, since they do not always have elements of interaction, such as mouse or keyboard.

e) Name: Scroll.

Guideline: The need for scrolling or rolling of the website page should be avoided. Studies show that the user will choose, in more than 75% of the times, a link which is available on the interface after the loading time. Therefore, the developer should avoid the use of long pages. Mainly for cell phones, this should be done due to the small size of their screens.

f) Name: Words.

Guideline: Users of websites tend to read only a little of the information contained on a page, and the more information available, the less will the user read. Studies show that users read at least 50% of the information contained on page that has 111 words or less [8]. Above this amount, the percentage of words read falls. Therefore, the use of short texts, with an option to expand them if the reader so desires, is recommended [8]. The use of few words improves visualization of websites when accessed by mobile devices, since they have very small screens.

g) Name: Scripts and flash.

Guideline: The use of scripts and flash on websites influences the user's experience in different ways, depending on the means of access used. The use of scripts can be very useful to developers, providing a powerful tool which can often improve elements related to the usability of websites. However, the use of scripts and the use of flash animation must be seen through a different perspective when developing an application that will be accessed via mobile devices. The different browsers used to access websites do not always have today's technologies so can cause serious problems, preventing the user from accessing the desired information. Therefore, one should avoid incorporating scripts and flash on items considered essential in the website.

h) Name: Map.

Guideline: The use of a navigational map, when downloading several pages of the website, helps the user to quickly locate the desired information without the need for extensive searching. Accessing the website through networks that have a low speed or high cost per KB, the use of the navigational map can reduce the time needed to reach the desired information.

i) Name: Dimension.

Guideline: Setting the size of the resolution established for a monitor may affect the experience that the user will have with the website. According to a study conducted by Market net share¹, about 21% of Internet users use a 1024x768 resolution and 17% a 1280x800. Due to this, the use of one of the two aforementioned resolutions is recommended to better serve users. In the category of mobile devices, specifically for mobile phones, the instruction is to use pages having a width of at least 120 pixels. Currently most mobile browsers implement functions that facilitate the viewing of websites with resolutions greater than this value [19].

j) Name: Frame.

Guideline: A frameset is a tag used in the HTML that gives the developer the division of the website in multiple frames, including the loading of other pages within each of these frames. When the Web started, the use of frames to create sites was very common, but due to problems related to navigation and location of pages by search engines, frames were gradually forgotten and currently only a few websites still use them. Therefore, it is recommended not to use frames in a website.

k) Name: Search.

Guideline: It is recommended that a search engine on the website be created for users to be able to quickly look for the content they want without the need for an exhaustive search through the site.

IV. WEBSITES ANALYSIS

The Internet has changed the way how companies conduct their business; it has become increasingly vital to their success. In recent years, e-commerce has grown and now moves billions of dollars in the global economy. In Brazil, e-commerce profit grew 30% in 2009 and peaked at 6.3 billion dollars². According to [20], 33% of the people already use mobile phones to buy goods over the Web and 47% to compare prices of products before purchasing. Another important fact is that users prefer to access the websites available on www instead of applications developed specifically for mobile phones.

Given the importance of the use of Internet for dissemination of company products and the need to develop quality websites accessible through any device, which are decisive factors for customer satisfaction, this article examined five Brazilian e-commerce websites: Americanas.com (www.americanas.com.br); Submarino

(www.submarino.com.br) ; NetShoes (www.netshoes.com.br); Compra Fácil (www.comprafacil.com.br); Saraiva (www.saraiva.com.br). The purpose of this analysis was to verify the impact of the adequacy, or not, to guidelines which aim to ensure indiscriminate access to information on websites, thus increasing the visibility of products and services and ensuring user satisfaction.

The analysis was done to rate total adequacy (T), partial (P) or inadequacy (I) of websites regarding the proposed guidelines, using the following access devices: a desktop, a laptop and a smartphone. To do this, we adopted that for the guidelines that have a set of values that vary according to the provided resources, we analyze the narrower range of values. Thus, the established connection speed for analysis was up to 256 kbps, which is the most used in Brazil. Moreover, it was observed that the browser used by smartphones and notebooks did not display images. Results are shown in Table 3.

Table 3. Web Site Analysis

Guidelines	Analyzed Websites				
	Americanas	Submarino	Netshoes	Compra Fácil	Saraiva
Media					
01- Length	T	T	T	T	-
02- Size	I	I	I	I	-
03- Images	P	I	I	T	I
Maximun access time					
04- Loading Rate	I	I	I	I	I
Interface					
05- Text	P	P	P	P	P
06- Title	T	T	T	T	T
07- Reading	T	P	P	T	T
08- Compactness	I	I	I	I	I
09- Scroll	I	I	I	I	I
10- Word	I	I	I	I	I
11- Scripts and flash	I	I	I	I	I
12- Map	I	I	I	I	T
13- Dimension	I	I	I	I	I
14- Frame	T	T	T	T	T
15- Search	T	T	T	T	T

4.1 Media

For this category, we found that this feature is beginning to be explored by Brazilian e-commerce websites as a way to demonstrate the benefits offered by their products. Furthermore, we observed that, generally, video viewing is done through a video portal available on the Internet, which makes access via smartphone difficult. Among the five analyzed websites, four had videos which only rated total adequacy for the "Length" guideline. Moreover, the guideline "Size" was not followed in any of the analyzed cases so, consequently, the efficiency of devices used for accessing was lacking. As for the "Images", only one of the websites had total adequacy to the guideline. The remaining images had been resized or without its actual size defined in the tag, which resulted in a partial rate for one site and inadequacy for the other three. This deficiency has led to problems related to portability and efficiency during the analysis, reducing the

¹ <http://marketshare.hitslink.com/report.aspx?qprid=17>

² <http://www.e-bit.com.br>

quality of user experience when accessing the site and causing the unnecessary loading of information and poor design of the page by the browser to a smartphone or notebook.

4.2 Maximum access time

In the guideline "Loading Rate" all websites examined had pages that exceeded the size limit to the speed selected. As a result, there were difficulties in accessing information through different devices, significantly jeopardizing desired efficiency.

4.3 Interface

In this category it was possible to observe some critical points regarding the efficiency and portability of analyzed websites. The guideline "Text" had been partially followed in the five analyzed websites as it was found that none of the websites provided a function that allowed the user to not access the images. This led to serious problems because the purchase button disappeared and was not easily found.

During the use of a smartphone, it became evident that the deficiency in this category was because guidelines were not followed, endangering, in many cases, the use of the website and causing a loss of quality. The guideline "Title" was fully met in all websites. The guideline "Reading" was met in part in two websites, jeopardizing the quality of interaction with websites when it was not possible to view images.

The guideline "Compactness" could be considered as met only in situations where you used the search as way to find the desired product. However, we found that when this feature was not used, the amount of levels needed to access the page with the desired information went beyond the limit with three pages. Moreover, the guidelines "Scroll", "Word" and "Dimension" were not met in any of the analyzed websites, making it difficult to visualize the information shown. The inadequacy of websites in relation to the "Scripts and flash" guideline caused a big problem when accessed via smartphone as this device does not support these technologies.

Thus, during tests with smartphones, the use with scripts that were not supported by the device prevented the access to links and thus denied access to various areas of the websites. The guideline "Map", rated total adequacy in only one of the analyzed websites. This made it difficult to search for information in the other websites. Finally, we observed that the guidelines "Frame" and "Search" were fully met on all websites. The guideline "Search" is used as a tool to aid navigation in all analyzed websites, which could not be otherwise when it comes to e-commerce.

V. CONCLUSION

It is undeniable that the search for websites that satisfactorily meet the needs of users is a requirement of the market and becomes a factor influencing customer loyalty and consequently the visibility of organizations. This paper therefore presented a set of guidelines that can help with the construction of websites that allow indiscriminate access to information regardless of resources.

Towards this end, the priority is for quality characteristics, portability and efficiency. In e-commerce websites, availability and easy access for users is an important element

for the success of the enterprise. As a result of the validation performed on five Brazilian e-commerce websites, we observed that the ones that only partially met the guidelines established in this work, or simply did not follow them, had their access to information jeopardized by low efficiency and lack of portability. Therefore, we conclude that more attention is needed to the design quality of a website as a way of ensuring greater availability and ease of access, regardless of the devices and network used.

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