# Preliminary web accessibility evaluation method through the identification of critical items with the participation of visually impaired users

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## Abstract

In order to ensure the access of the visually impaired to all information provided online it is necessary to remove existing barriers on the websites through several existent approaches, from recommendations to web development to validations of existing websites. The issues on navigating through the web that are detected only during the user's interactions on the sites, creates a need to evaluate this user's interactions aiming to ensure the web accessibility. So, in this scenery, this study uses previous researches on the subject and web accessibility rates in order to identify those barriers commonly founded by these users with total visual impairment, as well as to come up with a list of recommendations in order to optimize the evaluation process.

## 1. Introduction

Accessibility corresponds to the right of everyone to enjoy products, services and information that belongs to a life in society, regardless of their physical and motor, perceptual, cultural and social skills [1].

Currently, web development projects contribute to a more inclusive Internet and, knowing its importance, it can be considered to be more effective when allows access by anyone, regardless of their disability or any other type of restriction [2].

One of the steps to promote accessibility is removing barriers that may prevent daily activities [3]. There are several recommendations and guidelines to the development of accessible systems, such as the Web Content Accessibility Guidelines (WCAG). To verify that the websites are in compliance with these guidelines, there are softwares that automatically evaluate web page accessibility level [4].

The evaluation of a page also should be made with the participation of users with disabilities. This evaluation helps to identify additional accessibility barriers that are not easily discovered by an automatic validation or by a specialist. Understanding the real accessibility problems, designers can implement effective solutions that facilitate the access for all users, improving the site usability in general [5].

In this context, the present study analysed works that conducted web accessibility evaluations with users with total visual impairment in order to identify problems commonly encountered by them while browsing websites. From this, experts classified these barriers and selected the ones considered most critical for the evaluation process.

Also, an evaluation was conducted with total visually impaired users, focusing on the most critical problems, selected previously. So according to the observations made, it was possible to realign the list, resulting in a final one.

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After that, recommendations were created to assist professionals, when conducting web accessibility evaluations, focus their implementation in the identification/verification of the most common barriers during user interaction with the selected profile, optimizing the process and aiming to detect barriers on the pages to be evaluated.

Given the difficulty to perform accessibility tests with users, especially with total visually impairment, this study provides as contribution a set of recommendations that can guides the developers when designing accessible websites, since the main barriers usually faced by this user profile were previously identified. With these recommendations professionals can focus on the most critical problems.

## 2. Web accessibility

Many websites and softwares have accessibility barriers that hinder or preclude its use by many users. These barriers can be caused by the inadequate construction of the pages, leading to poor and hard understand interaction. People with total visual impairment access websites through assistive technologies - screen readers, but in order to work fairly well, these pages must be in accordance with accessibility guidelines [6]. To find out if a page is in conformance with the guidelines, it is necessary that its accessibility be evaluated according some method.

### 2.1. W3C proposed web accessibility evaluation methods

- **First review of accessibility:** through the use of it is possible to quickly identify some initial accessibility problems. The items for verification does not have the intention to serve as a definitive evaluation but cover some accessibility problems through simple steps and, after that, it is still possible to identify accessibility barriers even with all those recommendations met [7].
- **Website accessibility conformance evaluation:** it consists in an approach to determine a website conformance level with WCAG and should ideally be made after the first review and the removal of initial barriers [8].
- **Involving users in web accessibility evaluation:** by including real users in evaluations is possible to understand the real operation mode of the website and its resources, and, also, identify problems non encountered by the conformance evaluation [5].
- **Using combined expertise to evaluate web accessibility:** an effective evaluation must be performed by professionals with knowledge on current technologies, W3C coding standards, automated evaluation tools, assistive technologies, among others [9].

## 3. Research method

The present study contained four main steps: a) selecting a method and a support technique to be used; b) choosing the user profile as a focus of the study; c) preparation of the case study; d) analysis of results.

### a)  Selecting a method and a support technique to be used

As it was necessary to select the most critical items to be considered, it was conducted a bibliographic research that identified several problems already reported in the literature regarding the web accessibility evaluation involving users with total visual impairment.

After that, Delphi method was chosen, in order to: identify the most critical items through the participation of experts and prioritization phases; achieve a consensus between researchers and a rating for a given selection of items [10]. I.e., it was obtained a checklist, classified and prioritized, used for an evaluation involving visually impaired users to validate, record and analyse the results.

### b)  Choosing the user profile as a focus of the study

According to IBGE (Brazilian Institute of Geography and Statistics), in the last census conducted in 2010, 6.6 million Brazilians reported having some type of total visual impairment, declaring have great difficulty too see or even not see at all [11]. For this work was chosen focus on the websites evaluation for total visually impaired users.

### c)  Preparation of the case study

This case study was conducted in two steps, detailed in the following sections: application of the Delphi method and the users evaluation.

*d)  Analysis of results*

From the results and data obtained during the users observations were possible to make adjustments in the generated checklist, changing some items. Furthermore, this research resulted in a set of recommendations, through the use of this final list to conducting a web accessibility evaluation with total visually impaired users.

*3.1. Research limitations*

One limitation of this study was the choice of a profile of users, it is important to remember that visual impairment is only one aspect of web accessibility, other types of impairment also require efforts to have their access facilitated [6].

The selection of the websites to be evaluated and used in the case study restricted the accessibility problems encountered to a specific scope. Some problems reported in the literature were not found in the evaluated pages.

Another limitation is the concept of experts used, as according to the W3C it is necessary experience in web technologies, evaluations tools, barriers faced by people with disabilities, assistive technologies, among others. Due to the difficulty in finding a group of experts with a complete profile, were selected the ones with experience in web technologies and previous work in the field as well as familiarity with the culture and the navigation models used by the selected user profile. In addition, the questionnaire sent contained items about theirs previous works, confirming earlier experience in web accessibility evaluations.

## 4. Application of the Delphi method

This section describes the development of the checklist proposed through the application of the Delphi method.

*4.1. Gather group of experts*

For this stage, were developed two forms using Google Forms and SurveyMonkey tools, witch contained questions on the profile of the twelve selected participants. All the communication requests and feedbacks were made via email.

Most of them work with computers science, acting as a systems analyst, manager and programmer. In addition, most have a college degree, followed by participants with a completed master. In order to meet the participants' experience with web accessibility evaluations, it was necessary for them to respond which techniques they had already used, as summarized in Figure 1.
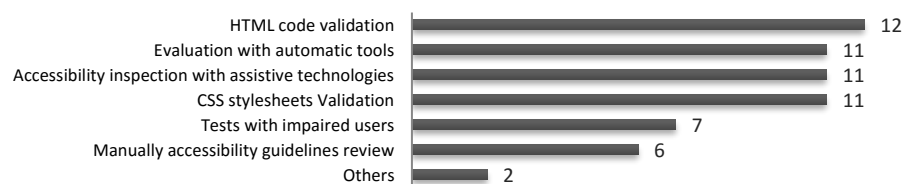


Figure 1: Accessibility evaluations performed by the participants of the panel of experts. Source: Collected data.

*4.2. Identify alternatives*

In order to identify the most common errors encountered in users' evaluations, a bibliographic review was conducted focused exclusively in researches with the participation of total visually impaired users. These works were filtered and the points highlighted by them were condensed into a starting list.

For this research, several periodicals, scientific magazines and journals were analysed, totalling 87 works, among these, nine were highlighted for containing findings of evaluations and accessibility problems encountered by users.

After that, 97 problems were identified in each of these studies and then, was applied a filter to select the items mentioned more than once, ordered by frequency and resulting in an initial list of 21 items, all cited more than once.

This selection, in addition to its intention of identifying recurring errors, i.e. that are reported more than once in evaluations, is based on Schmidt [10], which suggests that the number of items to be used in a round Delphi should be around twenty items.

*4.3. Phases*

The participants were contacted initially by e-mail, containing a link to the form with instructions and information about the research. In addition, it was also analysed the profile of the members and relevant information to the study (errors list elaborated in section 4.2). The following describes the steps taken during the Delphi method.

- *Delphi phase 1 – Limit alternatives*

It was designed a form through Google Forms, containing the items list, and the participants were asked to rate each one as "Neutral", "Important" or "Very Important". After the results given by the participants, the items with the lowest criticality were removed from the list. Initially five items would be removed, however, as some problems have been reported with the same level of importance, six of them were removed.

- *Delphi phase 2 – Classify alternatives*

It was designed a second form with SurveyMonkey, containing the items resultant from phase 1. And, after that, the thirteen experts were asked to order the new problems' list according to their relevance in an order from 1 to 15.

After the two phases described above, the initial list of errors was reduced to fifteen items as described in Table 1.

Table 1: Final list of critical items prioritized after the second Delphi phase.

| List of critical items |
| --- |
| Use of images to security verifications (CAPTCHA), without a proper accessible alternative. |
| Difficulty in navigating pages using the keyboard. |
| Lack of proper identification to images alternative textual description fields. |
| Lack of accessibility or accessible alternatives in multimedia files developed with Flash. |
| Difficulty in navigating inaccessible tables. |
| Lack of proper identification in form fields to be filled. |
| Difficulty in navigating on pages that use tables for layout. |
| Difficulty accessing non-accessible PFD files. |
| Interruption of navigation caused by automatic paging refresh. |
| Difficulty of understanding frames content without the proper description. |
| Highly complex pages and navigation structures. |
| Interruption of navigation caused by expired session. |
| Lack of proper feedback to actions taken. |
| Difficulty using pages search tools. |
| Interruption of navigation caused by pop-up windows. |

## 5. Users evaluation

This session describes the steps during the selection of participants and their respective profiles, execution of the tests and the results achieved.

## 5.1. Selection of participants

The evaluations were conducted with five participants, since is a number considered enough to understand the problems in a usability evaluation [12]. So, five users were present in the final evaluations and one was in the pilot test performed to arrange the procedures to be conducted [13].

For that, was contacted the IBC (Benjamin Constant Institute), reference centre for visual disability issues in Brazil, which has a school and conducts training activities, advice and medical care, among others activities [14].

Following the selected protocol [13], participants were asked to complete a questionnaire in order to obtain information on their profiles. All of them were male and had completed high school or college degrees and were aged between 35 and 67 years. In addition, other data were collected: half of the participants reported using the Internet for more than three years and four of them reported accessing the Internet daily, showing some familiarity with the context.

## 5.2. Selection of websites to be used in the study

The selection of the sites to be used in the case study was carried out from the list provided by Alexa web analytics tool[1]. For that, a search was carried to identify the most accessed websites in Brazil that provided community services and, from that, were selected three websites: 1) Caixa Econômica Federal (Caixa); 2: Correios; 3) UOL news.

Caixa, besides providing bank services, is also responsible for some social programs as the retirement program, social integration program, unemployment insurance, among others, representing activities of high relevance to Brazilians[2].

The next website to be evaluated Correios (Post office) website, public enterprise and of a federal scope, responsible for shipping and delivering correspondences in Brazil. Besides that, the webpage provides essential services as zip code searches and mails localization[3].

In order to include another type of information, UOL news website was added in this study, for being the news website more accessed in the moment of the research. Having more than 50 millions unique access by month, UOL provides an extensive journalistic content in addition to an Internet services and products platform[4].

## 5.3. Users evaluation location

All the evaluations took place in IBC informatics laboratory that provides classes on how to use the screen readers for people with several types of visual impairment. Problems with participants reaching the test location did not interfered in the research, since they were already used to attend to the selected laboratory to take their classes.

Besides that, all the required softwares were already installed and configured, the participants were already familiarized with the used technologies and all the evaluations were recorded with an extern camera, with their consent.

The machines used run Windows, with DosVox and NVDA installed, both used during the evaluations, according to the each user's preference. Even with others browsers installed, all the participants choose for Internet Explorer.

## 5.4. Pilot test

At first was conducted a pilot test, with one visually impaired user, in order to verify possible problems and flaws with the planned evaluation, according to the selected protocol [13]. After that, some adjustments were made in the script and tasks to be executed – in order of difficulty – leading to the final script described below.

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[1] http://www.alexa.com

[2] http://www.caixa.gov.br

[3] http://www.correios.com.br

[4] http://www.uol.com.br

*5.5. Users evaluation final script*

The participants were informed about the research details, such as goals and stages, and it was provided an electronic version of the consent form so he could read and signed for himself, through a screen reader and the user profile form was answered orally [13,15].

After that, the tasks to be executed (Table 2) were presented orally and also in an electronic version, in case the user wanted to re-look during the evaluation. Was emphasized that the participant, at any moment, could demand the oral repetition of the current task and he was encouraged to use the simultaneous verbalization technique during the interaction, reporting problems and difficulties that he might encountered [13,15].

The time limit for the task execution was 70 minutes, estimating 10 minutes for each task. Whatsoever, so that the evaluations did not become tiresome leading to uncertain results [16] and to avoid the frustration observed in the pilot test, was informed to the participants that, after 10 minutes, he would be notified, being able to give up of the task at any moment.

Table 2: Tasks to be executed in the selected websites.

| Tasks list |
| --- |
| Tasks – UOL website |
| Access Rio de Janeiro news page and check the main headline. |
| Access international news page and check the latest news sections, informing the five ones listed. |
| Tasks – Correios website |
| Search for the zip code corresponding to IBC address (Avenida Pasteur, 350 – Urca – Rio de Janeiro – RJ, Brasil). |
| Search for the address corresponding to Unirio CCET (Center of Exact Sciences and Technology) zip code (22290-255). |
| Tasks – Caixa website |
| Search for the address corresponding to a Caixa agency in Urca neighborhood. |
| Check which documents are necessary to buy a property using FGTS (Time of Service Guarantee Fund) from the corresponding Caixa page (http://www.caixa.gov.br/novo_habitacao/Minha_Casa/index.asp). |
| Access FGTS page (http://www.caixa.gov.br/fgts/index.asp), then the accounts statement, informing each one of them using the NIS (Social Identification Number) nº 14174664273. |

*5.6. Evaluation analysis*

During all evaluations it was noticed that the most patience users i.e., those who have read the pages almost completely, had more success in the tasks execution. Some participants, when realizing being in a different page that the one wanted, lost the navigation focus, accessing random pages, not knowing how to get back till the end of the task time. Another observed detail was about the search tool available; even if none of the tasks specified the use of this tool, all the users ended up recurring to it in order to find the desired content quickly.

It was also noticed that they, however, did not perceive several menu options that were made available via scripts during their interaction. Therefore, by selecting the desired links, the website response was only perceived visually, leaving the users confused without having a feedback to their actions. Besides that, the lack of non-visual feedback was constantly observed, as the users questioned several times to the researcher about the page status after their actions, like if the page was loading after trying to access some link.

Problems with localization were also perceived, since the users led themselves to other pages, including external websites, several times without noticing. Also, they accessed pages repeatedly without realizing that they had already read that content.

The participants were also confused about text content and available links, as, for several times, they tried to access inexistent options based on the reading provided by the screen reader, so, when they heard something related to the desirable theme they pressed the "Enter" key hoping to access a page, however not obtaining any results. This

problem was caused, sometimes, for the excessive information or by the elements misidentification, also making them to pass through the desirable content without perceiving.

## 6. Data Analysis

From the evaluations conducted, the main difficulties found by the participants and observed by the researcher were related to the errors list developed in the first research stage. Then, the barriers non-detected/included on the Delphi step were listed, generating a new critical problems list.

In Table 3 is possible to check the critical items ordered by the frequency that they were identified during the evaluation with the five users. From the fifteen most critical during the context interaction, five were not found.

Table 3: Frequency of the problems found according to the errors list developed.

| Error description | Frequency |
|---|---|
| Lack of proper feedback to actions taken. | 5 |
| Lack of proper identification in form fields to be filled. | 5 |
| Lack of proper identification to images alternative textual description fields. | 4 |
| Difficulty using pages search tools. | 4 |
| Highly complex pages and navigation structures. | 3 |
| Interruption of navigation caused by pop-up windows. | 2 |
| Difficulty accessing non-accessible PFD files. | 1 |
| Interruption of navigation caused by automatic paging refresh. | 1 |
| Difficulty of understanding frames content without the proper description. | 1 |
| Difficulty in navigating inaccessible tables. | 1 |
| Use of images to security verifications (CAPTCHA), without a proper accessible alternative. | 0 |
| Difficulty in navigating pages using the keyboard. | 0 |
| Lack of accessibility or accessible alternatives in multimedia files developed with Flash. | 0 |
| Difficulty in navigating on pages that uses table for layout. | 0 |
| Interruption of navigation caused by expired session. | 0 |

Table 4 presents the new problems found during users evaluations, not covered in the errors list first developed, with their correspondent occurrence frequency.

Table 4: New problems found by the users evaluations frequency.

| Error description | Frequency |
|---|---|
| Difficulty in identifying pages. | 5 |
| Lack of proper identification referring to the pages to be accessed by the links provided. | 4 |
| Impossibility to cancel the current operation. | 4 |
| Difficulty in using/understanding links with imperceptible functions (like changing the visual presentation from an element). | 2 |
| Difficulty of understanding frames content without the proper description. | 1 |

From the five new identified problems, three of them were present in previously works analysed in the literature search, from that, two were included in Delphi phase 1 but considered less critical than the others according to the experts consulted.

### 6.1. Final critical items list

With the results of the two conducted studies, the items contained in the list developed in Delphi method that did not caused any interference on the evaluations were removed, as the new identified ones were added to it, generating a new fifteen items list ordered by their occurrence frequency, as shown in Table 5.

Table 5: Critical items list restructured after users evaluations.

| Final critical items list |
| --- |
| Lack of proper feedback to actions taken. |
| Lack of proper identification in form fields to be filled. |
| Difficulty in identifying pages. |
| Lack of proper identification to images alternative textual description fields. |
| Difficulty using pages search tools. |
| Lack of proper identification referring to the pages to be accessed by the links provided. |
| Impossibility to cancel the current operation. |
| Highly complex pages and navigation structures. |
| Interruption of navigation caused by pop-up windows. |
| Difficulty in using/understanding links with imperceptible functions (i.e. changing the visual presentation from an element). |
| Difficulty accessing non-accessible PFD files. |
| Interruption of navigation caused by automatic paging refresh. |
| Difficulty of understanding frames content without the proper description. |
| Difficulty in navigating inaccessible tables. |
| Lack of content shortcuts. |

Other barriers also identified in the evaluations and previously works were considered general user interaction difficulties. These problems may be consequence of a navigation model not focused in the reading performed by the screen reader, such as: loss of much of the perceptual experience, by the fact that most of pages are developed focusing on visual navigation; difficulty in understanding pages not designed linearly; differences between the visual layout and their code description; difficulty in understanding the functioning of the tools available. Those items were not included in the final list for being related to a bigger context that should be considered at page development, since they consist in usability problems, which may affect also others users' profiles.

Another point to be considered was the difficulty to distinct structural content page's mark-up read by the screen reader, however this barrier was understood as a problem with the screen readers used.

Besides that, during the evaluations, the suggested tasks were elaborated in such a way that the necessarily users found those problems in order to make possible to observe the navigation interference from that barrier. Some of the items were not analysed since any participant achieved the last task and only one of them concluded the second last.

### 6.2. Recommendations for evaluations with total visually impaired users

W3C provides a first review guide covering some accessibility problems in order to obtain a general status about the accessibility of the page provided, however, these items are intended for an evaluation to be conducted by specialists before conducting an evaluation with final users [7].

The present work aims to provide a support for the specialists that conduct web accessibility evaluations with total visually impaired users, guiding them through the main problems that should be analysed. From that, is expected that the tests involving final users can be conducted in an optimized way, achieving to detect the main obstacles.

Besides that, W3C also guides evaluations involving users, but either in W3C or in the literature was found guiding to which points have to be checked in a user evaluation. So, trough the identified barriers, the final critical items was developed, providing information to support evaluations with users.

It also can be considered that, by treating the identified problems, several barriers will be removed. From the knowledge acquired on the problems faced by the users, to each item listed was explicated what to check during the evaluation to guarantee that the barrier had not caused difficulty and/or interruption in the user navigation.

- **Feedback to actions taken properly provided:** several actions are not perceived by the user that, without knowing what happened with the page, make the same steps or give up from the current navigation. It is necessary that, when interacting with websites and theirs tools, user have a clear status of his localization at the current page and action taken. The pages have always to inform the user of changes made, checking if he is aware of these information.
- **Form fields identification properly provided:** regarding to form navigation, it must be considered the general context that it is located. In pages that contain excessive information and texts, the localization becomes complicated, so the user has always to receive essential information about the fields to be filled. When using forms is necessary that, besides labelling correctly with information concerning the filed, fields labels also have clear information about the general form, avoid the context loss by the user.
- **Pages properly identified:** when accessing a new page, especially subpages, i.e. intern pages from the same website, the title of the page must reflect the content available. Therefore, it should be checked if, when accessing a page, the user is able to understand the page general subject. It also has to be checked if the title provided concerns only the subject matter, not including others themes outside the context.
- **Textual descriptions of images properly provided:** regarding images, is essential to ensure that the correspondent alternative text is relevant and pass the same message than the image; however, in case of decorative images the *alt text* may be omitted. For the navigation of those users is more important a simple and informative page, since excessive information causes tiredness and takes the focus out of the navigation. It is important to ensure that these elements do not represent a barrier for their navigation bringing only clear and essential information.
- **Search tools efficiently provided:** when using a search tool the user must be able to search not only for the text content but also have access to all menu options and features available in the website. Beside that, its use must be guided with filled instructions to avoid confusion, since the user may not know how to conduct this process. The website also has to consider treating the terms to be searched, suggesting possible expressions and options to the user.
- **Pages to be accessed by the links properly identified:** links should have, besides the proper title attribute, a correct description to the page to be accessed by it. It should be avoided the use of excessive information so the user can have the right understanding of the action to be taken.
- **Capacity of errors recuperation properly provided:** when taking undesirable actions, like access the wrong page, fill a form, access frames among others, the user must be able to retrocede in his navigation. The website should provide information and resources to go back to the previous action and/or cancel the actual one.
- **Pages and structures of navigation simply designed:** in pages with a lot of information, it is essential that the page structure is simple, avoiding the use of many sections and content blocks. When keeping the page linearity, the reading made by the user is facilitated, as he is able to follow the order established by the layout. It is necessary to check if the user, besides reading the page, is also capable to understand its structure.
- **Pop-up windows that interrupt navigation avoided:** several times, websites present information through windows that overlaps the content. The ones created with page code addition usually do not represent a difficulty for the users, because, when made available, are not perceived by them. So, in case that website has to provide some essential information to the user, having to interrupt his navigation, it is recommended the maximum of clarity in the message and in its identification. It should be also considered that this windows must be avoided, since causing an interruption of user navigation, he may became confused and lost the current line of thought.

- **Links with imperceptible functions to the user identified properly:** when using resources that perform only visual changes on the page, is essential that the user is notified, i.e. in links that do not execute the expected/default behaviour – like access a new page – the result of its action must be adequately provided.
- **Access to PDF files properly provided:** the user must be able to perceived all the information available through PDF files, since that may become an impeditive barrier to access the content.
- **Automatic page refreshing avoided:** this feature should be avoided since that causes a severe navigation interruption, leaving the user really confused. However, in case that its use is indispensable, the user must be notified, informing him what it will happen and the reasons of this action.
- **Identification of frames properly provided:** when providing pages inside frames, the element should be identified correctly, allowing the user knows his location and the accessed content.
- **Navigation of provided tables properly provided:** during tables navigation it is necessary to ensure that the user is capable to understand its structure, navigate through it and access all information available, identifying header and content sections.
- **Content shortcuts provided:** websites, traditionally, have lots of information before the content, like menus and headers. So, the navigation becomes tiresome to the user that, besides the excessive texts, still has to read all this initial area each accessed page. Providing a shortcut (skip link) direct to the content represents a substantial help and should be available, verifying its proper functioning.

## 7. Final considerations

This work aims to contribute with inputs for conducting evaluations with visually impaired users. Once that is provided by several organizations, guides and checklists to evaluate artefacts, development processes, automatic tools evaluations among others, this stage with users is considered very costly, being essential to make the most of it. Therefore, to make it less subjective, providing a checklist to the evaluators, it may be possible to identify more clearly the accessibility problems in websites according to the total visually impaired users interaction.

Future work includes carrying out this preliminary research with another user profile. Also, applying those recommendations in a complete evaluation in order to analyse the results.

## Acknowledgements

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