



Web accessibility evaluation from the perception of people with disabilities: case of Argentina

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Abstract

This article analyses web accessibility, not only from a regulatory point of view, but also from the emotional burden it implies and affects people with disabilities (PwD). In Argentina a significant number of e-government services for citizens are available only on the Web, without proper accessibility considerations, increasing the marginalization and loss of autonomy. Argentina still fails in digital accessibility according to the biennial reviews of the Convention on the Rights of PwD. For this reason, research on the perception of accessibility was developed with the participation of 53 PwD, based on their experiences of interacting with Argentine websites. Also, a technical evaluation of web accessibility according to Web Content Accessibility Guidelines (WCAG 2) standard is included, in order to have a comparative analysis between what is perceived at user experience (UX) perspective and what is automatically validated. Several usability evaluation techniques considering accessibility were used such as interviews and questionnaires for the perception accessibility evaluation, and heuristic evaluation and cognitive walkthrough for the technical accessibility evaluation. After this comprehensive study important reflections emerged. The human impact and UX must be factored into technical accessibility criteria. An unmet accessibility criterion can generate several deep emotional aspects. The perception of web accessibility is built through multiple experiences in which people face barriers not only from the interaction with each particular website. Web developers have to listen to the voices of PwD, to gain a better understanding of their experiences and advocate for their rights creating a more accessible and inclusive web.

Keywords Disability · Web accessibility · User experience · Usability evaluation methods · WCAG

1 Introduction

In today's interconnected world, technology has a profound impact on our daily lives. The digital landscape has undeniably reshaped how we live, work, and interact. Its access is essential to social interactions, to carry out our daily

activities, to stay informed, to acquire new knowledge, to adopt tools to stay competitive and to be able to endure and thrive in this environment. Digital accessibility, especially web accessibility, becomes a necessary condition to avoid exclusion and marginalization, and to guarantee equal opportunities for all vulnerable communities such as Persons with Disabilities (PwD).

PwD are able to navigate the Web with the assistance of assistive technologies such as screen readers, screen magnifiers and other products. However, if websites fail to adhere to accessible development standards, they are unable to be accessed successfully by PwD, resulting in limited or erroneous access to web content. The digital barriers that have been generated or persistently exist impede the transformation that society needs to be able to adapt to constant technological progress and reap the benefits that this progress offers in order to improve the quality of life of its citizens.

Accessibility is a quality of software that supports different user interaction scenarios, settings and technologies.

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Users with disabilities, in a digital poverty condition or in other vulnerable situations, might require access to and use of websites and applications through specific interaction contexts [1].

Insufficient access to the Web can mean that PwD are placed in vulnerable situations in society and exposed to serious risks of discrimination, poverty and social exclusion. Accessibility affects the user experience (UX) at an emotional level in a more profound way than any other software feature. Compared to usability, this goes beyond the level of satisfaction, it is to be able to access or not to access web content and services, it is to feel considered as a potential user or to feel totally excluded [2].

At present, web accessibility is regulated in many countries. Most nations and regions in the world have laws and policies that promote digital accessibility, especially for public websites. The approval of the Convention on the Rights of Persons with Disabilities (CRPD) of the United Nations (UN) [3] has promoted the development of the regulatory framework on digital accessibility in the countries that have adhered to it. Argentina adhered to the CRPD in May 2008 and in November 2010, the Law 26.653 was unanimously adopted. This law concerns the accessibility of the content of websites belonging to public sector bodies, with a particular focus on ensuring that citizens with disabilities and the elderly are able to access said content [4, 5].

Regarding the level of compliance with the CRPD, there are disparities and different progress among the Member States that have adhered to it. The latest UN review on accessibility in Argentina determined that the level of compliance is still pending, and that accessibility problems must be addressed from several aspects that have not yet been resolved [6]. For this reason, it is important to know the actual accessibility compliance level of Argentine websites, with a focus on how it really affects PwD, as well as their assessment and emotional impact. It is necessary to inquire about their emotions when interacting with a website that is accessible and one that is not, even more when the transaction or service is only available online. It is important to consider the human factors involved in the user interaction, before performing a transaction or task in a software system, while developing it and after its completion as specified by Norman in his definition of UX [7].

Therefore, the purpose of this article is to analyze the assessment or degree of awareness of web accessibility based on the experience of the PwD. Aspects of human factors and the transversality and integrality of accessibility will be taken into account. For this purpose, 53 PwD were consulted and commented on their experiences of using Argentine websites and applications and expressed their degree of assessment regarding perceived accessibility. This analysis was complemented with the technical and

normative evaluation of accessibility in order to also have a comparative analysis between what is automatically validated and what is perceived at an experimental level by PwD.

In the following section, web accessibility will be approached from the normative and legal aspect in Argentina in order to provide the context of the research developed. This is followed by a review of literature related to the area of research. Then, the web accessibility analysis process is explained from the assessment and perception of the PwD consulted, including details of the sample, methodology, instruments used and the main results obtained from the research. It also describes the technical and normative evaluation of the websites referenced by PwD. Finally, the conclusions of the study and future work are detailed.

1.1 Web accessibility legal framework in Argentina

According to Argentine Law 26.653, web accessibility refers to “the possibility that the webpage content can be understood and consulted by people with disabilities and by users who have different configurations in their equipment or programs” [5]. This law was unanimously approved in November 2010 and is in compliance with the CRPD through Law 26.378 related to Argentina’s adhesion to CRPD and its facultative protocol [4]. This law obliges the National State and its three powers (executive, legislative and judicial), public service entities as well as organizations with subsidies, contracts or other relationships with the State, to provide accessible websites.

The Oficina Nacional de Tecnologías Informáticas (ONTI) (in English, the National Office of Information Technology) of Argentina regulates the bases and criteria for applying accessibility. Its latest act of September 2019 refers to the guidelines WCAG 2.0 [8]. Specifically, it requires compliance with accessibility criteria of priority A and AA of that recommendation [9].

Since Law 26.653, the Argentine provinces have been adhering to it, establishing their own legal regulations, as is the case of Law 15.115: on Accessibility in information, approved in the Province of Buenos Aires, in 2019 [10]. There were also other important initiatives such as that of the Banco Central de la Nación Argentina (BCRA) (in English, Central Bank of the Argentine Republic), which expanded its regulatory framework to improve accessibility to the financial system for all PwD thorough Communication “A” 7517 of May 2022 [11]. In its Sect. 3, it proposes to consider the WCAG 2.0 recommended by ONTI for financial and banking websites -including home banking- to guarantee accessibility for PwD.

With regard to the CRPD, the UN carries out biennial reviews of the degree of compliance by each adhered State,

through a specific committee for this purpose. In its latest review report of Argentina, in December 2023 [6], it expresses its concern, among other issues, about the following state of situation:

- Little progress in ensuring and improving accessibility in key areas such as education, health, access to justice and public transport;
- Lack of accessibility of the electronic documentation management system and the web platform for remote procedures for citizens, as well as of the governmental mobile application.

These points highlight the transversal and integral scope of accessibility that must be applied in e-government, e-health, transport, e-commerce, e-education and other areas. The use of the Internet is essential nowadays to carry out important activities for the community and even more so when there are functionalities and transactions that are only available on the Web. Applying accessibility governmental mobile applications is also requested. Although they are not required by Law 26.653, they have been emerging significantly in recent times with essential services for citizens.

The UN review committee's report [6] shows that accessibility is still an unresolved issue in the country, that there are still digital barriers in access to information and services available to the citizens, mainly those with disabilities. This means that even if people have assistive technologies and adaptations in their devices to browse web pages or access mobile applications [12], if these websites are not designed and developed in compliance with accessibility standards, interaction and access to them will be unsuccessful. This situation leads to a lack of autonomy and violates the rights of PwD to access information [13].

Argentina does not have any regulations on the usability or quality of use of software. Accessibility is a quality related to usability, but it has more profound implications if we analyze it in terms of human factors [14]. One issue is a time-consuming navigation to locate a desired option within a web page, and an even more serious problem is a complete or partial inability to access it. One difficulty may be the high-cost of performing a task but another is to overcome the accessibility barriers before dealing with those usability problems.

According to Norman [7], User Experience (UX) encompasses all aspects of the end-user's interaction with the company, its services, and its products. ISO 9241–210, which deals with ergonomics of human-system interaction, also defines UX as “A person's perceptions and responses that result from the use and anticipated use of a product, system or service” [15]. But, in the digital experiences of PwD, the emotional issues that are manifested in the lack of

accessibility are also of a different kind. Accessibility barriers can have a profound impact on the emotional and psychological well-being of individuals with disabilities. When people encounter obstacles in accessing digital content or services and also, in other products and places, it can lead to feelings of isolation, frustration, anger, feeling disrespected and undervalued.

A lack of accessibility can affect their self-esteem and mental health, leading to an increased risk of anxiety and depression [16]. It is crucial to recognize that accessibility is not just about compliance, but also about creating inclusive experiences that respect the dignity and autonomy of all users.

1.2 Literature review

Both the CRPD and the International Classification of Disability Functioning and Health (ICF) [17] recognize that the participation of PwD in activities is fundamental and that this can be affected by environmental factors and the context in which PwD live. They define disability as a situation, not a characteristic of individuals, and that it can be aggravated or intensified by interacting with social or environmental barriers that obstruct their full, effective and equal participation in society. The CRPD, in turn, endorses accessibility as it specifically states in Article 9 to ensure access to the physical environment, to transportation, to information and communications, including software systems and to other facilities and services open or provided to the public [6].

During the COVID-19 pandemic, the critical importance of digital access and inclusion was dramatically highlighted [18]. With widespread lockdowns and social distancing measures, the Web became an essential tool for education, healthcare, employment, and social connection to maintain social ties, highlighting the need for inclusive digital spaces [19]. After that, several services and procedures still remain exclusively online.

In this sense, it is important to carry out a survey on literature in the field of study, considering the last years. To cite a few examples, a Springer Link query on all metadata including terms such as “Web Accessibility Perception of People with Disabilities” in the last 5 years showed 362 results, in IEEE Xplore Digital Library it showed 13 results and, in Wiley Online Library, Computer Science returned 328 results. In the case of Taylor & Francis Online returned 6,658 results considering all the open access journals. The queries from which the above results were obtained are detailed in Appendix A.

Analyzing the works found, we can highlight those that address advances in accessibility such as facial recognition of emotions, robotics and disability, Artificial Intelligence (AI), home automation and smart cities. Others carry out

studies on accessibility applied to accessible tourism, accessible museums, as well as on electoral voting systems, educational platforms or health systems. However, the related works relevant to this article were based on the accessibility of websites and web applications and how this affects PwD.

MartínezTorán, M. and Sendra, C. conducted research on digital accessibility and its different applications on a population of 390 PwD from different provinces of Spain [20]. Among their most interesting findings is the community's need for access to the Web for training and job search. This work emphasizes the need to improve accessibility in order to be able to access the same content and services used by the majority of people. They request to use the same websites or mobile applications as everyone else, without any particular group being excluded.

In their study, on students with disabilities in higher education in Spain, Gutierrez et al. [21] claim to have to face six barriers that still exist beyond current legislation. Among the barriers to be faced, such as teaching, communicational, architectural, social and institutional barriers, there is a lack of digital accessibility mainly in websites, educational materials, repositories and web platforms of educational institutions.

The investigation conducted by Finkelstein, A. and Gross, T. in Israel shows the importance of integrating the experiences of PwD in research and information about their rights [22]. Based on 61 PwD surveys and 9 focus groups, the results show that the most important barriers they face are stigma, bureaucracy and digital inaccessibility. These are issues that affect decisions and limit the behaviors of PwD both in everyday life and in significant stages of life.

Borowska-Besztet al. conducted an analysis on accessibility in banking apps [23]. They examined a selection of mobile banking apps from four Polish banks that had to adapt and make their apps accessible due to complaints from customers with disabilities who reported financial exclusion. Despite the adaptations made, and the fulfilment of several accessibility criteria, the study indicates that this is not enough. More guidelines are needed to improve the usability and accessibility of these applications, resulting from further involvement and research on the interaction and navigation of PwD.

Alajarmeh, N. conducted exploratory research on the accessibility of public health websites in some 25 countries [24]. From Latin America, it includes Mexico and Brazil. These official websites provide reliable information on appropriate health advice, medical advice on disease prevention and control, and relevant topics such as the COVID-19 pandemic. The health websites allow citizens to be kept informed about essential health issues, mainly by avoiding informal, arbitrary or fake sources of information. One of the main findings of the study is the lack of accessibility

compliance in most of them, regardless of whether the country had specific legal regulations on eHealth accessibility or not.

In relation to large-scale analysis of web accessibility, Martins, B. and Duarte, C. [25]. conducted a systematic study by applying automatic accessibility evaluation to 2,884,498 web pages from 166,311 websites in different countries. Among their main findings, they found an average of 30 errors per page and only 0.5% of the websites in the sample are accessible, considering WCAG 2.1 level A and AA.

According to the literature reviewed, it can be concluded that the lack of accessibility is a recurrent problem that still persists and is worldwide. Also, studies conducted by Alajarmeh, N. [24]., Borowska-Besztet al. [23], Gutierrez et al. [21], and MartínezTorán, M. and Sendra, C. [20]. revealed that digital barriers are present in different types of websites such as health, banking, education or for training or job search, infringing people's rights to access information that is fundamental to their daily activities.

Finally, important research on formal metrics and questionnaires for assessing UX and subjective issues over the last decades was discussed. Beyond usability satisfaction questionnaires such as System Usability Scale (SUS), there are others specific to UX [26]. These may include User Experience Questionnaire (UEQ), meCUE or AttrakDiff questionnaires such as those described by Díaz-Oreiro et al. [27]. In these cases, they use pre-established categories about the software such as complicated/easy, recommended/not recommended, confusing/clear, unpredictable/unpredictable, among others. The UEQ study by Laugwitz et al. [28] uses a scale with 6 categories. It qualifies if the application is attractive, that is, if users like or dislike the product; if it is easy to get familiar with and learn to use; if it is effective, if users can solve their tasks without unnecessary effort. Other factors also include flexibility, whether users feel in control of the interaction and finally, stimulation, whether they find it exciting and motivating to use the product and to use it again.

In contrast to the literature analyzed, our study differs in that it does not use categories of possible qualifications about the products used, but rather about the users' own emotions. The focus is on how PwD feel when using accessible or non-accessible websites. The perceptions, thoughts, subjective and emotional aspects experienced by people in these digital experiences are investigated. In addition, another differential issue to take into account is that the categories considered in this study were defined through a participatory process with PwD, they came as a result of people's own interventions and opinions.

2 Materials and methods

The aim of our research is to evaluate PwD's perception of accessibility based on their experiences in a broadest sense, considering the transversality and integrity of accessibility. The accessibility perception may come from not only as a result of PwD's experiences using or trying to use websites required to carry out their daily activities, but also as a result of a conjunction of feelings, emotional traces and memory obtained in multiple and continuous experiences interacting with the digital environment and other contexts as a whole.

In order to have a comparative analysis between what is perceived at an experimental level and what is automatically validated, a technical and normative evaluation of accessibility of websites is included. The methodological process consists of two consecutive main phases:

- Evaluation of the perception of accessibility: includes the calling for PwD with different disabilities, computer literacy and age, the data collection through questionnaires and individual interviews and the analysis of the results of the accessibility evaluation regarding PwD perception;
- Technical evaluation of the accessibility: includes the selection of websites most referenced by PwD, the normative evaluation according to WCAG 2.1 standard and the analysis of the compliance degree.

The following sections discuss methodological issues, the sample of users and data collection instruments used. Then, the results obtained in both evaluations will be explained, and finally, the comparative analysis between perception and technical evaluation of accessibility is explained in the Sect. 6 Discussion.

2.1 Sample of users

When PwD were invited to participate in the inquiry process, they were asked about their disability, age, computer literacy, technical requirements to use the computer and preferred devices to access the Web.

In this study 53 PwD participated. There were 8 blind participants; 14 with a visual disability; 3 with autism; 3 deaf; 2 had hearing disability; 2 had dyslexia; 10 had a physical disability in upper extremities and 11 were elderly people. Each individual indicated his or her own disability status and self-identified with a profile. Older participants stated that they had some hearing, motor and visual impairments related to the age, "because of the age", they said.

On this point, Leahy discusses the tendency to separate or reject elderly people from disability [29]. He suggests that there is a difference in the identification processes of

people who experience disability first in older age compared to those who experience it earlier in life.

This analysis implies that older individuals are often assumed not to identify with a disability identity, while younger individuals are more likely to do so.

In terms of age, 16 participants were between 20 and 35, 18 between 36 and 50, 11 between 51 and 65, and 8 over 66 years old. Regarding the level of studies in progress or completed, 7 participants had received primary education only, 22 had secondary education, 11 had post-secondary trades and 13 had university education.

Regarding the different assistive technologies, the PwD used, and considering that several participants selected more than one technology, we have:

- Screen readers (14 PwD);
- Screen settings i.e., high contrast (21 PwD);
- Magnifiers (18 PwD);
- Captioning (9 PwD);
- Keyboard interaction (20 PwD);
- Plain language, simple organization and help (47 PwD);
- Neither flashes nor movements without user control (32 PwD).

Finally, regarding the use of devices for web browsing, 38 PwD prefer the computer for important or large transactions and the mobile phone for communication, mobility and social networks, while 11 only use computers and 4 only mobile phones.

2.2 User data collection for accessibility perception assessment

Before starting the evaluation process of the perception of accessibility, PwD were introduced to the research team and a presentation of the objectives and the steps of the evaluation were given. It was emphasized that it was not the people who would be evaluated but the websites they referred to. They were also asked about the requirements to be taken into account in the evaluation process. All the participants were asked for informed consent with their rights, indicating that they could leave the research at any time, and that the websites would be analyzed, not the people who use them.

The methods of user data collection were by an initial questionnaire and a subsequent personalized interview. Of the 53 participants, 39 answered the questionnaire and participated in the interview in person, the remaining 14 remotely. The physical place and the virtual space were adapted with the resources requested by PwD. A sign language interpreter was available, screen readers and screen magnifiers were installed and configured, and headphones were made available.

The questionnaire used in this research is included in Appendix B. It consisted of three parts. The first part is to find out about the characteristics and profile of the participants. The second part is to ask PwD about their user interaction experiences or use cases of websites they had used or tried to use and that they wanted to give their opinion on. The other part of the questionnaire is about subjective questions.

The questions in the first part that PwD had to answer were: Which Argentine websites would you like to comment on accessibility based on good or bad experiences of use? What kind of application was it, i.e., governmental, educational, commercial, entertainment, banking? Was it the only way to perform the task in mind? Were you able to achieve your objectives or tasks on the website and how, with or without difficulty, with or without help? Finally, they were asked if they experienced any difficulties in using the website, such as problems in perceiving or understanding the content, in interaction and navigation, or if they experienced technological problems such as the website did not support assistive technologies, a non-standard browser or a slow connection.

The subjective part of the questionnaire consisted of open-ended questions to allow people to make a final and conclusive analysis of their experiences of using the websites discussed. The questions were: How did you feel before you had to use a website to perform a task or transaction? How did you feel after using it, whether you achieved your goal or not? Why did you think that there were still inaccessible websites despite legislation? Finally, they were asked if they thought that technological advances such as AI could help to improve accessibility and inclusion.

All 53 PwD answered the questionnaire. Although the questionnaire gave them the possibility to read and complete it at their own time, the open-ended subjective questions in the second part of the questionnaire were answered very briefly. Complementing this with a semi-structured in-depth individual interview conducted with PwD after responding to the questionnaire, gave them the opportunity to reflect on the difficulties and barriers they experienced, and to better explain their feelings and emotions.

2.3 Tools for technical accessibility evaluation

In the technical accessibility evaluation process, there was no user participation. This process consisted of an exhaustive study on the selected Argentine websites that required the following instruments or technological tools:

- **WAVE Chrome extension:** this web accessibility evaluation tool, version 3.2.7.2, was required to analyze many WCAG accessibility criteria. It is a very useful

tool for testing issues of contrast, reading order, semantic structure of headings, link texts, accessibility names, language definition, accessibility of forms, among other important accessibility features;

- **Screen readers:** NVDA for Windows was used and mobile screen readers such as Talkback for Android and VoiceOver for iOS. These are very important tools for analyzing both keyboard and gesture-based sequential interaction, also able to analyze the perception of content through listening;
- **Other tools:** several software programs were used for manual checks on the websites to be analyzed and to subject them to different interaction scenarios. For simulators of different visual conditions the Chrome extension Web Disability Simulator was used, as well as magnifiers such as built-in browser zoom. To simulate an interaction of a person with dyslexia, Dyslexia simulator extension for Chrome was utilized, and finally a Windows Resizer tool was installed to check the responsive design.

3 Results of the comprehensive accessibility evaluation process

In this section we analyze the results obtained from the integral evaluation process carried out on the accessibility of Argentine websites, which included both a study on the perceived accessibility based on the experiences of use of people with disabilities, and a technical analysis of the sites referenced by them.

3.1 Results regarding experiences of use

Through the questionnaire and the interview, valuable information was obtained from PwD. The interview method allowed many participants to elaborate on their experiences of use, referring to more than one Argentine website: 12 PwD reported on their experience with one website, 20 people on two websites and 21 on three websites. In total, 109 experiences or cases of use were reported and commented on. Some people referred to the same website.

According to the type of website, 16 commented experiences of use were about government websites; 45, about commercial websites; 11, about health websites; 5, about information websites; 9, about educational websites; and 20, about banking websites.

The government websites included public services websites and mobile web applications. In the commercial category, transport websites, supermarkets, delivery systems, free market and travel systems were considered. In healthcare, social security websites were consulted, as well as

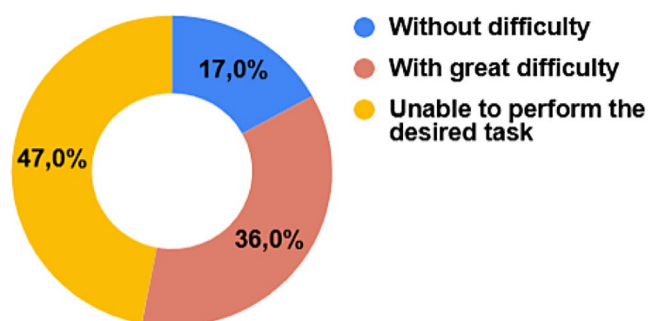


Fig. 1 Percentage of task accomplishment

websites for appointments at doctors' surgeries and hospitals. At the banking level, home banking and virtual wallet applications were mentioned.

In terms of whether they were able to perform the tasks planned on the websites referred, according to the experiences described by the respondents, it can be highlighted that in 19 experiences of use, PwD carried out their tasks in mind without difficulty; in 39, they achieved the objectives but with great difficulty; in 51, the PwD was unable to perform the desired task. Figure 1 illustrates these results with their percentages.

In 65 experiences of use reported by PwD, they asked for assistance, of which in 37 cases they had to let the person who helped them finish the whole task for them and in 28 cases they were guided. In the other 44 commented experiences of use, PwD did not request assistance, because they could not find someone available at the time (14 cases) or because they preferred not to do it (30 cases). In both circumstances, the task remained unfinished.

Finally, regarding the accessibility problems encountered during the interaction based on their experiences of use commented, they could answer more than one option: in 17 experiences of use they did not detect any drawbacks; in 53,

they detected accessibility failures due to content perception problems; in 44, they detected interaction and navigation problems; in 28, they detected comprehension problems; and in 15 experiences of use their assistive technologies were not supported by the website. Figure 2 illustrates these results.

Through the interviews, some adjustments were made to the above categories. Inadequate or insufficient alternative texts, such as describing an image using the name of the image file or explaining different images with the same text, were considered as comprehension problems by 5 PwD, and were internally computed as a perception failure, as referenced in the WCAG [8]. Other perception problems were considered as comprehension failures by PwD such as lack of subtitles, overloading with information, unclear organization. In other cases, interaction and operable accessibility problems such as too many steps to reach an option mainly using screen readers or presence of distracting animations or movements were considered as perception problems by PwD.

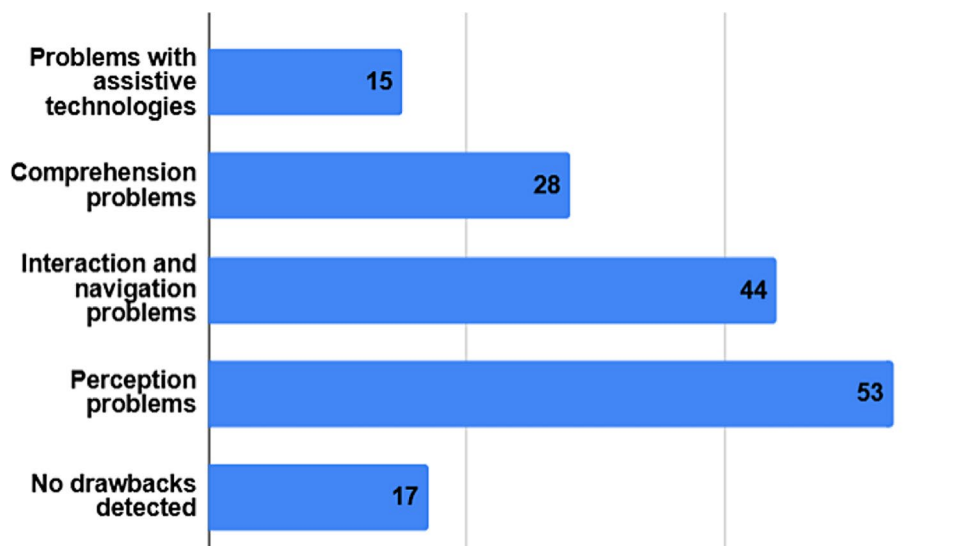
3.2 Results regarding emotional issues

After discussing experiences of use, PwD had to complete the open-ended and subjective part of the questionnaire. In addition to the surveys, they were able to reflect on these digital experiences and clearly express their feelings.

During the participants' reports on their experiences in using the websites, many feelings came to the surface, as described below. This is accompanied by expressions and phrases that were striking, worthy of being highlighted.

- **Feeling marginalization:** due to the fact that the sites they visited did not cater for their interaction requirements. Most of the PwD, exactly 41 individuals,

Fig. 2 Accessibility problems detected during the interaction with the websites



complained that websites were not designed for PwD, but only for people in optimal conditions. They said: “The target audience is people who see, hear, understand well, and can operate the mouse with dexterity”; “We are not on the agenda”; “We are not a priority”.

- **Feeling that they are bothered:** by issues of technological ignorance. “It is sad that every time my grandson visits me, I have to ask him to help me with the paperwork online. I’m afraid he won’t want to come anymore” (Nelba, 72 years old).
- **Feeling ashamed:** because there had to be more people affected to be able to detect some improvements about the lack of accessibility. “It is embarrassing to say this, but the pandemic has benefited us a little because some companies have improved their customer service and assistance to users in case of problems with the website” (Analía, person with dyslexia, 45 years old).
- **Feeling stressed or feeling that the software is harmful to them:** because the lack of accessibility sometimes makes their disability worse. “I can only use the keyboard. The mouse makes me nervous. It requires a lot of precision and I end up moving everything, making my neurological condition worse. With the discounted transport website for the disabled, it is impossible to buy the ticket without the mouse” (Mabel, person with motor disability, 39 years old).

Another account that referred this feeling: “I don’t like movements in web pages, things moving all the time. They upset me and make it difficult for me to keep reading the page. I can’t stand it. You can’t concentrate” (Manuel, person with autism, 21 years old, interacting with a shopping web page with permanently active product carousels).

- **Feeling that the right to privacy and intimacy is violated:** “You cannot imagine what it feels like when an important result of a private lab test, which you download from the website, is in a non-accessible PDF. It was an HIV antibody test and the report had a crossed stamp with the text Negative. The screen reader could not read it. Without really meaning to, I had to ask my mother to read it to me” (Tomás, blind person, 26 years old).
- **Feeling annoyed and overwhelmed:** because of the emotional exhaustion caused by non-accessibility sensitive and confidential web services. This emotional aspect was revealed in the following expressions:

“In the middle of Covid-19 compulsory precautionary isolation, using the mobile app to be able to ask permission to go out the next day, the screen reader said to me: Do you have a fever? Button Button. Have you lost your sense of smell? Button Button. They did not provide alternative text. I didn’t

know what the No button was. I had to guess about such an important issue”(Maximiliano, blind person, 29 years old).

“Now to complete an important transaction on home banking, it sends a validation token to a mobile app. Because of the token I have to install the bank’s mobile app, but I have never been able to log in with facial recognition, I cannot get through the authentication process. It is impossible to read the prompts in small fonts, to see the box where I can focus my face with the right light and accuracy”(Silvia, 33 years old, little visually impaired).

With regard to the question on UX, considering the perceived emotional aspects before an interaction with the software product, the following answers were obtained:

- 19 persons mentioned the term **patience**. They argue that prior to initiating a transaction for the first time on a site, having to join forces and courage to face difficulties due to the lack of accessibility, which is already assumed. They assume that it will take time and effort to go through the web page, to understand how it is developed and to analyze what can be done with it. They never expect it to be accessible;
- 18 persons said they felt **worried**, or **afraid**, especially when it is an important online transaction and there is no other way to do it. Doubts and thoughts arise such as what happens if I fill in my personal data or account or credit card number and then the accessibility is cut off, what happens to my data and the transaction is interrupted? Questions of insecurity or mistrust multiply in cases of PwD;
- 6 persons said “It depends on my **mood** that day, sometimes I take it easy and sometimes I get **angry** as soon as I meet the first barrier or obstacle on the website, feeling that way for the rest of the day”. They indicate that these mood changes can arise even after interaction with the site and can vary according to the negative remembrance of the experience of using the site;
- 10 persons said they were previously **encouraged** and **happy** that they can do it online without having to leave the house.

Considering the responses on how they feel after using a website or application mainly if it was unsuccessful, the following results can be highlighted:

- 14 persons highlighted the term **resigned**. This state of mind arises from feeling low self-esteem or the feeling that there is no solution to such an adverse situation;
- 13 persons reported feeling **distressed**, mainly when a transaction is interrupted due to lack of accessibility and the transaction is incomplete. “You don’t know how the

information was left and there is often no contact to get a person to attend to you”;

- 18 persons said they felt **frustrated** or **annoyed**, as they were unable to realize their intentions and wasted a lot of time trying to do so;
- 8 persons said they felt **angry**, especially when they had to ask for help. They explain that the lack of accessibility undermines people’s autonomy so that their dependence on others generates a feeling of great anger.

Finally, when asked whether advances in technology such as AI can help inclusion, the majority responded that “It will certainly help, but if it depends on human intervention, it must have a disability and accessibility perspective in order to be used correctly”.

3.3 Results regarding technical evaluation of accessibility

In this section, a technical evaluation of accessibility will be carried out for the three most commented or referenced websites by the PwD interviewed. It is important to know the degree of accessibility from the normative aspect and its comparison with the perceived accessibility.

The selection of the Argentine websites to check for conformance with WCAG was according to the perspective of the PwD considering their opinions and their reported experiences of use obtained in the inquiry process. The three most referenced websites were:

- **A commercial website** of an international chain supermarket, referenced in 45 experiences of use. It offers deals, own-brand products at lower prices and instalments on payment plans. The URL of this website is www.carrefour.com.ar;
- **A governmental website** that was referenced in 38 experiences of use. It was the National Transport Regulatory Commission’s (CRNT) website for ticket booking. The URL of this website is <https://reservapasajes.cnrt.gob.ar/login>;
- **A national banking website** that was referenced in 32 experiences of use. The URL of this website is <https://www.bna.com.ar>.

A WCAG 2.1 AA compliance assessment was carried out on the homepage and on other five web pages of each selected website considering the experience of use reported by PwD. Finally, 18 web pages were analyzed in total. The technical evaluation process consisted of:

- **An automatic evaluation:** each web page was validated using the web accessibility evaluation tool WAVE.

We analyzed the color contrast, tab order, hierarchy of headings, use of Accessible Rich Internet Applications (ARIA), alternative texts, form elements, link texts. In the case of PDF documents, we installed the PDF/UA accessibility checker software PAC, version 2024;

- **Manual checks:** each website was tested with 200% and 400% magnification, and keyboard navigation only. Subtitles and audio description, mouse and keyboard focus, adequacy of content structure, consistent navigation and clear terminology were checked;
- **Experimental evaluation:** the selected web pages were navigated by screen readers where we could analyze for instance the adequacy of alternative texts, the sequential navigation, the skip to main content, the feedback and notifications access, the visual and hearing reading consistency, the accessible names according to visual names, language specification.

For this evaluation process, usability inspection methods such as heuristic evaluation and heuristic walkthrough were applied [30]. The success accessibility criteria of the WCAG 2.1, level A and AA, were considered as a list of design principles or heuristics. Each website was compared to them in order to identify where the product does not follow those principles. Also, it was necessary to work through a set of prioritized tasks to find additional problems.

The main findings of the technical evaluation process based on WCAG 2.1 A, AA on the supermarket website, on the government website for booking tickets, and on the banking website, are presented next.

The A and AA success criterion failures for WCAG Perceivable principle detected in the three websites are explained in Table 1.

The A and AA success criterion failures for WCAG Operable principle detected in the three websites are shown in the following Table 2.

In Table 3, the A and AA success criterion failures for WCAG Understandable principle detected in the three websites are explained.

With respect to the A and AA success criterion failures for WCAG Robust principle detected in the three websites, it was found that progress and feedback messages were not accessible for screen readers so the accessibility success criterion 4.1.3 about Status Messages (Level AA) failed.

The screenshots referenced in the technical accessibility assessment as Figs. 3, 4 and 5 are shown below. Figure 3 shows the government website with contrast problems. It also includes words in English, the labels are not associated with the respective input text boxes, and the explanation of the acronym CNRT is inserted within the logo image and is not detailed in the alternative text.

Table 1 Perceivable WCAG success criterion failures detected

WCAG Success Criterion	Level	Description
1.1.1 Non-text Content	A	Inadequate or lack of alternative texts in figures, buttons, banners. Images should have alternative text describing their meaning. In the commercial website, there were many product images in carousels with no or insufficient alternative text. In the government website, images with links such as credit cards to pay did not provide alternative texts. This interrupts the entire payment process for blind people. In the banking website, interactive elements with no textual alternative such as the button to activate the chat were detected.
1.2.2 Captions	A	There were explanatory videos with insufficient contrast in captions affecting the comprehension and reading for everyone who required the instructions and explanations, specifically deaf people, people with dyslexia, and people with visual impairments.
1.2.3 Audio Description	A	There were explanatory videos with text animated without audio description or transcription being inaccessible for blind people and for people with cognitive disabilities.
1.3.1 Info and Relationships	A	Form fields without labels or associated labels. Lack or absence of section headings and proper hierarchy of content both visually and programmatically necessary for all to understand. In the commercial website, there was information overload and improperly categorized products making them difficult to locate. In the banking website, there were tables to specify interest rates on loans without adequate headings.
1.3.2 Meaningful Sequence	A	Both visual and audible reading must be correct. In the commercial website, the menu hamburger and the login option were skipped audibly. In the banking website, there was visual information about the different loans with more content than what was heard.
1.3.3 Sensory Characteristics	A	Instructions provided for understanding content and processes that assumed a viewing audience were detected, such as “click on the highlighted button”, “scan the code”, “click on the arrow below”.
1.4.2 Audio Control	A	Some available explanatory videos had background sound with no mechanisms to control it, affecting people with neurological disorders as well as blind people.
1.4.3 Contrast Minimum and 1.4.11 Non-text contrast	AA	Insufficient color contrast between text and background and between nearby graphic objects, in links and in different component states (focus, hover, active). Figure 3 shows a poor color contrast in keyboard focus in the government website.
1.4.4 Resize Text and 1.4.10 Reflow	AA	Display and overlapping problems were detected when the screen is magnified. There were fragmented texts, loss of information because of the magnification. At 400%, there was little space or viewport to display the content to be scrolled.
1.4.5 Images of Text	AA	There were found several images with embedded texts with important information not present in the alternative texts excluding blind people or screen reader users.

The Fig. 4 shows the screenshot that belongs to the commercial site where, in addition to the presence of carousels with no control by the user, there is an overload of information, without a correct distance between sections and with a lack of headings structure.

Finally, Fig. 5 shows the screenshot of the banking site, with inconsistencies between the link title and the corresponding target page. The link ‘Save more’ referencing the fuel issue takes you to another website of benefits and promotions in general causing context change. The home page of this site is entitled “Buscáloscomerciosceranos con proms” (in English, Find nearby shops with special offers).

4 Discussion

The following reflections and findings can be drawn from the study:

- Regarding the comparison of perceived accessibility and the technical assessment of accessibility, the non-conformance of some success criteria may mean multiple complications and emotional impact for the PWD. Each infringed criterion generated access barriers not only on the web page where it was detected, but also in all transactions deriving from it. Of the 78 WCAG 2.1 accessibility testable success criteria, problems were detected in 28 criteria, which is 36%. Although this is not a very significant proportion, have impeded the seamless progression of crucial processes, including the purchase process on a commercial website, the transportation ticket payment process on a government website, and the application process for opening a savings bank or a bank loan on a banking website;
- Some AA criteria considered by the WCAG as of medium priority were of the highest priority for PwD to complete their activities. Each not-fully-accessible sequence of steps required to complete a major activity or transaction had a negative impact. On an emotional level, each infringed accessibility principle that a person permanently encounters on the different Argentine websites continuously generates multiple negative effects on the human being, leaving traces that shape the whole UX and the final level of perceived accessibility;
- In this comprehensive evaluation process, there were also differences between what was designed and what was perceived, so the disability perspective must be internalized in the process itself. There was a gap between

Table 2 Operable WCAG success criterion failures detected

WCAG Success Criterion	Level	Description
2.1.1 Keyboard	A	Important functional options were not accessible by keyboard. Pop-up windows with no keyboard access, their focus remains on the page below. In the commercial website, the hamburger menu, the shopping cart icon and the map were not accessible by keyboard.
2.1.2 No Keyboard Trap	A	Keyboard users got stuck in the hamburger menu when it was magnified over 200%.
2.2.2 Pause, Stop, Hide	A	In the commercial website, there were carousels in permanent movement with no options to control them as shown in Fig. 4. This situation causes severe complications, affecting screen reader users and people with motor, neurological and cognitive impairments.
2.4.1 Bypass Blocks	A	There was no jump to the main content. In the banking website, a keyboard user had to perform sequentially between 18 to 25 steps to access the main content in every web page visited.
2.4.2 Page Titled	A	The page title was not present or the same for different web pages was given.
2.4.3 Focus Order	A	Focus was detected on elements that were not visible.
2.4.4 Link Purpose	A	Insignificant, missing or duplicated link texts such as “Click here”, “More information” or “Download” for different pages were detected, making it difficult for screen reader users to identify and access the links directly.
2.4.5 Multiple Ways	AA	More than one way is available to locate a web page within a set of web pages. No website map provided in none of the three websites.
2.4.7 Focus Visible	AA	Sequential keyboard navigation had focus problems; it was absent or it was not distinguishable. This accessibility problem affects visual and motor impaired people.
2.5.3 Label in Name	A	No matching between the accessible name and the visible label found.

the WCAG principles and what people understood and perceived. Incomplete or inadequate alternative text for images or inaccessible videos with instructions or explanations is ultimately failures of understanding for PwD, but for WCAG they are failures of perception;

- Regarding the instruments used in the enquiry process, the questionnaire instrument provided the time needed to complete it, the pace to understand the statements and answer it in time, as well as confidentiality for the answers. It was complemented with personal interviews to describe the open-ended subjective questions and experiential accounts. Some PwD felt some discomfort during the questionnaire. They found it difficult to

Table 3 Understandable WCAG success criterion failures detected

WCAG Success Criterion	Level	Description
3.2.1 On Focus and 3.2.2 On Input	A	Changing the setting of any user interface component does not automatically cause a change of context. New windows opened suddenly without warning.
3.2.4 Consistent Identification	AA	There were link texts that did not match appropriately with the title or main heading of the target web page, as shown in Fig. 5. Different words with the same meaning were detected making the content difficult to understand. For example, words like offers, discounts, promotions, deals that they were used to reference the same concept.
3.3.3 Error Suggestion	AA	Insufficient information on suggestions for error correction was given.
3.3.2 Labels or Instructions	A	Insufficient information on instructions, lack or absence of glossary and semantic explanations.

write down situations in which they felt marginalized. Later, through the interviews, they were able to relax and talk about it. Another point that emerged through the interviews, when people were asked about AI, was their concern about labor market insertion, specifically whether these technological advances will allow PwD to have more tools to find work or, on the contrary, to be more excluded than at present. The interview session was used also to empower PwD by emphasizing their rights to access to information;

- Regarding the enquiry process, awakening emotional issues through accounts of experiences of interaction in an inaccessible context was a great challenge and made the assessment process more complex. Some of the questions posed to PwD were: How do you quantify the impact of not being able to access the contents of a private report on a health test and having to have it read to you by your mother? How do you measure the indignation of not being able to finish a ticket purchase because the credit card buttons had no alternative texts? Inquiring about these issues is not only difficult for PwD who may have to remember and recount them, but also to categorize, quantify and register them;
- With regard to UX, PwD must overcome accessibility difficulties but also usability and design problems. They face greater complexities in a state of increased vulnerability. Accessibility is intrinsically linked to usability issues but affects more deeply and incisively the UX. The costs of execution, being able to see and observe the whole screen is very different from the costs of execution when interacting only with the keyboard, sequentially, listening to the options. Even more so when

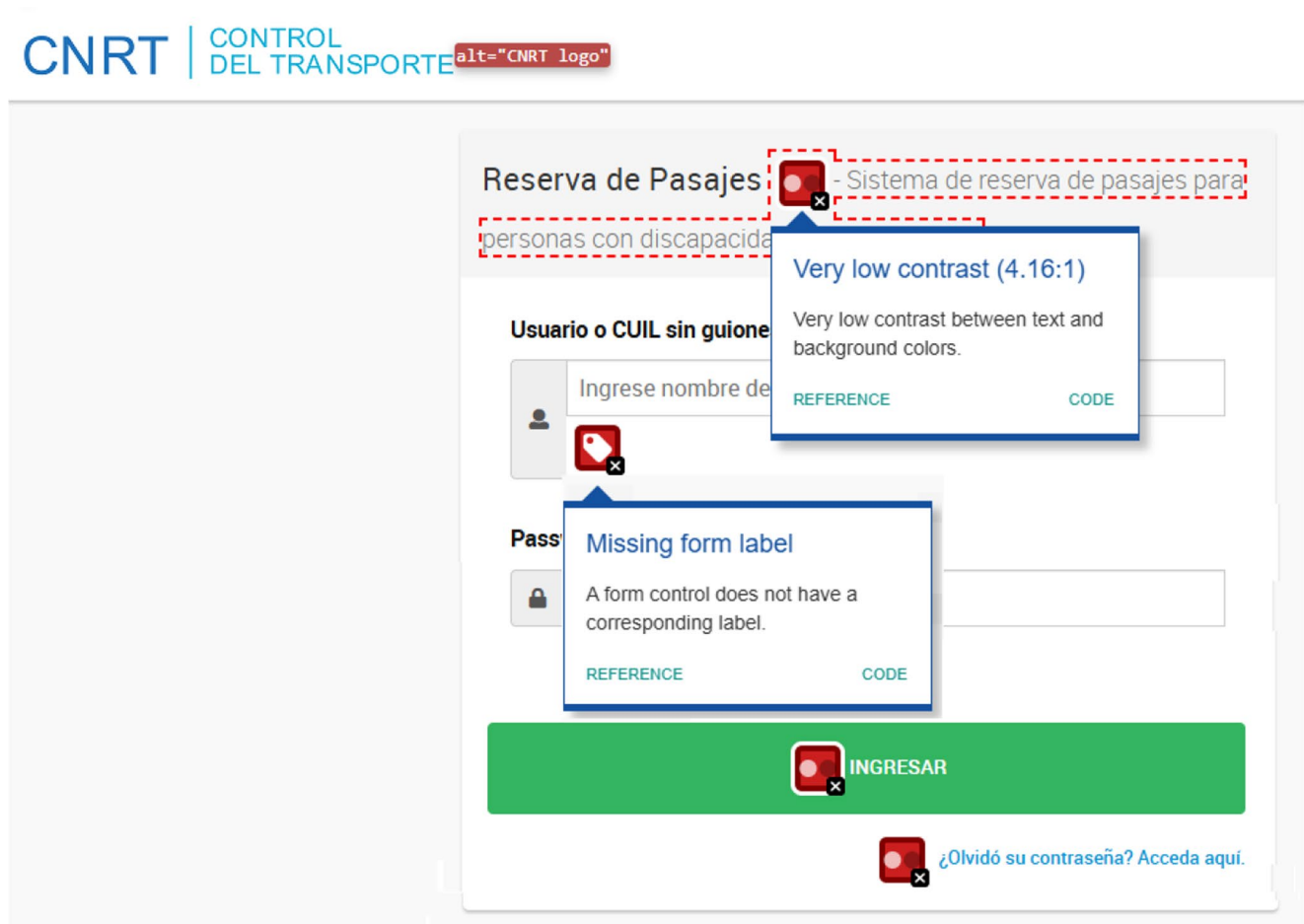


Fig. 3 Screenshot of government website with accessibility problems

everything is designed and intended for people who can see. Complications such as getting lost, not finding the options (findability) or not following the 3-step rule to find the required functionality are perceived to be magnified in a disability context. If the skip to the main content is not available, it may require the sequencing of multiple steps to reach the destination, increasing the possibility of getting lost. Usability problems increase the lack of accessibility perceived.

5 Conclusions

This article analyzed the web accessibility from an approach centered on the PwD. Although the focus of this research is on the case of Argentina, all the lessons learned can be applied to other countries.

This work described the evaluation and survey process on the perception of accessibility from the perspective and experience of PwD and an analysis of the emotional impact this generated. It evaluated the websites that they themselves

gave their opinions or made references to. Finally, it compared the problems found by the automatic evaluation and the way in which they were perceived by the people themselves. An accessibility problem was more than a barrier, it entailed an overload not only of execution and effort but also an emotional burden that left its mark on people's digital experiences. Emotional issues such as low self-esteem, anxiety, patience, hope, frustration, anger that were aroused showed that accessibility affects use, perception, as well as feelings.

Despite the fact that there have been regulations and legislation regulating accessibility in public places for more than 10 years in Argentina, they still present accessibility failures and continue to emotionally affect thousands of PwD. This shows the existence of cultural barriers that are still present and that are transferred to the virtual environment.

Finally, this study tried to contribute in two ways, mainly to PwD to reflect from their point of view, to express their voice and to make their claim viable. And then, for web developers and other roles involved in the development of the web pages, so that they reflect on their level

Fig. 4 Screenshot of a commercial website with accessibility problems



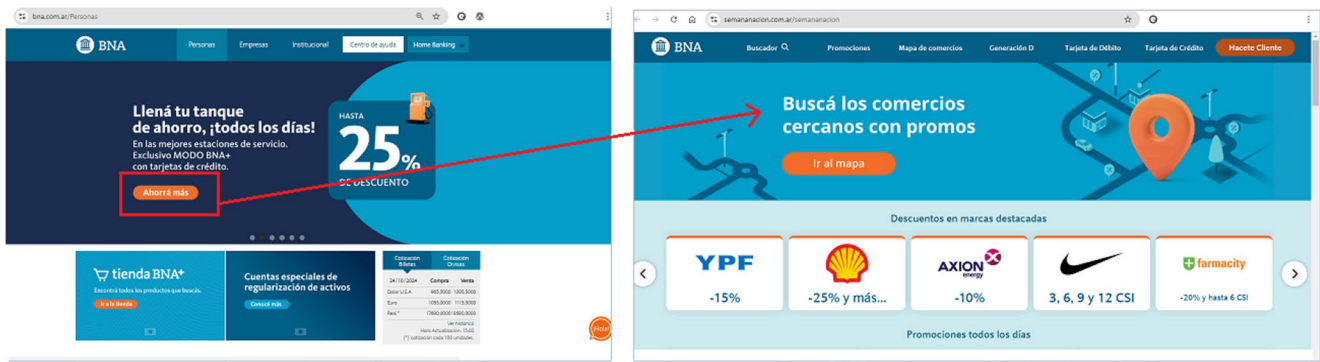


Fig. 5 Screenshots of web pages of the bank website with problems of accessibility

of responsibility to avoid discrimination and exclusion of people in their productions.

6 Appendix A list of queries developed in the literature review

The list of queries carried out for the survey on literature, are:

- Springer Link query results:

<https://link.springer.com/search?newsearch=true&query=Web+Accessibility+Perception+of+People+with+Disabilities&date=custom&dateFrom=2019&dateTo=&facet-discipline=%22Computer+Science%22&sortBy=relevance>.

- IEEE Xplore Digital Library query results:

<https://ieeexplore.ieee.org/search/searchresult.jsp?newsearch=true&queryText=Web%20Accessibility%20Perception%20of%20People%20with%20Disabilities>.

- Wiley online Library query results:

<https://onlinelibrary.wiley.com/action/doSearch?AfterYear=2019&AllField=Web+Accessibility+Perception+of+People+with+Disabilities&BeforeYear=2024&content=articles+Chapters&target=default&startPage=&ConceptID=68>.

- Taylor & Francis Online query results:

<https://www.tandfonline.com/action/doSearch?AllField=Web+Accessibility+Perception+of+People+with+Disabilities&content=standard&target=default&queryID=11%2F7357133207&AfterYear=2020&BeforeYear=2024>.

- Disability & Society Journal query results:

<https://www.tandfonline.com/action/doSearch?AllField=Web+Accessibility+Perception+of+People+with+Disabilities&content=standard&target=default&queryID=11%2F7357133207&AfterYear=2020&BeforeYear=2024&startPage=&SeriesKey=cdso20>.

7 Appendix B questionnaire of the participant survey

The questionnaire instrument was used in the evaluation of the perception of accessibility by PwD. It was redesigned several times after several tests. Its final version is as follows:

7.1 Initial greeting

Dear colleagues:

This is a survey to know your opinion about the accessibility of websites that you have used or wanted to use. It is intended to make a survey of the problems that you have detected in the use of them. Accessibility is the quality of a product such as an app, a website that allows its navigation and use in diverse conditions of use. It takes into account that users can enter using magnifiers, screen readers, with subtitles, high contrast, only with keyboard or that it requires its content to be simple and understandable, among other conditions.

This survey has 3 parts A, B and C. In the Part A, you will be asked to answer about your user profile. In the Part B you will be asked to indicate if possible, for each type of site (such as governmental, educational, commercial, health, other), the name of the website you want to give feedback based on your experience of use. Social networks such as Facebook, Instagram or other are outside the scope of this survey.

7.2 Part A: about user profile

First name and surname:

Age:

Level of education:

- Did you have or do you have training related to computer technologies (schools, courses, other)?

☐ Yes ☐ No.

- Do you use the Internet for information, formalities or other activities?

☐ Yes ☐ No.

- What device do you use to access Internet?

☐ Computer.

☐ Mobile phone.

☐ Tablet.

Other:

- How do you navigate the websites?

☐ Screen reader ☐ With subtitles.

☐ High contrast ☐ Keyboard.

☐ Magnifier ☐ Simple language.

Other:

7.3 Part B: about your experience of use of websites

Try to remember an experience of use (one or more) of Argentine websites and bring your feedback about it. It could be a good or bad experience.

For each website chosen that you have wanted to use or used, answer according to your experience:

- Which website did you use or tried to use?

.....

- Which type of website did you choose?

☐ e-government website of citizen-related procedures and transactions.

☐ Commercial website, such as e-shopping, supermarkets.

☐ Website of health services, such as hospital appointments, clinics.

☐ Information websites, such as newspapers or magazines.

☐ Educational websites, such as school, college, academy websites.

☐ Websites of Banks, home banking, e-wallets, credit cards.

Other:

- Why did you want to access to it?

.....

- Were you able to realize your intentions?

☐ Yes ☐ No.

- Did you experience any of the following difficulties in using the website?

☐ the website content was not accessible.

☐ I did not understand its contents.

☐ I could not find what I wanted.

☐ I could not navigate it fully.

☐ I could not see or perceive it correctly.

☐ I have no problem to access that website.

7.4 Part C: about your opinion

- What do you think about how the sites are designed?

.....

- How do you feel before you use a site or digital application to carry out a transaction or use a service, and when it is the only way to do so?

.....

- Did you know that there is a Law of Accessibility in Argentina that requires e-government websites to be accessible and understandable to all people?

☐ Yes ☐ No.

- Do you think that the Argentine websites comply with this law?

☐ Yes ☐ No.

- What feelings, thoughts or opinions do you have when using such websites or digital applications, both at the end and during their use?

.....

- Do you think that IA could resolve problems of web accessibility?

☐ Yes ☐ No Why?

- What improvements or suggestions would you like to make?

.....

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Declarations

Ethical approval The research conducted in this manuscript is not an interventional study where ethical approval is required by the La Plata National University. It is an observational and quantitative study. It does not include any information that by itself or linked to other data, may reveal the identity of the participants. It ensures that the participants' identities remain anonymous and their personal information is protected. The research conducted adheres to ethical guidelines and privacy regulations of Argentina in observance of requirements imposed by the Data Protection Act 1998.

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