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Research Paper

Gov.br Portal: Contrasting the Results of an Accessibility Assessment by Automated Tools with the Analysis of a Person with Low Vision

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Abstract. Governments worldwide have increasingly adopted centralized models for delivering public services to citizens. In 2019, Brazil launched the Gov.br portal, which consolidates the digital channels of all federal government agencies and provides unified access to information and services. This study aims to assess the accessibility of the Gov.br portal using three automated evaluation tools (ASES, AccessMonitor, and TAW) and a contrast verification tool (Contrast Checker), in addition to a manual evaluation conducted by a low vision web accessibility specialist. This qualitative and exploratory analysis reveals that, despite Gov.br achieving favorable scores in automated evaluations, significant challenges remain regarding the user experience of individuals with low vision. The most frequent issues identified include the portal's lack of responsiveness when displayed at maximum zoom on smartphones, insufficient color contrast, and the absence of contextual information in links. As a contribution, the study proposes corrective measures to enhance the website's accessibility, thereby promoting inclusive access for all users.

Keywords: accessibility, eGov, e-government, inclusion, accessibility evaluation, visual impairment

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1 Introduction

The Gov.br portal [Brasil, 2019b], launched by the federal government in August 2019 [Brasil, 2019c], represents a key initiative within Brazil's Digital Government Strategy [Brasil, 2020]. Its objective is to unify the digital channels of all agencies and entities belonging to the direct, autonomous, and foundational administration of the Federal Executive Branch [Brasil, 2021]. By centralizing the services offered by public institutions in a single platform, the portal seeks to streamline access to government information and services, reducing the need for citizens to wait in lines or travel to physical service locations. The government initially set a goal of making approximately 3,300 services available on the portal by 2022 [Serpro, 2019]. The Brazilian project was inspired by similar large-scale digital government initiatives implemented in other countries, such as the United Kingdom (2012), Mexico (2014), and Uruguay (2017).

The project is one of the main initiatives in the process known as the "modernization of the Brazilian public service" [Serpro, 2019]. According to Jorge Oliveira, former Minister-Chief of the General Secretariat of the Presidency of Brazil, the country ranks fourth worldwide in terms of internet access, with approximately 140 million people connected. Paulo Uebel, former Special Secretary for Debureaucratization, Management, and Digital Government of the Ministry of Economy, further notes that the portal's administrators estimate annual time savings of around 60 million hours for Brazilian citizens [Serpro, 2019].

As of August 2024, Gov.br offered a total of 4,986 services, with a 51 percent approval rate in citizen evaluations. The services available on the portal are categorized as fully digital, partially digital, or non-digital. Fully digital services are those in which all stages of the process include at least one digital channel. Partially digital services are those in which at least one stage involves a digital channel. Finally, non-digital services are those in which none of the stages include a digital channel.

The COVID-19 pandemic, which began in the first half of 2020, accelerated the digitalization of public sector services. Health measures recommended by relevant authorities, such as social distancing, prompted public administrators to expand the range of services offered. As a result, digital service platforms must be designed to ensure accessibility for the entire population.

Given the Brazilian government's plan to expand digital services and, in some cases, reduce or eliminate in-person services, it is essential that Gov.br comply with the accessibility standards and best practices established by the Brazilian Law for the Inclusion of Persons with Disabilities (LBI, Lei Brasileira de Inclusão) (No. 13,146/2015) [Brasil, 2015].

The objective of this study is to present a comprehensive evaluation of the Gov.br portal using the automated tools ASES [Brasil, 2009], AccessMonitor [AMA, 2018], TAW [CTIC, 2007], and ContrastChecker [Acart Communications, 2017], as well as to compare these results with an analysis conducted by a person with visual impairment (low vision). Based on these evaluations, the study seeks to identify the errors detected by both approaches, compare the find-

ings, and propose corrective measures for the issues identified.

This work extends a paper previously presented at the Brazilian Computer Society Congress (CSBC, in Portuguese: Congresso da Sociedade Brasileira de Computação), during the Workshop on Applied Computing in E-Government [Barros *et al.*, 2024]. The paper, published in the Extended Proceedings of the CSBC 2024, presented an evaluation of the accessibility of the Gov.br platform using automated tools to verify its compliance with the Web Content Accessibility Guidelines (WCAG) 2.1 guidelines [Freire *et al.*, 2024]. The results revealed recurring issues, such as the absence of alternative text, color contrast errors, difficulties in keyboard navigation, and improper use of labels in forms. Such issues negatively affect the experience of users with disabilities, along with suggestions for correcting the identified issues.

In this extended version, in addition to updating the previous results based on the WCAG 2.2 guidelines, we include a new study involving a manual evaluation conducted by a person with low vision and expertise in accessibility [Salton *et al.*, 2024]. Updating the results obtained through automated tools was necessary for two reasons: (1) many issues identified in the original study had been resolved by the portal's development team; and (2) the inclusion of an evaluation by a person with low vision aligns with the World Wide Web Consortium (W3C) recommendation, which emphasizes the importance of human assessment in verifying a website's compliance with accessibility standards. These updates have enriched the results of the present study compared with the previous work. The main extensions introduced in this version are summarized below:

- Inclusion of a theoretical foundation for manual evaluation in Section 2 - Background;
- Revision of the research method to more accurately describe the updated evaluation process, which combines automated and manual assessments, as detailed in Section 4 - Research Method;
- Reorganization of Section 5 - Evaluation, presenting the new results obtained from the updated analyses;
- Expansion of Section 6 - Discussion, to integrate and compare findings from both automated and manual evaluations and;
- Translation of the article into English with the support of an artificial intelligence tool, followed by an in-depth review to ensure its quality.

It should be noted that a structured manual evaluation conducted by an accessibility specialist using a checklist, as commonly employed to complement automated assessments in accessibility studies [W3C, 2024], was not performed in this research. Nevertheless, the automated evaluation was strengthened by an analysis conducted by a low-vision specialist, whose contribution was essential to validate and enrich the findings, though from the specific perspective of that user profile. According to the W3C, no automated tool can encompass all aspects of accessibility; therefore, human participation is indispensable for identifying barriers that extend beyond automatic detection [W3C, 2023].

The remainder of this article is organized as follows: Section 2 presents the background, addressing key concepts related to accessibility and evaluation; Section 3 reviews related work; Section 4 details the research method; and Section 5 describes the execution of the evaluation. The results are discussed in Section 6; the study's limitations are analyzed in Section 7; and Section 8 concludes the paper, outlining directions for future work.

2 Background

According to W3C [2021], properly coded websites and web tools can be effectively used by individuals with disabilities. A person is considered to have a disability when physical, mental, intellectual, or sensory impairments, combined with external barriers, restrict their full participation in society [Brasil, 2015]. Accessibility ensures that these individuals can navigate and interact with the web. It encompasses a range of disabilities, including auditory, cognitive, motor, and visual, while also benefiting users without disabilities. These include individuals using devices with small screens, such as mobile phones, smartwatches, or smart TVs; older adults; people with temporary impairments, such as a broken arm or misplaced glasses; those in situational constraints, like bright sunlight or noisy environments; and users with slow internet connections or limited bandwidth.

The WCAG [W3C, 2022], version 2.2, is the document developed by the W3C that provides guidelines and recommendations for implementing accessibility on websites. It is organized around four core principles and thirteen guidelines. Each guideline includes testable success criteria, whose evaluation, whether met or unmet, determines the accessibility assessment outcome. When all success criteria at the basic level are satisfied, the page is considered compliant with Level A. Compliance with the intermediate level indicates adherence to Level AA, while meeting the advanced level denotes compliance with Level AAA. It is important to note that these levels are cumulative; achieving the highest level of accessibility requires meeting all criteria from the preceding levels as well.

Web accessibility in government portals is essential to ensure that public information and services offered through these channels can be used by all members of society under equal conditions, thereby reinforcing the fundamental right of access to information [Corado and dos Santos, 2020]. It further contributes to strengthening the relationship between governments and citizens [Mezzaroba *et al.*, 2016] and to reducing the barriers faced by people with disabilities in their daily lives, particularly those related to accessing information provided on government portals. Such barriers can hinder the social and digital inclusion of this population [Silva and Rue, 2015].

The Brazilian Law for the Inclusion of Persons with Disabilities (LBI – Law No. 13,146, 2015) [Brasil, 2015] seeks to guarantee and promote, on an equal basis, the exercise of fundamental rights and freedoms for people with disabilities, with an emphasis on social inclusion and citizenship. According to this law, effective inclusion requires the provision of accessibility, which entails eliminating barriers and obstacles that hinder people with disabilities, in-

cluding those affecting access to information and communication. The legislation further mandates that all websites operated by companies established or represented in Brazil, as well as those managed by government agencies, must be accessible to users with disabilities.

The accessibility evaluation of Brazilian government portals can also be conducted through compliance testing with the Accessibility Model in Electronic Government (eMAG) [Brasil, 2014]. Developed based on international accessibility guidelines, including WCAG, eMAG provides guidance for the development and adaptation of digital content within the federal government. Unlike WCAG, however, eMAG's recommendations are not organized by priority levels but by implementation needs. They address aspects related to markup, behavior (DOM), content and information, and presentation and design, in addition to specific guidelines for multimedia and forms. The eMAG framework enables the standardized and practical implementation of digital accessibility, ensuring compliance with international standards while aligning with national requirements. It is worth noting that eMAG represents a localized adaptation of WCAG for the Brazilian government and does not exclude any of WCAG's best practices.

In this context, accessibility evaluation serves to verify whether a developed website complies with the guidelines established by eMAG and WCAG. This process can be conducted through two complementary methods: manual evaluation and automated evaluation, both aimed at identifying as many inconsistencies with the guidelines as possible. Automated evaluation is performed using tools provided or recommended by the W3C or the Brazilian Electronic Government, which assess compliance with various web standards, including code validity and color contrast. Manual evaluation, in turn, can be conducted either by accessibility specialists or by individuals with disabilities. Its primary purpose is to identify issues that automated tools are unable to detect. Combining both evaluation methods enhances the reliability of results and reduces the likelihood of overlooking accessibility problems [Mateus *et al*., 2024; W3C, 2023].

eMAG proposes a sequence of steps to be followed during the accessibility evaluation of a website. These steps include: (1) validating the HTML and stylesheet code; (2) verifying the page's reading flow; (3) performing automated accessibility validation; (4) conducting manual validation; and (5) testing with real users.

More recently, the technical standard ABNT NBR 17225:2025 [ABNT, 2025] was published, addressing accessibility in web content and applications. Although it establishes guidelines to be adopted by federal executive branch agencies, the standard is not yet mandatory, as its effective implementation depends on specific regulation. This regulation is expected to be issued through a decree to be published by the Ministry of Management and Innovation (MGI) later in 2025, when the standard is expected to be instituted as the new guideline for digital accessibility compliance in Brazil [Brasil, 2025].

2.1 Tools for Automated Evaluation

This subsection presents the tools employed in the evaluation conducted in this study. Their selection is justified by the fact that these software tools are listed under item "5.2.2.1 Evaluation Criteria" in the regulations of the National Web Accessibility Award TODOS@WEB [Brasil, 2016b]. This item states:

> Accessibility
> The registered website will undergo validation using automated tools such as TAW[1], Access Monitor[2], ASES[3], and other tools deemed relevant by the jury, based on WCAG 2.0 accessibility guidelines (Levels A and AA). Contrast assessments will be conducted using automated tools such as Contrast Analyser[4] and the Luminosity Colour Contrast Ratio Analyser[5], as well as other tools deemed relevant by the jury.

Additionally, the tools recommended by the Accessibility Portal of the Portuguese Government[6] were also evaluated, as long with the contrast verification tool ContrastChecker[7].

2.1.1 ASES

The Accessibility Evaluator and Simulator for Websites (ASES) is a fundamental tool designed to evaluate, simulate, and improve the accessibility of web pages, websites, and portals, making it particularly useful for developers and content editors. Developed by the Department of Electronic Government (DGE) and the Federal Institute of Education, Science, and Technology of Rio Grande do Sul (IFRS), this platform seeks to simplify the implementation of accessibility in government agencies, ensuring that websites are usable by all individuals, regardless of the navigation device or type of disability.

ASES does not modify the evaluated website directly; instead, it identifies the necessary changes for users to implement. The tool is available in both web-based and desktop versions. Its main objectives include being the first tool to evaluate web page accessibility in accordance with the recommendations of the eMAG, enabling citizens to easily and quickly assess and rate the accessibility of web pages, contributing to the enhancement of accessibility across government websites, and facilitating access for individuals with disabilities to online public services.

2.1.2 AccessMonitor

AccessMonitor is a tool designed to evaluate a website's accessibility compliance according to WCAG 2.1 guidelines. Maintained by the Portuguese Government, it forms part of a broader set of initiatives aimed at promoting digital accessibility. Portugal's accessibility project began in 1999, making it the first EU member state to adopt accessibility requirements for the content and services provided by public administration on the internet.

Established in 2007, the Agency for Administrative Modernization (AMA) [Portugal, 2016] is responsible for promoting and implementing administrative modernization

[1] http://www.tawdis.net
[2] https://accessmonitor.acessibilidade.gov.pt/
[3] https://asesweb.governoeletronico.gov.br/
[4] http://www.paciellogroup.com/resources/contrast-analyser.html
[5] http://juicystudio.com/services/luminositycontrastratio.php
[6] https://www.acessibilidade.gov.pt/ferramentas/
[7] https://contrastchecker.com/

in Portugal, particularly in areas such as customer service, digital transformation, and process simplification. AMA conducts the necessary monitoring activities to ensure that both public and private organizations make their online content and services accessible, especially for citizens with disabilities.

AccessMonitor is available exclusively as a web-based tool, and evaluations can be conducted in three ways: by entering the URL of the page to be assessed, by pasting the HTML code to be analyzed, or by uploading a file containing the HTML code for evaluation.

2.1.3 TAW

TAW is an online automated tool developed to assess the accessibility of websites. Based on the WCAG 2.0 established by the W3C, it has been in use for over fifteen years and is regarded as the reference tool in the Spanish-speaking world. Its primary objective is to verify the level of accessibility achieved during the planning and development of web pages, ensuring access for all users regardless of their individual characteristics. TAW is intended for both novice users seeking to evaluate the accessibility of their websites and professionals in the field, including developers, programmers, designers, and other specialists.

2.1.4 ContrastChecker

This tool was developed for designers and developers to test color contrast compliance with the WCAG established by the W3C. The calculations are based on the formulas defined by the W3C. To perform the test, users must select a foreground color and a background color. The results are then automatically generated, presenting a score that indicates the level of contrast between the selected colors.

2.2 Manual Evaluation

Although automated tools are useful, relying solely on them is not recommended for determining whether a website complies with accessibility standards; manual or human evaluation is also required [W3C, 2023]. The W3C recommends several strategies for conducting manual evaluations [W3C, 2023]:

- **Initial Checks**: used to quickly identify accessibility issues on a website. This strategy targets only specific problems and was developed with an emphasis on speed and simplicity, without the intention of being exhaustive or conclusive;
- **Conformance Evaluation and Reports**: used to assess the extent to which a specific webpage or web application complies with accessibility standards. The W3C introduced the Website Accessibility Conformance Evaluation Methodology (WCAG-EM) to support adherence to WCAG guidelines. In addition, the W3C offers tools and templates to facilitate the preparation of evaluation reports, along with supplementary resources to assist throughout the evaluation process;
- **Human Involvement**: refers to the participation of individuals in the accessibility evaluation process, either through collaborative reviews, where professionals and participants with diverse experiences contribute to a more comprehensive analysis, or by including people with disabilities in the evaluation itself, ensuring that the assessment accounts for the real barriers they encounter.

3 Related Work

Several studies have employed automated tools to assess website accessibility. Souza and Almeida (2021) evaluate the compliance of library portals from Federal Universities in Minas Gerais with the WCAG 2.1 and eMAG guidelines, identifying issues such as poor color contrast, lack of alternative descriptions, and barriers for screen readers. The results show that most websites do not meet the minimum accessibility requirements, indicating the need for greater institutional commitment and staff training. Cavalcante (2017) analyzed major news websites in Pernambuco using AccessMonitor and found that Diário de Pernambuco demonstrated greater compliance with WCAG recommendations compared to Folha de Pernambuco. In the governmental context, Oliveira and Eler (2015) examined the accessibility of 39 Brazilian government websites using the now-defunct tool daSilva, which was designed to verify compliance with both WCAG and eMAG guidelines. Their findings indicated that only one of the evaluated websites complied with eMAG, and none met WCAG standards, highlighting the need for improvements in website coding practices.

Furthermore, Almeida *et al.* (2016) assessed the accessibility of six portals from Federal Higher Education Institutions using the TAW tool, revealing that all pages failed to meet the minimum WCAG conformance level. Subsequently, Carvalho *et al.* (2017) evaluated the accessibility of Brazilian state government websites using AChecker and Functional Accessibility, both based on WCAG. Their results demonstrated non-compliance with the LBI (Law No. 13,146/2015), as the evaluated websites did not satisfy the minimum required accessibility standards.

Focusing on specific user groups, Duarte *et al.* (2020) evaluated the Paraná Artificial Intelligence Portal (PIÁ) using the eScanner tool, aligned with eMAG guidelines, alongside the NVDA and TalkBack screen readers and a manual accessibility checklist targeting individuals with visual impairments. The findings indicated that the portal was only partially accessible and required adjustments to better accommodate its intended audience.

Carvalho (2017) analyzes the compliance of state government portals with the WCAG and eMAG guidelines using the AChecker and Functional Accessibility Evaluator tools. The study identified issues such as the absence of alternative text, low color contrast, and limited keyboard navigation, concluding that none of the websites fully comply with the Brazilian Inclusion Law (LBI), reinforcing the need for greater public commitment to digital accessibility.

Similarly, Ribas (2022) examined the accessibility of five Brazilian public digital services available on Gov.br, focusing on older adults (e.g., Proof of Life – INSS). The study employed AChecker in combination with a manual evaluation, resulting in practical recommendations for improving the accessibility of the analyzed services.

Although individuals with visual impairments are frequently invited to participate in accessibility testing, their inclusion as integral members of evaluation teams remains

relatively uncommon [Gouveia *et al*., 2024]. The study conducted by da Silva *et al*. [2024] examined the accessibility of the Virtual Learning Environment (VLE) of the National Industrial Learning Service (SENAI) for users with visual impairments. The evaluation involved two participants, one with low vision and one who was blind, who were asked to complete a series of predefined tasks. The study emphasizes the importance of assembling multidisciplinary teams in the development of accessible educational platforms, aiming to foster both digital and educational inclusion for individuals with visual impairments.

The present study expands upon previous research by conducting a comprehensive evaluation of the accessibility of popular and citizen-oriented pages on the Gov.br portal. The evaluation employed three automated tools: ASES (based on eMAG), AccessMonitor (based on WCAG), and TAW, along with a contrast assessment using Contrast Checker and a complementary analysis performed by a person with a disability. Conducted in 2024, this analysis identified new accessibility issues and proposed targeted recommendations for improvement.

4 Research Method

To achieve the objective of this study, a qualitative and exploratory investigation was carried out to identify accessibility issues on the Gov.br portal. The research method comprised five stages: (1) selection of the evaluation methods; (2) choice of tools used in the automated evaluation; (3) selection of the pages to be assessed; (4) execution of both automated and manual evaluations; and (5) analysis of the results and proposal of the necessary corrections as the study's contribution.

The first step consisted of selecting the evaluation method. The researchers adopted a dual approach, combining an automated evaluation using specialized tools with a manual assessment performed by a user with disabilities who is also an expert in accessibility evaluation.

The second step consisted of selecting the tools used for the automated evaluation, namely ASES, AccessMonitor, TAW, and Contrast Checker. This choice was guided by the regulations of the National Web Accessibility Award [Brasil, 2016b], which cites these tools in subitem 5.2.2.1, Evaluation Criteria, as the basis for assessment by the jury. They are also recommended by the government's official website.

In the third step, the pages to be evaluated on the portal were defined. The researchers selected three pages, considering their relevance to the users of the site. The first page chosen was the homepage [Brasil, 2019b], as it represents the user's first interaction with the portal and serves as a starting point for all other pages. The second page selected was the one containing the most frequently used service by the public, as indicated by the site itself during the evaluation period, which was the service "Check CPF (Individual Taxpayer Registry)". Finally, the last page chosen was the one containing the latest news [Brasil, 2019a], as it provides information released by the government that is of public interest.

The evaluations were carried out in November 2024. This information is relevant because the results may change over time. Such variation was observed when comparing the findings of this study with those of the previous work Barros *et al*. [2024].

During the evaluations, the links to the selected pages were submitted for analysis using the ASES, AccessMonitor, and TAW tools. For the Contrast Checker tool, it was necessary to manually select and input the text and background colors from different areas of the evaluated pages.

The evaluation conducted by a person with a disability was performed by an individual with low vision. The evaluator, a co-author of this article, is an IT technician with two years of experience in accessibility assessments. The evaluation did not follow a predefined checklist or protocol. Instead, the evaluator interacted with the three selected pages of the Gov.br portal using the strategies and tools she routinely employs for web navigation: a smartphone with the iOS operating system and the Google Chrome browser, along with the accessibility features she customarily uses. The decision to use a smartphone for the evaluation was based on the fact that this type of device is the most commonly used for Internet access in Brazil, according to a government survey [Brasil, 2024].

The results obtained from the automated tools were analyzed both individually and collectively. They were then integrated with the findings of the manual evaluation, using a shared document as a support resource. This document also contained suggestions for addressing the issues identified in the fifth step. The outcomes of these analyses are presented in Sections 5 and 6.

The study was not submitted to a Research Ethics Committee in Brazil because it did not involve external participants requiring compliance with national ethical regulations. All evaluations were conducted by the authors, including one consultant with low vision, who consent to participate and to have her experience documented.

5 Evaluation

This section presents the evaluation results, beginning with the findings from the automated tools, followed by the outcomes of the manual analysis.

5.1 Automated

This subsection presents the feedback provided by each tool for the evaluated pages. The evaluation considered only the error indications reported by the tools. In ASES, errors are defined as issues that directly affect the accessibility of the website. Warnings, on the other hand, correspond to situations in which the tool cannot definitively determine the presence of an error and therefore require human verification [Brasil, 2016a]. The AccessMonitor and TAW tools follow the same logic as ASES, explicitly identifying in their reports which items require manual verification. These situations are marked as "To check manually" in AccessMonitor and "Warnings – Manual review needed" in TAW.

5.1.1 ASES

ASES classifies the evaluated page into one of four categories based on the percentage score obtained. The first level, represented by the color green, indicates a score equal to or greater than 95%. The second level, represented by yellow, indicates

a score between 85% and 94%. The third level, represented by orange, corresponds to scores between 70% and 84%. Finally, the red level indicates a score below 70%. In addition to this classification, the tool provides a summary of the errors and warnings identified, organized in a table according to the eMAG sections. Figure 1 illustrates the information generated by the tool for the homepage evaluation, and Table 1 presents the ASES evaluation results, broken down by evaluated page and eMAG section.

The first evaluation focused on Gov.br homepage, which achieved a compliance rate of 96.52% with the accessibility criteria, placing it in the highest classification tier. A total of nine errors were identified, three in the Markup section (*Marcação*) and six in the Content/Information section (*Conteúdo/Informação*). The total number of warnings was 203, of which 166 were related to the Markup section, 13 to the Behavior section (*Comportamento*), and 24 to the Content/Information section.

The "Check CPF" service page was the second to be evaluated, achieving a compliance rate of 95.05%, which also placed it in the highest classification tier. The tool identified a total of nine errors, four in the Markup section and five in the Content/Information section. A total of 265 warnings were reported, of which 223 were related to the Markup section, 16 to the Behavior section, 20 to the Content/Information section, and six to the Forms section.

Finally, the "Latest News" page was evaluated and achieved a compliance rate of 96.13%, placing it in the highest classification tier. The tool identified a total of eight errors, three in the Markup section and five in the Content/Information section. A total of 270 warnings were reported, of which 206 were related to the Markup section, seven to the Behavior section, and 57 to the Content/Information section.

5.1.2 AccessMonitor

AccessMonitor evaluates pages according to the WCAG 2.1 criteria and assigns a score ranging from 0 to 10, with 10 representing the highest level of compliance. The tool categorizes the results as Acceptable (*Aceitáveis*), Requiring manual verification (*Para ver manualmente*), or Unacceptable (*Não aceitáveis*), distributed across levels A, AA, and AAA. In this study, only the elements classified as Unacceptable were considered, as shown in Table 2.

Figure 2 presents the information provided by the tool during the evaluation of the homepage. The homepage received a score of 8.7, with 38 practices identified: 27 categorized as acceptable, 7 as requiring manual verification, and 4 as unacceptable. The "Check CPF" service page achieved a score of 9.3, with 39 practices identified—30 acceptable, 7 requiring manual verification, and 2 unacceptable. Finally, the "Latest News" page obtained a score of 9.0, with 40 practices identified: 29 acceptable, 8 requiring manual verification, and 3 unacceptable.

Among the practices classified as unacceptable on the homepage, the tool identified the following: a label improperly positioned, hindering correct association with the elements it describes (1.3.1 and 3.3.2); an element configured as decorative but containing interactive content (focusable), which may prevent recognition by assistive technologies such as screen readers (4.1.2); two interactive elements with visible labels that were not included in the accessible names recognized by assistive technologies (2.5.3); and sixteen color combinations with contrast ratios below the required minimum (1.4.3).

For the evaluated service page, AccessMonitor identified the following unacceptable practices: a label improperly positioned, hindering correct association with the elements it describes (1.3.1 and 3.3.2), and a color combination with a contrast ratio below the minimum required by WCAG, 3:1 for large text and 4.5:1 for regular text (1.4.3).

Finally, for the "Latest News" page, the tool identified nine images with non-equivalent alternative text (1.1.1), a label improperly positioned, hindering correct association with the elements it describes (1.3.1 and 3.3.2), and two color combinations with contrast ratios below the required minimum (1.4.3).

5.1.3 TAW

TAW evaluates web pages according to the four WCAG principles: Perceivable, Operable, Understandable, and Robust. The Perceivable principle requires that information and user interface components be presented in ways that users can perceive. Operable means that interface components and navigation must be functional and easy to use. Understandable indicates that both the information and the operation of the interface should be clear and intuitive. Finally, Robust signifies that the content must be sufficiently resilient to be reliably interpreted by a wide range of user agents, including assistive technologies.

Additionally, the tool classifies the identified nonconformities as problems, warnings, or non-evaluated items. Problems are issues in which nonconformity has been confirmed and requires correction. Warnings refer to items that must be manually reviewed to determine whether they constitute nonconformities, while non-evaluated items require a full manual assessment. The analysis was conducted at level AAA. Figure 3 illustrates the information provided by the tool during the homepage evaluation, and Table 3 presents the TAW evaluation results, organized by the evaluated pages.

The homepage presented 234 problems (110 under the Perceivable principle, 25 under Operable, 99 under Understandable, and none under Robust), 179 warnings (36 in Perceivable, 120 in Operable, 23 in Understandable, and none in Robust), and 30 unchecked items (7 in Perceivable, 13 in Operable, 9 in Understandable, and 1 in Robust).

The second page evaluated, "Check CPF," exhibited 221 problems (107 under Perceivable, 7 under Operable, 106 under Understandable, and 1 under Robust), 195 warnings (37 in Perceivable, 121 in Operable, 37 in Understandable, and none in Robust), and 27 unchecked items (7 in Perceivable, 12 in Operable, 8 in Understandable, and none in Robust).

The third page evaluated, "Latest News," contained 218 problems (110 under Perceivable, 9 under Operable, 99 under Understandable, and none under Robust), 264 warnings (109 in Perceivable, 138 in Operable, 17 in Understandable, and none in Robust), and 30 unchecked items (7 in Perceivable, 13 in Operable, 9 in Understandable, and 1 in Robust).

The problems identified on the homepage were concen-

Figure 1. ASES Tool Results in the Evaluation of the Homepage (Content in Portuguese). Source: https://asesweb.governoeletronico.gov.br/

Table 1. Errors Identified by ASES per Page, Distributed by eMAG Sections.

eMAG Recommendation	Homepage	CPF Service	Latest News
Markup (*Marcação*)	3 errors in 1.2 Organize HTML code in a logical and semantic manner	4 errors in 1.2 Organize HTML code in a logical and semantic manner	3 errors in 1.2 Organize HTML code in a logical and semantic manner
Behavior *(Comportamento)*	0	0	0
Content/Information *(Conteúdo/Informação)*	6 errors in 3.5 Clearly and concisely describe links	5 errors in 3.5 Clearly and concisely describe links	5 errors in 3.5 Clearly and concisely describe links
Presentation/Design *(Apresentação/Design)*	0	0	0
Multimedia (*Multimídia*)	0	0	0
Forms (*Formulários*)	0	0	0
Total	**9**	**13**	**8**

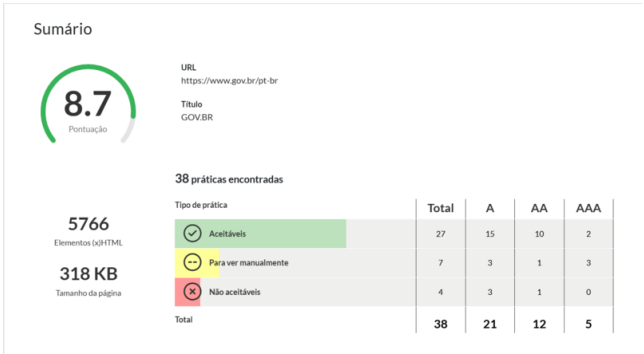

Figure 2. AccessMonitor Tool Results in the Evaluation of the Homepage (Content in Portuguese) Source: https://accessmonitor.acessibilidade.gov.pt/

trated in the following items: Text Alternatives – Non-Text Content (1.1.1); Adaptable – Info and Relationships (1.3.1); Navigable – Link Purpose (In Context) (2.4.4) and Link Purpose (Link Only) (2.4.9); Compatible – Parsing (Obsolete and Removed) (4.1.1); and Input Assistance – Labels or Instructions (3.3.2).

The problems identified on the service page were concentrated in the following items: Text Alternatives – Non-Text Content (1.1.1); Adaptable – Info and Relationships (1.3.1); Keyboard Accessible – Keyboard (No Exception) (2.1.3); Navigable – Link Purpose (In Context) (2.4.4); Predictable – On Input (3.2.2); Input Assistance – Labels or Instructions (3.3.2); and Compatible – Name, Role, and Value (4.1.2).

Finally, the problems identified on "Latest news" page were concentrated in the following items: Text Alternatives – Non-Text Content (1.1.1); Adaptable – Info and Relationships (1.3.1); Navigable – Link Purpose (In Context) (2.4.4) and Link Purpose (Link Only) (2.4.9); and Input Assistance – Labels or Instructions (3.3.2).

5.1.4 ContrastChecker

For the evaluation using Contrast Checker, it was necessary to select the background and foreground colors employed on the website to verify whether the contrast between them was adequate. It was observed that the three pages selected for evaluation shared the same color palette; therefore, a single analysis was sufficient.

As a result, it was observed that the website features a white background, with most of the content displayed in dark gray and dark blue text. Figure 4 presents the results for the most frequently used color pairs on the site, along with their respective classifications for each indicator.

Most of the evaluations conducted by the tool (9 out of 11) indicated contrast levels in compliance with WCAG success criteria 1.4.3 (minimum contrast ratio of 4.5:1 for

Table 2. Errors Identified by AccessMonitor per Page, Distributed by WCAG Levels.

WCAG Levels	Homepage	CPF Service	Latest News
A	3 errors in 1.3.1 Info and Relationships 2.5.3 Label in Name 3.3.2 Labels or Instructions 4.1.2 Name, Role, Value	1 error in 1.3.1 Info and Relationships 3.3.2 Labels or Instructions	2 errors in 1.1.1 Non-text Content 1.3.1 Info and Relationships 3.3.2 Labels or Instructions
AA	1 error in 1.4.3 Contrast (Minimum)	1 error in 1.4.3 Contrast (Minimum)	1 error in 1.4.3 Contrast (Minimum)
AAA	0	0	0
Total	**4**	**2**	**3**

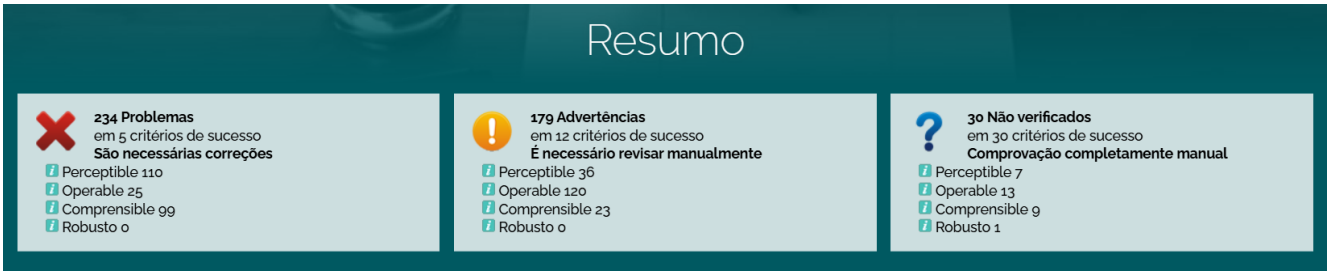

Figure 3. TAW Tool Results in the Evaluation of the Homepage (Content in Portuguese). Source: https://www.tawdis.net/

text with fonts smaller than 18 pixels and 3:1 for larger fonts) and 1.4.6 (enhanced contrast ratio of 7:1 for text with fonts smaller than 18 pixels and 4.5:1 for larger fonts).

The two color combinations that did not comply with WCAG were identified in the area displaying the numbering of the most accessed services (Figure 5-a), in the section highlighting new services (Figure 5-b), and on the buttons used to start a service—triggered on the internal page (Figure 5-c). For the service numbering, the color contrast ratio was significantly below the minimum required by success criterion 1.4.3 (only 1.21:1), rendering this section of the page noncompliant with WCAG Level AA. The contrast used in the highlighted sections and buttons also failed to meet success criterion 1.4.6, corresponding to Level AAA.

Additionally, two issues were identified that, although not directly related to WCAG success criteria, may affect readability for individuals with color blindness. These issues were flagged in the tool's report under the label Color Diff. Figure 6 presents the detailed results for one of the colors that fall into this category.

5.2 Evaluation by a Person with Low Vision

The evaluation began with navigation through the homepage of the Gov.br portal. Upon first accessing the page, it was not immediately possible to view the content clearly. Although the page offers a white background and an option to adjust contrast (switching to a black background with white text), the default font size was too small to allow natural interaction without the use of magnification tools. Therefore, it was necessary to activate the device's zoom function from the bottom menu. The magnification process is illustrated in Figure 7.

After adjusting the zoom for better visibility (by pressing the "+" icon to its maximum extent), the main bar containing the phrase "Serviços e Informações do Brasil" ("Services and Information of Brazil") overlapped other site elements. This overlap compromised the legibility of adjacent items and caused the phrase itself to appear truncated, along with the persistent display of the numbers "2" and "3" (Figure 7, item 4). The problem persisted even when the page was viewed in landscape mode, with the smartphone positioned horizontally. This issue is related to WCAG 2.2 success criteria 1.4.4 (Resize Text) and 1.4.10 (Reflow), which stipulate that no loss of functionality should occur when content is resized by 200% and 400%, respectively [W3C, 2022]. It is noteworthy that, on iPhones, the zoom percentage applied is not displayed, and this information is also unavailable on the Google Chrome help page [Google, 2024].

Furthermore, the page appeared visually unbalanced, with all information aligned to the left, while the right side contained substantial empty space, indicating that the content was not properly distributed (Figure 8). During navigation, it was also observed that some textual elements lacked adequate contrast, such as the numbers indicating the most accessed services.

In addition to the contrast issue, the applied zoom caused the numbers to overlap with the first letter of each word, resulting in visual disorganization (Figure 8). This aspect is related to success criteria 1.4.3 (Contrast – Minimum) and 1.4.6 (Contrast – Enhanced), which require minimum contrast ratios of 4.5:1 and 7:1, respectively.

Continuing with the homepage analysis, in the "Serviços digitais por perfil" (digital services by profile) section, the beginning of the sentence appeared truncated, and overlapping of textual content occurred in the subsequent words. This section also contained illustrations and small images that did not adjust to the applied zoom, making it difficult to identify the icons and read the text embedded

Table 3. Errors Identified by TAW per Page, Distributed by WCAG Principles.

eMAG Recommendation	Homepage	CPF Service	Latest News
Perceivable	110 errors in 1.1.1 Non-Text Content 1.3.1 Info and Relationships	107 errors in 1.1.1 Non-Text Content 1.3.1 Info and Relationships	110 errors in 1.1.1 Non-Text Content 1.3.1 Info and Relationships
Operable	25 errors in 2.4.4 Link Purpose (In Context) 2.4.9 Link Purpose (Link Only)	7 errors in 2.1.3 Keyboard (No Exception) 2.4.4 Link Purpose (In Context)	9 errors in 2.4.4 Link Purpose (In Context) 2.4.9 Link Purpose (Link Only)
Understandable	99 errors in 3.2.2 On Input 3.3.2 Labels or Instructions	106 errors in 3.2.2 On Input 3.3.2 Labels or Instructions	99 errors in 3.3.2 Labels or Instructions
Robust	0	1 error in 4.1.2 Name, Role, Value	0
Total	**234**	**221**	**218**

within the images (Figure 9). In this case, in addition to the success criteria related to text resizing, there was also a violation of criteria 1.4.5 (Images of Text) and 1.4.9 (Images of Text – No Exception), which emphasize the importance of avoiding the use of images of text to convey essential content.

In addition to the responsiveness issues identified on the homepage, the page for the most accessed service, "Consultar CPF" (Check CPF), presented a problem with the main button that allows users to access the service: the text that should appear inside the button was missing, leaving only a green rectangle with rounded corners visible (Figure 10). Another issue on the service page occurred in the "Ouvidoria" (Ombudsman Service) section, where the icons overlapped with the text, hindering legibility (Figure 11). Once again, page resizing negatively affected interaction with the site—this time more critically, as it rendered the most important button on the page, the one used to initiate the service, nonfunctional.

Finally, the evaluation of the "Latest News" page was only possible through a direct link shared by another person, as accessing this page via smartphone navigation was not feasible: it is available exclusively on desktop computers. The news subpages could be reached through the menu; however, access to the main page listing the latest news was unavailable, revealing a usability issue.

Regarding the accessibility of the "Latest News" page, the same responsiveness and contrast issues were observed, with particular emphasis on the inadequate adjustment of images to the available screen space. On this page, images were made too small to be understood (Figure 12), making it extremely difficult to discern their content.

Another critical issue involved the pagination feature used to access subsequent news pages. Figure 13 illustrates the pagination in its normal view (1) and with zoom applied (2). When zoom was applied, the overlapping of elements made it difficult to recognize the feature as pagination. Moreover, the appearance of the pagination differed substantially from the non-zoomed version, further impairing its usability.

The evaluation results for the participant with low vision indicate that all issues identified across the three analyzed pages are directly associated with the success criteria of the Perceivable principle of the WCAG (1.4.3, 1.4.4, 1.4.5, 1.4.6, 1.4.9, and 1.4.10). This finding was anticipated, as visual impairments primarily impact perceptual aspects of interaction. Nevertheless, these barriers also create navigation challenges, since overlapping elements, truncated text, and non-responsive layouts obstruct the recognition of actionable components. Comprehension is similarly affected when essential information becomes visually distorted or fragmented, or when it is conveyed through text images that fail to adapt to magnification.

6 Results

After conducting the automated accessibility evaluations using the ASES, AccessMonitor, TAW, and Contrast Checker tools, it was found that none of the evaluated pages fully comply with the international accessibility standards established by Brazilian Law No. 13,146/2015 [Brasil, 2015]. Although significant improvements were observed compared to the previous study by Barros *et al*. [2024], the results underscore the need for additional reviews and adjustments. Although ASES structures its results according to eMAG categories, this accessibility guide is a specialized adaptation of WCAG, and consequently, all its recommendations are aligned with the corresponding WCAG guidelines.

It was observed that the distinction in result categorization provides developers with a comprehensive overview of the necessary corrections. In ASES, the results are organized by eMAG sections, which are grouped under specific sets of recommendations. AccessMonitor, in contrast, presents results directly aligned with the three WCAG conformance levels, facilitating the immediate identification of both the number and the severity of required corrections.

Additionally, TAW reported a higher number of errors compared to the other tools, including some related to a success criterion that is now obsolete and has been removed from version 2.2 of the WCAG: criterion 4.1 (Parsing). The latest

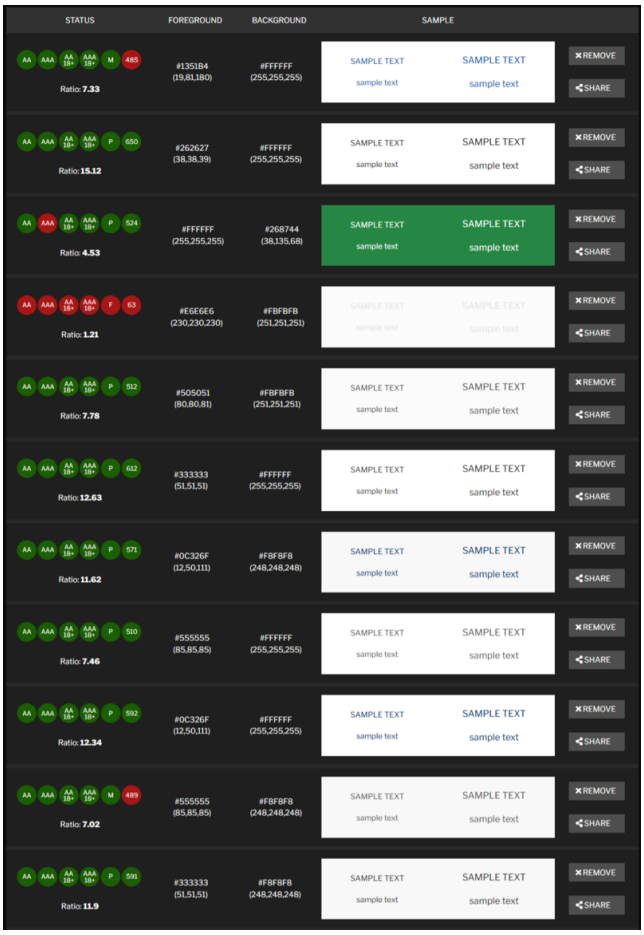

Figure 4. ContrastChecker Results in the Evaluation of the Homepage. Source: https://contrastchecker.com/ | Link to view the image in full size.

version of the guidelines clarifies that this criterion was originally introduced to address challenges encountered by assistive technologies that directly parsed HTML code. However, since modern assistive technologies no longer depend on direct parsing, the issue has become either irrelevant or covered by other criteria. Therefore, the criterion was deemed obsolete and removed from the current version of the guidelines (2.2).

For these reasons, all three accessibility evaluation tools were employed in this study to maximize the identification of relevant errors and to support the prioritization of necessary corrections. In addition, the Contrast Checker was used to assess the color palette adopted on Gov.br, yielding consistent results across the three evaluated pages, as they share the same palette. This evaluation corroborated the findings previously identified by AccessMonitor, indicating that the portal still does not fully comply with the contrast criteria established by WCAG 2.2, despite the improvements observed in comparison with the previous assessment [Barros *et al.*, 2024]. In light of these results, revising the color combinations that remain inadequate for users with visual impairments is essential.

The results of the automated evaluation revealed that the three analyzed pages exhibited similar issues, as identified by the tools employed. All pages presented errors related to the semantic structuring of the HTML code, problems with links, the absence of alternative text for images, and inadequacies in text color contrast.

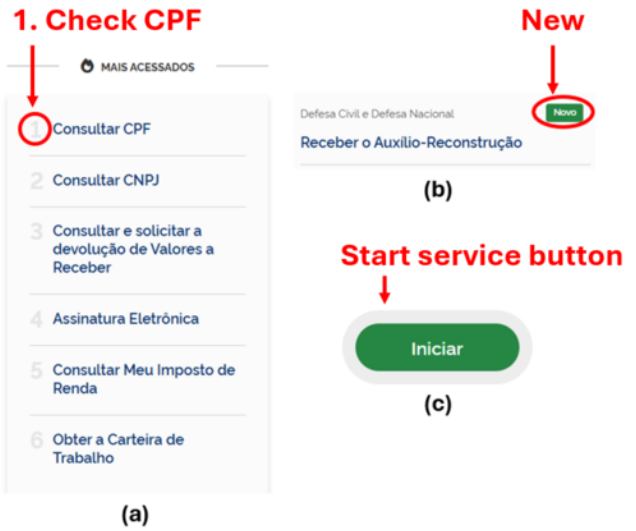

Figure 5. Interface areas with issues: (a) list of most popular services, with emphasis on Check CPF (b) highlight for new services, and (c) button to start a service (Content in Portuguese). Source: https://www.gov.br/, edited by the authors.

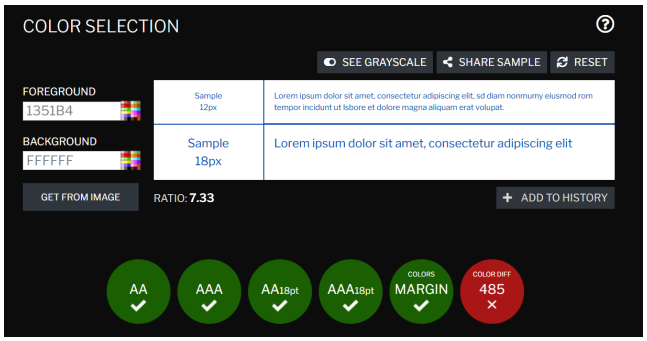

Figure 6. Individual result of a contrast evaluation for the homepage. Source: https://contrastchecker.com/

The evaluation conducted by a low vision specialist reinforced the severity of the issues related to color contrast. Even with substantial screen magnification applied through the smartphone's zoom feature, some text elements with insufficient contrast remained difficult to read.

Additionally, the evaluation conducted by the specialist revealed critical usability issues and accessibility barriers that were not detected by the automated tools. Among the most significant were the inadequate distribution of content and the loss of functionality and information when zoom was applied. In this context, the importance of involving people with disabilities in manual evaluations is reinforced, as they contribute real perspectives and specific experiences that help identify barriers often overlooked by non-disabled evaluators or automated tools.

These findings reinforce the importance of evaluations conducted by people, even considering the progress observed on Gov.br compared to the previous study by Barros *et al.* [2024], as well as the high scores achieved in some automated tools. Table 4 presents the necessary corrections to enhance the portal's accessibility, indicating their criticality according to the WCAG compliance level and specifying in which evaluation(s) each correction was identified.

While prioritizing actions based on WCAG guidelines is essential to ensure compliance with the most critical accessibility levels in the shortest possible time, limiting efforts

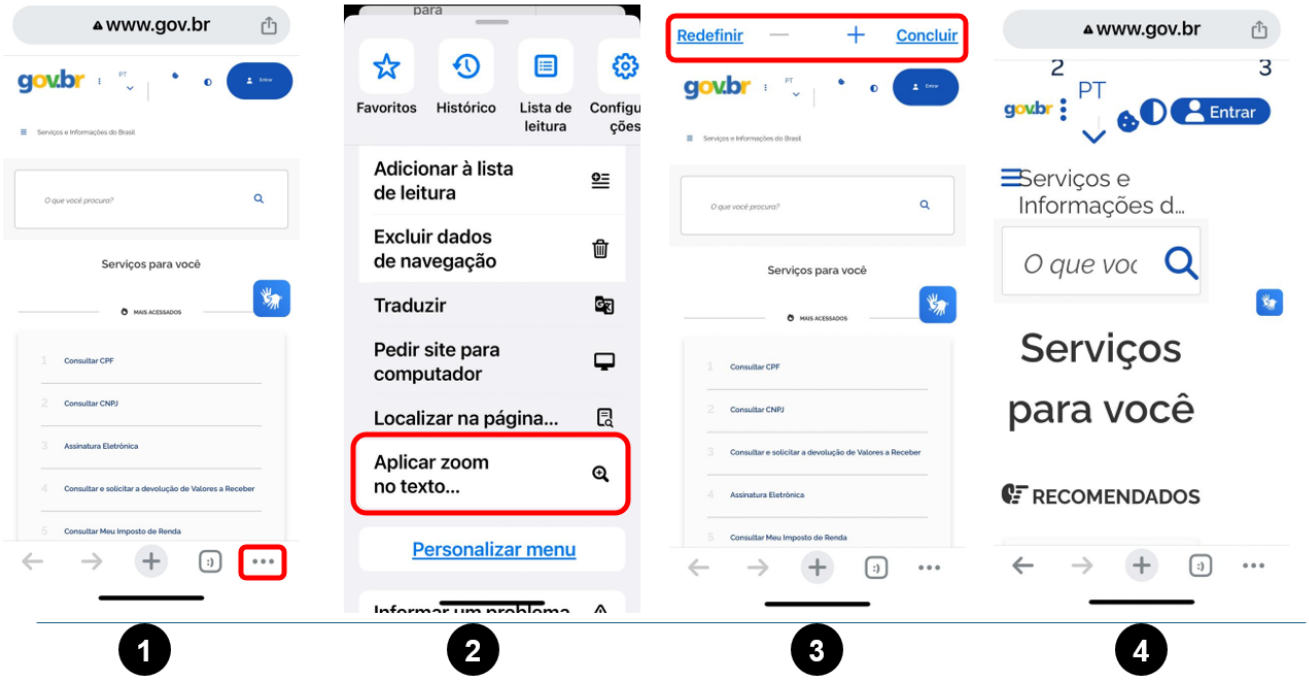

Figure 7. Steps Required to Activate Zoom. (Content in Portuguese). Source: https://www.gov.br/

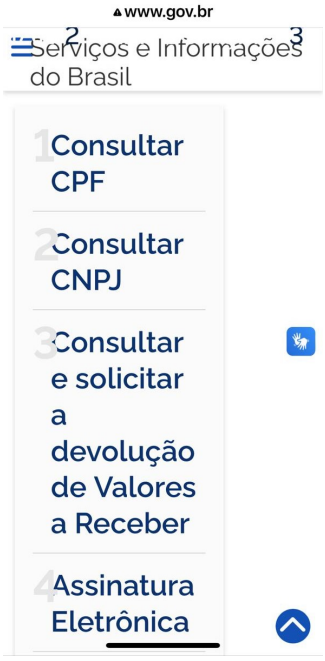

Figure 8. Lack of responsiveness and contrast issue in the numbering of the most accessed services, which also overlaps with the text (Content in Portuguese). Source: https://www.gov.br/

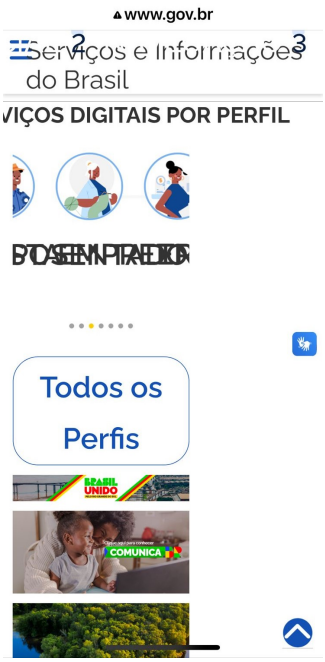

Figure 9. Text Truncation and Overlap, as well as Illustrations and Images that Do Not Adapt to Zoom (Content in Portuguese). Source: https://www.gov.br/

solely to these priorities may disadvantage people with disabilities. This occurs because not all issues considered less critical by the guidelines are necessarily less significant in practice for users. For instance, while the absence of an image description (item 4, Level A) is crucial for screen reader users to understand the content, other aspects classified as Level AA or AAA, such as appropriate color contrast or the ability to resize text when zoom is applied, can also be decisive for an inclusive experience for individuals with low vision. Therefore, focusing exclusively on what WCAG defines as a priority may overlook important barriers that directly affect the usability and autonomy of people with disabilities.

7 Limitations

This study was limited to the evaluation of three pages from the Gov.br, selected for their high relevance to users. The issues identified on these pages exhibited similar characteristics, suggesting a recurring pattern in the elements that require adjustment to enhance the portal's overall accessibility.

The research was further limited to automated evaluation methods, employing four tools, and to a manual evaluation conducted by a specialist with low vision. This manual assessment focused on accessibility barriers specific to that audience, being confined to an individual experience that

Table 4. Necessary Corrections in Gov.br

ID	Necessary Corrections	WCAG Level	Automated	Manual
1	To avoid text elements with color contrast issues relative to the background, the cascading style sheet should be corrected, taking into account the size and colors of the text elements.	A	X	X
2	The HTML code was not organized in a logical and semantic manner and does not present elements in an understandable order or one that corresponds to the intended content. It is suggested to check for the presence of H1, H2, H3, H4, H5, H6, A, P, and LABEL elements that include opening and closing tags but lack textual content.	A	X	
3	Each link's destination should be clearly identified, including an indication if the link redirects to another website. It is recommended to fix links that are empty or images without descriptions.	A	X	
4	A description should be provided for images on the page that contain content relevant to the reader's understanding. It is recommended to correct images with an empty ALT attribute, except for those of a decorative nature. Whenever possible, decorative images should be incorporated into the style sheets.	A	X	
5	The website's content, including images and text, must adjust to the available screen space when zoom is applied, regardless of screen size, ensuring that no elements overlap and no functionality is lost.	AA		X
6	The website should be designed to ensure consistent menu functionality and information availability, regardless of whether it is accessed via desktop or mobile devices.	AA		X

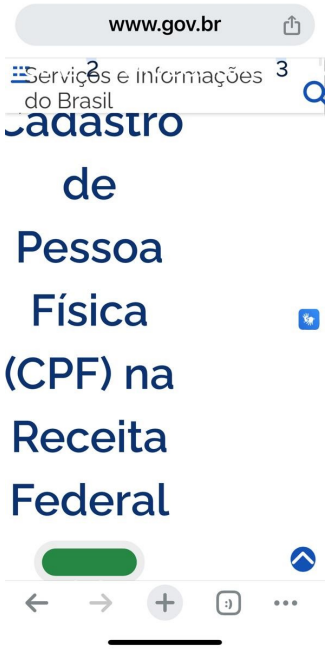

Figure 10. Button to Access CPF Service Without Text (content in Portuguese). Source: https://www.gov.br/

Figure 11. Icons Overlapping Text (content in Portuguese). Source: https://www.gov.br/

Figure 12. Images with Disproportionate Sizes (content in Portuguese). Source: https://www.gov.br/

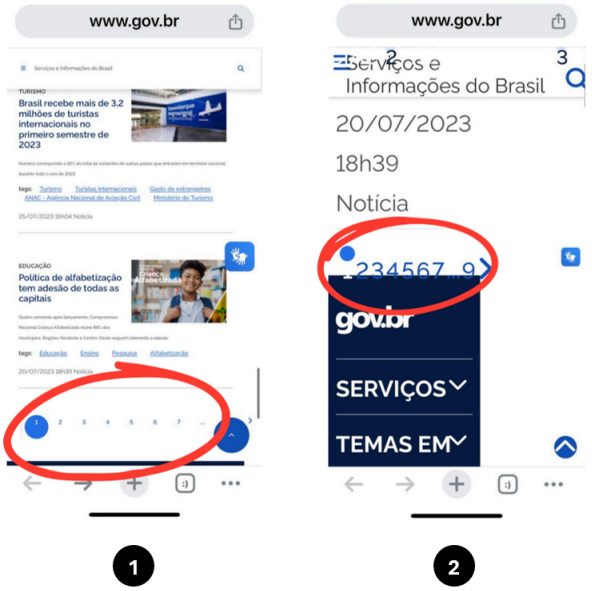

Figure 13. Pagination in "Latest News" - With Zoom (1) and Without Zoom (2) (content in Portuguese). Source: https://www.gov.br/

cannot be generalized, a characteristic feature of qualitative studies.

The inclusion of a more comprehensive manual evaluation, involving a larger and more diverse group of participants with different needs and types of disabilities, could reveal barriers not identified by the methods employed, thereby enriching the findings and providing a stronger foundation for future interventions.

It is also important to note that the automated evaluation was conducted using the desktop versions of the pages, as the tools applied were designed for this environment and focus on aspects detectable through source code analysis. In contrast, the manual evaluation was performed on a smartphone to capture interaction issues specific to mobile devices—a predominant mode of access in Brazil that automated tools often overlook. This dual approach sought to combine the strengths of both evaluation methods; however, the differences between the analyzed environments are recognized as a potential limitation, particularly when comparing results from the automated (desktop) and manual (smartphone) analyses.

Supporting materials were not preserved after the completion of the initial study due to storage and data management constraints. Nevertheless, all relevant information and representative examples are documented in this paper to ensure the transparency and reproducibility of the analysis.

8 Conclusion

This study aimed to assess three pages of the Gov.br portal using three accessibility evaluation tools (ASES, AccessMonitor, and TAW) and a contrast verification tool (Contrast Checker), in addition to a manual assessment performed by a specialist with low vision. This work extends the study presented in Barros *et al.* [2024] by introducing a new round of automated evaluations and incorporating a manual evaluation.

Some of the identified issues were classified as severe because they may hinder the use of the portal by people with disabilities. Since Gov.br centralizes citizen services and information about the activities of the Federal Government in a single platform, it is essential that the website ensures accessibility for all users.

The evaluation revealed issues on all assessed pages, primarily related to the semantics of the HTML code and the structure of the links. In addition, a substantial portion of the website was designed using low-contrast colors (white, gray, and blue), which hinders navigation for users with visual impairments. When the site is accessed on a smartphone with zoom enabled, content comprehension becomes even more difficult, and certain functionalities are lost.

The findings indicate that the portal does not meet the minimum accessibility standards. Although the results of the various evaluations are presented differently, they consistently indicate similar types of errors. Considering that Gov.br was developed using the same architecture as the evaluated pages, it is likely that other pages exhibit the same issues identified in this assessment. Addressing the errors listed in Table 4 represents an essential step toward achieving compliance with accessibility guidelines and fostering uni-

versal access and social inclusion.

As future work, this study could be complemented by a manual validation conducted by accessibility specialists, encompassing needs beyond low vision and including tests with individuals who have other types of disabilities. Additionally, future research could extend this investigation to other contexts, such as banking applications, which have become increasingly essential for daily activities and thus require careful attention to accessibility. Such an approach would enable the identification of issues that were not detected in the present study, thereby providing a more comprehensive and accurate evaluation of the accessibility of the Gov.br portal.

Declarations

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This article is an extended and revised version of the original work by Barros *et al*. [2024]. The authors acknowledge the support of the generative artificial intelligence tool ChatGPT 5 in translating the manuscript into English and producing alternative text for the images included in the article. These alternative texts are intended to enhance accessibility by allowing individuals with visual impairments who use screen reader software to access the content conveyed through the images.

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Authors' Contributions

The authors' contributions, according to the CRediT taxonomy, are as follows: Ygor Barros: Conceptualization, Investigation, Methodology, and Writing – original draft. Juliana Outão: Conceptualization, Investigation, Methodology, and Writing – original draft. Carolina Sacramento: Investigation, Methodology, and Writing – original draft. Yndiana Gouveia: Investigation. Simone Bacellar Leal Ferreira: Supervision and Writing – review and editing. Rodrigo Santos: Supervision and Writing – review and editing. Mariano Pimentel: Supervision.

Availability of data and materials

The materials generated and analysed during the current study are available in this paper to ensure the transparency and reproducibility of the analysis.

Competing interests

The authors declare that they have no competing interests.

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