Accessibility of COVID-19 Websites of Asian Countries: An Evaluation Using Automated Tools

Telcia Niom1 · Frank Lin2

Received: 22 August 2022 / Accepted: 12 September 2022 / Published online: 29 September 2022
© The Author(s), under exclusive licence to Springer Nature Singapore Pte Ltd 2022

Abstract
Web accessibility helps in making the websites accessible for all. There has been too much research on the accessibility of websites across different domains such as education, health, banking, route services, Government portals, literature, etc. In this research, we have tried to explore the much less investigated domain of the accessibility analysis of COVID-19 vaccine registration and information websites of Asian Countries. The analysis has been done based on WCAG 2.0 and 2.1 guidelines. The evaluation has been done using automated tools including Access Monitor and AChecker. The results indicate that only 62% of the websites have passed the accessibility score. We have also identified common errors in these websites and have given recommendations for improvement.

Keywords Accessibility analysis · COVID-19 · Website accessibility · WCAG · Website design

Introduction
The importance of Internet access in the modern world cannot be overemphasized. A survey of adult men in Asia found that 52% respondents believe that Internet access is more vital than food or housing. The Internet is the biggest repository of access to diverse information sources today, with 24-h instantaneous access to information on almost every aspect of human knowledge, ranging from entertainment, and news to the latest discoveries. It interconnects people across the globe through email, Internet telephony, social media, and much more. The Internet has also become, and sometimes is an essential addition to many traditional businesses such as online shopping or effectively replaces traditional stores in modern homes.

Accessibility benefits all the strata of society, including persons with disabilities. And thus, improved accessibility improves the quality of life. It creates more independence and a better society. It also leads to better health and can bring cost savings in many areas. In many countries, web accessibility is protected under various laws.

Running a website accessibility test is a preliminary way to detect errors or design flaws in websites. Website accessibility testing is also crucial in identifying issues that affect accessibility. Website accessibility is tested based on the Web Content Accessibility Guidelines (WCAG) [1]. WCAG is divided into three compliance levels: Level A, Level AA, and Level AAA, according to the accessibility of web content. The levels are briefly discussed below:

– Level A: Level A is the lowest conformance level. Level A sets the minimum accessibility level and does not strive for universal access in most cases.
– Level AA: The mid-range and most common accessible conformance level is level AA. Level AA is the recommended conformance for all web-based information.
– Level AAA: Level AAA is the utmost challenging level of conformance. It is difficult to strive for complete AAA compliance as it is impossible to fulfill all Level AAA Success Criteria for some web content.

This article is part of the topical collection “Enabling Innovative Computational Intelligence Technologies for IOT” guest edited by Omer Rana, Rajiv Misra, Alexander Pfeiffer, Luigi Troiano and Nishtha Kesswani”.

Telcia Niom
telcianiom@gmail.com

1 Bhartiya Vidya Bhavan, JP, India
2 California State University, San Bernardino, CA, USA
WCAG comprises following four principles:

- **Principle 1**: The content, including text information, multimedia, video, and audio, must be presented to users in a way they can perceive easily (Perceivable).
- **Principle 2**: The user interface and navigation components must be operable (Operable).
- **Principle 3**: User interface information and operation must be understandable (Understandable).
- **Principle 4**: Enable contents to be interpreted reliably by various user agents, including assistive technologies, must be robust (Robust).

This study is based on WCAG 2.1. 61 WCAG 2.0 success criteria and 78 WCAG 2.1 success criteria (excluding compliance). WCAG 2.0 is a subset of WCAG 2.1, since all 61 guidelines for WCAG 2.0 are part of WCAG 2.1. WCAG 2.1 added 17 new successes to WCAG 2.0. Fulfilling these guidelines will help in making the content accessible to most people with disabilities, including blind and visually impaired, hearing, limited movement, speech impaired, as well as persons with certain learning and mental disabilities.

WCAG 2.1 offers two additional benefits as compared to WCAG 2.0 support technologies users. It addresses special issues for users with motor and occupational disabilities, visually impaired people, those with vestibular disabilities, and people with intellectual disabilities. The guidelines address access to web content on devices including desktops, palmtops, laptops, and mobile devices. This improves the functionality and interoperability of the Web interface. It also contains suggestions for making content significantly more accessible than previous guidelines. Compliance with these guidelines will facilitate end-users in navigating the web content. The new version of WCAG 2.1 guidelines supports the following:

1. **Low-level users**: WCAG 2.1 expands image diversity requirements and introduces new text and custom text guides for web content and controls to support a better visual concept. Intelligent users, language, or learning disabilities—WCAG 2.1 incorporates the requirements for providing additional information about the specific purpose of input control and additional requirements for end-of-life support due to inactivity.
2. **Support for mobile devices**: In fact, the WCAG 2.1 guidelines are the best way to improve the usability and accessibility of all mobile device users.

There are some existing research [2–4] that focus on accessibility of websites across diverse domains. However, to the best of our knowledge, none of the existing works focus on the accessibility of COVID-19 websites. And this is the main motivation behind the current research.

The major contributions of this research are to analyze the accessibility of COVID-19 vaccination registration websites using automated web accessibility tools—Access Monitor and A checker under different WCAG 2.0 compliance standards and 2.1 guidelines. The reason why automated tools have been taken is that they are proven to identify a reasonable number of accessibility issues with websites. To overcome the bias of one tool, we have analyzed two automated tools. For this study, we have analyzed 45 websites of Asian countries.

The organization of the paper is as follows. In "Background", we have discussed the accessibility tools used in this research. The "Related Work" gives an overview of related work. Experiments and Results are described in "Experiments and Results". The "Errors and Recommendations" illustrates the common errors in website design and recommendations to overcome these errors. The last section concludes the paper.

**Background**

There are many types of automated web accessibility testing tools available online that help in checking the web accessibility of web pages or websites. Some commonly used tools are WAVE, Sort Site, A Checker, AATT, Fire Eyes, and the A11y Compliance platform. These automated tools give a detailed report of the accessibility of the website’s pages. Each one of them has its own method to evaluate the errors. In this study, we have used Access Monitor and A Checker for analysis. Using different automated tools can help in improving the accuracy and test reliability.

**AChecker**

AChecker (Accessibility Checker) [5] is a digital website evaluation tool based on WCAG 2.0, which is used to quickly scan the website pages and provides technical accessibility issues and errors, so that we can improve them.

**Access Monitor**

Access Monitor [6] is the most commonly used website evaluation and validating tool based on WCAG 2.1 guidelines. We can obtain an accessibility report using one of the following methods: By inserting a URL or HTML Code or by directly uploading the HTML file. This tool gives the results defined in three categories: Acceptable, To view Manually, and Not Acceptable under three different conformance levels of WCAG 2.1 (Level A, Level AA, and
Level AAA). This tool gives the best accessibility practices for web content to improve the accessibility of websites and mobile applications.

**Related Work**

In this study, we have analyzed the accessibility of COVID-19 vaccine registration and information websites, because this pandemic has affected billions of people across all strata of society. This pandemic was the worst ever and has affected people’s health and wealth. Information regarding health matters the most, and due to the pandemic, about 80% of the health information is online. Thus, it is important that this information is accessible. In addition to this, official websites need to be more and more accessible to people, so that they can access the vaccination information with ease.

So far, there has been researching across different domains like the accessibility of government websites, education, health, Banking sector, library websites, etc. There are a few studies that have explored the accessibility of COVID-19 websites. In this section, we discuss the existing work in this domain.

An evaluation of Accessibility Analysis of Government Websites was conducted to determine the quality of websites [7]. This study carried out the analysis using two automated tools—TAW and AChecker. The results show that more than 30% of these websites were poor in terms of accessibility.

Another study focused on web accessibility analysis of 65 Indian E-government websites in India [8]. The researchers have used automated evaluation tools based on WCAG 1.0 and WCAG 2.0. The research indicated that some e-government websites give low priority to accessibility aspects during website design and development. Therefore, there is a need for significant improvement in the accessibility and usability of e-government websites to have a better E-Government Development Index rank in India.

Apart from this, some researchers have also focused on the COVID-19 websites. Sarah Alis [9] has analyzed and investigated the status of web accessibility of 54 COVID-19 vaccine registration websites in the United States with respect to WCAG 2.0 and 2.1 guidelines through AChecker, WAVE, and Sort site accessibility checking tools. Based on their findings, they recommended improving the websites, so that persons with special needs can fix vaccination appointments with ease.

A study with four Web accessibility tools Mauve++, Nibbler, and WAVE has been carried out by Jinat Ara [10] on COVID-19-related government websites. An evaluation was done through both tools and human observation. Results revealed that a few websites were accessible and the rest were not accessible for disabled persons. Also suggested improvement measures for websites in future.[2] Dylan H. Hewitt & Yingchen He [11] in their paper investigated the accessibility of 55 state and territory COVID-19 websites in the United States using automated tools including MAUVE++, CynthiaSays, and AChecker. This paper highlights the testing of the homepage and vaccine pages of each state and revealed 81% violations in the cases and then ranked the states by their accessibility ratings and also provided suggestions for remedies.

Moreover, in previous studies, there are various domains where several researchers have tried to access web accessibility. The world has a 7.75 billion population, and out of this, there are 5 billion Internet users, which is 63% of the global population and about 15% of the world’s population has some form of disability, according to The Internet Society Accessibility Special Interest Group [12]. Therefore, users with disabilities may experience significant problems in accessing the websites on the World Wide Web. Furthermore, they also depend on assistive technologies and other accessibility hardware and software.

It is evident from the existing works that the COVID-19 vaccination and information websites need to be accessible to all. Furthermore, to the best of our knowledge, there is no existing study that focuses on the accessibility of COVID-19 websites in Asian countries. In this research, we have tried to address this gap.

**Experiments and Results**

In this research, we have analyzed the accessibility of COVID-19 information and vaccine registration websites in Asian Countries.

For the sake of brevity, we have analyzed the home pages of the public COVID-19 vaccine registration Websites using automated web accessibility evaluation tools—AChecker and Access Monitor 2.1. Furthermore, we extracted the accessibility errors of the websites of Asian countries based on WCAG 2.0 and WCAG 2.1 guidelines.

Through AChecker, analysis has been performed in three conformance levels: Level A, Level AA, and Level AAA. While in Access Monitor 2.1, analysis has been performed on the basis of Known problems, Potential problems, and Likely problems.

Figure 1 shows the accessibility analysis using A checker. It is evident from the results that the websites of countries like India, Hong Kong, and Bahrain are well designed from the accessibility perspective, while the websites of countries like Azerbaijan are not so good in terms of accessibility.
Fig. 1  Known, likely, and potential problems reported by A checker
Fig. 2 Accessibility problems reported by Access Monitor
The accessibility analysis using Access Monitor is shown in Fig. 2. The results of Access Monitor were analyzed across all three conformance levels A, AA, and AAA. The conformance was checked under WCAG 2.1.

We have also observed that out of 45 websites that were analyzed, 28 websites passed the accessibility score test. The score was calculated and provided by the Access Monitor web accessibility tool under the WCAG 2.1 guidelines. According to it, websites that have a score above 5 out of 10 were declared “Passed” the accessibility score, whereas the websites which scored below 5 out of 10 were declared to “Failed” the web Accessibility test. Thus, according to the evaluations, about 62% websites have passed the web Accessibility test and the remaining websites need to be redesigned in such a manner that they are accessible to all.

In the next section, we discuss some of the common errors and recommendations to overcome those errors.

Errors and Recommendations

Some of the success criteria overlooked during website design include missing Text alternatives. Alternative text plays an important role in images and other non-text content. This helps in making websites more accessible through screen readers. Thus, while designing the website, alternative text should be given for non-text content.

Another success criterion that should be taken care of is color contrast between the link text and the background. Furthermore, it was found that there were missing labels on many of the websites. It is important that text should be added to labels for better accessibility.

In some cases, it was found that the websites are not navigable. The websites should have multiple ways in which the users can navigate the content.

If the above-mentioned criteria are fulfilled, most of the accessibility problems with the websites can be resolved.

Conclusion

In this paper, we analyzed the accessibility of 45 COVID-19 vaccination registration and information websites in Asia. The results indicate that only 62% of the websites were accessible and there is a scope improvement in this regard. The findings of the research would help governments in identifying the flaws in the website design and making the websites accessible for all.

Funding This study was not funded by any source.

Declarations

Conflict of Interest Telcia Niom declares that she has no conflict of interest. Frank Lin declares that he has no conflict of interest.

Ethical Approval This article does not contain any studies with human participants or animals performed by any authors.

References

1. Web Content Accessibility Guidelines (WCAG) 2.1 - W3C. https://www.w3.org/TR/WCAG21/. Accessed: 30 April 2022.
2. Kesswani N, Kumar S. Government website accessibility: a cross-country analysis of G7 and BRICS countries. Univ Access Inf Soc. 2022;21(3):609–24.
3. MACAKOĞLU ŞS, Peker S. Web accessibility performance analysis using web content accessibility guidelines and automated tools: a systematic literature review. In: 2022 International Congress on Human-Computer Interaction, Optimization and Robotic Applications (HORA), 2022; pp. 1–8, IEEE.
4. Bai Y. The relationship between website accessibility and usability: an examination of US county government online portals. Electron J e-Govern. 2019;17(1):47–62.
5. AChecker web accessibility checker. https://achecker.achecker.ca/checker/index.php. Accessed: 12 April 2022.
6. AccessMonitor. https://accessmonitor.acessibilidade.gov.pt/. Accessed: 16 June 2022.
7. Kesswani N. Conference proceedings of icdlair 2019. Lecture notes in networks and systems, vol. 175, Springer, New York.
8. Paul DS. Accessibility evaluation of Covid-19 vaccine registration websites across the united states. Univ Access Inf Soc. 2020;19:949–57.
9. Alismail S, Chipidza W. Accessibility evaluation of Covid-19 vaccine registration websites across the united states. J Am Med Inform Assoc. 2021;28(9):1990–5.
10. Ara J, Sik-Lanyi C. Investigation of Covid-19 vaccine information websites across Europe and Asia using automated accessibility protocols. Int J Environ Res Public Health. 2022;19(5):2867.
11. Hewitt, DH, He Y. Internet Accessibility for blind and visually-impaired users: An evaluation of official us state and territory covid-19 websites. In: Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 2021; vol. 65, pp. 154–158, SAGE Publications Sage CA: Los Angeles, CA.
12. Awan DMS. Introducing the internet society accessibility special interest group; 2022.

Publisher’s Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.