**Original Research Article**

**Evaluating the Performance, Quality, and Accessibility of Ghanaian Government Portals Using Diagnostic Tools.**

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***Abstract*** *-* In today's world, e-government has become an increasingly important aspect of public administration. With the widespread use of the internet, many governments have developed websites and portals to provide services and information to citizens. However, the success of these e-government programs depends on several critical factors, such as accessibility, quality, and efficiency. This research evaluated 20 e-government websites and portals in Ghana using a set of industry-standard Web diagnostic tools (TAW3 and Google PageSpeed Insights and W3C Web Validators). The results are presented in this paper. The findings show that none of the evaluated sites meet the recommended Priority AA conformance standard, and there are significant weaknesses in accessibility, quality, and performance. Most of the websites did not follow the Web Content Accessibility Guidelines (WCAG)'s robust, perceivable, operable, and understandable principles, which resulted in non-compliance problems like slow page loads and broken connections. These results underline the necessity of substantial enhancements to Ghana's e-government websites' usability, effectiveness, and efficiency to improve the citizen experience and guarantee the success of e-government initiatives.

Keywords: Web Accessibility, Performance, WCAG, e-Government, e-government websites

# Introduction

Technology is increasingly becoming an integral part of daily life for many Ghanaians. The term information technology (IT) is used to describe the innovative tools, systems, and processes that support digital innovation and general knowledge management (Oliveira-Dias et al., 2022). According to Yaokumah (2016), information technology has revolutionised many aspects of our lives, both now and in the future as it allows us to maintain our data and stay connected to others electronically. Educational institutions use IT to improve the quality of their teaching platforms by using different software applications (Al-Mamary, 2022). Also, Government agencies use IT to control the information they disseminate to the public.

E-government is a system where all government services are accessed and managed electronically (Ahmed & Al-Amin, 2023; Hooda et al., 2022). It has vital benefits for citizens, governments, and businesses that operate within both sectors. E-government uses technology to lower costs and increase services (Amend et al., 2021). Many services can be accessed online, such as passport applications or tax forms. People no longer need to call government offices to ask questions or file reports. All of this increases efficiency and promotes customer service. Also, it prevents fraud by cutting down on people pretending to be other people on the phone or online. Additionally, it allows government employees to stay up to date on the latest software while working. This makes their work much more efficient and effective. This study focuses on the use of Information Technology by governments.

## Study Background

Many Ghanaians are already familiar with going online to access government services. Many government offices are set up online so people can easily access them. For example, the passport application website is easy to navigate and has all of its forms conveniently listed on the web pages. People also find it much easier to file taxes online with simple software programs. All of this increases convenience for citizens and reduces the cost of running the government (Amend et al., 2021). Additionally, it is much easier to update government systems as new applications become available. This allows agencies to run smoothly and provide quality services to the public.

E-government works well for communicating with citizens online (Ahmed & Al-Amin, 2023). Many people interact with each other on social media platforms regarding government issues. There is also a system where individuals can file grievances with state authorities through their website. No one needs to contact an agent to ask questions or make a report anymore as they can simply message someone or contact an office directly via email or phone number. This increases transparency and contact between citizens and authorities alike (Addo, 2021).

Overall, e-government has a lot of potential due to its convenience, cost savings, and communication abilities among citizens and authorities alike (Ahmed & Al-Amin, 2023). The system is still in its infancy stages but rapidly growing thanks to technological advancement (Obaid et al., 2022). People are already familiar with accessing government services online, which is setting the foundation needed for future e-government developments. Technologies such as cloud computing are making the system more reliable while simultaneously increasing functionality and affordability for all involved parties involved in e-government development schemes. The efficiency, performance and quality of these e-government portals also depends on factors such as web accessibility.

Web accessibility is a way to accommodate people with disabilities, cognitive challenges, or blindness (Gartland, 2022). Therefore, ensuring web accessibility is essential for anyone working with the web. Web accessibility ensures all citizens have access to information from their government. Most institutions provide information online and constantly update it. This way they can communicate with citizens and keep them informed. Anyone can benefit from an accessible website no matter their background or needs. Every government website must be accessible to all users whether they have disabilities or not. Failure to do so risks alienating potential customers, taxpayers, and constituents with disabilities. In addition, inaccessible websites reduce the number of people with disabilities who can help authorities with problems. Therefore, every website must be accessible to everyone.

Unfortunately, accessibility is still a problem even when it is done right (Manca et al., 2023). This makes it difficult for anyone to access websites efficiently or easily understand them. For example, many web pages use black text on white backgrounds that non-sighted people find difficult to read. People with physical disabilities often need to use web communication accessibility as a part of their daily life (Sharp & Sharp, 2022). They may need help accessing web pages, downloading files, and using electronic devices. However, these people are often overlooked by web developers who design for sighted people first. As a result, sites look confusing and unhelpful to people with disabilities. Developers also fail to follow best practices for an accessible design that helps people with disabilities navigate content. If anyone cannot access your website, you need to make sure everyone can access it safely. There are several options for people who need help accessing websites. Alternatively, setting up web proxies for blind people lets them access the web safely without vision. Several other solutions are also available all designed to help people with disabilities access the web.

To communicate with citizens, the government should use web accessibility daily. Many users will find it handy when accessing government websites when they follow accessibility standards. That said, many people with disabilities use it to access resources not available to non-disabled people (Sharp & Sharp, 2022). Allowing users with disabilities is easy if you follow web accessibility, quality, and performance guidelines. Despite the increasing importance of government portals and ministry websites in providing public services and information, there is limited research on this subject in Ghana.

The Quality Performance and Accessibility of Government Portals were studied by Yaokumah et al. (2015) using Web Content Accessibility Guidelines (WCAG) 2.0 requirements. The study's findings revealed that none of the 19 government portals reviewed met the required standard for accessibility. The study also revealed that concerns with website quality, performance, and accessibility may evolve. Therefore, future research should take place. This provides a reason for this study to re-evaluate these web portals for accessibility and quality using the new WCAG 2.1 requirements. This study aims to assess the current state of government portals and ministry websites in terms of their accessibility, quality, and performance using diagnostic tools. The findings of this study can provide valuable insights for policymakers and stakeholders to improve the online presence of government institutions and enhance citizen engagement.

# Literature Review

Governments across the world are searching for effective e-government services (S. R. Chohan & Hu, 2022). The ubiquitous usage of cell phones and other digital devices makes this possible. People are now allowed to purchase items from digital stores like mobile games using their phones. Due to how practical it is to execute transactions; online banking has grown in popularity. In the modern world, electronic banking is a must for bank transformation and competitiveness (Adepoju & Adeniji, 2020). For the same reasons, the government has also found it essential to take advantage of this technological advancement and reach citizens.

## Website Accessibility, Quality, And Performance Standards

The development of technology has enhanced access to materials and information as well as the World Wide Web's (WWW) functionality (Seetha & Ayyadurai, 2022). Different methods for facilitating human interaction and communication have been presented recently. Accessibility is a vital concept to understand when working with the World Wide Web.

Accessibility refers to the ability of people with disabilities to access information and communicate, and it can refer to any condition that limits or prevents such access (S. Gartland, 2022). In other words, accessibility is about making sure everyone who uses the web has an enjoyable experience. By making accessibility a priority, organisations can make sure their content is accessible to people with disabilities. Accessibility is about promoting the needs of users over the needs of developers. This philosophy is most evident in web development standards, where developers prioritise accessibility over functionality. For instance, web developers strive to create accessible websites by relegating functionality to secondary positions on web pages. They do this by placing text on web pages instead of interactive elements such as buttons or links.

The World Wide online Consortium (W3C) and the Web Content Accessibility Guidelines (WCAG) have released the most important set of online accessibility guidelines (Conte et al., 2022). Given the rising participation of people with disabilities (PwDs) in higher education in nations like Ghana, accessibility analysis of government websites is crucial to ensuring that they are inclusive. The W3C created the Web Content Accessibility Guidelines (WCAG) in collaboration with people, groups, and governments from all over the world to create a generally recognized standard for web content accessibility that satisfies everyone's requirements. The abbreviation POUR stands for the four governing principles of accessibility: perceivable, operable, understandable, and robust.

On mobile touchscreen devices, those who are blind or visually challenged have different interaction and access needs (Acosta-Vargas et al., 2022). The reason for this is that using electronic gadgets often requires non-visual access. Even though WCAG 2.1 contains specific guidelines for mobile content, there is still a sizable lack of adherence to these principles in widely used mobile content, claims an article by (N. Alajarmeh, 2022).

## Website Accessibility, Quality, And Performance Tools

Accessibility has grown to be a crucial component because the goal of software creation is to make it usable by all users, regardless of their abilities. The huge array of interactive services available on mobile devices and PDAs, as well as conventional GUI-style apps, websites, and other interactive software systems, are all examples of interactive software systems where usability is now recognized as a crucial component. User interfaces that are difficult to use are actually the most common reason for failure in interactive systems that incorporate both humans and machines. A solution's usability for a wide variety of users, including those with various impairments, is evaluated through accessibility testing. Companies are increasingly prioritising accessibility, and the testing of accessibility is crucial to creating solutions that are accessible to everyone (Bai et al., 2019).

Web technologies have expanded as a result of the quick development of digital technologies. Making the web available to everyone as a consequence has grown to be a fascinating area of research and advancement. Web accessibility is the process of creating tools, platforms, and websites that allow people with impairments to use them independently or with little help. It tries to make sure that users can successfully perceive, understand, navigate, and engage with the web. There have been efforts over the years to make the web accessible to those with physical, visual, and sensory limitations (Hortizuela, 2022).

One way Google promotes accessibility is by providing free tools and services for web developers and users with disabilities. These include Google's Web Accessibility Test Page and Search Engine Continuity Program (SCCP). The Web Accessibility Test Page allows developers to test their websites for accessibility issues such as captchas and text resizing. The Search Engine Continuity Program ensures that sanctioned accessible web pages remain alive during website maintenance periods. Allowing free access to these tools gives accessibility a head start for companies looking to make their websites accessible to all users.

According to Yaokumah et al. (2015), The World Wide Web Consortium also created some of these technologies and instruments. The validators use markup languages like HTML, XHTML, and CSS to examine the markup validity of web sites. Google also produced a web accessibility tool known as PageSpeed. PageSpeed automatically evaluates HTML codes as well as checking for browser compatibility, page load time, and broken links, andalso provides recommendations to these problems.

## The Acceleration of E-government

Providing residents with e-services in a variety of areas, including communication, financial management, and macroeconomic forecasting, is a developing subject known as e-government (Burlacu et al., 2021). The provision of administrative services, the sharing of information, and the promotion of contact and communication among administrative employees all involve the use of information technology. Citizens can now easily, effectively, and conveniently utilise government services thanks to e-government (Burlacu et al., 2021).

Millions of people have been affected by the COVID-19 pandemic, and at this crucial time, social media and e-government have been widely used to tell the public about precautionary measures, highlighting the significance of effective e-government (Dawi et al., 2021).

Ensuring quality and performance standards in web development promotes accessible websites for users with disabilities. Promoting accessibility through user choices can be difficult, but allowing free access to testing tools makes it easier for both sides of the equation. Apart from Google, many other organisations are striving towards making the web more accessible for all users. However, visibility remains an issue for those working towards inclusive standards- which is a reason for promoting accessibility is vital no matter what side of the table you are on.

# Methodology

The methods used in this study are similar to that used by (Yaokumah et al., 2015). In the study, 19 government portals were also examined for accessibility, quality and performance. To complete this study, 20 government websites and portals launched by the National Information Technology Agency (NITA) on the e-Service Ghana platform will be chosen and examined to see how closely they correspond to the WCAG 2.1 requirements. These include the websites of the ministries, agencies, and departments of the government.

The research methodology is content analysis, which makes use of online diagnostic tools. The process of content analysis entails compiling comparable information within the context of particular ideas and themes and organising it in a way that is understandable to readers. In recent years, content analysis has gained popularity as a tool for website assessment (H. Chen et al., 2022).

## Instruments for Data Collection and Analysis

Based on WCAG 2.1 recommendations, the study used TAW3 to gather and assess accessibility issues on the chosen websites. Checkpoint categories A, AA, and AAA are all evaluable by TAW3. Additionally, the HTML, CSS, and Extensible HTML (XHTML) Validator were used. The World Wide Web Consortium created these tools to check the markup accuracy of web documents. Finally, suggestions for enhancing website user experience on desktop and mobile devices were made using PageSpeed Insights (PSI). PSI is a component of Google PageSpeed tools and provides both lab and outdoor data. At the Developer Conference in 2010, it was first presented.

# Data Analysis and Presentation

The study's findings are given in three sections: web performance using PageSpeed Insights; web accessibility using TAW3; and web accessibility using W3C web validators. Over the course of two weeks, the selected websites were evaluated.

## Web Accessibility Using TAW3

The TAW3 English version was used in the research' initial phase to determine the government websites and platforms' conformance levels (Priority A, AA, and AAA). This was done by reporting errors and warnings in the success criteria and human review issues for each conformance level. In accordance with WCAG 2.1, a web page must meet Priority AA conformance level to be considered accessible. However, neither the fundamental Priority Level A conformance level nor the AA conformance level were reached by any of the assessed websites.

Table 1: TAW3 Analysis - Government Websites Conformance Levels

| Website | Priority Level A | Priority Level AA | Priority Level AAA |
| --- | --- | --- | --- |
| National Health Insurance Authority | Not Reached | Reached | Not Reached |
| Ministry of Environment, Science, Tech. & Innov. | Not Reached | Reached | Not Reached |
| Ministry of Finance | Not Reached | Reached | Not Reached |
| Ministry of Local Gov. & Rural Development | Not Reached | Not Reached | Not Reached |
| Ministry of Health | Not Reached | Not Reached | Not Reached |
| National Identification Authority | Not Reached | Not Reached | Not Reached |

The National Health Insurance Authority, the Ministry of Environment, Science, Technology and Innovation, and the Ministry of Finance all had fewer AA mistakes than the other sites, making them the ones that were nearest to conformance at level AA. On the other hand, a significant number of mistakes were found on the webpages of the Ministry of Local Government and Rural Development, the Ministry of Health, and the National Identification Authority, all of which showed the least adherence to Priority Level AA. These errors imply that the web pages do not adhere to the standards for correct HTML coding, which may result in sites that show incorrectly in various web browsers. These websites violate sound coding principles.

We examined the four WCAG 2.1 principles to determine which success factors and principles were not met within Priority Level AA compliance level. (perceivable, operable, understandable, and robust). The research revealed that all of the websites had a significant number of issues with perceivable principles, followed by violations of operable principles. The robust principle was least frequently broken.

Table 2: WCAG 2.1 Principles Violations within Priority Level AA Compliance

| Website | Perceivable | Operable | Understandable | Robust |
| --- | --- | --- | --- | --- |
| National Health Insurance Authority | High | Moderate | Moderate | Low |
| Ministry of Environment, Science, Tech. & Innov. | High | High | Moderate | Low |
| Ministry of Finance | High | Moderate | Moderate | Low |
| Ministry of Local Gov. & Rural Development | High | High | Moderate | Low |
| Ministry of Health | High | High | Moderate | Low |
| National Identification Authority | High | High | Moderate | Low |

### Some Screenshots from the Study on TAW3

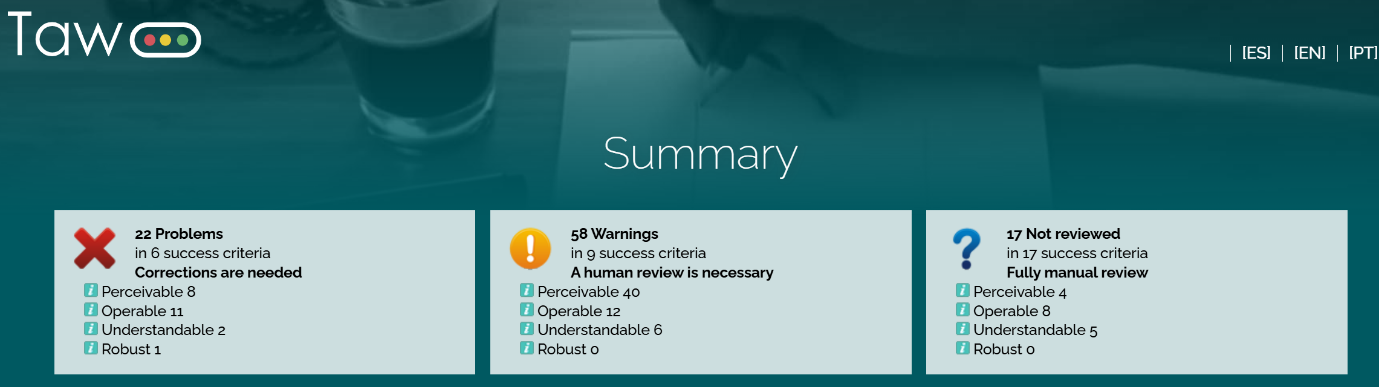


Figure 1: TAW 3 screenshot on National Health Insurance Authority

A screenshot of a computer

AI-generated content may be incorrect.

Figure 2: TAW 3 screenshot on Ministry of Finance

A screenshot of a computer

AI-generated content may be incorrect.

Figure 3: TAW 3 screenshot on National Identification Authority

In general, it appears that the websites were not developed in accordance with WCAG standards. It is important to observe that the NITA online portal did not break any clear-cut rules, showing that NITA implemented best practices when carrying out e-government-related activities. The NITA online portal also broke the four rules with the fewest mistakes overall.

The study also showed a failure to adhere to good coding practices, as more warning messages than error messages were logged. The Ghana Revenue Authority site in particular logged the most operable mistakes (50) and perceivable errors (79). If the errors are not fixed, users who want to access e-government sites for services and activities on these sites may become distracted by the site's material when viewed from various browsers. Overall, the study emphasises how crucial it is to follow WCAG standards when creating e-government websites to guarantee usability and reduce user inconvenience.

## Web Accessibility Using W3C Web Validators

The second stage of our analysis uses HTML, XHTML and CSS Validators.

Table 3: W3C Web Validators Analysis - Errors and Warnings

| Website | HTML Errors | HTML Warnings | XHTML Errors | XHTML Warnings | CSS Errors | CSS Warnings |
| --- | --- | --- | --- | --- | --- | --- |
| Ministry of Foreign Affairs and Regional Integration | High | Low | Moderate | Low | Low | Low |
| Ghana Statistical Service | High | Low | High | Low | Moderate | Low |
| Ministry of Environment, Science, Tech. & Innov. | High | Low | Moderate | Low | Low | Low |
| Ministry of Interior | High | Low | High | Low | Low | Low |
| National Petroleum Authority | High | Low | High | High | Low | None |

Again, The Ministry of Foreign Affairs and Regional Integration, Ghana Statistical Service, Ministry of Environment, Science, Technology and Innovation, Ministry of Interior and National Petroleum Authority show an incredibly large number of errors, though with relatively fewer warnings. Conversely, Ministry of Finance, Ministry of Health, Ministry of Lands and Natural Resources and the National Health Insurance Authority websites show fewer errors. Again, this time around, the National Information Technology Agency (NITA) portal showed some warning messages.

### Some Screenshots from the Study W3C Web Validators

### A screenshot of a computer AI-generated content may be incorrect.Figure 4: W3C Web Validators screenshot on National Identification Authority

A screenshot of a computer

AI-generated content may be incorrect.Figure 5: W3C Web Validators screenshot on National Health Insurance Authority

A screenshot of a computer

AI-generated content may be incorrect.

Figure 6: W3C Web Validators screenshot on Ministry of Finance

## Web Performance Using PageSpeed Insights

The third stage of the analysis involves the use of PageSpeed Insights, a tool that evaluates a webpage's user experience based on its loading speed and performance on both desktop and mobile devices. The test conducted using PageSpeed Insights focused solely on mobile devices, and the tool provides a detailed report that highlights any issues found and suggests corrective measures. The four key metrics captured by the field data provide insight into different aspects of a webpage's loading speed and performance. These metrics are measured in either milliseconds or seconds, with the exception of Cumulative Layout Shift (CLS). The metrics are as follows:

1. **First Contentful Paint (FCP):** This metric measures the time it takes for the first image or text to load on the page.
2. **Largest Contentful Paint (LCP):** LCP measures the time it takes for the largest image or text to load on the page.
3. **First Input Delay (FID):** FID captures the time it takes for the browser to respond to the user's first interaction with the page.
4. **Cumulative Layout Shift (CLS):** This metric measures any movement that occurs in the viewport of the page, and a CLS score below 0.1 is considered good, while a score above 0.25 is poor.

### First Contentful Paint (FCP)

Websites should strive for a Largest Contentful Paint of 1.8 seconds or less for the best user experience. However, the First Contentful Paint times for the Ministries of the Environment, Science, Technology, and Innovation, Lands and Natural Resources, Tourism, Arts, and Culture, National Health Insurance Authority, Ghana Statistical Service, and Ghana Revenue Authority were all over three seconds. It's essential to note that while some of the evaluated e-government sites had a moderate First Contentful Paint (FCP) spanning from 1.8 to 3 seconds, none of them attained a good FCP.

### Largest Contentful Paint (LCP)

Websites should strive for a Largest Contentful Paint (LCP) of 2.5 seconds or less to guarantee a favourable user experience. The Ministry of Environment, Science, Technology and Innovation had the worst LCP of 10.5 seconds, followed by the Ministry of Tourism, Arts and Culture, the Ghana Statistical Service, the Ghana Immigration Service, the Ministry of Finance, the Ministry of Education, and the Ghana Revenue Authority. The LCP of the Ministry of Interior was 3.1 seconds, which was noticeably better. The National Information Technology Agency (NITA) portal's LCP of 9.1 was also poor.

### First Input Delay (FID)

Websites should strive for a First Input Delay (FID) of 100 milliseconds or less to provide a satisfying user experience. In this evaluation, the only entity whose portal needed refinement was the Ghana Immigration Service because of its FID of 210 milliseconds. However, remaining portals all had acceptable FIDs and favourable results, which was a hopeful result.

### Cumulative Layout Shift (CLS)

Websites should strive for a Cumulative Layout Shift (CLS) score of 0.1 or fewer to guarantee a favourable user experience. The CLS score of 0 was earned by the Ministry of Lands and Natural Resources, Ministry of Health, Ministry of Interior, and Ministry of Environment, Science, Technology, and Innovation. The Ministry of Local Government and Rural Development, the Ministry of Foreign Affairs and Regional Integration, the Ministry of Energy, and the Driver and Vehicle Licensing Authority, on the other hand, all had subpar CLS scores of over 0.25.

### Some Screenshots from the Study PageSpeed Insights

A screenshot of a computer

AI-generated content may be incorrect.

Figure 7: PageSpeed Insights screenshot on Ministry of Finance

A screenshot of a computer

AI-generated content may be incorrect.

Figure 8: PageSpeed Insights screenshot on National Identification AuthorityA screenshot of a computer

AI-generated content may be incorrect.

Figure 9: PageSpeed Insights screenshot on National Health Insurance Authority

# Conclusion and Recommendations

Assessing the usability, effectiveness, and efficiency of Ghanaian government websites was the aim of the research. The study was conducted using a variety of tools, including TAW3, W3C site validators, and PageSpeed Insights. According to the results, neither the Priority AA conformance level nor the fundamental Priority Level A conformance level were reached by any of the assessed websites.

The National Health Insurance Authority, the Ministry of Environment, Science, Technology, and Innovation, and the Ministry of Finance, however, were the ones who came the nearest to achieving the AA conformance standard with fewer AA errors. The research also showed that there were numerous problems with the perceivable principles, which were followed by the operable principles, on all of the websites. The least amount of the robust concept was broken. The prevalence of warning messages over error messages suggested that sound coding standards were not adhered to. Additionally, there were a sizably high number of errors reported by the Ghana Statistical Service, Ministry of Environment, Science, Technology, and Innovation, Ministry of Interior, and National Petroleum Authority.

The Ghana Immigration Service site needs to be improved, as demonstrated by the study performed using PageSpeed Insights, where the Largest Contentful Paint was 210 milliseconds. The research suggests that the government follows the WCAG recommendations and spends money updating its websites to improve their content, performance, and accessibility. Additionally, they ought to employ experts to create websites that adhere to the rules of online accessibility.

It is also recommended that the government should ensure that the websites are continuously monitored and updated to ensure that they are fully accessible, of high quality, and offer an excellent user experience. They should also adopt a user-centred design approach and ensure that the websites are tested with assistive technologies to ensure full accessibility.

Finally, the study suggests that the government should organise regular training workshops for web developers and designers to enhance their skills and knowledge of web accessibility, quality, and performance. The government should also collaborate with web accessibility organisations to conduct audits and provide guidance on best practices for web accessibility, quality, and performance. This study's findings can be used as a benchmark for future evaluations of government websites' accessibility, quality, and performance in Ghana.

## Future Study

Despite the comprehensive analysis carried out in this study, there are still areas that need further investigation. Some of the potential areas of research that can be explored in future studies are:

* **In-depth analysis of the content of the web pages:** While this study focused on the technical aspects of the websites, a future study can evaluate the content of the websites, specifically the readability, comprehensibility, and accuracy of the information provided. This would provide valuable insights into the user experience and help in improving the overall accessibility and usefulness of the websites.
* **Comparative analysis of e-government websites in different countries:** A comparative analysis of e-government websites in different countries would provide an opportunity to benchmark Ghana's e-government websites against those of other countries. This would enable policymakers to learn from the best practices of other countries and implement policies that are effective in improving the accessibility and usability of the websites.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.

2.

3.

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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