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Understanding the Challenges of Web Accessibility Implementation in the Digital Era

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Abstract

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In this thesis, we gave an overview of the current Web accessibility standards, principles, and guidelines, viewed their compliance, and its relationship with Usability, and finally discussed the challenges and solutions. The first accessibility guidelines were introduced in 1999, this was the first step towards providing equal web access to disadvantaged people. Web accessibility is a crucial need that should be available to everyone, inclusivity in the design and development of websites is necessary. Today, the standards have gone through several upgrades, but we are still facing problems in the implementation of website accessibility. This thesis answers one fundamental question; "What is the reason for the implementational failure of Web accessibility in this technologically advanced digital era?"

The research methodology used in this thesis, is a qualitative desk-based approach. The result of this thesis turned out to be a disappointment regarding the practical implementation of Web accessibility. While there are standards, their implementation proves challenging due to the need for perfect precision, and the outcome may still be an inaccessible website. The government has not legally mandated strict restrictions on inaccessible websites; therefore, all attempts, especially from the private sector, are voluntary. Lastly, private companies are not investing in hiring accessibility experts as a new job role. On the other hand, developers are undertrained, unaware, and not knowledgeable enough to implement accessibility properly.

Keywords: web accessibility, disabilities, assistive technologies, web content accessibility guidelines, accessibility challenges, accessibility solutions, accessibility overview, inclusive design

The originality of this thesis has been checked using Turnitin Originality Check service.

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List of Abbreviations

WCAG: Web Content Accessibility Guidelines.

UX: User Experience.

1 Introduction

The world has become a global village, almost everything is available now through the internet, even the most critical of websites and platforms such as immigration services or online shopping stores, etc. The necessity to ensure they are accessible to all types of individuals equally, arises. Web accessibility is the practice that ensures websites are accessible to everyone, including individuals with disabilities i.e. blindness. It extends Internet access to all individuals, especially for physically disabled to use, comprehend, traverse, and engage with online material. [2]. Web accessibility is a basic human right, according to the United Nations Convention [10]. The Institute for Disability Research, Policy, and Practice, researched 1 million website homepages, which revealed 96.3% of websites were inaccessible [11].

The purpose of this thesis is to provide a holistic view of Web accessibility, to highlight its significance, give an overview of its standards, principles, theoretical background, compliance with standards, challenges, and proposed solutions, and lastly to provide constructive conclusions of this study. This research provides a consolidated document to people seeking a better understanding of Web accessibility. Hence, they will be able to gauge the current situation, Web accessibility Best Practices, and have a positive impact on the design and implementation of Web accessibility.

2 Material and Methods

The topics of Web Accessibility discussed in this thesis are not new and they have been researched in previous literary works such as Web accessibility standards, principles, compliance case studies, challenges, and solutions dated back to 1999. Nevertheless, there needs to be more research that aims to integrate these concepts.

This study answers a basic research question; “What is the reason for the implementational failure of Web accessibility in this technologically advanced digital era?”

For this literary work, a qualitative desk research approach has been used to deeply investigate the different aspects of Web accessibility. Furthermore, the desk research approach has been combined with the methodology of the case study. Multiple case studies, and research experiments of different websites such as T-Mobile and Orange, etc are picked to better portray the current situation of Web accessibility.

There are a total of 6 sections in this study, the first section introduced the background and motivation of the research topic. The second section discussed the material and methods utilized in this research. In the third section, the current state of Web accessibility is analyzed in a way that laid the foundation of the core concepts of this thesis. In the fourth section, the framework of theoretical principles, standards of Web accessibility, and Inclusive Design were discussed. In the next section, a few proposed solutions to existing Web accessibility challenges were highlighted. Lastly, a summary of findings, their implications, recommendations, limitations, and possible future research topics are pointed out.

3 Current State Analysis

This section serves as a foundation for understanding the current landscape of Web accessibility and the importance of its relation to user experiences. It encompasses an overview of Web accessibility, the Web Content Accessibility Guidelines (WCAG), Inclusive design principles, the intersection of Usability and Web accessibility, the current state of website compliance with Web accessibility, and lastly challenges discussed.

3.1 Web Accessibility Overview

As described earlier, Web accessibility ensures websites are accessible to everyone, including physically impaired individuals. It extends internet access to all individuals, making it possible for those with disabilities to use, perceive, navigate, and interact with web content. According to the World Wide Web Consortium, disabled people can be empowered by providing accessible websites, e.g., the ability for a blind person to shop and browse online.

Therefore, the availability of accessible websites will offer an effective platform for disabled individuals. Web content can be utilized and accessed through the Web accessibility principles that lay the basis of accessible websites. There are four foundational principles of web accessibility i.e. *Perceivable*, *Operable*, *Understandable*, and *Robust*. If any of these principles are missing, web content will not be accessible [2].

Based on these principles, a set of 13 guidelines known as Web Content Accessibility Guidelines (WCAG) are derived to serve as objectives for web page designers. It sets rules to enhance Web content accessibility for individuals with diverse disabilities such as vision, hearing, physical impairments, verbal, mental, linguistic, learning difficulties, and neural limitations. These guidelines provide a foundational framework for design and development. Following the development phase, the website undergoes a series of requirements and conformance testing. Subsequently, a conformance level is assigned, which falls into one of three categories: from lowest A, AA, to

highest AAA [2]. Further details on WCAG will be discussed in section 4 of this thesis.

3.2 Inclusive Design Principles

Inclusive design is defined as the approach to make the systems more accessible whether they are physical or digital to a wide audience regardless of their physical abilities. Inclusive design is derived from a set of principles which include seven key elements i.e. *Equitable usage*, *Flexible usage*, *Intuitive and simple usage*, *Perceivable information*, *Error tolerance*, *Less physical effort*, *Accommodate size and space for approach*. These inclusive design principles serve as the basis of inclusive design, which helps create welcoming and functional environments and experiences available to a wider audience [3]. A detailed discussion on Inclusive design principles is under section 4.

3.3 Web Accessibility and Usability

Understanding Web accessibility and its relationship with website Usability could play a vital role in providing websites with better User experience (UX) for impaired people. According to ISO 9241-11[9], Usability is described as “the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use”. Moreover, the scope of websites is not only limited to performing particular tasks but they are also used for communication and network building etc. The better the website is able to satisfy the users, the more users will value it. Therefore, the perception of users about a website plays a vital role in its success, highlighting the importance of human-computer interaction in terms of user experience. A survey has revealed that defining User experience (UX) is a little tricky as it is subjective, context-dependent, and dynamic. However, researchers agree on the correlation between Web accessibility and Usability,

which means if we separate the two from each other, it will result in either usable or 0accessible websites [4].

User experience (UX) and Web accessibility relationship has been researched in one of the few researches, which demonstrated a major correlation between perceived Web accessibility and User experience (UX). For example, users were better able to understand the websites integrated with the User experience (UX) concepts i.e. interest, disappointment, frustration, and annoyance rather than the Web or assistive technology. Furthermore, there was a strong connection between User experience (UX) and website conformance with the Web Content Accessibility Guidelines (WCAG) [4].

Another study investigated the Web accessibility and Usability of websites and focused on T-Mobile and Orange company websites, which involved both visually impaired and sighted users, as shown in Figure 1, the total number of tasks accomplished by the sighted vs blind user out of 7 tasks. The findings revealed that Web accessibility and Usability issues intersected but were not identical. Some problems were unique to blind users due to their use of screen readers, while others pertained to the visual presentation, affecting only users with sight. Notably, the overlap between the sighted and blind groups was around 14%, which indicates commonalities in Web accessibility and Usability that require more attention. Blind users are more affected by the severity of shared problems, as they receive limited support, but further investigation is needed.

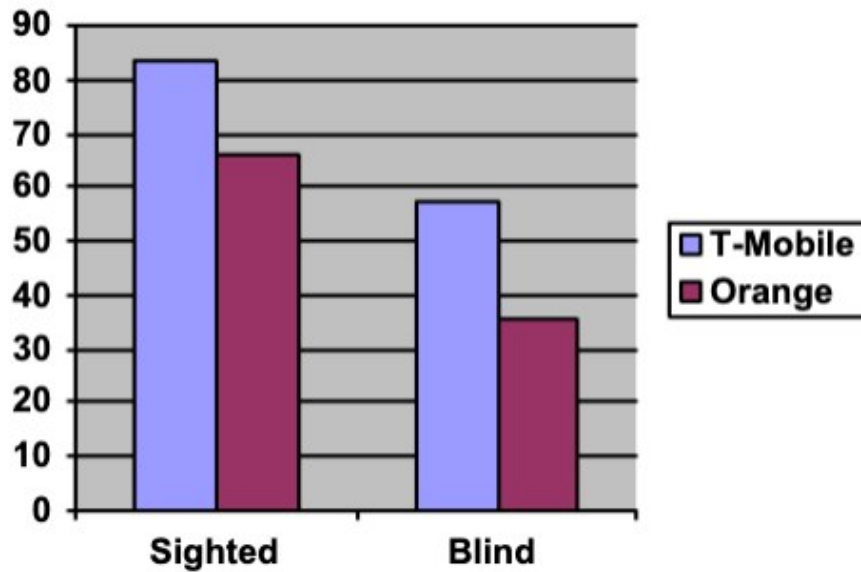


Figure 1: Screenshot of tasks accomplished out of 7 (success rate). Source: [5]

Most intriguing, there was a lack of significant correlation between ratings provided by users of problem importance and Web Content Accessibility Guidelines (WCAG) ratings of problem severity. It suggests the need for more research on the relationship between user experiences and guideline-based ratings. This study emphasizes the complexity of the Web accessibility and Usability relationship and underscores the importance of addressing both Web design and evaluation process [5].

3.4 Compliance with Web Content Accessibility Guidelines (WCAG)

Conformance or compliance to the Web Content Accessibility Guidelines is when you meet the requirements laid out by these guidelines to ensure Web accessibility. A study in India revealed significant differences in compliance while comparatively analyzing Web accessibility guideline violations in Government, Education sector, and Commercial websites. The highest number of violations of perceivable guidelines are on Commercial websites (41.09%), while the lowest number of violations are on Educational websites (26.91%). Operable guideline violations are most prevalent on Commercial websites

(44.93%) and least prevalent on Educational websites (27.30%).

Understandability guideline violations are most notable in Commercial websites (41.21%), with Government websites displaying the lowest violations (27.66%). Lastly, Robustness guideline violations are significant on Commercial websites (75.00%), while Government websites show none (0%). These experimental findings emphasize the necessity of tailored Web accessibility enhancements in each website category and the importance of addressing WCAG 2.0 guideline violations or compliance with WCAG 2.0 guidelines to improve Web accessibility [6].

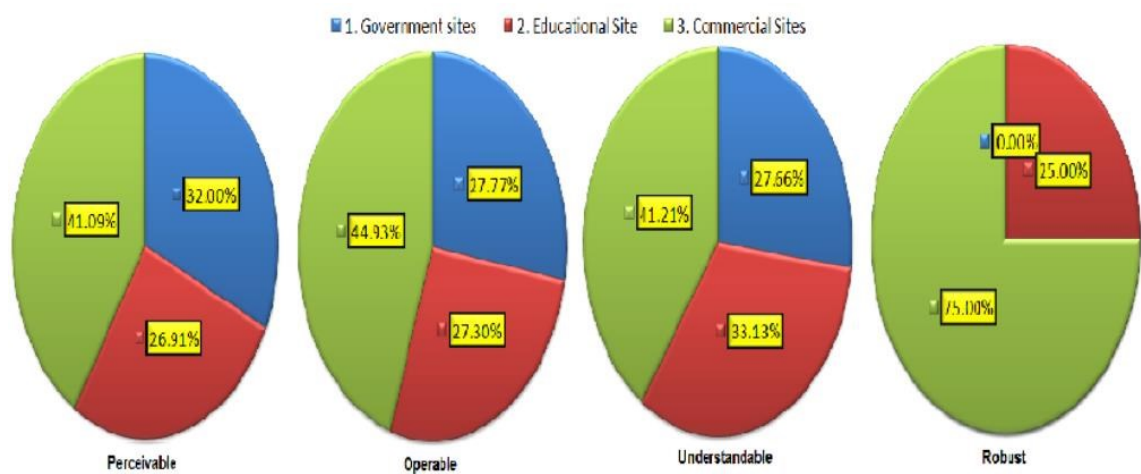


Figure 2: Screenshot of WCAG guidelines violation of Government, Education, and Commercial Websites. Source: [7]

Another research work has analyzed the Web accessibility compliance of the leading public Spanish hospital website, especially in terms of WCAG 2.1 Level AA recommendations. The research findings revealed a significant gap in compliance, with 0 out of 48 examined websites fulfilling the WCAG 2.1 Level AA standards, and only 4 complied with Level A. Multiple issues were identified during the evaluation, including missing textual descriptions for images that made interpretation difficult for the screen readers and information on the purpose of links was absent, making access more challenging for individuals with cognitive, visual, and motor disabilities. Additionally, the readability of these websites was found to be subpar, with 33 out of 48 sites presenting readability

barriers for users. The study highlights the significance of compliance with Web accessibility WCAG 2.1 guidelines for the developers of hospital websites and content authors to ensure inclusivity for all citizens [7].

3.5 Challenges and Barriers

Nowadays, Web accessibility is considered one of the biggest problems for the digital community. A study conducted by Abuaddous et al. in 2016, highlighted critical barriers surrounding Web accessibility and the challenges faced by disabled users, which can impede the equal rights of users and the revenue of an organization.

An interview was conducted with 14 evaluators of accessibility, revealing that the evaluators were confused between automated and manual testing of Web accessibility and the scope of testing using automated tools. Another survey, which included 27 non-expert evaluators and 22 expert evaluators of accessibility, was given a webpage to evaluate. The finding was that the experts differed on whether the problem was present or not; 50% of the evaluators were unable to come to a consensus of 80%. Further, 20% of the problems highlighted were false positives, i.e., not actual problems and 32% of problems were overlooked.

Research of 20 websites of Finnish higher education institutes showed that 30% of the websites had A-level accessibility but none conformed to the AA-level accessibility. The tests were conducted using TAW an automated accessibility tool. The researcher argued that the main reason is the need for more awareness of web developers.

A survey was held including 334 web developers to study the problems, needs, and processes of website development and also to understand the tools they used. The survey revealed that the developers were conscious of the quality and usability of the website but 5% of the participants were able to do Web

accessibility testing. The hypothesis was that this was due to their lack of knowledge and motivation for voluntary testing as it is time-consuming.

A survey of more than 400 developers done all across Europe found that 85% of them wanted additional training in Web accessibility. Another study done in Brazil found that 45% of experts in Web fields were aware of screen readers for the visually impaired but did not know how to implement that functionality in Web pages [1].

A Web accessibility automation tool was tested in a study, it concluded that manual testing is required in a few guidelines. Moreover, some guidelines have rules (Success criteria) requiring human intervention. Hence, this imposes a limitation on automation tools. Therefore, only the guidelines that do not need manual testing are evaluated. This leads to partially satisfying the guidelines and leaves a lot of room for false positives. Web accessibility WCAG 2.0 and 2.1 guideline versions include additional guidelines on certain aspects that necessitate human involvement, limiting the potential for automated assessment of websites. Additionally, selected guidelines encompass success criteria, with some mandating manual intervention [15].

Two more tools were assessed in Malaysia, Accessibility was tested in 20 universities using these tools and the conclusion was that the results differed as the tools used different understandings of the guidelines, which caused different numbers of errors to occur in the different tools, displaying variance. The reliability is hence, doubtful [1].

In a nutshell, Abuaddous et al. in 2016 underlined 3 main challenges faced by Web Accessibility. Firstly, Web accessibility standards and guidelines WCAG 2.0 challenges; existing WCAG 2.0 guidelines are ambiguous; only WCAG 2.0 is not enough to ensure accessibility, website designers and website developers find it difficult to navigate through links and tables presented in the guidelines, and some prior technical experience is required by developers to decode the guidelines, these standards need perfect compliance on each level to earn the

logo of conformance, meeting the guidelines criteria can lead to slow validation phase and can cost a lot to large companies. Secondly, challenges related to the design & development of websites; lack of awareness and motivation among web developers for Web accessibility due to the time-consuming testing process, and untrained information technology (IT) professionals. Lastly, Challenges faced during website evaluation; evaluating websites according to WCAG 2.0 guidelines is time-consuming and involves manual effort, lab setup is also expensive, difficult to find impairments matching the audience of the website, expert evaluator needs to review testing, and lastly, problems in picking up right test cases for evaluation [1].

A few proposed solutions addressing the above challenges will be discussed in the later sections of this thesis.

4 Theory

This section will explore the core Web accessibility principles and further discuss the international Web accessibility standard being used nowadays and Inclusive design principles. This will lay a strong foundation for the theoretical framework of Web accessibility.

4.1 Web accessibility principles

The Web accessibility principles are the core principles that serve as the cornerstone for every other standard. These principles need to be understood properly so that all the possible limitations of people with disability can be satisfied and cover the widest range of accessibility issues possible. Those are as follows [2]:

1. *Perceivable*: This principle underscores the necessity of information being perceivable by the user. Essentially, it emphasizes that users should be able to see and perceive web content even if one sensory input is unavailable. For example, providing alternative text for images, ensuring sufficient contrast for the text to be visible, providing captions for multimedia, etc.
2. *Operable*: This principle necessitates that the web content should be easily understandable. Avoid including any jargon and complicated wording or having an unorganized content structure. An example would be not having clear headings and structure, using very technical wordings, etc.
3. *Understandable*: This principle necessitates that the web content should be easily understandable. Avoid including any jargon and complicated wording or having an unorganized content structure. An example would be not having clear headings and structure, using very technical wordings, etc.
4. *Robust*: It highlights the importance of a consistent and reliable web page that can be used by many people for a long period. Web pages will stay accessible as technology evolves and as users increase.

4.2 Web Content Accessibility Guidelines (WCAG)/ Accessibility Standard

Web Content Accessibility Guidelines (WCAG) is a standard developed to create a common standard for Web content accessibility that provides international guidelines for governments, organizations, and individuals [2]. The World Wide Web Consortium (W3C) created the Web Accessibility Initiative (WAI) on the 7th, of April 1997 Which was also endorsed by The White House and the goal was to provide Web functionality for those with disabilities. The WAI deployed several working groups whose goal was to provide accessible technology for various types of disabilities, Initialized in August of 1997 [13]. The World Wide Web Consortium (W3C) Web Accessibility Initiative (WAI) has an Accessibility Guidelines Working Group (AG WG) who are responsible for writing the WCAG technical documents [2]. The first version was released on the 5th of May 1999 called Web content accessibility guidelines 1.0 [13]. The next version was WCAG 2.0, released in December 2008, WCAG 2.1 in June 2018 (updated in September 2023), and WCAG 2.2 published in October 2023 [2].

The guidelines of WCAG are derived from the four accessibility principles, Perceivable, Operable, Understandable, and Robust. From these four principles, 13 guidelines are produced as follows [2]:

“Perceivable

- Provide text alternatives for non-text content.
- Provide captions and other alternatives for multimedia.
- Create content that can be presented in different ways, including by assistive technologies, without losing meaning.
- Make it easier for users to see and hear content.

Operable

- Make all functionality available from a keyboard.
- Give users enough time to read and use content.
- Do not use content that causes seizures or physical reactions.

- Help users navigate and find content.
- Make it easier to use inputs other than the keyboard.

Understandable

- Make text readable and understandable.
- Make content appear and operate in predictable ways.
- Help users avoid and correct mistakes.

Robust

- Maximise compatibility with current and future user tools.”

These 13 guidelines are objectives; they are not testable and are intended solely for developers to follow and effectively implement the guidelines. These guidelines also help the developers to understand the success criteria so that they can develop websites accordingly.

Next is the success criteria i.e. requirements to meet the guidelines, for the success criteria to be a valid criterion it needs to check certain boxes. Firstly, the problem being judged should be affecting people with a disability rather than the people with no disability. Only then, it would become a Web accessibility issue. Hence, it will be judged by Web accessibility success criteria. Secondly, the criteria should be testable and evaluated with satisfactory evaluation trials to have a high level of confidence in the result, which would make it gradable. These two rules should be there to produce valid success criteria for Web accessibility.

Further, according to the level of success criteria satisfaction achieved, a conformance grade is assigned. There are three conformance levels A(low), AA, and AAA(high). To properly assign and evaluate these grades, several directly affecting points are also taken into consideration. Those points are:

Are the criteria necessary?

Would the criteria be able to satisfy every type of web page and content?

Can the developers easily work on these criteria and do they have the required knowledge?

Would the criteria limit the visual feel of the web page?

Are there any backup or secondary options if the success criteria are not met?

When these questions are answered, the working group then assigns a conformance level of A(low), AA, or AAA(high) to the webpage [2].

4.3 Inclusive Design Principles:

Inclusive design is defined as the approach to make the systems more accessible whether they are physical or digital, to a wide audience regardless of their physical abilities. Inclusive design is derived from a set of principles which include the following seven key elements:

1. *Equitable Usage*: It prevents the exclusion of a certain number of users and ensures that the inclusive design is useful and accessible to people with different physical abilities.
2. *Flexible Usage*: It acknowledges the varying needs, preferences, and physical abilities of the users and provides them with multiple ways to interact with or use the inclusive design.
3. *Intuitive and Simple Usage*: It aims at avoiding the unnecessary complexity that can lead to a bad user experience by causing confusion and hindering users. Therefore, inclusive design should be straightforward and easy to understand.
4. *Perceivable Information*: It ensures that information is presented in a way that users can perceive, regardless of their sensory abilities i.e. in case of non-text content availability of text alternatives.
5. *Error Tolerance*: The likelihood of errors should be minimized in the inclusive design along with providing feedback and options for correcting mistakes when they occur.
6. *Less Physical Effort*: User interactions and use of the design should be physically comfortable and less demanding, which

means the inclusive design should reduce the need for excessive force, repetitive motions, or extended physical effort.

7. *Accommodate Size and Space for Approach:* Inclusive design caters to users of diverse sizes and abilities, encompassing those who use mobility aids or possess different reach capabilities.

Above inclusive design principles serve as the basis of inclusive design, which helps to create welcoming, functional environments and experiences that are available to a wider audience [3].

5 Proposed Solutions

Previously we discussed various challenges that are there in terms of the successful and effective implementation of Web accessibility standards or guidelines. In this section, we are going to expand on solutions that are available nowadays.

5.1 Practical Solutions

As recommended by Abuaddous et al. in 2016 [1], Figure 3 shows the number of proposed solutions to Web accessibility challenges which will be discussed one by one next.

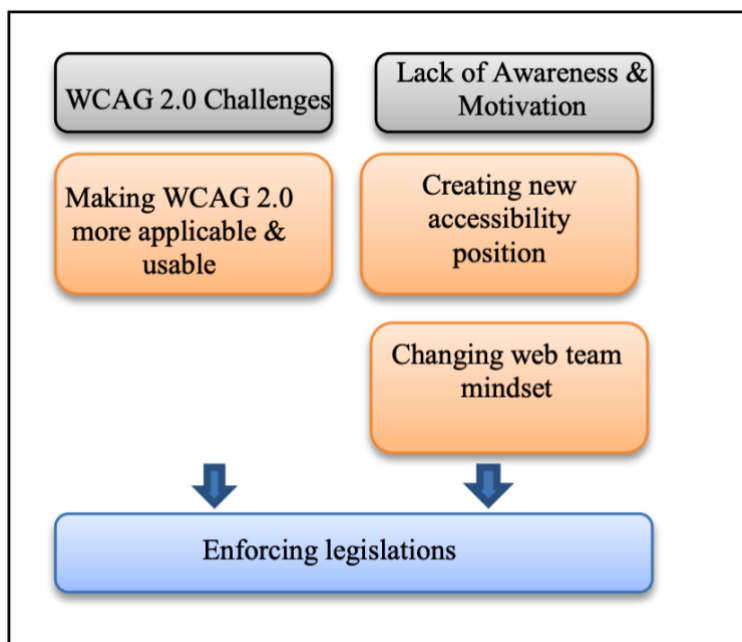


Figure 3: Screenshot of Proposed solution to Web accessibility challenges.
Source: [1]

Firstly, the Web Content Accessibility Guidelines (WCAG) standard must be clearer and allocated properly so that each accessibility guideline is associated with a particular disability. Also, a clear measure of the costs will be helpful, and instead of reaching perfection the guidelines should provide some flexibility to the

web developers so that it is easier for them to implement this will decrease the difficulty of understanding and applying the guidelines.

Next, another solution should be to create new job roles in accessibility such as hiring an expert in accessibility or an accessibility specialist. This specialist can communicate with the team to ensure proper implementation of the guidelines and also with the community to figure out the needs. This person can also be a web developer or project manager who can learn and acquire knowledge of accessibility. Internally in the company, there should be training sessions on Web accessibility which could increase the accessibility knowledge of the concerned teams. If the company can allocate a certain budget for such coaching sessions, it would be beneficial.

Thirdly, many developers still do not know what Web accessibility is and do not include it in the development process. There is a need or requirement for the developer to understand the end-users, to test the website for disabled people, and to use accessibility tools. There is a real need for developers to change their mindset from a problem-based approach to an inclusive design approach for web designing and development. While coding the developer should be aware enough to understand the problem of the disabled person and encode accordingly. The entire team should be involved in this; additionally, the company and the government should recognize this as an important indicator of website quality. Accessibility education should be included at the beginning of a developer's education so that early on they are aware of this important issue. This will make accessibility an introductory or a main focus of the student i.e. the future developer [1].

Last but not least, rather than having accessibility as a voluntary step, accessibility should be legal legislation enforced by international law and also by the law of the country. This will enforce a necessary implementation of accessibility. It will also provide the country with its specific legal standards and legislation, making it easier and obligatory to follow. This will ensure that there is no discrimination against people with disability and also equality of Usability.

Eleanor et al. [8] conducted regression analyses to understand the impact of relatable variables and Web accessibility to answer the question “Does legislation ensure that websites are accessible?”. The following figure displays the regression model, it shows that the relation between usability testing and accessibility testing is significant and both would be done at the same level. Further, the finding was that legislation does affect accessibility directly and indirectly: directly by enforcing compliance to the Web accessibility standards and indirectly by increasing the number of websites that are tested for accessibility. Hence, the results show that legislation will make the website more likely to be accessible.

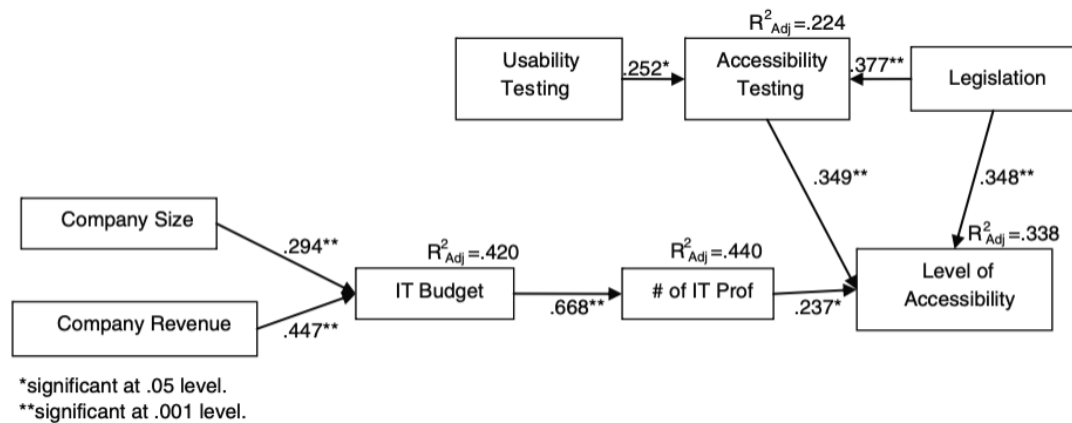


Figure 4: Screenshot of Regression model. Source: [8]

6 Conclusions

6.1 Summary of Findings

This thesis concluded that currently, we are facing a huge implementation failure in Web accessibility, 96.3% of website home pages in a survey of a million websites were still inaccessible [11]. This thesis discussed three main challenges that are faced today, firstly the difficulty in understanding and inapplicability of the Web Content Accessibility Guidelines (WCAG) standard such that its perfect implementation requirement is hard to achieve and it also doesn't lead to assurance of Web accessibility, secondly the lack of awareness, knowledge and training of developers creates a challenge in website's design and development. Moreover, the challenges encountered during the evaluation, whether utilizing automation tools or conducting user testing, are minimal.

To widely implement Web accessibility all across the World, we need to address these challenges or barriers coming in the way of Web accessibility. Therefore, the Government should put effort and implementing legislation and ensure the enforced implementation of accessibility. On the other hand, private companies should also be willing to invest in training developers about Web accessibility, making them aware that this can impact the way they write code, and also hire specialized Web accessibility experts who supervise the development further ensuring successful implementation. Furthermore, the Web Content Accessibility Guidelines (WCAG) also need to be more flexible and easier to implement as they can easily demotivate a voluntary effort to implement accessibility [1].

6.2 Implications

There are 1.6 billion people in the world who have disabilities, this is 16% of the world [14]. It is a basic human right for web content to be accessible to everyone [10], it should be a top priority to make the most critical online services available to disabled people and it would be a huge failure for humanity as a whole to not provide accessible websites.

6.3 Recommendations

The incentive for the private sector participants is lacking, and if the reason for implementation is only humanitarian reasons, then this clearly shows, that it is not enough. Hence, the effort should be put into creating stronger incentives a form of these could be grants from the government, rebates, or other forms of monetary benefits. However, the government must legislate and enforce otherwise the importance of accessibility will never be understood.

6.4 Limitations and Future Research

For all of the above to be possible we need more awareness and research on this matter, currently, there is not as much attention even in the research area as there should be. There should be research on how to bridge this gap between the standards and practical implementation, through incentives and any other means discovered which are feasible.

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