



Sudan University of Science and Technology  
College of Graduate Studies  
Computer Science



## Evaluating the Accessibility of E-Government Websites in Sudan

تقييم قابلية الوصول لموقع الحكومة الإلكترونية في السودان

A Thesis Submitted in Partial Fulfillment for the  
Requirements of the Degree of M.SC in Computer Science

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## الآية

﴿ أَلَمْ تَرَ أَنَّ اللَّهَ أَنْزَلَ مِنَ السَّمَاءِ مَاءً فَأَخْرَجْنَا بِهِ ثَمَرَاتٍ مُخْتَلِفًا أَلْوَانُهَا وَمِنَ الْجِبَالِ جُدَدٌ بَيْضٌ وَحُمْرٌ مُخْتَلِفٌ أَلْوَانُهَا وَغَرَابِيبُ سُودٌ وَمِنَ النَّاسِ وَالدَّوَابِّ وَأَلْوَانُهُ كَذَلِكَ إِنَّمَا يَخْشَى اللَّهَ مِنْ عِبَادِهِ الْعُلَمَاءُ إِنَّ اللَّهَ عَزِيزٌ غَفُورٌ ﴾

(35 فاطر آية 27-28).

## **Dedication**

I dedicate this thesis to my beloved father Ismail Awadallh and to my mother Idrak Yousif for her never ending love. I also dedicate this to my sisters and friends, who provided me with continuous encouragement to continue to work hard.

## **Abstract**

Government websites offer great benefits to citizens and governments. Such benefits, however, cannot be realized if websites have accessibility issues that make the ability to perceive, understand, navigate and interact with the site difficult to the users. It is essential that electronic government (e-government) sites be accessible to all persons with equal access and equal opportunities for all people including those with disabilities. It is therefore necessary to ensure greater compliance of the government websites with established web accessibility standards and guidelines. This is inline with an initiative to promote better delivery of government websites. This research investigate the extent to which accessibility is taken into account in the design of Sudanese e-government website. The accessibility of the Sudanese e-government websites was investigated based on Web Content Accessibility Guidelines (WCAG) 2.0. The investigation conducted by using two evaluation methods, namely automatic testing tools and expert checking of target Website. The results found that Sudanese e-government portal is not fully compliant to the WCAG 2.0, and revealed a variety of accessibility problems with the sites. The most common detected accessibility problems were related to the absence of text equivalents for non-text elements, the absence of labels or instructions when content requires user input and link purpose is not identified from link text alone.

## المستخلص

تقدم مواقع الحكومة الإلكترونية فوائد عظيمة للمواطنين والحكومات. ومع ذلك ، لا يمكن تحقيق هذه الفوائد إذا كانت تلك المواقع لديها مشاكل في إمكانية الوصول. تلك المشكلات التي تجعل من الصعب على المستخدمين الوصول إلى الموقع والتنقل بداخله. فمن الضروري أن تكون مواقع الحكومة الإلكترونية متاحة لجميع الأشخاص بإمكانية وصول متساوية وفرص متكافئة للجميع بما في ذلك الأشخاص من ذوي الإعاقات . ولذلك من الضروري ضمان امتثال المواقع الحكومية للمعايير والمبادئ التوجيهية للوصول إلى الويب. وذلك لتشجيع تحسين تصميم مواقع الحكومة الإلكترونية. هذا البحث يتحقق من درجة مطابقة تصميم بوابة حكومة السودان الإلكترونية للمبادئ التوجيهية لإمكانية الوصول إلى محتوى الويب (WGAG). تم تقييم الموقع باستخدام طريقتين : التقييم بأدوات الاختبار الإلكترونية والتقييم بواسطة الخبراء. وأظهرت النتائج أن بوابة حكومة السودان الإلكترونية غير متوافقة بشكل كامل مع المبادئ التوجيهية لإمكانية الوصول إلى محتوى الويب ، وكشفت عن مجموعة متنوعة من مشاكل الوصول داخل الموقع. أكثر المشاكل شيوعاً كانت تتعلق بعدم وجود مرادفات نصية للعناصر غير النصية ، عدم وجود علامات أو تعليمات عندما يتطلب المحتوى إدخال المستخدم ولا يمكن التعرف على الرابط من الاسم فقط . يجب أن تشجع مشكلات إمكانية الوصول التي حددها هذا البحث مصممي الويب على فهم إرشادات ال WCAG الحالية. بالإضافة إلى ذلك ، يمكن بسهولة إصلاح العديد من هذه الأخطاء بواسطة مطوري الويب أثناء التحديثات الدورية لمواقعهم.

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## List of Abbreviations

| <b>Abbreviation</b> | <b>Terms</b>                         |
|---------------------|--------------------------------------|
| E-Government        | Electronic Government                |
| W3C                 | The World Wide Web Consortium        |
| WCAG                | Web Content Accessibility Guidelines |
| WAI                 | Web Accessibility Initiative         |
| TAW                 | Web Accessibility Tester             |

# **1. Chapter One**

## **Introduction**

### **1.1. Background**

Most governments today are promoting the transition of their countries towards an information society where e-government websites are becoming the primary gateways to citizens and businesses for government information and e-service delivery.

E- Government can be defined as the public sector's use of the most innovative information and communication technologies, like the Internet, to deliver to all citizens improved services, reliable information and greater knowledge in order to facilitate access to the governing process and encourage deeper citizen participation (Ndou, 2004). In order for the citizens to avail themselves of the various benefit of online government services which include better efficiency, user convenience and better citizen political participation (Freeman & Loo, 2009), there is need to validate the accessibility and usability of the websites to improve them. We suggest in this research to assess the accessibility of e-government web sites in Sudan to provide a clear picture of what needs to be improved according to the Web content accessibility standards (WCAG).

### **1.2. Problem statement**

E-government websites target diverse users; hence, the government is facing the challenge of providing websites accessible and usable for the various categories of citizens, and according to my knowledge, there are no previous studies investigated the accessibility level of Sudan electronic government websites and finding out the conformance level of them.

### **1.3. Research significance**

Investigating of electronic government websites leads to the discovering of accessibility problems in order to fix them to make the website more accessible and usable for all categories of users and more easily provide the online services to users, increase users satisfaction and hence encourage people to use them.

### **1.4. Research aim and objectives**

The research aim concerned about using automatic and expert testing methods to investigating the accessibility level of Sudan electronic government websites according to specific standard. The aim of research is going to be achieved by the following objectives:

1. To analyze Sudan e-government websites from accessibility aspect.
2. To evaluate the accessibility of the websites with regard to the web content accessibility guidelines.
3. To provide services accessibility recommendations.

### **1.5. Research scope**

This project will be to evaluate e- government websites in Sudan only.

### **1.6. Research organization**

The structure of this research divided into four chapters as shown below:

Chapter 1: Describes the whole idea behind the theses. Defines the problem statement, why it is important, objective and scope research.

Chapter 2: Provide background and literature review of the thesis.

Chapter 3: Contains the research methodology.

Chapter 4: Contains the results of Accessibility Evaluation of E-Government Websites.

Finally, Chapter 5: Contains the Conclusions and Recommendations.

## **2. Chapter Two**

### **Literature Review**

#### **Introduction**

This chapter is divided into two sections. The first section gives general description about Electronic government, Web Accessibility and Web accessibility evaluation tools. The second section describes the previous studies related to this study.

#### **2.1. Electronic Government**

E-Government has become a popular focus of government efforts in many countries around the world. More and more governments around the world have implemented and introduced e-government systems as a means of reducing costs, improving services, saving time and increasing effectiveness and efficiency in the public sector.

There are many definitions for e-government such as the delivery of government information and services online through the Internet or other digital means (Alshehri et al., 2010). In addition, another definition was given by (Deakins & Dillon, 2002) as the unification of information and communication technologies, and administrative practices to provide government e-services to citizens, businesses and other e-governments. The benefits of online government e-services include better efficiency, user convenience and more citizen political involvement (Freeman & Loo, 2009). To enable all citizens to benefit from the full potential of e-government services, it is important to secure universal accessibility. This accessibility enables persons with disabilities to take full advantage of the

information and services offered by e-governments; the same way a person with no disability would.

## **2.2. Electronic Services**

With the prevalence of the Internet and the World Wide Web in everyday life, a number of tasks that formerly required a person's physical presence can now be carried out in an electronic fashion. To this end, a lot of effort and resources are being invested in the development of electronic services that will support the public with its everyday interaction with governmental services. Such services range from simple informational services in their simplest form, to composite transactional services where the user exchanges data with the corresponding governmental agency.

## **2.3. Web Accessibility**

Web accessibility can be defined as the degree to which web information is accessible to all human being and automatic tools (Abanumy et al., 2005). Web accessibility means that people with disabilities can use the Web. More specifically, Web accessibility means that people with disabilities can perceive, understand, navigate, and interact with the Web, and that they can contribute to the Web (Jonathan Frank, 2008). An accessible website is designed to meet different user needs, preferences, skills and situations, this flexibility can benefit people in certain situations, such as people using a slow Internet connection, people with temporary disabilities such as a broken arm, and people with changing abilities due to aging (Sergio Luján, 2013). The main objective of web accessibility is not only to provide accessible websites for people with disabilities, but also to benefit people without disabilities (Muhammad Saleem, 2016).

### **2.3.1. Importance of Web Accessibility**

The Web is an increasingly important resource in many aspects of life: education, employment, government, commerce, health care, recreation, and more. It is essential that the Web be accessible in order to provide equal access and equal opportunity to people with disabilities. An accessible Web can also help people with disabilities more actively participate in society.

### **2.3.2. Web Accessibility Guidelines**

The World Wide Web Consortium (W3C) has established a set of standards and guidelines regarding the implementation of accessible web technology, which different countries around the world are applying as they see fit, at either a national or local level (Muhammad Saleem, 2016). People from different sectors, such as government, industry and organizations, have been involved in helping the W3C develop these web accessibility guidelines in order to make websites accessible for all people, including those with visual disabilities, physical disabilities and auditory disabilities (Muhammad Saleem,2016).Creating websites with accessibility and usability features is an important aspect of the Web; however, without the web accessibility guidelines, there would be yet another challenge for developers and designers to take into account when building accessible websites. In April 1997, the W3C launched the Web Accessibility Initiative (WAI) to promote and achieve web functionality for people with disabilities (Charlotte Mulvey, 2008).The WAI has developed diverse accessibility guidelines, including:

- Web Content Accessibility Guidelines (WCAG)
- Authoring Tool Accessibility Guidelines (ATAG)
- User Agent Accessibility Guidelines (UAAG)

#### **2.3.2.1. Web Content Accessibility Guidelines (WCAG)**

Currently, there are a number of guidelines and tools Web designers and webmasters can use to make their websites accessible to people with disabilities. Such guidelines include the WCAG developed by W3C. The Web Content Accessibility Guidelines covers a wide range of recommendations for making web content more accessible to a wider range of people with disabilities, including blindness and low vision, deafness and hearing loss, learning disabilities, cognitive limitations, limited movements, speech disabilities, photosensitivity and combinations of these (Solomon & Ibrahim Shehi, 2016). It is aimed at making web content more usable by older individuals with changing abilities due to aging and often improve usability for users in general.

## **1. Web Content Accessibility Guidelines 1.0**

WCAG 1.0 were introduced by the WAI in 1999, the purpose of which was to inspire designers, developers and authors to make accessible websites and content (Muhammad Saleem, 2010). Moreover, following these guidelines makes websites accessible not only to people with disabilities, but to all users (Muhammad Saleem,2010). One of the benefits of using these guidelines is in helping users to navigate and find information quickly. The developers of authoring tools have been similarly directed to use these guidelines when developing and implementing accessible tools (Muhammad Saleem, 2010).

## **2. Web Content Accessibility Guidelines 2.0**

WCAG 2.0 was published as a W3C Recommendation on 11 December 2008. the main objective of these guidelines is to cover a wide range of recommendations and also to make websites more accessible and usable for all types of users, including those with blindness and low vision, deafness and hearing loss, learning disabilities, cognitive limitations, limited

movement, speech disabilities, photosensitivity and combinations of these (Muhammad Saleem, 2010). There are four main principles that these guidelines use: Perceivable, Operable, Understandable and Robust. Under each principle, further guidelines are offered. There are 12 guidelines that assist authors of web content to make websites accessible to users with disabilities; these guidelines have three different levels of priority: A, AA, and AAA. Level A sets the minimum requirement, while level AAA gives the maximum requirement that websites need to meet in order to reach WCAG 2.0 (Muhammad Saleem, 2010).

There is a significant improvement in WCAG version 2.0, and one of the main differences between WCAG versions 1.0 and 2.0 is that the structure of the levels, which in WCAG 1.0 are called priority 1, priority 2 and priority 3, are called A, AA and AAA in WCAG 2.0. In addition, the main point of WCAG 2.0 is that it can be applied and used more widely in diverse web technologies, as well as advanced technologies (Muhammad Saleem, 2010).

### **2.3.3. Web accessibility evaluation tools**

Web accessibility evaluation tools are software programs or online services that are used to check your website's accessibility level under web accessibility guidelines. There is a huge number of accessibility tools for commercial purposes or freely available on the web such as Watch Fire Bobby, A-Checker, Cynthia Says, EvalAccess, Accessibility Valet Demonstrator (WebThing), AccMonitor Online (HiSoftware), Torquemada (WebxTutti), Wave 3.5 (WebAIM) and Tawdis etc.

These tools are very useful for programmers and designers to determine whether their sites follow WCAG. During the design, implementation, and maintenance phases of Web development if these tools are used carefully, it can help the targeted users in preventing accessibility barriers, repairing encountered barriers, and improving the overall quality of Web sites.

## 2.4. Related Works

(Solomon Adelowo & Ibrahim Shehi, 2016) evaluated the accessibility and performance analysis of the state government websites in Nigeria by using two online automated tools: TAW checks for the conformance of each state websites with the WCAG 2.0, while site analyzer gives the overall performance of the websites in terms of percentage. Results from the study showed that none of the websites evaluated totally conform to the WCAG 2.0 standard. Violations discovered have to do mostly with guidelines 1 and 2. These include missing of linked images, missing alternate text, empty links and form control without label. The results also show that there is no significant difference in the performance of the websites among different states in the country.

(M. Basel & Faouzi ,2013) investigated the extent to which accessibility is taken into account in the design of Dubai e-government websites by using two online automated tools: TAW software accessibility testing tool and EvalAccess 2.0 to analyze website accessibility based on the WCAG. The Results from the study showed that Many Dubai e-government sites did not meet the minimum W3C accessibility conformance level for all evaluated websites, accessibility barriers were identified. The most common detected accessibility issues were related to the absence of text equivalents for non-text elements and the failure of the static equivalents for dynamic content to get updated when the dynamic content changes.

(Mrinal Kanti et al., 2012) investigated whether the Bangladesh government websites conform to international accessibility guidelines W3C WCAG 1.0 or not. and discovered to what extent web accessibility is considered by the government's websites of Bangladesh, by testing each website manually as well as automatically with the help of some well-known accessibility tools (W3C Markup Validation Service, A Checker, EvalAcces) and assistive technologies (NVDA, Lynx) and also the researches have prepared some questionnaires for 10 participants from different age groups of which most of them were with visual disabilities and taken feedbacks

from them. The Results from the study showed that none of the websites of different ministries of Bangladesh conformed to international accessibility guidelines W3C WCAG 1.0.

(Yakup & Kemal , 2016) evaluated the accessibility of each of the 25 e-Government websites in Turkey by people disabilities based on the WCAG1.0 and 2.0. The home page of each one of the websites has been analyzed from three points of view: HTML and CSS validity; web accessibility; and, current use of HTML5 and ARIA. Two automatic evaluation tools have been used to evaluate the validity of the HTML and CSS of the websites, the Markup Validation Service and CSS Validator Service. Thirteen automatic evaluation tools have been used to evaluate the accessibility of the websites analyzed in this study: A Checker, eXaminator, TAW, Total Validator, WAVE, Web Accessibility Assessment Tool, Eval Access, Cynthia Says, MAGENTA, HERA, Amp and Sort Site. The results of study indicate that the prevalent accessibility barriers identified in this study were related to the absence of text equivalents for non-text elements, and the failure of the static equivalents for dynamic content to get updated when the dynamic content changes.

(Muhammad & Amjad , 2012) evaluated the websites of central government in Pakistan including all ministries and divisions by using two accessibility evaluation tools based on W3C web accessibility standards. Total Validator to check whether the websites meet WCAG 1.0 and WCAG 2.0 accessibility requirement or not and FAE to compare the accessibility level based on the percentage of success evaluation results. The Results from the study showed that most of the web sites are not developed according to the accessibility standards for disabled persons.

(Wan Abdul Rahim et al., 2011) investigated the usability and accessibility of Malaysia e-government websites by using automatic evaluation tool, Eval Access 2.0 for accessibility evaluation and axandra usability tool to assess the site's broken link. The Results from the study showed that there is a high number of usability (speed and number of broken links) and accessibility problems for state website.

(Aidi & Rosli , 2016) evaluated the web accessibility of 25 federal government's website in Malaysia based on the WCAG 2.0 guidelines and United States Rehabilitation Act 1973 (Section 508). Using A-Checker and WAVE as automated accessibility evaluation tools, the results suggest relatively low compliance of the standards amongst the ministries websites examined. Further improvements are recommended, particularly on the contrast view requirement as well as the use of input and image-related elements.

( Joel S. & Aron W., 2017) evaluated the accessibility and usability of each of the 22 e-government websites in Tanzania using the SortSite tool, an automated website testing tool. The study found that many government websites suffer from accessibility and usability issues that hinder users from accessing information and services. Nearly 50% of websites (10 out of 22 websites) had more than 50 pages with accessibility issues out 100 scanned pages. The study also found there is a lack of contrast between text and background in many websites. Moreover, many websites are not accessible in various small and handheld devices such as mobile phones and tablets.

(Makoza & Chigona, 2013) assessed accessibility of e-government websites in Malawi using the WCAG 1.0, A-Checker, and TAW testing tools. Using a sample of 28 websites, the study found that the majority websites did not meet accessibility features.

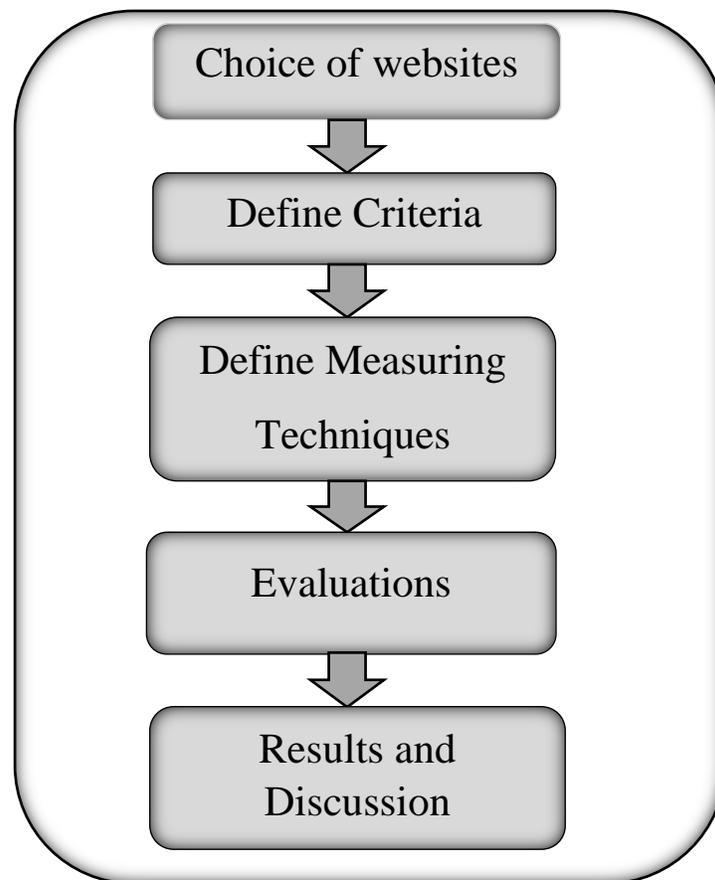
### 3. Chapter Three

#### Research Methodology

This chapter investigate the accessibility level of Sudan Electronic Government Websites according to the WCAG 2.0 by using two methods automatic testing and expert testing.

#### 3.1. Methodology

The study was carried out between March and April 2018. In order to investigate the accessibility level of Sudan Electronic Government Websites the following steps need to be followed see figure 3.1.



**Figure 3.1: The Research Methodology.**

### **3.1.1. Choice of websites**

The first step in the methodology was to determine which e-government websites should be evaluated, Sudan Governmental Portal was chosen to undergo the test for accessibility. Because it is inclusive of all government ministries websites that offer electronic services.

### **3.1.2. Define criteria**

Evaluation are based on the WCAG 2.0, because it is considered today the most comprehensive and authoritative reference for website accessibility (M. Basel & Faouzi, 2013). and it is covers a wide range of recommendations for making web content more accessible to a wider range of people with disabilities, including blindness and low vision, deafness and hearing loss, learning disabilities, cognitive limitations, limited movements, speech disabilities, photosensitivity and combinations of these. It is aimed at making web content more usable by older individuals with changing abilities due to aging and often improve usability for users in general. According to WCAG 2.0 standard, a website must be based on four principles of Perceivable, Operable, Understandable and Robust. And each principle consist of numbers of guidelines provide the basic goals that authors should work toward in order to make content more accessible to users with different disabilities as shown in Table 3.1.

**Table 3.1: The WCAG 2.0 Guidelines**

|   |
|---|
| <b>1. Perceivable</b>   |
| 1.1 Provide text alternatives for any non-text content so that it can be changed into other forms people need, such as large print, braille, speech, symbols or simpler language. |
| 1.2 Provide alternatives for time-based media.  |
| 1.3 Create content that can be presented in different ways (for example simpler layout) without losing information or structure.  |
| 1.4 Make it easier for users to see and hear content including separating foreground from background.   |
| <b>2. Operable</b>  |
| 2.1 Make all functionality available from a keyboard.   |
| 2.2 Provide users enough time to read and use content.  |
| 2.3 Do not design content in a way that is known to cause seizures.   |
| 2.4 Provide ways to help users navigate, find content, and determine where they are.  |
| <b>3. Understandable</b>  |
| 3.1 Make text content readable and understandable.  |
| 3.2 Make Web pages appear and operate in predictable ways.  |
| 3.3 Help users avoid and correct mistakes.  |
| <b>4. Robust</b>  |
| 4.1 Maximize compatibility with current and future user agents, including assistive technologies.   |

**Table 3.2: WCAG Priority Level accessibility checks Descriptions**

| <b>Priority</b> | <b>Description</b>   |
|-----------------|--|
| Priority A      | A Web content developer must satisfy this checkpoint. Satisfying this checkpoint is a basic requirement for some groups to be able to use Web documents. |
| Priority AA     | A Web content developer should satisfy this checkpoint. Satisfying this checkpoint will remove significant barriers to accessing Web documents.          |
| Priority AAA    | A Web content developer may address this checkpoint. Satisfying this checkpoint will improve access to Web documents                                     |

### **3.1.3. Measuring Techniques**

There are many ways by which one can assess and test for e-government website accessibility level. These include:

- Expert testing.
- End-user testing.
- Automated testing.
- Manual testing.
- Surveys targeting e-government webmasters and site developers.

In this study, Websites were tested by using two methods automatic testing to minimize time and appears to be less complicated and Expert testing to ensure reliability, enhance maximum accuracy and it can find violations and accessibility issues that automated tools cannot.

#### **3.1.3.1. Automatic Testing Tool**

Two Automated tools were used namely Web Accessibility Tester (TAW) and A-Checker. The basis for using these testing tools is that they are available online for free, they did not repair or modify the source code of the website being

tested and they are widely used by the researchers. For the tools to be used in evaluation, the URL of the websites will have to be entered. Upon submission, the respective website will be scanned and analyzed.

## 1. TAW

Is an online tool for the accessibility analysis of web sites based on the W3C WCAG 1.0 and WCAG 2.0. TAW enables the tester to specify one page (such as the home or index page) or the entire website pages for automated accessibility testing. For each accessibility checkpoint, TAW provides a detailed report of detected issues, as well as additional tagged warnings that require manual inspection and human judgment on the part of the tester (Solomon & Ibrahim, 2016).

The image shows two screenshots of the Taw web accessibility testing tool. The top screenshot displays the 'Web accessibility test' interface. It features a text input field containing the URL 'http://esudan.gov.sd/' and a prominent 'Analyze' button. Below the button, there are 'Options' for 'Analysis level' (Level A, Level AA, Level AAA) and 'Supported technologies' (HTML, CSS, JS). The current configuration is 'Level A - Technologies: HTML, CSS'. The bottom screenshot shows the 'Summary' report. It contains three main sections: '247 Problems in 8 success criteria. Corrections are needed' (Perceivable: 128, Operable: 16, Understandable: 15, Robust: 88), '356 Warnings in 11 success criteria. A human review is necessary' (Perceivable: 114, Operable: 28, Understandable: 5, Robust: 209), and '8 Not reviewed in 8 success criteria. Fully manual review' (Perceivable: 3, Operable: 4, Understandable: 1, Robust: 0). At the bottom, it provides the resource URL, date (10/08/2018 11:58), and guidelines (WCAG 2.0). A link is provided to access the detailed report.

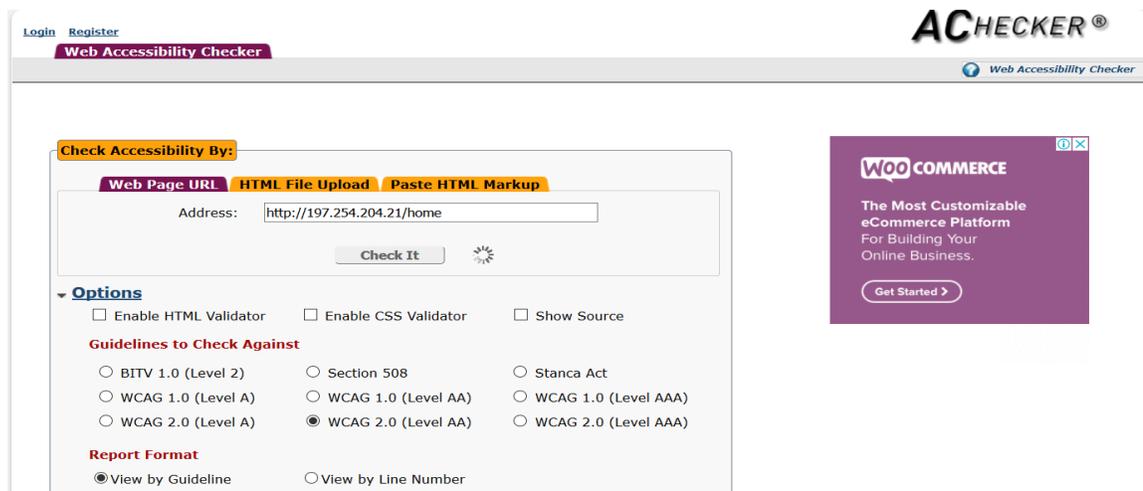
**Figure 3.2: Taw Report of the Home Page of Sudan Governmental Portal**

## 2. A-Checker

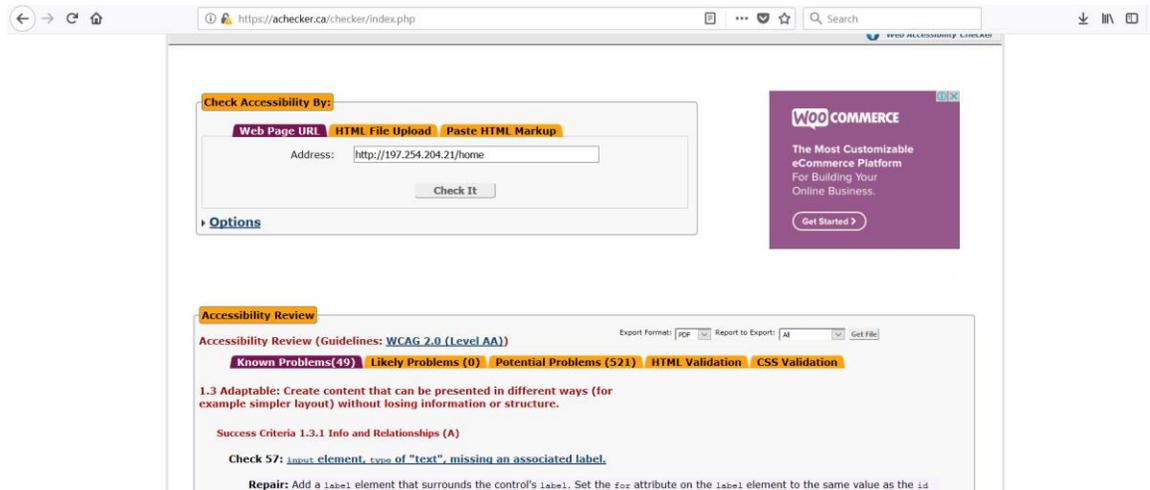
It is an online accessibility checker that tests web pages for conformance to accessibility guidelines including WCAG 1.0, 2.0, Section 508, Stanca Act and BITV. It supports both English and Italian languages. It is a free open source software, which is easy to use. A-Checker identifies accessibility issues under three types of problems:

1. Known Problems – must modify web page to fix these problems.
2. Likely Problems – may need to modify web page to fix these problems.
3. Potential Problems – may not have to modify web pages to fix these problems. (Charlotte, 2008).

This study evaluated the main pages only. The justification of doing so was because the main pages of a Websites serves as an index or table of contents to other documents stored at the site and the first destination that the user will arrive at. The main pages is also the user's first impression of the site; a good impression of a website welcomes the user and invites him to further explore the site's contents.



The screenshot shows the A-Checker web interface. At the top, there are links for "Login" and "Register", and the "Web Accessibility Checker" logo. The main content area is titled "Check Accessibility By:" and has three tabs: "Web Page URL", "HTML File Upload", and "Paste HTML Markup". The "Web Page URL" tab is active, showing a text input field with the address "http://197.254.204.21/home" and a "Check It" button. Below this, there are "Options" for enabling HTML and CSS validators and showing source code. Under "Guidelines to Check Against", several radio buttons are listed, with "WCAG 2.0 (Level AA)" selected. At the bottom, there are "Report Format" options, with "View by Guideline" selected. A purple advertisement for "WooCommerce" is visible on the right side of the page.



**Figure 3.3: A-Checker Report of the Home Page of Sudan Governmental Portal**

### 3.1.3.2. Expert Testing

Fifteen participants were invited for the evaluation of Sudan Governmental Portal, all of them have master degree in computer science and a good Experience in human computer interaction concept; based on three principles namely: perceiving, operability, and understanding a questionnaire have prepared. The participants asked to go through Sudan Governmental Portal website and investigate the accessibility of the portal according to the prepared questionnaires without determine specific time for the evaluation process.

#### 1. Questionnaire Design

The questionnaire for this research was designed based on WCAG 2.0 by using Microsoft Excel to ensure that all the participants could open it. The questionnaire was distributed via email to the participants. The questionnaire consisted of 32 questions in total, each question cover one guideline in WCAG 2.0, we chose the guidelines that does not required checking the website source code because this type of checking done by the automatic testing tools. The questionnaire questions took the form of five statements, which the person filling in the form would grade according to their personal opinion. The grading of the statement used

a Likert scale. The Likert scale is the popular approach for questionnaires. This question asked the respondent to indicate their agreement or disagreement with the statement. It was decided to use five different responses of varying scales. The responses available for each statement were:

- Strongly Agree
- Agree
- Undecided
- Disagree
- Strongly Disagree

**Table 3.3: The Questionnaire**

| The Questionnaire questions                 | Evolution items  | Evolution           |            |                |               |                        |
|---|--|---------------------|------------|----------------|---------------|------------------------|
|   |  | Strongly Agree<br>4 | Agree<br>3 | Undecided<br>2 | Disagree<br>1 | Strongly Disagree<br>0 |
| Questions of the operability of the website | <ul style="list-style-type: none"> <li>- Is the site's navigation easy to understand?</li> <li>- No advertisements interfered with navigation?</li> <li>- The purpose of each link can be determined from the link text alone?</li> <li>- Is there a link to the home page on every page in the site?</li> <li>- Are visited links clearly defined?</li> <li>- Do all the links work properly?</li> <li>- Is a search feature available?</li> <li>- Does the site provide a site map?</li> <li>- The web page has a descriptive and informative page title?</li> <li>- Is every web page capable of full functionality via only the keyboard?</li> </ul> |                     |            |                |               |                        |

|   |   |  |
|---|---|--|
|   | <ul style="list-style-type: none"> <li>- Web pages do not contain anything that flashes more than three times in any one second period?</li> <li>- Users can complete an activity without any time limit?</li> </ul>  |  |
| <p>Questions of the perceivability of the website</p> | <ul style="list-style-type: none"> <li>- Does each non-text element on the page have a text equivalent via "alt" (alternative text attribute)?</li> <li>- A sign language video is provided for all media content that contains audio?</li> <li>- Color is not used alone to convey meaning?</li> <li>- When a form contains both required and optional fields, is there Instructions at the top of the form explain that required fields are labeled with red text and also with an icon whose text alternative says, "Required?"</li> <li>-Text color has sufficient contrast with background color?</li> </ul> |  |

|  |  |  |
|--|--|--|
|  | <ul style="list-style-type: none"> <li>- Are the fonts easy to read on various screen resolutions?</li> <li>- Text can be resized without assistive technology up to 200 percent without loss of content or functionality?</li> <li>- Instructions do not rely upon shape, size, or visual location (e.g., "Click the square icon to continue") or upon sound?</li> </ul>  |  |
| <p>Questions of the understandability of the website</p> | <ul style="list-style-type: none"> <li>- Is there a help link on every Web page?</li> <li>- Instructions are provided when content requires user input?</li> <li>- Is there a mechanism for identifying specific definitions of words or phrases used in an unusual or restricted way, including idioms and jargon?</li> <li>- Does the site Provide a text summary that can be understood by people with lower secondary education level reading ability ?</li> </ul> |  |

|  |  |  |
|--|--|--|
|  | <ul style="list-style-type: none"> <li>- Navigation mechanisms that are repeated on web pages do not change order when navigating through the site?</li> <li>- If the user can submit information, the submission is reversible, verified, or confirmed?</li> <li>- Input error is identified and described to the user in text?</li> <li>- If an input error is detected (via client-side or server-side validation), suggestions provided for fixing the input in a timely and accessible manner?</li> </ul> |  |
| <p>Questions of the personal opinion of the user</p> | <ul style="list-style-type: none"> <li>- How satisfied were you with your visit on the website?</li> <li>- Please grade the website on the overall content.</li> <li>- Please grade the website on overall look.</li> <li>- Does the Site Load time is reasonable?</li> </ul>  |  |

### **3.1.4. Evaluation**

After selecting the websites and specifying guidelines to be followed, automatic testing tools and Expert testing are applied to investigate the accessibility level of Sudan Governmental Portal. Chapter four is going to discuss the result of evaluation in more details.

## 4. Chapter Four

### Results and Discussion

This chapter show the evaluation results of Sudan Governmental Portal and the discussion of the evaluation result.

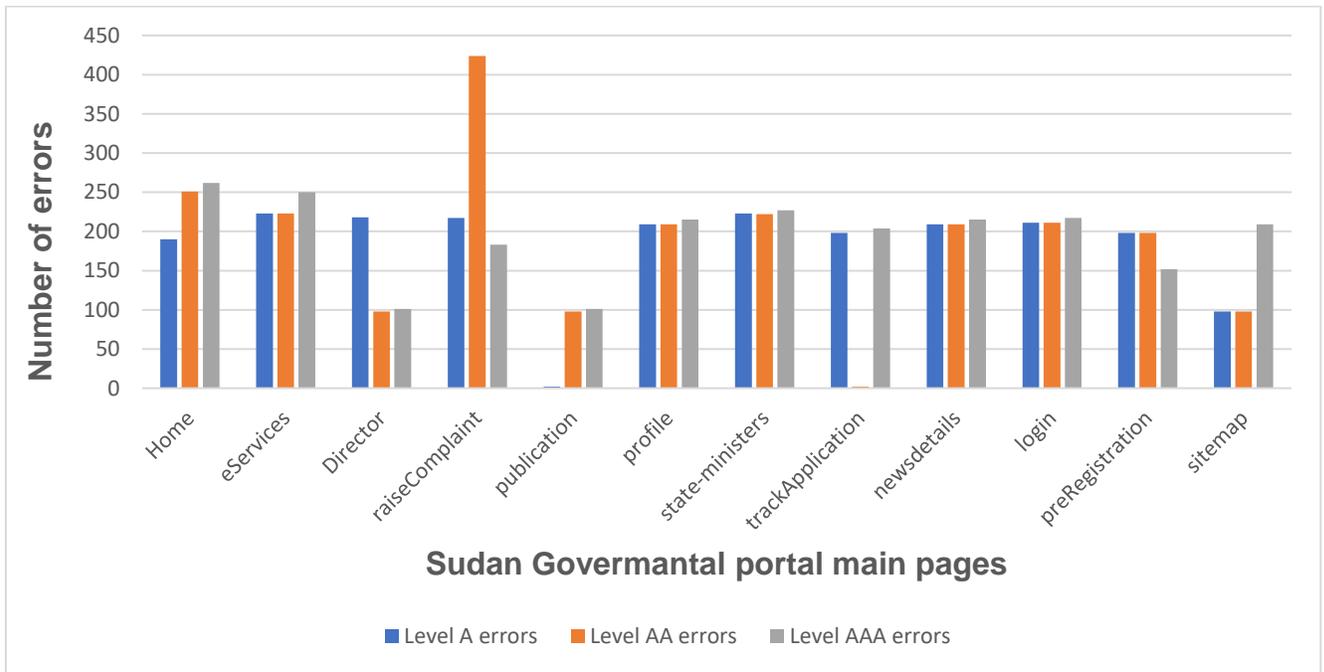
#### 4.1. Web Accessibility Results based on TAW

Table 4.1 below summarizes the accessibility results for Sudan Governmental Portal by using TAW web accessibility tool. It shows that none of Sudan Governmental Portal main pages passed any of WCAG 2.0 Priority level A, AA and AAA accessibility checks. Level A sets the minimum requirement, while level AAA gives the maximum requirement that websites need to meet in order to reach WCAG 2.0. According to TAW, Known problems refer to the problems that have been identified with certainty as accessibility barriers and warnings refer to the need of manual inspection and human judgment on the part of the tester. The website passes the accessibility evaluation if no error found for all three problem categories.

**Table 4.1: WCAG 2.0 Accessibility Conformance as per TAW Results**

| Website main pages | Level A errors | Level A warnings | Level AA errors | Level AA warnings | Level AAA errors | Level AAA warnings |
|--------------------|----------------|------------------|-----------------|-------------------|------------------|--------------------|
| Home               | 190            | 686              | 251             | 438               | 262              | 440                |
| eServices          | 223            | 309              | 223             | 338               | 250              | 347                |
| Director           | 218            | 295              | 98              | 232               | 101              | 237                |
| raiseComplaint     | 217            | 635              | 424             | 363               | 183              | 263                |
| publication        | 2              | 138              | 98              | 232               | 101              | 237                |

|                  |     |     |     |     |     |     |
|------------------|-----|-----|-----|-----|-----|-----|
| profile          | 209 | 293 | 209 | 326 | 215 | 335 |
| state-ministers  | 223 | 284 | 222 | 324 | 227 | 349 |
| trackApplication | 198 | 285 | 2   | 139 | 204 | 324 |
| newsdetails      | 209 | 283 | 209 | 319 | 215 | 323 |
| login            | 211 | 291 | 211 | 320 | 217 | 329 |
| preRegistration  | 198 | 286 | 198 | 315 | 152 | 267 |
| sitemap          | 98  | 220 | 98  | 232 | 209 | 331 |



**Figure 4.1: TAW Errors Result**

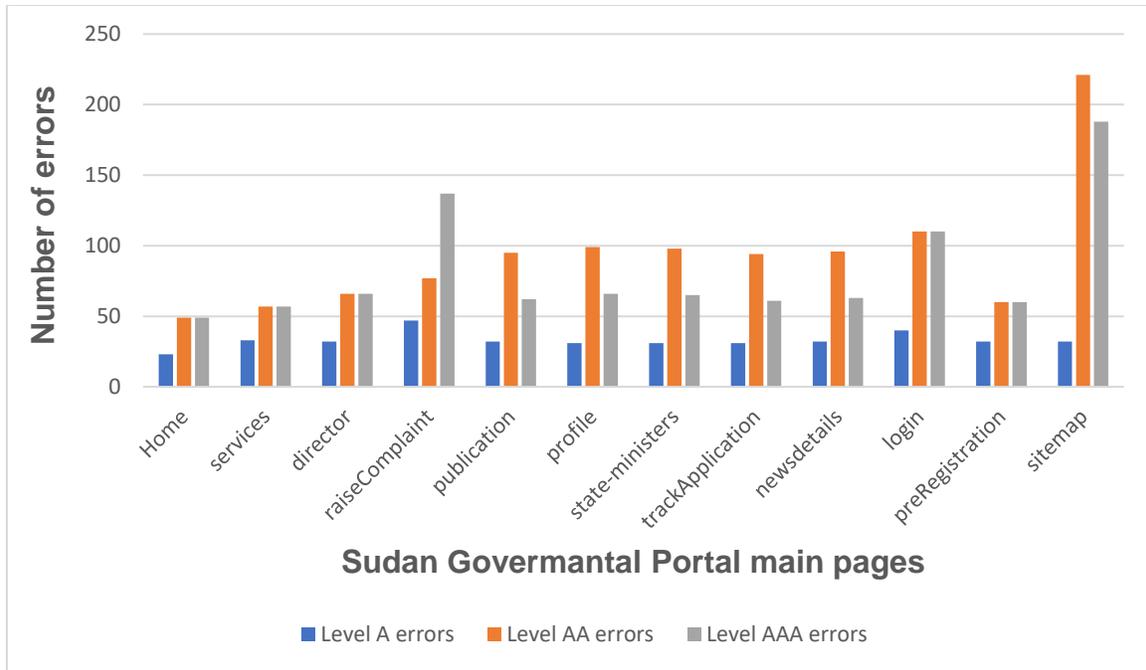
## 4.2. Web Accessibility Results based on A-Checker

Table 4.2 below summarizes the accessibility results for Sudan Governmental Portal by using A-Checker web accessibility tool. It shows us a slightly different result from the TAW result. But the result also indicates that none of Sudan Governmental Portal main pages passed any of the WCAG 2.0 Priority level A, AA

and AAA accessibility checks. According to A-Checker, Known problems refer to the problems that have been identified with certainty as accessibility barriers. Likely problems include all problems that have been identified as probable barriers, but requires manual inspection of the web for confirmation. Meanwhile these problems should be fixed. The website passes the accessibility evaluation if no error found for all three problem categories.

**Table 4.2: WCAG 2.0 Accessibility Conformance as per A-Checker Results**

| Website main pages | Level A errors | Level A warnings | Level AA errors | Level AA warnings | Level AAA errors | Level AAA warnings |
|--------------------|----------------|------------------|-----------------|-------------------|------------------|--------------------|
| Home               | 23             | 0                | 49              | 0                 | 49               | 0                  |
| services           | 33             | 2                | 57              | 4                 | 57               | 4                  |
| director           | 32             | 1                | 66              | 2                 | 66               | 2                  |
| raiseComplaint     | 47             | 1                | 77              | 2                 | 137              | 2                  |
| publication        | 32             | 1                | 95              | 2                 | 62               | 2                  |
| profile            | 31             | 5                | 99              | 6                 | 66               | 6                  |
| state-ministers    | 31             | 2                | 98              | 3                 | 65               | 3                  |
| trackApplication   | 31             | 1                | 94              | 2                 | 61               | 2                  |
| newsdetails        | 32             | 5                | 96              | 6                 | 63               | 6                  |
| login              | 40             | 1                | 110             | 1                 | 110              | 1                  |
| preRegistration    | 32             | 1                | 60              | 1                 | 60               | 2                  |
| sitemap            | 32             | 2                | 221             | 2                 | 188              | 2                  |



**Figure 4.2: A-Checker Errors Result**

### 4.3. Web Accessibility Results based on TAW and A-Checker

Table 4.3 below shows the WCAG 2.0 violated checkpoints in Sudan Governmental Portal which consider as accessibility barriers by both TAW and A-Checker Testing tools.

**Table 4.3: The Common Accessibility Barriers between TAW and A-Checker**

| WCAG 2.0 checkpoint reference | Accessibility barrier   | Description   |
|-------------------------------|---|---|
| WCAG 2.0 checkpoint 1.1.1     | Failure to Provide text alternatives for any non-text content | All non-text content that is presented to the user must has a text alternative that serves the equivalent purpose |
| WCAG 2.0 checkpoint 3.1.1     | Failure at Language of Page                                   | The default human language of each Web page must be programmatically determined                                   |

|                              |   |   |
|------------------------------|---|---|
|                              |   |   |
| WCAG 2.0<br>checkpoint 3.3.2 | Failure to provide labels or instructions   | labels or instructions must be provided when content requires user input.to identify the controls in a form so that users know what input data is expected  |
| WCAG 2.0<br>checkpoint 4.1.1 | failure at Parsing  | In content implemented using markup languages, elements must have complete start and end tags, elements must be nested according to their specifications, elements do not contain duplicate attributes, and any IDs are unique, except where the specifications allow these features. |
| WCAG<br>checkpoint 3.3.1     | Failure to Help users avoid and correct mistakes.                                   | If an input error is automatically detected, the item that is in error must be identified and the error should be described to the user in text.  |
| WCAG 2.0<br>checkpoint 1.3.1 | Failure to Ensure that information and structure can be separated from presentation | Information, structure, and relationships conveyed through presentation must be preserved when the presentation format changes  |
| WCAG 2.0<br>checkpoint 3.2.2 | Failure to Make Web pages appear and operate in predictable ways.                   | Changing the setting of any user interface component must not automatically cause a change of context unless the user has been advised of the behavior before using the component.  |

|                              |                         |  |
|------------------------------|-------------------------|--|
| WCAG 2.0<br>checkpoint 2.4.4 | Failure at Link Purpose | The purpose of each link must be determined from the link text alone or from the link text together with its programmatically determined link context. |
|------------------------------|-------------------------|--|

#### 4.4. Web Accessibility Evaluation Results based on the Expert testing

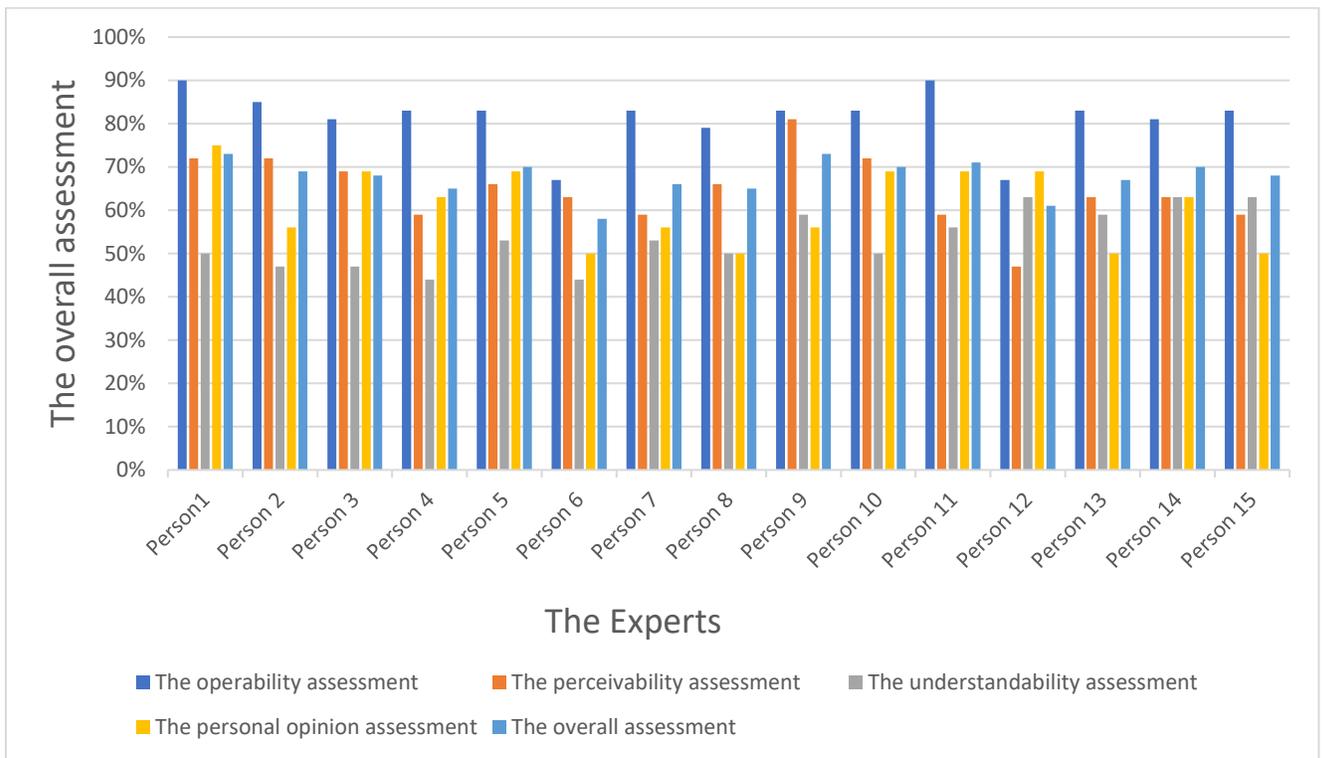
Table 4.4 below summarizes the accessibility results for Sudan Governmental Portal by using Expert testing method. The result indicates that Sudan Governmental Portal is not fully compliant to the WCAG 2.0, it's noticeable that the understandability principle rate is the lowest, which consider serious issue because if users can't understand the website they can't use it even if it is perceivable or operable .

**Table 4.4: Accessibility Evaluation Results based on the Expert testing**

|                 | <i>The operability assessment</i> | <i>The perceivability assessment</i> | <i>The understandability Assessment</i> | <i>The Personal opinion Assessment</i> | <i>The overall assessment</i> |
|-----------------|-----------------------------------|--------------------------------------|---|--|-------------------------------|
| <b>Person 1</b> | 90%                               | 72%                                  | 50%                                     | 75%                                    | 73%                           |
| <b>Person 2</b> | 85%                               | 72%                                  | 47%                                     | 56%                                    | 69%                           |
| <b>Person 3</b> | 81%                               | 69%                                  | 47%                                     | 69%                                    | 68%                           |

|                  |     |     |     |     |     |
|------------------|-----|-----|-----|-----|-----|
| <b>Person 4</b>  | 83% | 59% | 44% | 63% | 65% |
| <b>Person 5</b>  | 83% | 66% | 53% | 69% | 70% |
| <b>Person 6</b>  | 67% | 63% | 44% | 50% | 58% |
| <b>Person 7</b>  | 83% | 59% | 53% | 56% | 66% |
| <b>Person 8</b>  | 79% | 66% | 50% | 50% | 65% |
| <b>Person 9</b>  | 83% | 81% | 59% | 56% | 73% |
| <b>Person 10</b> | 83% | 72% | 50% | 69% | 70% |
| <b>Person 11</b> | 90% | 59% | 56% | 69% | 71% |
| <b>Person 12</b> | 67% | 47% | 63% | 69% | 61% |
| <b>Person 13</b> | 83% | 63% | 59% | 50% | 67% |

|                  |     |     |     |     |     |
|------------------|-----|-----|-----|-----|-----|
| <b>Person 14</b> | 81% | 63% | 63% | 63% | 70% |
| <b>Person 15</b> | 83% | 59% | 63% | 50% | 68% |



**Figure 4.3: Expert Testing Result**

Table 4.5 summaries the most prevalent accessibility barriers in Sudan Governmental Portal when evaluated by using expert testing.

**Table 4.5: The most Prevalent Accessibility Barriers in the Expert Testing Result**

| <b>WCAG checkpoint reference</b> | <b>Accessibility barrier</b>  | <b>Description</b>  |
|----------------------------------|---|---|
| WCAG 2.0 checkpoint 1.1          | Failure to provide “alt” text alternative for each non-text element   | All non-text content that is presented to the user must has a text alternative that serves the equivalent purpose   |
| WCAG 2.0 checkpoint 1.2.6        | Failure to provide Sign language interpretation for all prerecorded audio content in synchronized media.                | Sign language interpretation may be provided for all prerecorded audio content in synchronized media.   |
| WCAG 2.0 checkpoint 3.1.3        | Failure to provide a mechanism for identifying specific definitions of words or phrases used in an unusual way.         | A mechanism is available for identifying specific definitions of words or phrases used in an unusual or restricted way, including idioms and jargon.  |
| WCAG 2.0 checkpoint 3.1.5        | Failure to provide a text summary that can be understood by people with lower secondary education level reading ability | A mechanism is available for identifying specific pronunciation of words where meaning of the words, in context, is ambiguous without knowing the pronunciation.  |
| WCAG 2.0 checkpoint 3.3.3        | Failure to provide suggestions for correction if an input error is automatically detected.                              | If an input error is automatically detected and suggestions for correction are known, then the suggestions are provided to the user, unless it would jeopardize the security or purpose of the content. |

## 4.5. Result and Discussion

There were a number of accessibility issues highlighted in the assessment result by both automatic testing tools and Expert testing:

- One of the most serious issue was the absence of text equivalents for any non-text content, Text alternatives are a primary way for making information accessible because they can be rendered through any sensory modality (for example, visual, auditory or tactile) to match the needs of the user. Providing text alternatives allows the information to be rendered in a variety of ways by a variety of user agents. For example, a person who cannot see a picture can have the text alternative read aloud using synthesized speech. A person who cannot hear an audio file can have the text alternative displayed so that he or she can read it.
- The absence of labels or instructions when content requires user input, providing instructions or labels that identify the controls in a form help users know what input data is expected. Instructions or labels may also specify data formats for fields especially if they are out of the customary formats or if there are specific rules for correct input. Content authors may also choose to make such instructions available to users only when the individual control has focus especially when instructions are long and verbose.
- The Link Purpose is not identified from link text alone the purpose of a link can be identified from its link text to help users understand the purpose of each link in the content, so they can decide whether they want to follow it. So that People with cognitive limitations will not become disoriented, by extra navigation to and from content they are not interested in and also helps people with motion impairment by letting them skip Web pages that they are not interested in.
- The default human language of each Web page is not programmatically determined, The default human language of the Web page is the default text-

processing language .When a Web page uses several languages, the default text-processing language is the language which is used most . when the language of the Web page is identified we can ensure that both assistive technologies and conventional user agents can render text more accurately . Screen readers can load the correct pronunciation rules. Visual browsers can display characters and scripts correctly. Media players can show captions correctly. As a result, users with disabilities will be better able to understand the content.

- The last serious issue was related to the robust of the content, In content implemented using markup languages, elements must have complete start and end tags, elements must be nested according to their specifications, elements do not contain duplicate attributes, and any IDs must be unique, except where the specifications allow these features to ensure that user agents, including assistive technologies, can accurately interpret and parse content. If the content cannot be parsed into a data structure, then different user agents may present it differently or be completely unable to parse it.

## **5. Chapter Five**

### **Conclusion and Recommendations**

#### **1.5. Conclusions**

This study investigated the accessibility of Sudan Governmental Portal based on WGAG 2.0. The investigation used automatic testing and expert testing. The findings from this study have clearly shown that Sudan Governmental Portal has many accessibility problems. The most common detected accessibility issues were related to the absence of text equivalents for non-text elements, the absence of labels or instructions when content requires user input and link purpose is not identified from link text alone. The accessibility checkpoint problems identified by this research should encourage Web designers to understand current WCAG industry guidelines. In addition, many of these errors could be easily fixed by Web developers during periodic updates to their sites. accessibility testing tools should be used to review errors, and then prioritize changes to be made to their Web pages based upon criticality of the checkpoint errors and the difficulty or ease of making the updates.

#### **1.2. Recommendation**

As a complement to this Study, there are some recommendations for researchers in this subject to improve the accessibility assessment process:

- Include people with disabilities in the assessment process.
- Increase the number of the automatic assessment tools.

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