

Usability Evaluation of Academic Websites Using Automated Tools

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Abstract—In a bid to reposition the universities in Nigeria, the management of various universities in the country has been embarking on various technology innovations aimed at increasing and improving the web presence of their institutions. This involves re-designing of websites using the latest state of the art technology so as to improve its usability. This research was conducted in order to know the usability level via accessibility evaluation of the federal universities in Nigeria. The automated tools used are Web Accessibility checker, HERA and WAVE. The tools inspected the conformity of the websites with Web Content Accessibility Guidelines (WCAG 1.0 and 2.0) by reporting violations in forms of errors and problems. Results show that all the websites have a number of accessibility errors hence they are not in total compliance with WCAG. Recommendations for improvement on the websites are included.

Keywords - website, usability, accessibility, Nigeria, automated tools.

I. INTRODUCTION

Websites today have become a major medium of information dissemination to the public. Through the web, it is practically possible for most people nowadays to get information easily from Internet from anywhere and anytime [1]. This is because the use of the internet to disseminate information to users by many organisations is ever increasing. As a result of this, various universities in the world now have websites in order to become current, competitive and visible globally[2], [3].

However, there is concern about the various ways in which academic websites should be designed to ensure that it meets the end users goals. Sadly enough most academic websites as with most website designs are often driven by latest technology, organization objectives, fund availability, target market and so on rather than its satisfactory usage by end users [4].

But communication to be successful between the university and the end user of the university websites, information passed from one end should get to the other end with little or no effort made by the receiver of the information. Therefore, a cordial communication between the university and the website user plays a vital role in the proper governance of university. The information flow to all stake holders must be timely and effective [5]. For a university website, different types of user

(able and disabled) are expected to interact with it. Hence, there is great need to incorporate usability and accessibility guidelines in the design of the website. The importance of usability in website has been widely acknowledged to be very paramount and important in web design. It is aimed at satisfying users' need [6], [7].

At present, many universities in the country have made tremendous efforts to improve the design of their websites in order to ensure that they are in accordance with international standard. Hence, there is need to evaluate the usability of these websites from accessibility point of view so as to know its level of compliance with international accessibility guidelines. In this paper, we present the results of usability evaluation of all the federal universities' websites in the country by using automated tools. It is aimed at discovering the errors (problems) inherent in the websites and check for their conformity with web accessibility guidelines. The evaluation is based on the Web Content Accessibility Guidelines, WCAG 1.0 and WCAG 2.0.

II. LITERATURE REVIEW

Web usability is an approach that is used to test whether or not websites are easy to use by the end users without any effective training, or learning. A site's ease of use or its usability is seen as an integral part of its success especially as the site becomes more interactive and complex with some features [8]. Usability is the backbone which connects the university and the end user be it a student or any user that has any affiliation with the university. Usability can be defined as the ease of use of a product. The product could be a software product in form of website. Any product with bad usability is good for nothing. Reference [6] further defined usability as a quantitative and qualitative measurement of the design of user interface grouped into five key factors: learnability, efficiency, memorability, errors and satisfaction

Web Accessibility on the other hand describes the ability of a websites to be easily used by people with disabilities. Web Accessibility Initiative (WAI) founded by the World Wide Web Consortium (W3C) to promote the accessibility of the Web, defines web accessibility to mean that people with disabilities can use the Web. It means that people with disabilities can perceive, understand navigate and interact with websites and tools [9], [10]. Web accessibility also includes all

types of disabilities that impact access to the web and thus includes visual, auditory, physical, speech, cognitive and neurological disabilities [11]. Accessibility therefore is a subset of usability and it further follows that usability implies accessibility [12], [13]. So, for a website to be usable it must be accessible. Also, according to [14], accessibility is the usability of a product, service, environment or facility by people with the widest range of capabilities. Therefore, in the context of this paper accessibility is viewed as an integral part of usability and hence the terms usability and accessibility are used interchangeably.

From the literature, evaluation of websites can be done by using different methods. It could be inspection based through the use of expert; test based, through the use of user or tool based through the use of automated tools. Inspection-based method involved the use of expert to test a web site. Test-based method involved the use of users via questionnaire, survey, user task and so on. Tool-based automated evaluation uses an automated tool to determine internal (or underlying) attributes of the website. Properties such as textual duplicates of links embedded in images, the number of HTML page sizes, HTML files, the sizes of images, the number of broken or bad links, browser compatibility, download time, mobile friendliness, page rank and other technical deficiencies within the web pages are discovered through these tools [1], [15]. The main aim of the evaluation is to ensure quality [3], [16].

In their study, [4] used two online automated tools (HTML toolbox and web page analyzer) and questionnaire to evaluate nine universities websites in Jordan. The result obtained from the evaluation was used to provide suggestions to enhance usability of the websites. Results from the study indicated that there were some weaknesses in some aspect of design, interface and performance of the websites.

Study by [17] inspected whether the websites of the Malaysian public universities are fulfilling the usability guidelines as provided by WCAG or not. Eleven Malaysian public universities were compared by using two automatic evaluation tools; Bobby and LIFT. The study also compared universities website in term of navigation design. The results revealed that Malaysia public universities were still very low in terms usability and accessibility.

Another study to evaluate the usage of university websites in Bangladesh was conducted by [18]. They employed the use of both automated tools and user testing methods. The automated tools include HTML tool box and web page analyzer. The research shows that the download time, HTML code errors, image size among others are not in conformity with acceptable standard. The level of users' satisfaction was found not encouraging. Furthermore, reference [19] evaluated the web usability and content accessibility of top USA universities. Two automated tools were used; Bobby and LIFT. It was reported that there was a low compliance (30%) with WCAG 1.0 and a low usability rating for most of the universities websites. The accessibility approval was also found to correlate significantly with overall usability ratings of the websites.

Reference [16] used two automated tools; HTML toolbox and webpage analyzer, to evaluate the usability of websites of two Polytechnics in Nigeria. The results show that there were some weaknesses in the aspect of design and interface. However, it was concluded that the overall usability level of the studied websites are acceptable.

In their research, [20] used automated web homepage usability tester (webHUT) to evaluate the usability of Asian websites. The tool used an extensive automated quantitative analysis of XHTML source code of homepages against seventeen organised web usability guidelines. It was discovered that all categories of Asian websites have usability problems.

Research by [21] involved the used an automated tool named WebQual to evaluated three African countries websites. The report compares the accessibility quality and the level of structural complexity of these African countries government's Web pages. It was discovered that that hand coded pages tend to have larger number of HTML elements and also present higher number of accessibility problems. They further suggested ways to repair the most common problems in these pages.

The study by [22] investigated the usability and content accessibility of UK e-government websites and see if these two measures are correlated. The two automatic evaluation tools used are Bobby and LIFT. Based on the automatic evaluation results, ten selected websites were further evaluated by using heuristics evaluation and cognitive walkthrough. The study also involved the use of assistive technology to assess the accessibility issues. The results show a relatively high compliance with the WCAG and a relatively low usability rating for most UK e-government websites.

Another study was conducted to evaluate the usability of a departmental website at University of Bangazi. Both questionnaire based method and an online automated tool: HTML tool box, were used [23]. It was reported that a satisfactory level of performance was obtained from the evaluation. Consequently, suggestions were provided based on the discovery made.

III. WEB ACCESSIBILITY AUTOMATED TOOLS

Automated tools work by examining the source code of web pages in order to determine the compatibility of web pages with specified guidelines. These guidelines may cover universally accepted guidelines or guidelines accepted in a specific society. Below is a brief description of the automated tools used in this study [18].

WAVE: This is a Web Accessibility Tool developed and made available as a free community service by WebAIM (Web Accessibility In Mind). Originally launched in 2001. It is used to determine the accessibility of web content. WAVE helps developers identify potential accessibility problems. It checks for compliance issues found in the Section 508 and WCAG 2.0 guidelines. WAVE result is summarized by showing the number of violations encountered based on errors,

alerts, features, structural elements, contrast error, HTML5 and ARIA.

Web Accessibility Checker (Achecker) is a tool designed to check for conformity with WCAG 2.0 which just became operational in October 2012. AChecker identifies three types of problems: Known, Likely and Potential problems. Known problems are problems that have been identified with certainty as accessibility barriers. The web page must be modified in order to fix these problems. Likely problems are problems that have been identified as probable barriers, but require a human to make a decision. One will likely need to modify the web page to fix these problems. Potential problems are problems that AChecker cannot identify and it requires a human decision. In this study, the webpages are checked at AA conformance level, which is a medium level.

HERA is a tool to check the accessibility of Web pages according to the specification of WCAG 1.0. HERA means Style sheets for accessibility testing. To use this tool, a set of preliminary tests is performed on the page in order to identify any automatically detectable errors, checkpoints met or which checkpoints need further manual verification. The result is presented by reporting the number of errors based on priority 1, priority 2 and priority 3. These are further categorized into fail, pass, need checking, partial or cannot tell. HERA Version 2.1. Beta is used in this study.

IV. METHODOLOGY

Three appropriate tools to evaluate website accessibility based on WCAG are carefully selected for the study. Although different automated accessibility tools are available on the internet, the authors carefully chose the ones that satisfy the aim of the study. We selected the following tool: Achecker (<http://www.achecke.ca>), HERA (www.sidar.org/hera/index.php.en) and WAVE (<http://www.webaim.org>). Detailed explanations about the tools were discussed in the previous section.

The study was carried out between April and July 2014 at the Federal University of Technology Minna. All the thirty six Federal Universities websites were chosen for the study. The schools are located in the thirty six states of the federation including the federal capital territory. The names of the universities and their URL are listed in the Appendix A.

In order to use any of the automated tools to evaluate the accessibility of the websites, the address of the websites will have to be entered. The website will then be scanned and a report indicating the accessibility barriers that do not conform to the checkpoints established in WCAG will be generated. All the evaluations were conducted in both Mozilla Firefox and Google Chrome running under Windows 7 starter. The websites were tested in both browsers to ensure that the results are uniform, consistent and valid.

V. RESULTS AND DISCUSSIONS

First, result obtained from the web accessibility checker (Achecker) is shown in Fig. 1. The numbers of problem detected are categorized as Known, Likely and Potential problems. From fig. 1, all the websites have a great number of potential problems. The numbers of known problems are equally high while the numbers of likely problems are comparatively very small. Based on the number of known problems which is a serious accessibility barrier, Nigerian defense academy recorded the highest number of these problems. Also, 61% of the total websites have more than 20 known problems. OAU, MOUA and UDUS websites were not available during the period of the evaluation.

Further analysis shows that the most common errors detected are that of linked images missing, missing alternate text, missing form label, document language missing and empty links. Missing alternate text occurs when image alternate are not present. Linked image missing implies that an image without alternate text is present in the webpage. Empty link means that a link contains no text. Missing form label implies that a form control does not have a corresponding label, while document language missing implies that the language of the document is not identified.

Results from WAVE are shown in Fig. 2. Only the numbers of errors found in the websites are put into consideration while using this tool. Like the results obtained from Achecker, all the websites of the tested universities have a lot of errors. UNILAG and NDA websites reported a very high number of errors. 16% of the websites recorded less than five errors with the remaining (84%) have more than five errors detected by the tool. MOUA and UDUS websites were not available for analysis.

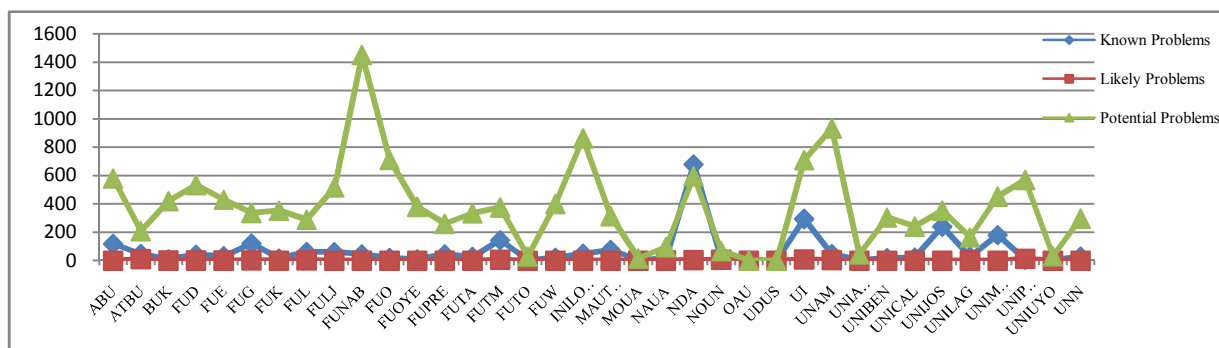


Fig. 1. Achecker result

The breakdown of the results is similar to that of Acheck-er. It is worthy to note that there is no single university that fully satisfies the accessibility criteria based on the WCAG 2.0. One observation however is that there is a sort of disparity and variations in the number of errors detected by WAVE and known problems discovered by Achecker. This may be partly due to design of the tool used in the analysis and the level of conformance being tested. For example Achecker is set to test for conformance at level AA which is medium. Different results may be obtained if it is set at levels (A) or AAA (highest). WAVE on the other hand checks for compliance issues found in section 508 and WCAG 2.0.

Having discovered that the websites failed to conform to the WCAG 2.0, the researchers went further to test for conformance with the previous WCAG 1.0 standard. To achieve this, HERA was used and the results are shown Fig. 3. The results are categorized into priority 1; priority 2 and priority 3 based on WCAG 1.0. Priority 1 means a very serious one as its violation will make it impossible for one or more group of people to access the website. Priority 2 means less serious error whose violation will make it difficult for one or more group of people to access the website. Priority 3 is not so serious but its violation may only make one or more group of people to find it somewhat difficult to access the website.

The results shows that the number of errors detected are small compared to the previous tools used. However, there are a lot of errors inherent in all the websites. Usman Dan Fodio University could not be assessed due to unavailability of its website. University of Agriculture Makurdi recorded the highest number of Errors while Michael Okpara University of Agriculture recorded the lowest number of errors detected.

Only three universities did not record any priority1 errors. They are MOUA, FUL and FUIO. Others have 1 or more violations in this regard. This means that only 8% of the universities satisfied priority 1 checkpoint in all. Also all the universities fail in both priority 2 and priority 3 errors. This implies that some group of people will find it difficult to access most Nigerian federal universities websites.

In all a total of 45, 187 and 97 errors each for priority 1, priority 2 and priority 3 respectively are recorded for all the websites. On further analysis, the violations found include images without alternative text, incorrect style sheet code, absolute units in CSS, no keyboard shortcut provided, obsolete attributes in HTML, document main language not indicated and no label for control among others. These are all violations against set of checkpoints in the fourteen guidelines provided by WAI in WCAG 1.0.

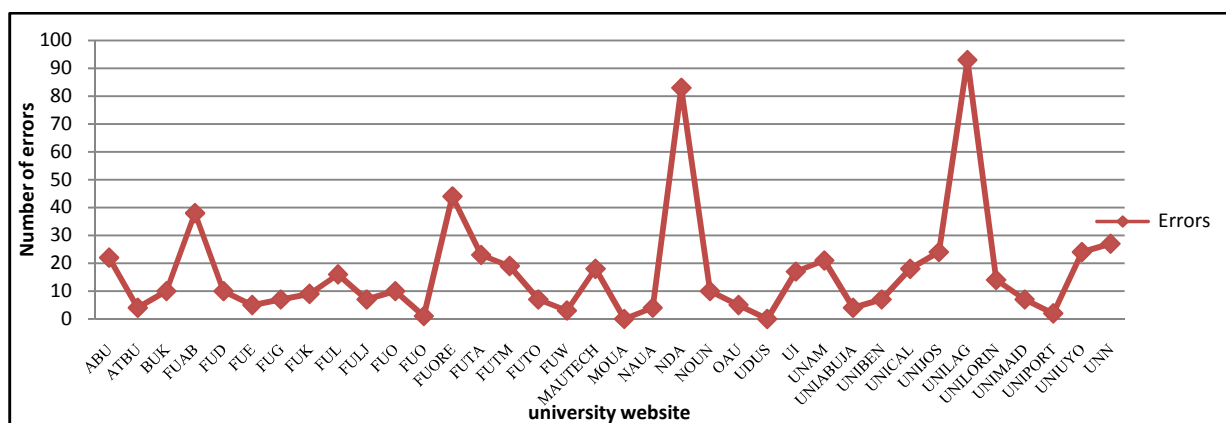


Fig. 2: WAVE result

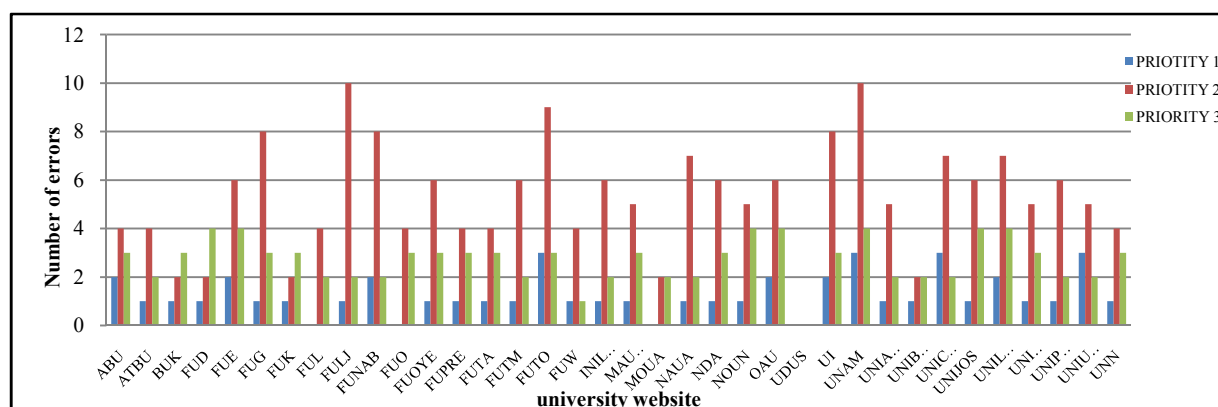


Fig. 3: HERA result

In general, Table I shows the overall number of errors recorded per tool for the whole websites. From the table it is clearly seen that errors discovered by Achecker are more. Perhaps it is due to the level of conformance being tested for and its recency. It is therefore clear that almost all the universities do not conform to the current standard of web accessibility guidelines. In summary there are still many accessibility issues that are still affecting the Nigerian universities websites. This implies that there is still a lot of accessibility violations by the websites tested. Some people with one form of disability or another will not be able to access the websites tested.

VI. PRACTICAL IMPLICATIONS AND RECOMMENDATION

Based on the findings of this research, we are of the opinion that to make Nigerian universities' websites more usable and accessible to diverse audience, the following should be done.

- Awareness about web accessibility and usability should be created in the country through the appropriate agents of the government.
- Web developers in various universities should adhere to international accessibility and usability principles in web design.
- Regulatory body like National University Commission (NUC) should mandate that all universities should comply with WCAG 1.0 and 2.0 in the design of their websites.
- Human Computer Interaction as a course should be included in the computer science curriculum of all institutions so as to promote the principle of user centred design.
- At every stage of web development, periodic usability and accessibility evaluations should be carried.

VII. CONCLUSIONS AND FUTURE WORK

This paper presented a study to investigate the usability of the federal universities' websites in Nigeria. It checks for conformance with both WCAG 1.0 and WCAG 2.0 using three automated tools. The result of this evaluation is an eye opener to the use of automated tools in evaluating websites especially in a developing country like Nigeria. While there are variations on the number of errors (problems) returned by different automated tools, notwithstanding the results point to one thing- lack of total conformity to universal usability and accessibility guidelines. All the websites tested showed there are errors inherent in them. It is therefore expected that the management of the various federal universities in the country will strive to ensure that websites of their various universities conform totally to international standard. This will not only better positioned the universities globally in future webometric ranking but will also ensure they keep to universal best practices.

TABLE I: NUMBER OF ERRORS PER TOOL

Tool	Number of Errors
Achecker	2506
WAVE	613
HERA	329

This will enable anybody with any form of disability to access the websites anytime, anywhere, anyhow and under any platform.

Further studies that will cover all other universities in the country are underway. Also, studies involving real users with the websites using any of the established methods could also be conducted. Other available automated tools could also be employed to get more detailed results. It is therefore strongly suggested that university management should give adequate training to their web masters and designers so as to avail them with the knowledge of the latest technology and tools in the domain. More so, universities being a frontline and custodian of knowledge are expected to adhere strictly to international standard in any practice they embark upon.

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APPENDIX A

Name of universities and their URL

S/N	University	Website
1	Abubakar Tafawa Balewa University, Bauchi (ATBU)	http://www.atbu.edu.ng/
2	Ahmadu Bello University, Zaria	http://www.abu.edu.ng/
3	Bayero University Kano (ABU)	http://buk.edu.ng/
4	Federal University of Tech Minna (FUTM)	http://www.futminna.edu.ng
5	Federal University Dutse (FUD)	http://fud.edu.ng/
6	Federal University Ebonyi (FUE)	http://www.funai.edu.ng/
7	Federal University Gombe (FUG)	http://www.fukashere.edu.ng/
8	Federal University Katsina (FUK)	http://fudutsinma.edu.ng/
9	Federal University Lafia (FUL)	http://www.fulafia.edu.ng/
10	Federal University Lokoja (FULJ)	http://www.fulokoja.edu.ng/
11	Federal University of Agriculture Abeokuta (FUAB)	http://www.unaab.edu.ng/
12	Federal University of Petroleum Resources Effurun (FUPRE)	http://www.fupre.edu.ng/s/
13	Federal University of Technology Akure (FUTA)	http://www.futa.edu.ng
14	Federal University of Technology Owerri (FUTO)	http://www.futo.edu.ng
15	Federal University Otuoke (FUO)	http://fuotuoake.edu.ng/
16	Federal University Oye (FUOYE)	http://fuoye.edu.ng/en/
17	Federal University Wukari (FUW)	http://fuwukari.edu.ng/
18	Michael Okpara University of Agriculture, Umudike (MOUA)	http://mouau.edu.ng/community
19	Modibbo Adamawa University of Technology Yola (MAUTECH)	http://mautech.edu.ng/
20	National Open University of Nigeria (NOUN)	http://www.nou.edu.ng/
21	Nigerian Defense Academy, Kaduna (NDA)	http://nda.edu.ng/
22	Nnamdi Azikwe University Awka (NAUA)	http://www.unizik.edu.ng/
23	Obafemi Awolowo University Ile-Ife (OAU)	http://www.oauife.edu.ng/
24	University of Ilorin (UNILORIN)	http://unilorin.edu.ng
25	University of Abuja (UNIABUJA)	http://www.unibuja.com/about.htm
26	University of Agriculture Makurdi (UAM)	http://uam.edu.ng/
27	University of Benin (UNIBEN)	http://uniben.edu/
28	University of Calabar (UNICAL)	http://www.unical.edu.ng/
29	University of Ibadan (UI)	http://ui.edu.ng/
30	University of Jos (UNIJOS)	http://www.unijos.edu.ng/
31	University of Lagos (UNILAG)	http://unilag.edu.ng/
32	University of Maiduguri (UNIMAID)	http://www.unimaid.edu.ng/
33	University of Nigeria (UNN)	http://unn.edu.ng/
34	University of Port Harcourt (UNIPORT)	http://www.uniport.edu.ng/
35	University of Uyo (UNIUYO)	http://uniuyo.edu.ng/
36	Usman Dan Fodio University Sokoto (UDUS)	http://udusok.edu.ng/