

A Practitioner's Approach to Assess the WCAG 2.0 Website Accessibility Challenges

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Abstract: *Now-a-days many of the users are accessing a website through their mobile devices. The user with a low vision disability finds difficult in accessing the content of the site using a mobile. This point made the researcher to think of website evaluation and identified that verification is needed to determine how best a website is accessible even for a person with different disabilities. The present article has reviewed 43 literatures and studied how their research is carried out, what suggestions they made, and what architecture frameworks or methods they suggested to evaluate the accessibility of a website content. The article also studied how the existing literatures considered W3C guidelines like WCAG 2.0 while developing the website. The main objective of the research is concluded with identifying of similarities with the past and the present research activities. Finally, a comparative study was made and later analyzed to determine their outcomes and some barriers if any.*

Keywords: *Architecture Frameworks, Website Accessibility, Website Content, W3C, WCAG 2.0.*

I. INTRODUCTION

Most of the websites are significantly transited from simple and static content to dynamic content because of the advancement in the web based technologies and dependency of people on them. The most sophisticated way of communicating with websites is to have a capability to interact with them. The development of web technologies is a phenomenon with a regular change and becoming more sensitive to all the requirements and expectations of the users in this modern world.

To harmonize a website, we need web development in such a way that it could be well structured and interface with the expectation levels of a user. It is better to have a user-centric process of design while developing a website so that it can meet the user requirements without any issues. The design must concentrate on visibility, language, satisfaction and legibility and also considering the user profiles. The purpose of the research can be fulfilled with a significant approach by defining the website audience and few common factors favored by both users and web developers.

From the web developer's perspective, managing the website development requires to understand the hosting web server, scripting languages used while doing client-side and server-side programming, web browser compatibility at the client-end, and web programming and design. From the user's perspective, the quality of a website relies on its satisfaction, usability and legibility. Finally, the content of a website is given higher priority for most of the reputed websites which uses their website as a primary source of communication.

A. Website Quality Factors

The primary need of a web developer is to develop a website which can solve the purpose of user while accessing the site content. There are several usability factors and complexity metrics are taken into account while evaluating the quality of website in terms of accessibility. It is mandatory for all the website developers to make sure that the site is easily accessible for all the levels of users in spite of their age, language, and education level. It is also necessary to evaluate a website in respect of accessibility even by the people with different disabilities. Several approaches have been evolved towards the website evaluation during the last decade. They have followed some informative-centric evaluation strategy to determine whether the website designed is per the needs of the users and followed the guidelines of the Web Consortium. During the evaluation process a list of web quality factors are identified through the review of literature on website quality. Several constraints that can be taken into account are accuracy, adaptability, analyzability, complexity in animation, website structure, content quality, user satisfaction in appearance, broken links, browser related issues, content clarity, colors used in designing, compatibility, download time and few other.

B. Need of the review

As the number of domains are increasing day-by-day and lots of information can be provided to the users in different kinds of services, it became mandatory to a website to provide all the services. The modern socio-infrastructure implies on the point that every service should be made available to all the users and they in turn can be accessed by a visually disabled also. This has made uncountable benefits to them at their area without any issues. In general, the users with visual disabilities use

screen readers to access the website content. In today's world an interest has been increased while developing the websites so that they can be easily accessible and usable. However, World Wide Web consortium has come with certain guidelines which can be followed and make sure that the website is not so complex to access for visually disabled users while reader the web content.

C. Objectives of the study

- Develop a standard web application as a common platform to perform website evaluation.
- To carry out the evaluation based on the website accessibility.
- To identify the influencing factors or measures under consideration.
- To determine whether there is need for optimization of a website.

II. REVIEW OF LITERATURE

A. Purpose of Research

The present article aims at reviewing and summarizing the existing state of art in website accessibility evaluation criteria based on W3C recommended guidelines named as WCAG 2.0. The review process is carried by proposing the solutions for the following questions:

- What is Website Accessibility and why it is so important?
- What are the guidelines recommended by W3C to evaluate website accessibility?
- What are the various approaches to assess the accessibility quality of a website?
- What are the various automation tools available for accessibility evaluation?
- Do really the automation tools behave similar to each other?

B. Search Criteria

Based on the questions framed for evaluation, a set of keywords and synonyms were defined as search queries. As the website evaluation is a burning concept in the website development life cycle, no year range for articles review was included in the search.

TABLE I: SEARCH KEYWORDS

Keywords	Synonyms
Website Accessibility	Accessibility of Websites
Accessibility Evaluation	Assessment of Accessibility
Automation Tools	Online Evaluation Tools

C. Sources of Information Review

The principles reviewed in this study were accommodated with respective of individual frameworks contributed by the authors of articles considered for review.

C. McInerney [1] in his research identified the significance of developing a user-friendly website with a good design and easy access in terms of navigation. The article has identified certain gaps between the design quality and the technology support. Website quality has treated as a comprehensive tool to assess its believability in terms of accessibility. B.M. Subraya and S.V. Subrahmanyam [2] in their research has identified and proposed some evaluation methods to assess the quality of a website. The article stated that the process of quality evaluation is to make ensure that the quality the measured in terms of usability, accessibility and design guidelines. Luis Olsina, Guillermo Laffuente and Oscar Pastor [3] during their research developed a repository with a list of metrics to evaluate the assessment of website quality. The recommended primary list of metrics was considered for reused mechanism which can in general from a more specific website type, criteria of evaluation based on formulae, application development procedures and other relevant predefined factors. M.Azuma [4] in the study remembered that the World Wide Web (WWW) and Internet Based Systems for Information are widely used by the people. Keeping this in view, the study has identified the significance of communication services to adopt the environmental changes and changes in the need of information.

G. Costagliola and F. Ferrucci [5] in the study identified that the usability of a website and its accessibility are the key factors which can characterize the quality of any web application. The study strongly believed that any website must be designed by following the guidelines recommended by WC3. Enruqui Herrera-Viedma et.al [6] in their research proposed and developed a fuzzy computation model to evaluate and assess the information with two major components. The first component is to analyze and evaluate the website in terms of both technical and linguistic recommendations. The second component is evaluation through user experience and generate linguistic suggestions based on the judgement of the user with linguistic evaluation. Ourania I. Markaki et.al [7] in the study identified that more authorities try to dump a huge amount of materials on the web and even keeps high expectations on online services for their inconvenience. The study also analyzed and stated that the present evaluation approaches are not as per the expectations. P. Windriyani et.al [8] in the article stated that it became mandatory to have information in online for business perspective. Webometrics is one of the area which can used to improve the quality of the website by increasing the website ranking. The study selected some educational institutions and analyzed how to improve their website quality by considering

the non-technical area of WCAG 2.0 guidelines for technology based criteria.

Kathrin Wille et.al [9] in the study have identified how website accessibility plays a vital role while accessing the content by the users with disabilities in the same way as for other users. It has been determined that every web content must fulfill the criteria stipulated by the web content accessibility as guidelines WCAG 2.0 for all kinds of people. It can be improved by identifying the non-trivial appropriate measurements. Later the study suggested an approach to calculate and measure the WCAG 2.0 implementation and evaluated whether the web content can meet the success criteria. Wan Abdul Rahim Wan Mohd Isa et.al [10] in the study investigated the accessibility of Malaysian websites to a certain period of time in 2014 by using AChecker automated tool and Website Content Accessibility Guidelines (WCAG 2.0). The study has identified six major accessibility issues in terms of non-text content, information and association, purpose of links, language of a page, and labels. Patricia Acosta-Vargas et.al [11] in the study evaluated 20 government websites with more competent level. The study has considered WCAG-EM (Website Accessibility Conformance Evaluation Methodology) to access a website. Patricia Acosta-Vargas [12] in the study pointed out the importance of web in people's daily life and how it has revolutionized as a primary source of accessing information especially in the area of educational institutions worldwide. The study has identified that many of the Latin America educational websites does not meet the website accessibility criteria of Website Content Accessibility Guidelines (WCAG 2.0).

M. Azuma [13] the study has identified the importance of integrating the software systems and its supporting systems with the parts of human and the machine. Later a three-layered architecture for information access is developed by integrating the decision supporting systems with the development and operating systems. The architecture has taken into account certain human and software metrics that can impact the assessment of website accessibility evaluation. G. Costagliola and F. Ferrucci [14] in the study identified that the usability of a website and its accessibility are the key factors which can characterize the quality of any web application. The study strongly believed that any website must be designed by following the guidelines recommended by WC3. The study also suggested some factors that can be considered while ensuring the quality of accessibility. Enruqui Herrera-Viedma et.al [15] in their research proposed and developed a fuzzy computation model to evaluate and assess the information with two major components. The first component is to analyze and evaluate the website in terms of both technical and linguistic recommendations. The second component is evaluation through user experience and generate linguistic suggestions based on the judgement of the user with linguistic evaluation. Ourania I. Markaki et.al [16] in the study analyzed and stated that the present evaluation approaches are not as per

the expectations. The study has proposed a modular approach through which the impediment can be overcome through a triangular fuzzy numbers. Paramaresthi Windriyani et.al [17] in their work tried to increase the webometrics and to improve the university websites in terms of both technical and non-technical factors. Webometrics and WCAG 2.0 are the two guidelines considered for evaluation of websites and found variations in their observations in technical and non-technical aspects. Sami Abduljalil et.al [18] research is carried out an analytical process to evaluate a website accessibility in terms of user-centric design, online survey, distributed survey so that they can identify the human factors while accessing. Markel Vigo et.al [19] the research was carried out on the websites of Government of Australia accessibility strategies with the WCAG 2.0 suggested by W3C. The evaluation process was carried out with the existing online tools and identified only 23-50% of the websites are covered under no violation report. Pedro Lorca et.al [20] carried a hypothetical based evaluation of 399 universities from 16 countries with respect to website content quality with regard of their web accessibility (WA) level. The research has observed that Anglo-Saxon countries pay more attention to web accessibility but not with the websites of Latin countries.

Balaji V et.al [21] in the research accessibility study was carried out with Google Accessibility Scanner which is a mobile. The research has analyzed various categories of mobile applications with several success criteria available in WCAG 2.0. The study has highlighted several frequently occurring accessibility errors and later suggested to improve the accessibility acceptance levels. Abid Ismail et.al [22] has considered 40 websites of North East Region of India and identified some common checkpoint errors in the process of web content accessibility evaluation. The verification of WCAG was done to check the accessibility using existing online tools. Islam Elkabani et.al [23] the study reviewed an open-source web accessibility evaluation tool to verify the webpage compliance with WCAG 2.0. The research adopted both qualitative and quantitative approach for usability evaluation and finally compared the results obtained by the tools considered. Mrinal Kanti Baowaly et.al [24] has analyzed and evaluated the web accessibility of e-government websites of Bangladesh according to WCAG 2.0. The entire process is carried out with the existing online tools and recommended suggestions to get improved to provide higher level of accessibility for their websites.

In this section, the study has considered 19 articles from the year 2013 to 2017 for review and a comparative study. It was observed that the evaluation was carried by using various automation tools [44]- [59] and identified the errors after the evaluation process. The results of the comparative analysis are represented in table II including tools used, websites selected, levels of evaluation. Several existing and popular evaluation tools were used in the authors. List of such tools and the percentage of their usage is represented in table III.

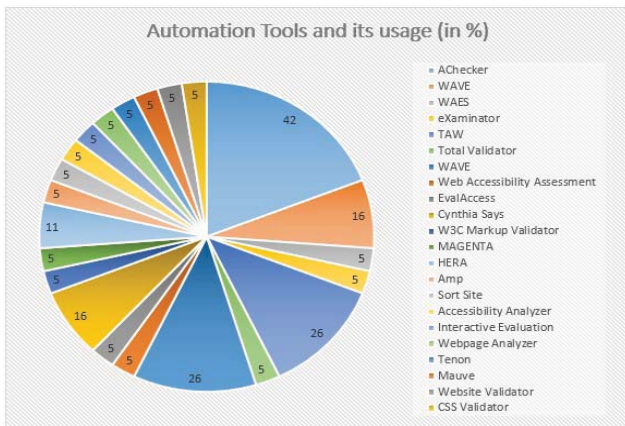


Fig. 1. Automation Tools with authors reference

Literature review has revealed that most of the research studies are been carried out from past two decades on web accessibility around the world. Some researcher used automated website analysis tools to evaluate the home pages of the website against the guidelines WCAG 2.0 stipulated by the web consortium. Some studies were carried out to identify the issues which may affect the effectiveness of the website accessibility. And it was found that most of the website designers never considered the users with visual disabilities and how best it can be easy for them to access.

In some of the studies, the evaluation process is directly performed based on the guidelines suggested by the web consortium by comparing the website design to match with the recommendations pointed out in WCAG 2.0. Each of the website URL has been tested with a WAVE toolbar and determined whether any of the website is violating the guidelines mentioned in WCAG 2.0.

D. Research gap identified

- It was identified that the evaluation process is fixed to specific country or an organizational website.
- It was identified the evaluation process is carried out with the existing online tools.
- It was identified that there is no common platform a consider and evaluate a website.
- There is no evaluation tool which can evaluate multiple websites for accessibility.

III. RESEARCH METHODOLOGY

Problem: Identified the articles related to the evaluation process of website accessibility in terms of usability and also to determine whether they meet the WCAG 2.1 requirements.

Solution: Certain review of literature is required to identify how the guidelines recommended by W3C can impact the accessibility of website content and improve the design quality such that even a human with disabilities can easily be accessed.

- Identify the relevant articles to the area on websites for quality assessment.
- Study each and every article and identify the process of evaluating the websites carried out earlier.
- Identify whether the authors of the articles concentrated on the website accessibility assessment.
- Identify whether the authors of the article have considered WCAG 2.0 guidelines suggested by W3C.
- Identify whether the research article has made any recommendations while evaluating the website content accessibility assessment.
- Identify whether the research article has proposed any framework or a method to check the accessibility of the website content based on recommended W3C guidelines.
- Compare the suggestions and recommendations of the reviewed literature and identify whether they are related to the present research or not.
- If the proposal of the articles reviewed does not match your research expectations, then continue to review other articles so that the similar articles of research can be identified.
- Try to show the difference how the present research proposals are different with the existing one.
- Interpret and identify how the proposed solution is different with the previous one and how it can reflect on the effectiveness in assessing the website content accessibility.

IV. RESULTS AND DISCUSSIONS

A total of 17 research articles related to the website accessibility were considered for study. Later a comparative analysis is made based on their methodologies and evaluation procedures.



Fig. 2. Study of review of literature process.

TABLE II: WEBSITE ACCESSIBILITY TESTING

Author Name and Year of Publication	Tools Used	Sample	Levels of Evaluation	Findings
Nuha Awlad Karaim et al. [25] - 2017	AChecker, TAW	32 Libyan Government websites	A, AA, AAA	287 errors by AChecker and 336 errors by TAW
Rita Ismailova et al.[26] - 2017	AChecker	60 Finland University websites	A, AA, AAA	465 errors by AChecker
Ku Azhar Ku Saud [27] - 2017	AChecker and WAVE	20 Malaysian Public University Libraries websites	A, AA, AAA	4266 errors by AChecker and 3892 errors by WAVE
Liang-Cheng Li [28] - 2016	Web Accessibility Evaluation System	32 China Government websites	L-1,2,3,4,5	61.87 Perceivable, 27.61 Operable and 12.27 Robust
Kyung-Ram Noh et al.[29] - 2015	Not mentioned	25 Korean Institutional websites	P-1,2,3,4	68% of Perceivable, 64.5% of Operable, 59.2% Robust and 28% Understandable
Yakup Akgul et al.[30] - 2016	AChecker, eXaminator, TAW, Total Validator, WAVE, Web Accessibility Assessment Tool, EvalAccess, Cynthia Says, MAGENTA, HERA, Amp and Sort Site	25 Turkey e-government websites	A, AA, AAA	809 errors by AChecker, 111 errors by eXaminator, 540 errors by TAW 1.0, 1639 errors by TAW 2.0, 1434 errors by Total Validator, 597 errors by WAVE, 562 errors by EvalAccess, 213 errors by Cynthia Says, 1545 errors by MAGENTA, 48 errors by HERA and 325 errors by Sort Site.
Swikruti Dongaonkar et al.[31] - 2017	AChecker, WAVE, Accessibility Analyzer, Interactive Evaluation Tool	Indian Government websites	A, AA, AAA	No errors were pointed.
Abid Ismail et al.[32] - 2016	AChecker, Webpage Analyzer and WAVE	302 Indian University websites	A, AA, AAA	375989 errors by all the tools.
Leandro Coelho Serra et al.[33] - 2015	Not mentioned	4 Brazil e-government websites	A, AA, AAA	Not mentioned
Helio Braga et al[34] - 2014	Individual Metrics	12 Brazil Internet Banking websites	LL-1,2,3	115 errors
Ramiro Goncalves et al.[35] - 2014	Not mentioned	790 Portuguese Enterprises websites	A, AA, AAA	An average of 916 errors
Kerstin Matausch et al.[36] - 2014	Not mentioned	German websites	PL, E2R	Not mentioned
I Gusti Bagus Ngurah Ekka Darmaputra et al.[37] - 2014	Total Validator, AChecker	34 Indonesian e-government websites	A, AA, AAA	20929 errors by Total Validator and 46744 by AChecker
Abid Ismail et al.[38] - 2017	AChecker, Cynthia Says, Tenon, WAVE, Mauve, HERA	33 Indian Government websites	A, AA, AAA	26430 errors by AChecker, 709 errors by Cynthia Says, 1573 errors by HERA, 3532 errors by Tenon, 2911 errors by WAVE and 12398 errors by Mauve.
Trinidad Dominguez Vila et al.[39] - 2017	TAW	210 Countries Tourism websites	AA, AAA	15023 errors by TAW
Sven Schmutz et al.[40] - 2016	Manual Process	13 Liechtenstein Municipalities websites	A, AA, NA	Among 3 chosen 6.6% was detected for perceived usability and 1.6% for trustworthiness
Winfred Yaokumah et al.[41] - 2015	TAW and Website Validator	19 Ghana e-Service websites	AA	288 perceivable errors and 174 robust errors by TAW.
Rita Ismailova et al.[42] - 2017	SPSS Package, HTML Toolbox and Webpage Analyzer	50 Kyrgyz Republic University websites	P-1,2,3	939 errors for Priority 1, 574 errors for Priority 2 and 103 errors for Priority 3
Veronica Segarra Faggioni et al.[43] - 2017	TAW and Cynthia Says, W3C Markup Validator and CSS Validation Service	3 Institutional websites	A, AA	4 errors by TAW and 17 errors by Cynthia Says.

A-known problems, AA-likely problems, AAA-potential problems, NA-very low conformance, L1-basic, L2-reinforced, L3-high, L4-superior, L5-additional, P1-3 guidelines and 5 requirements, P2-4 guidelines and 8 requirements, P3-4 guidelines and 5 requirements, P4-2 guidelines and 2 requirements, PL-plain language, E2R – easy to read

In [25] the performance evaluation was conducted through AChecker and TAW automation tools and observed that TAW tool has produced more accessibility errors than AChecker. It is also observed that only 10% of the Libyan government websites meet the evaluation acceptance criteria. In [26], evaluation was performed through AChecker tool and observed that only 5% of the Finland university websites meets the WCAG 2.0 guidelines. The study [27] has performed evaluation through AChecker and WAVE tools and observed that only 15% of the Malaysian websites meets the acceptance criteria.

Several existing and popular evaluation tools were used in the authors. List of such tools and the percentage of their usage is represented in Table III.

TABLE III: AUTOMATED TOOLS AND LEVELS OF USAGE

Tool Name	Used (in %)	Tool Name	Used (in %)
AChecker	42	MAGENTA	5
WAVE 1.0	16	HERA	11
WAES	5	Amp	5
eXaminator	5	Sort Site	5
TAW	26	Accessibility Analyzer	5
Total Validator	5	Interactive Evaluation	5
WAVE 2.0	26	Webpage Analyzer	5
Web Accessibility Assessment	5	Tenon	5
EvalAccess	5	Mauve	5
Cynthia Says	16	Website Validator	5
W3C Markup Validator	5	CSS Validator	5

The study [29] performed evaluation based on the revised KWAG 2.0 guidelines with total 13 guidelines and 20 requirements. It was observed that only 16% of the Korean websites are meeting the accessibility criteria. In [30], the evaluation was done based on 12 automation tools and observed that different tools produced different error results. Web Accessibility tool produced a highest number of errors with 2048 count and HERA tool generated the lowest number of errors with 48 count. It was observed that only 16% of the Turkey e-government websites are the meeting the accessibility eligibility criteria. In [32] the evaluation was conducted based on AChecker, Webpage Analyzer and WAVE tools and identified a huge error count of 375989 altogether. It

was observed that only 27% of the websites are meeting the accessibility free criteria issues.

In [34], accessibility evaluation was performed based on the website metrics and observed that only 6% of the Brazilian internet banking websites are moderately meeting the accessibility criteria. In [35] the evaluation process was carried based on the online evaluation tools and identified that more than 50% of the Portuguese enterprise websites are detected with WCAG 2.0 errors. In [36] the evaluation process was carried and identified that more than 60% of the German websites does not meet the accessibility criteria. In [37] the evaluation process was carried by using Total Validator and AChecker accessibility analysis tools and observed that only 1% of the Indonesian websites has passed WCAG 2.0 evaluation criteria. In [38] 6 evaluation tools were used and observed that only 20% of the Indian state Jammu & Kashmir websites are satisfying the accessibility criteria WCAG 2.0. The [39] conducted evaluation process based on TAW analytical tool and identified 15023 number of errors at level 3 of accessibility. It was observed that only 3% of the world’s tourism websites are as per the WCAG 2.0 guidelines. The [40] has conducted a manual process of evaluation with 61 human participants. Each participant has given 5 tasks and observed their activities and level of accessibility. The author has observed that only 10% of Liechtenstein municipality websites are meeting the accessibility criteria. In [41] an evaluation process was done based on TAW 3.0 and Website Validator analytical tool and identified that not even a single website of Ghana e-services meet the level of acceptance in accessibility criteria. In [42] HTML toolbox and Webpage Analyzer was used to evaluate Kyrgyz Republic websites and observed that nearly 91% of their websites did not meet the evaluation criteria. Finally, the study [43] considered TAW and Cynthia Says automation tools were used for evaluation and identified that only 66.67% of the websites are only meeting the accessibility evaluation criteria. A complete and detailed results were summarized and clearly depicted in figure 3. The Table IV shows the names of the country websites considered for review and analysis and also their level of accessibility free acceptance.

TABLE IV : WCAG 2.0 ACCEPTANCE LEVELS

Name of the Country	Level of acceptance (in %)	Name of the Country	Level of acceptance (in %)
Libyan	10	Portuguese	25
Finland	5	Germany	20
Malaysia	15	Indonesia	1
China	9	Liechtenstein	10
Korea	16	Ghana	0
Turkey	16	Kyrgyz Republic	9
India	21	Others	69
Brazil	28		

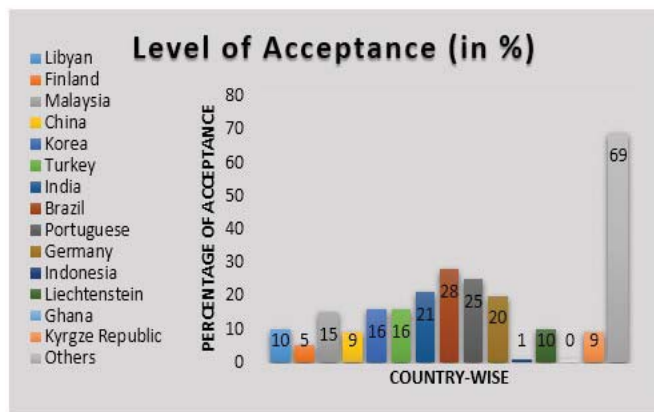


Fig. 3. Country-wise websites acceptance levels

V. CONCLUSION

The back bone of every research is to have an in-depth study of the research that has been already done in the area of evaluating the website content accessibility. The review of research literature can give better knowledge on how the present research were carried out to assess the website in terms of accessibility and how best they are suited to improve the effectiveness. It is also useful to determine whether they can be implemented so that a website can be evaluated by determining whether they followed the guidelines of the W3C and the people with different disabilities can access the website without the issues.

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