

Website Assessment and Feature Metrics of University's Website Accessibility: An Evaluation of 15 Top-Ranked Universities of India

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Abstract

Most Universities now use websites as their main source of information where students can interact and exchange their pertinent information. Web accessibility refers to the creation and design of websites, platforms, and tools for all people (abled/disabled). This study analyzes the usability of 15 of India's best universities as determined by Webometrics/QS Ranking 2023. Three key assessment tools—TAW, WAVE, and EIII—are customized for the website analysis. These tools show us the findings of a website's compliance with the WCAG 2.1 (Web Content Accessibility Guidelines). The assessment also identified a few recurring mistakes that could be fixed by simply including accessibility features. The total analysis's findings also emphasized the need for these sites' usability to be improved. The paper offers a list of errors that, if fixed, will benefit user groups with various disabilities, as well as useful recommendations for enhancing these websites' accessibility so that their intended audiences can access the information they provide without any hindrance.

Keywords: Web accessibility; University websites; Web contents evaluation; WCAG; TAW; WAVE; EII

1. Introduction

The internet has become the primary source of information, taking over from other forms of media. It provides a vast array of information on a broad range of topics such as business, education, instruction, government services, and products and services in various fields [1], [2]. In the late 1990s, a sophisticated robot called a Web crawler [3] was developed to systematically and independently gather data from the internet. This technology now serves as the foundation for major search engines such as Google, Bing, and Baidu. The World Wide Web (WWW), which is built on top of the internet, has evolved into a central hub of information and serves as a gateway to personal and business websites [4], [5]. The advancement of internet technology and the WWW has also had a significant impact on education, with websites becoming a powerful tool for communication. When seeking information about a university, for instance, people now frequently turn to the institution's website as their primary source of information. This information covers a variety of topics, such as news, promotions, and information on academic services, costs, timetables, and scholarships. The homepages of websites, or the first page that loads by default, receive the most views of all the pages. As a result, it is necessary to create and design suitable homepages that represent their goals and user requirements, regardless of the experience, background, and disabilities of users. It was intended for everyone to have access to the World Wide Web, which has grown to be the world's biggest information store.

The W3C's (World Wide Web Consortium) director, Tim Berners Lee, asserts that "the power of the web is in its universality" [6]. According to disabled people in India 2021, 2.21 percent of the nation's population, or about 26.8 million people, out of the 1.41 billion people in the country live with a specific type of impairment [7]. Consequently, the primary goal of universality is to unite everyone, regardless of ability. To accomplish universal website accessibility, the W3C has created standards known as the (WCAG) Web Content Accessibility Guidelines. 16% of the world's population, or 1.3 billion people, are considered to have a significant disability [8]. By adhering to the WCAG guidelines, one can produce web content that is accessible and usable. The W3C proposed different types of guidelines and standards (WCAG 1.0, WCAG 2.0, and WCAG 2.1). The WCAG 2.1 is an improved version of the WCAG 2.0, adding one guideline and 17 new SC (success criteria) to guarantee that websites that comply with WCAG 2.1 also comply with WCAG 2.0 [9]. Users can easily connect, interact, and explore the web thanks to web accessibility. Making websites accessible is thought to increase the advantages for companies, people, and society [10]. Additionally, in order to make

websites user-friendly, certain design principles and rules must be followed in addition to the requirement that they be accessible. Usability is therefore described as the degree to which the user and the computer can plainly interact while using the provided interface [11]. In this assessment, we sought to gauge the Web Content Accessibility of 15 of India's best universities as determined by the QS Ranking 2023.

2. Literature Review

As a large amount of new material is added to the Internet every day [12], the authors of this paper propose a strategy based on concurrent web crawling using mobile agents. Additional investigation is required in this domain, as the limited number of studies that have utilized automated techniques to evaluate the accessibility of university websites have identified significant issues with website accessibility. For example, Hashemian [13] studied the accessibility of university websites in the Finland higher education sector, including university admissions, using an automated rating system. The study found that despite at least a third of university websites achieving WCAG level A, none achieved WCAG level AA. (Priority 1). (Priority 2). Ninety (90) Japanese school and college websites were tested for accessibility according to the Japanese industry standard for online accessibility [14]. The findings revealed that university websites had higher accessibility issues than other types of educational institution websites. Aziz et al. [15] used WCAG 1.0 to assess the accessibility of 120 college/university websites in Malaysia. The researcher discovered that all websites needed further work to make sure that people with impairments could use them easily. Similarly, Ahmi and Mohamad [16] used AChecker and WAVE to evaluate 20 Malaysian public university webpages to WCAG 2.0 standards. Despite improvements in accessibility, according to the authors, institution websites still need more accessibility features, such as keyboard usability, easy browsing, and alternative text for non-text components, regardless of the potential disabilities of the users.

Another research [17] found that when utilizing the WebXACT tool to test accessibility, the majority of university websites in the United States did not adhere to the WCAG requirements of the US Rehabilitation Act. The study's underlying premise was that colleges with large student populations would be better able to meet website accessibility standards. However, the findings revealed that there was no correlation between the number of students and website accessibility. Solovieva and Bock [18] investigated the conformance of subpages of a prominent public university's website in the United States to WCAG 2.0 using the automated assessment tools Cynthia and WAVE. Only 35% of the 509 web pages analyzed passed the WCAG 1.0 accessibility test, whereas half (51%) passed the WCAG 2.0 compliance level A. Using the EvalAccess 2.0 automated assessment method, Ismailova and Kimsanova [19] assessed the usefulness and accessibility of forty two university websites based on Kyrgyzstan. These websites were found to be non-WCAG 1.0 compliant. Maisak and Brown's [20] assessment of Thai higher education websites using the WAVE & SortSite tools to determine their adherence to WCAG 2.0 guidelines revealed a significant number of accessibility problems, particularly in the perceivability and operability categories. The authors contend that more stringent internet accessibility standards should be implemented. In another investigation, 302 university webpages in India were evaluated for conformity with WCAG 2.0 using the AChecker and WAVE automatic evaluation tools [21]. The study identified a range of issues, such as a lack of alternative text for non-text web elements, the absence of page numbering, and the inability to adjust color contrast or navigate the webpages with a keypad.

Kurt [22] employed Web Accessibility Analyzer, AChecker, and SortSite to evaluate the homepages of various institutional websites in Turkey. To determine if the accessibility of these academic websites had improved over the previous five years, the author replicated his 2011 research in 2016 [23]. The author stated that although the findings showed a small improvement in accessibility across the board for university websites, those websites still lacked completely accessible user interfaces. The absence of alternative text to describe the meaning of non-text components like icons and images was found to be one of the most glaring accessibility flaws. With the aid of the automatic evaluation tools eXaminator and HERA, Espadinha et al. [24] evaluated the accessibility of 64 public colleges in Portugal. Over a three-year span, from 2007 to 2009, the authors examined changes in websites' usability. The findings showed that almost all university websites lacked open features while only a small percentage (12.5%) of them had features that made them user-friendly for students with disabilities. The authors did observe a rise in website accessibility during the goal time, though. In the USA, Zaphiris and Ellis [25] tested the usefulness and accessibility of the websites of the top 50 colleges, as ranked by US News in the same year, using the automated assessment tools Bobby and LIFT. The evaluation's findings indicated that 30% of the websites had inadequate WCAG guidelines conformance. Additionally, usability issues with the bulk of the websites were noted. In a separate study, Kane et al. [26] examined the accessibility of the homepages of the hundred highest-ranked institutions worldwide, as determined by the Times Higher Education World University Rankings. The study postulated that even the best universities from different countries still encounter accessibility challenges. To carry out the research, the team utilized Bobby, Functional Accessibility Assessor and Online InSight assessment tools. The findings demonstrated that even though some university websites complied with certain accessibility standards, many of them still had issues with WCAG 1.0 checkpoints.

2.1. Objective of the Study

The aim of this article is to identify appropriate measures that can be taken to enhance website accessibility. The study has the following general objectives:

- To examine the website usability of the 15 best universities in India as determined by Webometrics/QS Ranking 2023.
- To assess a website's usability using WCAG 2.1 tools that are industry standard.
- To look at website issues that are common and that will help a certain user group.
- To offer practical advice for the problems with webpages and other potential remedies.

3. Methodology

The assessment process was divided into three steps: 1) a description of the websites that will be evaluated, the evaluation instrument, and the accessibility standards that will be used to evaluate the websites; 2) WCAG 2.0 evaluation of the selected websites; 3) analysis and discussion of the findings.

The best universities from the QS list [27] were chosen to examine and evaluate the accessibility of university homepages in India. Universities are assessed in these ranking systems based on a variety of factors, including academic recognition, job reputation, and other indicators. Other rating methods, such as International Colleges and Universities [28] and Webometrics [29], only consider institution webpages. The Webometric/QS 2023 ranking was used to pick university webpages for this research. The research included the top 15 universities in India as decided by Webometrics/QS Ranking 2023. (Table 1).

Table 1. Top 15 Universities In India As Decided By Webometrics/Qs Ranking 2023

Ranking	University	Website
1	Indian Institute of Technology Bombay	https://www.iitb.ac.in/
2	Indian Institute of Technology IIT Kharagpur	http://www.iitkgp.ac.in/
3	Indian Institute of Technology IIT Madras	https://www.iitm.ac.in/
4	Indian Institute of Technology Delhi	https://home.iitd.ac.in/
5	Indian Institute of Science Bangalore	https://iisc.ac.in/
6	University of Delhi	https://www.du.ac.in/
7	Indian Institute of Technology IIT Kanpur	https://www.iitk.ac.in/
8	VIT University Vellore	https://vit.ac.in/
9	Tata Institute of Fundamental Research	https://www.tifr.res.in/
10	All India Institute of Medical Sciences AIIMS	https://www.aiims.edu/index.php?lang=en
11	Amity University	https://www.amity.edu/
12	Manipal Academy of Higher Education	https://manipal.edu/mu.html
13	Indian Institute of Technology IIT Hyderabad	https://iith.ac.in/
14	Anna University	https://www.annauniv.edu/
15	Indian Institute of Technology IIT Guwahati	https://www.iitg.ac.in/

The five stages of the approach used to assess the usability of educational websites are depicted in Fig. 1.

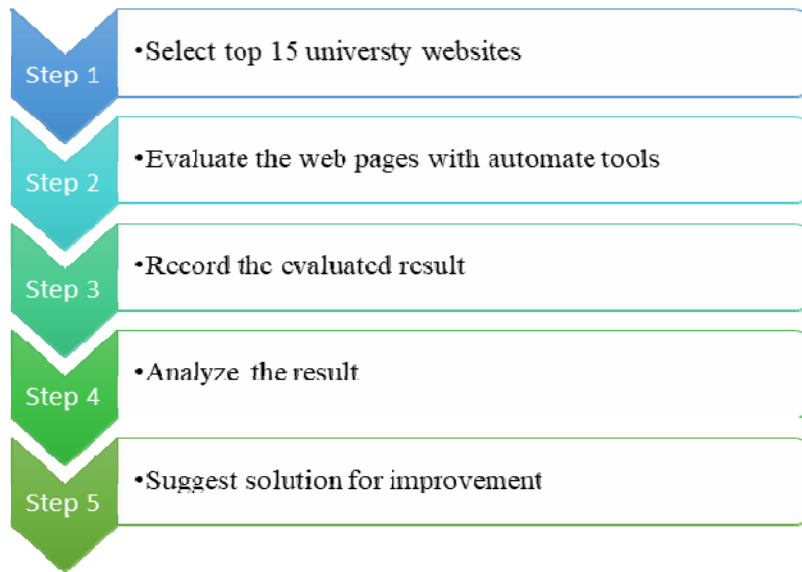


Fig. 1. Steps of accessibility evaluation of universities’ websites

Step 1: We chose the best 15 Indian university websites in this stage, which are listed in table 1. The website [30] was used to obtain the collection of Websites. The research particularly assessed how accessible each institution website's home page was. The main page is regarded as the most significant component of a site in terms of usability. Users are very likely to experience access issues with the website's other sites if there are accessibility issues preventing the main page from being inclusive.

Step 2: We used three accessibility assessment tools during this accessibility evaluation. All of the tools listed above are accessible online. The tools mentioned are built on WCAG 2.1 standards. The WAVE Tool [31] assesses website pages for Contrast Mistakes, Errors, Alerts, Features, Structure Components, and Accessible Rich Internet Apps (ARIA), (ii) TAW Tool [32] is built in accordance with the WCAG 1.0, 2.0, and 2.1 guidelines. (iii) The EIII Analyzer [33] follows the WCAG 2.0 standards.

Step 3: Enter the assessed findings from the WAVE, TAW, and EIII tools into a spreadsheet.

Step 4: Using SPSS software, statistically evaluate the data.

Step 5: Make recommendations about the mistakes and provide fundamental answers to common WCAG-2.1 errors, especially for designers and web developers.

4. Result and Analysis

Wave, TAW and EIII tool are used to generate and analyze the results.

WAVE [31] is an online tool designed to evaluate website accessibility by detecting WCAG errors and conducting a human assessment of the content. It assesses a website against WCAG 2.1 standards and employs symbols to indicate crucial accessibility evaluation information on the page. Red symbols highlight accessibility issues that require attention, green symbols indicate areas where accessibility features can be improved, and other symbols/alerts indicate areas that require further examination. The tool classifies its findings into six categories. It also provides information for each symbol and for items that the system cannot verify, allowing users to manually check these items. For example, WAVE may not be able to determine if the alternative text is accurate and appropriate and will therefore flag it for the user to review.

Table 2 shows the examined result of 15 top-ranked Universities of India according to Webometrics/QS Ranking 2023 using the Wave tool. Total Violations, Minimum, Mean and standard deviation are shown.

Table 2. Report of Wave Tool for Websites

WAVE (N=15)	Total Violations	Minimum	Mean	Std. Deviation
Errors	821	0	54.73	53.20
Alerts	4004	22	266.93	576.56
Contrast Errors	616	0	41.07	54.30
Features	691	11	46.07	36.58
Structural Elements	2854	33	190.27	227.42
ARIA	950	0	63.33	87.73

Fig. 2 depicts an accessibility study of 15 top-ranked Indian universities according to Webometrics/QS Ranking 2023. Alerts and structural elements require complete attention to reduce violations and achieve more approachable websites. The results indicate that warnings and structural components have more WCAG violations than others. The mistakes, contrast errors, features, and ARIA produce improved results but should be reduced.

Alerts can create accessibility problems, and 40.30% of the websites reviewed here had them. With 2315 notifications, the University of Delhi had the most. Many of these were caused by redundant links, duplicate title text, picture title property values that were identical or close to the element text, and so on. This should be prevented; instead, when users hover over a feature, the text should explain what it is and counsel the user on how to use it.

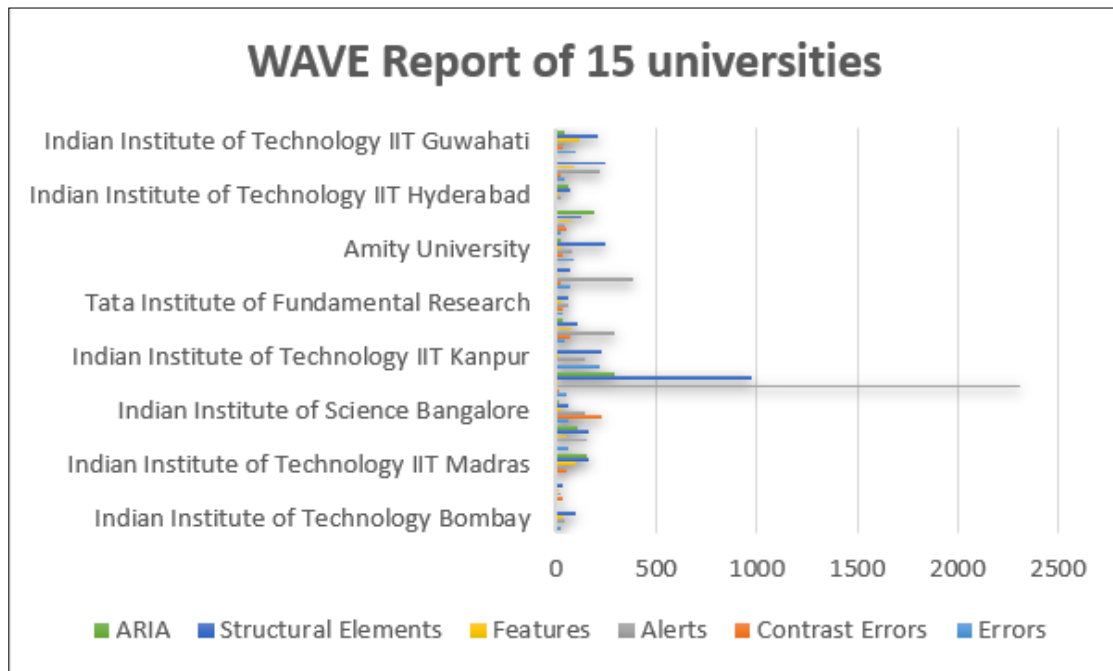


Fig. 2. Report of WAVE tool for top 15 universities website

Structural Elements can create accessibility problems, and 28.72% of the webpages reviewed here had them. With 970 warnings, the University of Delhi had the most. Many of these were caused by lists of areas and titles in sequence, which indicates any nesting of elements as well as any concealed elements.

ARIA elements are attributes introduced to HTML components to make apps and online content more accessible to assistive technology users. One notable result was that 86.66% of the institution homepages featured ARIA elements, with four of them containing more than 100 instances. The University of Delhi's site had the most ARIA components, with 296.

Errors create accessibility problems, and 8.26% of the websites reviewed here had them. With 217 mistake breaches, Indian Institute of Technology IIT Kanpur had the most. Many of these were caused by missing alternative text, lacking alternative text in connected images, empty links, and broken ARIA references.

Accessibility problems are caused by features, and 6.9% of the webpages reviewed here had them. With 119 errors, Indian Institute of Technology IIT Guwahati had the most. Many of these were caused by alt text, linked images with alt text, and language.

Contrast mistakes affect the text and backdrop colors. This sort of error was found on 6.20% of the university homepages examined. The average was 41.07 errors, with a standard deviation of 54.30, showing significant variation between institutions. A very low degree of contrast between the text and the background color was the most frequent form of contrast error. The contrast ratio should be greater than 4.5:1, which was not the situation in these instances. It is critical to correct this mistake, particularly for users with eye issues or color blindness. The greater the contrast ratio, the simpler it is for a user to comprehend the text.

TAW is an online application that autonomously evaluates websites' WCAG 2.0 compliance with regard to their level of web accessibility. TAW offers two different types of checks: automated, where the tool identifies a problem with accessibility that needs to be fixed, and manual, where the tool identifies the existence of a problem with online accessibility that the reviewer must confirm or reject [32]. When a website is investigated, the results are shown as issues, cautions, or items that haven't been thoroughly evaluated. Warnings require human involvement, whereas items marked as "not reviewed" require a thorough manual review because the tool is unable to identify the issue. The WCAG 2.0 standards checklist is used to compare the issues, warnings,

and "not reviewed" items in each of the four groups. (perceivable, operable, understandable, and robust). This makes it possible for the evaluators to obtain information about each checkpoint and to develop a plan for enhancing the website's accessibility.

Table 3 shows the evaluated results of 15 top-ranked Universities of India according to Webometrics/QS Ranking 2023 by TAW tool.

Table 3. Report of Taw Tool for Websites

TAW (N=15)	Total Violations	Mean	Std. Deviation
Perceivable	1299	86.60	137.32
Operable	1796	119.73	308.15
Understandable	69	4.60	8.28
Robust	76	5.07	9.07

Fig. 3 shows the chart of accessibility evaluated by the TAW tool. The errors are surveyed under A, AA and AAA priority levels. The results shows that we the websites were understandable but it was observed that there were large numbers of perceivable errors and operable errors. To overcome these errors checkpoints, steps are to be taken to reduce the amount of errors among webpages so that websites can perform better and we can attain more accessible websites.

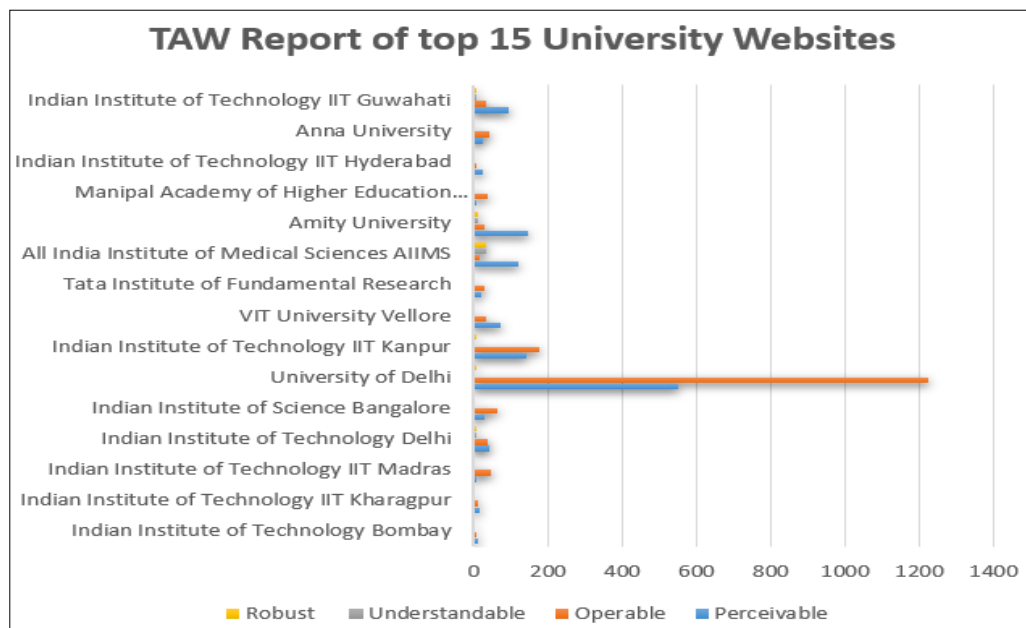


Fig. 3. Report of TAW tool for top 15 universities' website

The majority of the issues were linked to the operable group, which is 1796, which indicates that user interface components and functionality must be operable. The University of Delhi has the most breaches in Operable (37.78%) and Perceivable (16.98%) categories. In all mentioned universities, the University of Delhi has 55.09% violations. The Indian Institute of Technology Bombay has the fewest violations (0.52%), and it is also the top-ranked institution. The most common types of issues found were associated with specific guideline checkpoints, namely 1.1.1- Non-text Content (A), 1.3.1- Info and Relationships (A), 1.4.3- Contrast-Min (AA), 2.2.1- Time Adjustable (A), 2.2.2- Pause, Stop, Hide (A), 2.4.3- Focus Order (A), and 2.4.4- Link Purpose (A). Among these checkpoints, 1.1.1, 1.3.1, and 1.4.3 are related to the perceivability aspect, while 2.2.1, 2.2.2, 2.4.3, and 2.4.4 are associated with the operable aspect. The website must address some suggestion in order to overcome from violations. 1.1.1 Non-texts Contents (A), Add alt texts to your image Add full description to your videos or audios Add full names to input fields . 1.3.1 Info and Relationships (A), Break content with new sub sections Use html header tags Use tables and list Clearly label alt text on forms. 1.4.3 Contrast-Min (AA): Text and background ratio is 4.5:1 Use light color backgrounds, and dark color texts. Use dark color background and light color texts. 2.2.1 Time Adjustable (A): Set time limit Use minimum content All controls are keyboard accessible 2.2.2 Pause, stop, Hide (A) Moving, blinking, scrolling Remove everything (moves, scroll, blink) Automatically update contents hold by user. 2.4.3 Focus Order(A) Page can navigate with tab Keyboard accessible 2.4.4 Link purpose (A) Clearly define every link in title, it helps screen readers and assistive technologies.

Using the WCAG 2.0 guidelines, the EIII (European Internet Inclusion Initiative) [33] developed a page checker to rate the usability of webpages. The evaluation results are entered into a grading scale, and the

following marks are awarded: 100 indicates that there have been no failed tests, 95 to 99 indicates a few failed tests, 85 to 95 indicates a few failed tests, 70 to 85 indicates a lot of failed tests, and 0 to 70 indicates the majority of failed tests. Fig. 4 shows the EIII score of top 15 universities mentioned in the study.

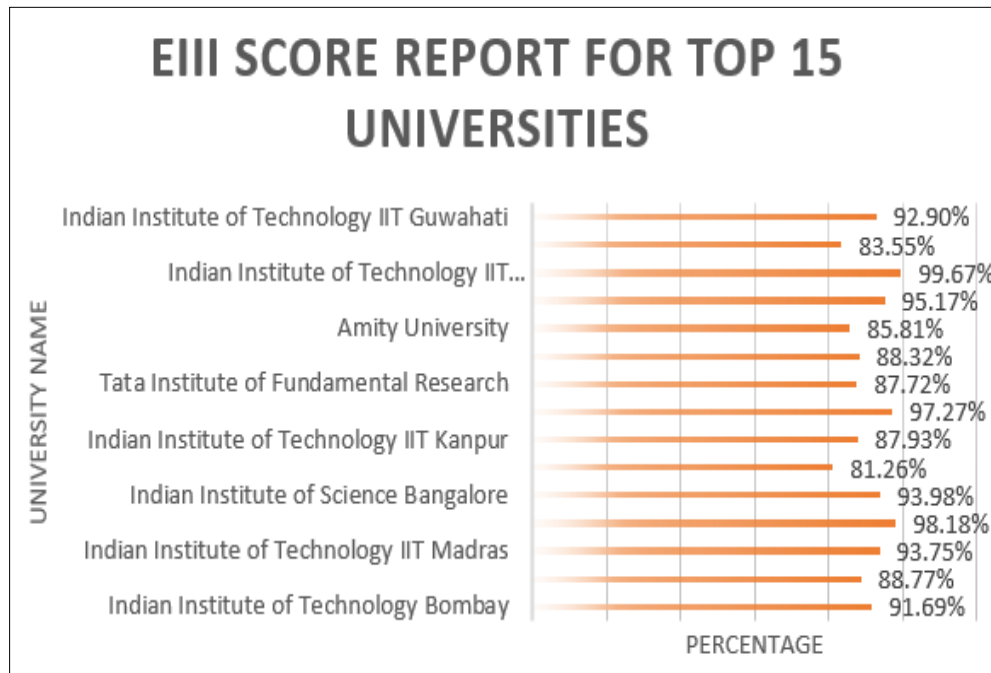


Fig. 4. Report of EIII tool score for top 15 university website

The University of Delhi had the lowest score (81.26%), and the findings from this tool indicate that 7.47% of colleges failed a number of exams. The data presented in Figure 5 demonstrates the frequency at which the University of Delhi homepage passed or failed checkpoints.

Images must have alternate text [1.1.1]	✓11, ✗12
Certain ARIA roles must contain particular children [1.3.1]	✓25
Certain ARIA roles must be contained by particular parents [1.3.1]	✓25
 and must only directly contain , <script> or <template> elements [1.3.1]	✓8
 elements must be contained in a or [1.3.1]	✓110, ✗21
ARIA hidden element must not contain focusable elements [1.3.1, 4.1.2]	✓5
Form elements must have labels [1.3.1, 4.1.2]	✗1
Inline text spacing must be adjustable with custom stylesheets [1.4.1.2, 2.1.a.a]	✓36
Elements must have sufficient color contrast [1.4.3]	✓391, ✗34, ?50
Ensure that scrollable region has keyboard access [2.1.1]	✓2, ✗1
<marquee> elements are deprecated and must not be used [2.2.2]	✗1
Page must have means to bypass repeated blocks [2.4.1]	✓1
Frames must have title attribute [2.4.1, 4.1.2]	✓1, ✗8
Documents must have <title> element to aid in navigation [2.4.2]	✓1
Links must have discernible text [2.4.4, 4.1.2]	✓492, ✗14

Fig. 5. Checkpoints failed by the University of Delhi.

As depicted in the Fig. 5, most of the highlighted checkpoints with violations were found to have occurred repeatedly. An example of such a violation is the absence of alternative text for images (1.1.1), the requirement that form elements have labels (1.3.1, 4.1.2), the requirement that <marquee> elements be deprecated and not used (2.2.2), the requirement that frames have title attributes (2.4.1, 4.1.2), etc. The Delhi University cleared 1461 tests while failing 99. Only two colleges, the IIT Delhi and the IIT Hyderabad, received scores of 99.67% and 98.18%, respectively. The standard deviation (SD) of the usability scores was 3.39, with an average value of 92.53.

5. Conclusion

This research provided an online accessibility measurement report of 15 top-ranked Indian universities based on Webometrics/QS Ranking 2023, using TAW, WAVE, and EIII tools. This research, which evaluated the web accessibility of the top 15 QS ranked institution homepages in India against the WCAG 2.0 guidelines, yielded a wide range of findings. The preceding research reveals a significant number of perceivable errors at the lowest degree of conformance. Furthermore, a large number of online accessibility violations warnings and notifications were discovered. Warnings and alerts are less potent than mistakes; attempts to reduce warnings will enhance and improve website accessibility. This endeavor can assist website administrators, designers, and writers in developing more inclusive online apps and webpages. Future study will look into university online accessibility in greater depth, looking at more websites for each institution and a larger number of universities altogether. Website creators, managers, and web application developer will receive proper training programs for web standards, accessibility standards, and different online awareness programs.

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