Accessibility Evaluation of Hospital Websites in India

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ABSTRACT

Hospital websites serve as an interactional communication between the patient requirements, healthcare specialists and other stakeholders. The patients can get online appointment and information from the website even after business hours. This study aims to present the analysis regarding accessibility of 29 hospital websites in India. For this purpose, three different automated testing online tools were used to examine the selected websites. The analysis results showed that web-pages of hospitals in India had low levels of compliance according to WCAG2.1 guidelines. The majority of web-pages did not follow the lowest level of accessibility criteria Level A. In addition, about half of the overall web sites had problems with accessing from mobile devices and about third of the websites had broken-links. Moreover, this study discusses some significant suggestions that may help in resolving the accessibility issues with websites. Hence, the results of this study shall serve as an impetus for respective website developers and managers in facilitating barrier-free web ecosystem for persons with disabilities.

Keywords
Web accessibility, WCAG2.1, Human computer interaction; persons with disabilities.

1. INTRODUCTION

According to statistics, the internet users in India-2022 increases by 833 million users with 59.5% penetration rate [1]. E-government means converting government public services into digital web forms and accessing these services from anywhere, anytime through mobile devices, tablets, and computers. Tax declaration, online health records, and applying for licenses are some of the main features of the e-government ecosystem. These resources have taken traditional non-digital practice towards the accomplishment of public service and various types of information's [2]. Nowadays for general information hospital sites are at the top of information sources in the world. Regarding this context, healthcare sites are considered as most important pillars of any governmental information resources [3][4]. Hospital websites provides easy communication and various medical informative services for their patients, treatment process, online payments, access doctor's information, online appointments, and methods for treatment. The COVID-19 pandemic has affected public services all over the World. Impose of lockdown in the country, all services suddenly got shut down and opened online. Due to which, the significance of hospital websites grew rapidly. Previous studies indicate that well designed, good color contrast, ease to use, color choice, and easy to read websites of hospital makes a good attraction to their patients [5]. WHO-2011 report, (World Health Organisation) 15.3% of the global population and 2.21% of the Indian population have some disabilities as per the census 2011 [6]. The United Nations General Assembly adopted Rights of Persons with disabilities. The Convention has eight signatories and 182 countries – including India. This signed agreement covers many areas and sectors such as government, economic, civil, education and internet access [7]. Therefore, to provide ecosystem that is fully accessible to all without any barriers comprises the universality. To achieve the website universality, the content should be accessible to everyone W3C (World Wide Web Consortium) has proposed several guideline and standards, which attempts to create barrier-free websites on the World Wide Web (WWW) via certain design principles and guidelines, for Persons with Disabilities (PwDs) [8].

The W3C provide widely recognized accessibility standards and guidelines (WCAG 1.0, 2.0 and 2.1) for any website. Depending upon these guidelines and standards, it becomes easy to evaluate and analyze how well the websites satisfies the basic need of users. **Error! Reference source not found.** Shows the tabulated details of all three standards of WCAG. Studies on the quality of web pages have increased greatly in multiple applications like health sector, banks, taxation and education with usage of websites. Various methods such as automated tools and expert assessment are used primarily to conduct the tests on websites, and to evaluate them for site security, usability and accessibility. For this purpose one of the frequently used methods is automatic tool based evaluation since it can supports manual testing and can be easily employed.

Hospital websites should give every citizen equal right to communicate and access information. Multiple disabilities of people, skills, and educational backgrounds should be considered while developing the accessible hospital sites. The aim of this study is to examine the hospital websites of India regarding web accessibility. This study also gathers the service provided to the hospital website users,

and tries to remove the literature gaps. To improve the website quality, this study provides constructive suggestions which may help in removing various issues in existing infrastructure of website.

Table 1: Comparison of all three standards

Web Content Accessibility Guidelines(WCAG)		
WCAG-1.0	*WCAG- 2.0*	*WCAG-2.1*
3 Priority Levels	*4 Principles*	*4 Principles*
14 Guidelines	*12 Guidelines*	*13 Guidelines*
67 Checkpoints	*61 Success Criteria*	*75 Success Criteria*
3 Priority Levels Per Checkpoint	*3 Levels Per Success Criteria*	*3 Levels Per Success Criteria*
3 Levels of Conformance	*5 Requirements for Conformance*	*5 Requirements for Conformance*

This paper is structured as follows: the upcoming section consist of literature review. In the section third describes, the methodology used to evaluate hospital sites. Section fourth consists of evaluation results. Section fifth consists of useful suggestions drawn for improvement of websites. Finally, paper concludes in the sixth section.

II. LITERATURE SURVEY

Previous studies examined the hospital websites in various developing and developed nations regarding accessibility [9][10][11]. The previous studies have shown the presence of accessibility problems in various websites across different nations based on guideline WCAG1.0 and 2.0 [12][13][14]. Some studies have examined the hospital websites regarding web accessibility in various countries such as Canada, Italy, America, Britain, Spain, Iran, Portugal, India, Africa, France, Brazil, Germany, Taiwan, Netherlands and EU [16][17]. Majority of these sites did not meet the minimum WCAG conformance levels. Moreover, the previous studies have used either 1.0 or 2.0 WCAG standard to examine accessibility for hospital sites [18]. However, few studies have also used both WCAG1.0 and 2.0 guidelines [19][20]. Studies on hospital sites in various countries are shown in Table 2. However, few similar studies examined similar issues (i.e., accessibility to health-care sites) [21]. All these studies show major accessibility issues and low compliance against WCAG accessibility standards.

In the post COVID-19 scenario, all hospitals around the world have started to deliver their information and services through online medium (e.g., websites) [22]. With the escalate growth in online health services, it becomes crucial to offer users an inclusive services. This study describes tools, countries, size and the methods used to analysis the hospital sites in India regarding web accessibility. Afterwards, we identify various levels of accessibility issues and provide useful practical changes that website designers and developers can make.

Table 2: Accessibility Studies

Author (year)	Sample Size	Country	Accessibility Guidelines	Tools Used	Finding
Grady L. (2005)	*49*	*Canada*	*WCAG1.0*	*BobbyTM*	*Not even single healthcare web site conform to basic level 1 error of WCAG 1.0 guidelines*

Mancini et al. (2005)	*170*	*Italy*	*WCAG1.0*	*Bobby and CynthiaSays*	*Above 75 percent of websites do not meet WCAG 1.0 guidelines*
Gilberto Llinas (2008)	*32*	*America, Britain and Spain*	*WCAG1.0*	*TAW*	*The outcomes highlighted only ten out of the 32 hospital sites follow WCAG 1.0 accessibility criteria*
John L. Brobst (2012)	*20*	*USA*	*WCAG1.0, Section 508*	*TAW*	*Evaluation result shows that only two-third of evaluated sites failed to provide basic levels of accessibility*
Martins et al. (2016)	*697*	*Spain and Portugal*	*WCAG2.0*	*AcessWeb*	*None of evaluated healthcare websites Portugal and Spain were accessible*
Kaur et al. (2017)	*280*	*India*	*WCAG2.0*	*TAW*	*The results revealed with 80.32 problems per website as an average, 22,491 errors in total, with and only 10% websites were screen reader compatible*
Kuzma et al. (2017)	*160*	*Asia, Africa, America, EU.*	*WCAG1.0, WCAG2.0*	*TAW*	*A higher count of issues discovered, out of 160 evaluated sites only 2 were truly level-A compliant.*
Acosta Vargas et al. (2018)	*22*	*United States, France, Brazil, Germany, Taiwan, and Netherlands*	*WCAG1.0, WCAG2.0*	*Wave, Tenon*	*The analysis result shows that most of the websites neglects the accessibility guidelines. The important control points are function, name, value, information, link purpose, and non-textual content*
K. Sarita et al. (2021)	*6*	*India*	*WCAG2.0*	*AChecker, TAW, WAVE*	*The outcomes highlighted that operable and perceivable factors were highly violated*
Krol et al. (2021)	*91*	*Poland*	*WCAG2.0*	*WAVE*	*The results declared that many of the web pages use content management system. The accessibility issues were neglected regarding WCAG 2.0 standard*
Macakoglu et al. (2022)	*58*	*Turkey*	*WCAG2.0*	*TAW*	*The results showed that most of the sites do not follow minimum level of compliance according to WCAG2.0 guidelines.*

III. METHODOLOGY

An accessibility analysis of hospital web sites in India is provided by the study. In this context, the list of top 30 hospital websites was obtained from the global and country hospital ranking [23]. While investigating the URLs, 1 website with country rank 13 and global rank 1211, (L.R.S. institute of Tuberculosis) found with Bad URL gateway, this website was excluded from this study. After initial investigation the remaining 29 websites were selected for evaluation. The Appendix, list the names, Indian rank, World rank, and URLs of 29 hospital websites under this study.

Tools:

TAW is online automatic testing tool that analyzes accessibility regarding WCAG2.1 standard. This tool also generates a report to the user as a result of analysis. This online tool is available at https://www.tawdis.net/. This tool is most frequently and successfully used in various studies for accessibility of hospital web sites [24]. The report of TAW tool consists of detail summary of problems, warnings and not reviewed. Not reviewed consist of various controls, where manual testing is required. The detailed report presented

in figure 1. Many researchers used TAW tool [11][12][14][15], such as K. Sarita and Parminder Kaur [17], Macakoglu and Peker [19], Ocha and Crovi [25] and Karaim and Inal [26], has been implemented and verified in testing the accessibility of websites in various domains.

Figure 1: Summary of TAW

The online tool Dead Link Checker was used to test the broken-links in a website. This tool previously used by many researchers for website evaluation [19][27]. URL checked summary of Dead link checker shown in figure 2. The broken links affect UX (user experience) and negatively affect SEO (search engine optimization) values [28].

Figure 2: Summary of Scanned URLs checked

Another major parameter affecting website accessibility is mobile usability. Google's Mobile-friendliness tool was used for this purpose to evaluate web-page response on compatible mobile device [29]. Interface of tool Mobile-friendly shown in figure 3 with test report. This tool was previously used by Macakoglu and Peker [19], and Verkijika [30] to evaluate university websites.
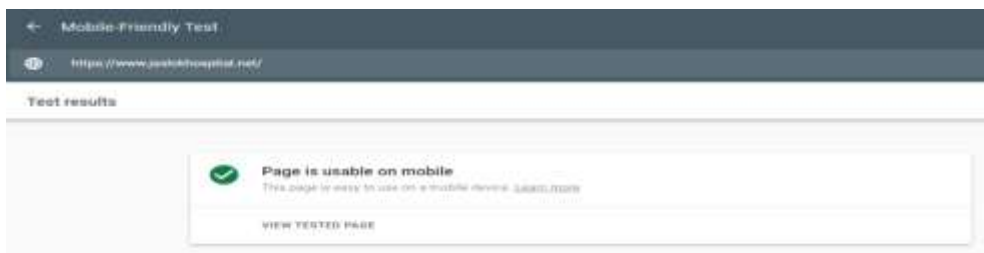

Figure 3: Report of Mobile Friendly Test

IV. RESULTS

The accessibility analysis results are presented as follows:

Accessibility analysis:

Website accessibility is the practice of creating web-pages more usable and accessible for users including abled and disabled users. This section presents the results of hospital websites analyzed using TAW tool. With the help of TAW tool, after analyzing 29 websites (1 website not tested due to bad gateway problem), accessibility problems were identified. The identified problems did not meet the basic level A conformance requirements. The list of problems on behalf of 4 principles POUR, namely perceivable, operable, understandable, and robust, is presented in figure 4.
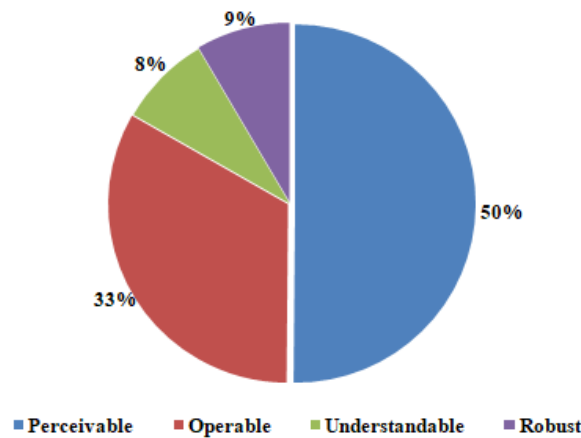
Figure 4: Accessibility issues according to POUR principles

The outcomes of the results show that the principles with majority of issues were perceivable (50%) and operable (33%). The principle understandable had lowest rate of error with 8%.

Table 3: Conformance level-wise report

WCAG 2.1 Levels	Total Errors	Error Percentage %
Level A (lowest)	3173	92.26
Level AA (mid range)	0	0
Level AAA (highest)	266	7.74

Table 3 shows the list of errors and error percentage by WCAG2.1 conformance level. The "WCAG 2.1 Levels" column shows the levels of conformance categorized by WCAG 2.1 guidelines, in order-to-fulfill the needs of different users. On the other hand, in the "Total Errors" column shows the level of errors, Error frequency (number of errors per guideline) and "Error Percentage", column shows the percentage of errors being violated. The result shows that the count of error and error percentage for Level A the lowest level was greatest. The higher count of minimum conformance Level A issues shows that most of the web-pages did not follow the requirements for website making.

Table 4 provides accessibility errors distributed by Level, error frequency, error percentage and success criteria including name and success criteria identity number. The "Success Criteria" column defines the violated guideline type and the name of the guideline. Secondly the column "Total Errors" shows the level depending upon a particular success criteria, error frequency (frequent number of errors), and error percentage of sites where guidelines and success criteria has been violated.

The overall accessibility report shows the clear evidence of violations based on both Levels A and AAA of WCAG2.1 guidelines. The higher count of accessibility problems for basic Level A of WCAG 2.1 in the Indian hospital web-pages indicates that majority of the web sites do not follow the minimum accessibility requirement. However, none of the sites had errors regarding level AA accessibility. The most repeatedly violated issues were 1.1.1--Non-text-Content and 2.4.4—Link-Purpose only for Level A, which were violated by all sites. These issues were followed by 1.3.1—Info and Relationships, 4.1.2—Name, Role, value. The least violated success criteria was 2.2.2—Pause-Stop-Hide and success criteria 2.4.10 – Section Headings was violated by a single website.

Table 4: Distribution of success criteria violations

Success Criteria		Total Errors		
Guideline	Name	Level	Error	Error

			Frequency	Percentage %
1.1.1	Non-text	A	1073	31.2
1.3.1	Info-Relationships	A	709	20.6
2.1.3	Keyboard	AAA	34	1.0
2.2.2	Pause, Stop, Hide	AAA	12	0.3
2.4.4	Link-Purpose	A	802	23.3
2.4.9	Link only	AAA	197	5.73
2.4.10	Section Heading	AAA	23	0.67
3.1.1	Language	A	52	1.51
3.2.2	On-Input	A	28	0.81
3.3.2	Labels or Instructions	A	219	06.37
4.1.2	Name, Roles, Value	A	290	08.43

Broken Link analysis:

In this analysis, Indian hospital sites were examined with online test tool Deadlink Checker. This tool checks the number of dead links or broken-links. 29 websites were evaluated for dead links out of 29, about 62% sites have no broken links, 7% of sites have less than five, and 31% have greater than five broken-links. Table 5 shows the analysis results of overall count of broken-link test. The highest count of broken-links among all hospitals site was 58. The investigated statistics uncovers that 38% of hospital websites having broken link issues.

Table 5: Number of websites with broken link

Broken Links	None	<5	>5	Average URLs checked	Min	Avg	Max
Number of websites (n= 29)	18	02	09	306.62	0	7.27	58

Mobile-Usability Analysis:

In this analysis, online test tool "Mobile-friendly Test" designed by Google was used for evaluation for mobile usability. The evaluation result shows that majority of hospital web-pages pass the mobile-usability test. In Figure 5, the usability test results of the 29 hospital web-pages are presented. Test result report shows that 15 (52%) websites pass the test and 14 (48%) websites fails in the test. Overall, according to results it proves that mobile usability is given very low priority in hospital web-pages in India. These test outcomes were identical to the Macakoglu analysis of Turkish hospital web-pages [19].
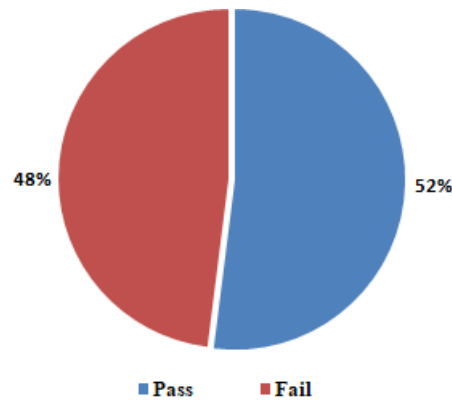
Figure 5: Results of mobile-usability test

V. SUGGESTIONS

The COVID-19 pandemic has affected all services over India. Therefore, the significance of electronic services grew rapidly. Hospital websites plays a significant role in providing mandatory information to various users. Based on the present evaluated results, the given below critical points should be considered while designing and developing various hospital websites.

1. For all non-text content for the web, text alternatives should be provided

2. Headers should be provided for each page, table, and section.

3. Any kind of information conveyed in the form of colors and symbols is also available in text.

4. Body color and text color contrast mechanisms should be there in default browsers.

5. Text images, text, captions and should be resized up to 200percent, and text should be wrapped around the line to line so that text should be vertically and horizontally scrolled through.

6. The purpose of each input field checkboxes, radio buttons, text fields, and drop-down menus should be appropriately identified.

7. Addition of essential accessibility components such as each link should be linked with text alone, skip to main content, and skip over repeated blocks so that user can easily navigate, keyboard focus with built-in CSS properties, and multi-language feature.

8. Role, values, and states on all user interface components provide compatibility with screen readers.

Furthermore, the inclusion of essential accessibility statement, accessibility components (skip to main content, skip over repeated blocks, keyboard focus with built-in CSS properties, and the multi-language feature) should be there, so that a user can easily access, navigate and fetch desired information which required. Moreover, these accessibility components should provide proper help to low vision or blind users when users use a screen reader feature.

VI. DISCUSSION AND CONCLUSION

Hospital websites in India were examined in this study in terms of accessibility. Online accessibility tools were used in this analysis. For accessibility errors TAW tool, for usability of mobile devices a mobile-friendly test by Google, and for broken-links Dead-link checker tool, were used in this analysis. The results declared that majority of issues were related to basic level A, according to WCAG2.1 standard. These errors indicates that majority of sites did not meet the basic success criteria for WCAG2.1 accessibility. Basic principle perceivable is one that website administrators, developers and site designers should consider, followed by principle operable. Majority of sites had accessibility problems related to basic level A success criteria: guideline Non text content-1.1.1, Name, role, value- 4.1.2, Link Purpose-2.4.4 and 1.3.1- info and relationship. The findings obtained were similar to previous studies accessibility analysis of government, and university websites [19][30][31][32][33].

This study also examined the total number of broken-links present in hospital web-pages in India. Broken-links are a web-page reference that redirects user to a particular "page not found" webpage which may overcome user's willingness to further redirect the

web-page. The findings declare that 62% sites had no broken-links and 38% websites had five or more broken links. However, we still recommend that website developers, broken-link issues should be properly defined using valid links of web-pages and timely check webpage's in order to provide equal access to all users.

Finally, the web-pages were examined in terms of mobile-friendliness. The result showed that nearly half of the websites failed to pass the test. The result outcome shows that websites are not mobile friendly. The result clearly indicates that the hospital website visitors may experience the issues regarding accessibility. In fact, these issues require proper attention because as per records mobile phone generates more than 62.31% of site traffic in India [34]. Nowadays, reliable online hospital websites provide general information, easily understandable information about the diseases, treatment options and symptoms of the disease. It is an unquestionable fact that by using hospital website effectively a user can proactively identify a health problem and make a good decision for cure. This study presented the accessibility evaluation results of hospital sites in India. According to the previous literature studies, no published study found which utilized new standards provided by WCAG2.1 to evaluate accessibility of hospital web-pages. Therefore, this study fills the gap by evaluating the website accessibility of hospital websites based on updated standard WCAG2.1, in context of India.

The results represent a clear view that many websites had various accessibility issues, not following the standards and guidelines provided by WCAG2.1. Website developers and designers do not consider guidelines while developing websites. Our study findings related to hospital websites also support previous that examined accessibility [35][36]. This study also helps raise awareness for equal access of information to all from practical point of view. Inaccessible websites may lead to poor adoption and ineffective service delivery to various users. Therefore, there is a need for proper training and awareness regarding accessibility to website designers and developers to minimize the identified issues and make hospital websites accessible to all groups of people, including (PWDs) persons with disabilities.

The future work could extend the accessibility study of hospital websites: First, detail evaluation-cum-analysis of these hospital websites. Second, further different parameters can be extended for accessibility under all levels of WCAG2.1 standards. Third, evaluate the websites from various nations to get the true image.

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