Accessibility Analysis of Bangladesh Government Websites Based on WCAG 2.0

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Abstract— The website is one of the most used platforms for information sharing. Every citizen has equal rights to get information from government websites. The main objective of this research is to analyze the accessibility, usability and security aspects of the government websites of Bangladesh. The research has been carried out based on WCAG 2.0 (level AA) by using various tools like TAW, WAVE, CCA, Total Validator, CynthiaSays, Keyboard Accessibility, and Readability test. This analysis was based on randomly selected 20 government websites that were found in the National Web Portal of Bangladesh. Results found that all of the government websites of Bangladesh failed to adhere to the minimum requirements of WCAG 2.0 (AA) guidelines. In the end, the researcher suggested some recommendations to increase web accessibility.

Keywords— Government, Website, Accessibility, WCAG 2.0, Bangladesh

I. INTRODUCTION

In this digital era information is wealth, every county government is providing their services and information through the internet, where the website plays a vital role in this operation. Gradually more and more people are going to be connected through the internet. So, the websites of the government should be accessible by everybody from anywhere in the world. Making a website that is accessible to everybody is quite hard because citizens include several limitations and disable persons too and they also must be able to use all of the websites in a normal way. According to the World Health Survey in Bangladesh, there are around 16.2% of people are disabled in anyways from the age group of 18-65 years old.[1] The Right to Information Act 2009 (Information Disclosure by Authorities: Section 6)[2] says that "Each authority has to publish and publicize all information in an indexed manner which is easily accessible to the citizens regarding any decision taken, proceeding or activity executed or proposed. So, the Right to Information and easily accessible information is ensured by Bangladeshi law. This study investigates the presence of inaccessibility at government websites. The latest version of Web Content Accessibility Guidelines (WCAG 2.0) published in 2008 by the World Wide Web Consortium (W3C) is used as a standard for this study.

II. RELATED WORK

Several researches have been conducted about web content accessibility analysis. Different methods and tools were used to do those researches, the research found that many countries' government websites including the Bangladesh government have some serious accessibility issues.

Akgül, Y., & Vatansever, K.[3] worked in Web Accessibility Evaluation of Government Websites for People with Disabilities in Turkey and they found the absence of text equivalents for non-text elements, and the failure of the static equivalents for dynamic content to get updated when the dynamic content changes. Bakhsh and Mehmood[4, 5] evaluated the government websites of Pakistan which include all ministry websites by accessibility evaluation tools, the result found that most of the government websites were failed to the accessibility test, Humaira Nazar and Srfaraz [6] also analyzed the bank websites of Pakistan and they have found many accessibility errors there. Paris, M.[7] worked on Website accessibility of e-government websites and legislation in Northern Ireland and found that websites are not adequately usable by all kinds of people. Paul T. Jaeger[8] have researched Section 508 compliance on federal e-government Web sites, he used multi-methods analysis and recommended some ways to improve the accessibility based on section 508 guidelines. Acosta-Vargas, P., Lujan-Mora, S., & Salvador-Ullauri, L.[9] have done another research based on government websites of 20 countries and found that the majority of the Web sites do not achieve an acceptable level of compliance. Elisa, N.[10] done another study on 79 selected e-government websites in Tanzania. The results reveal several issues on the usability, accessibility, and security of Tanzania e-government websites. S.S.R[11] have researched Website Accessibility Design Issues with Indian E-Government Sites, he used 3 government websites as a sample and after analyzing found many accessibility issues.

Some similar studies like accessibility analysis on the web sites of South America[12], Turkey[13–15] Kirgiz Republic[16] , Mexico[17], Philippine[18], Uganda[19], India[20], Kuwait[21], Saudi-Arabia[22]   and each of these showed some level of errors. On the other hand, Y. Shi evaluated Chinese local government websites[23], Youngblood[24] evaluated Alabama state websites accessibility and NewZealand E-Government website[25].

On Bangladesh's government websites a limited number of works have been done. Baowaly & Bhuiyan[26] have done one research before on the accessibility analysis of Bangladesh government websites but their sample size was small and old, furthermore, their study was based on WCAG 1.0 guidelines only. Muhammad Nazrul et al.[27] have done another research on the website accessibility of Bangladesh government websites, but their sample size was very limited which were only 6 randomly selected websites, 22 students participated in the survey, their methode was not based on WCAG 2.0 and it was based on old websites too. So, our research will give in depth overview of the current accessibility status of the new build government websites of Bangladesh.

III. WEB CONTENT ACCESSIBILITY GUIDELINES (WCAG 2.0)

Website is a mostly used platform that is used in the current world to share the information, website made with various elements like different colors combination, java scripts, menus, widget, browser independency, content with multilingual support, header-footer and support for assistive technology, etc. So, the quality and the accessibility of the website varied from designer to designer. So, to ensure the accessibility of all websites World Wide Web Consortium (W3C) set up some gold standards that were published in May 1999, it was known as Web Content Accessibility Guidelines (WCAG 1.0)[28]. These guidelines explain how to make web content accessible to people

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with disabilities. Following these guidelines will also help people find information on the Web more quickly regardless of disabilities.

In 2008, World Wide Web Consortium (W3C) setup new standard guidelines which is known as Web Content Accessibility Guidelines (WCAG 2.0)[29]. Although, after publishing this WCAG 2.0 standard more than 10 years have passed but an estimate by W3C reports that 90% of the websites, available on the World Wide Web, fail to provide access to disabled people while 70-98% websites all across the world have accessibility issues.

WCAG 2.0 is primarily intended for Web content developers, Web authoring tool developers, and Web accessibility evaluation tool developers. WCAG 2.0 consists of 12 guidelines which are further divided into four groups, for examples

1. **Perceivable:** Websites must be perceivable by people, regardless of their disabilities.
2. **Operable:** The content must be easily operable, anybody should easily operate the websites
3. **Understandable:** All information at the websites must be easily understandable
4. **Robust:** The content must be robust enough that can be interpreted by different kinds of users and assistive technologies
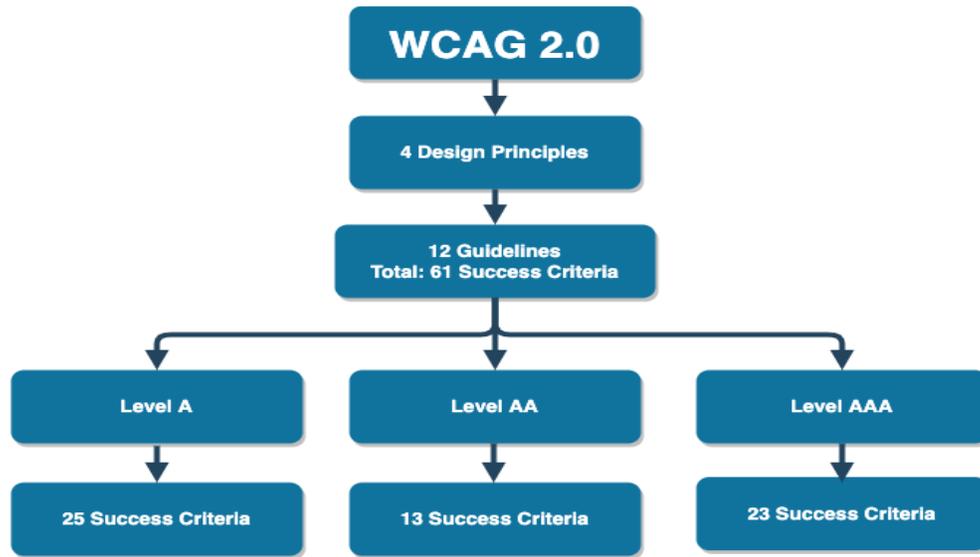

Fig. 1 WCAG 2.0 Guidelines Chart

12 guidelines have 61 success criterions and each criterion is assigned a specific conformance level depending upon its importance, such as level A, level AA and level AAA shown in table 1.

TABLE 1
LEVEL OF WCAG 2.0 AND ITS SUCCESS CRITERIONS

Standard	Conformance Level	Description
WCAG 2.0	A	The lowest level of accessibility must be fulfilled 25 success criterions
	AA	The medium level of accessibility must be fulfilled 13 success criterions along with 25 success criterions from Level "A"
	AAA	The highest level of accessibility must be fulfilled 23 success criterions along with 25 and 13 success criterions from Level "A" & Level "AA"

IV. WEB ACCESSIBILITY EVALUATION TOOLS

There are a large number of tools available for accessibility testing for both commercially or free use. WCAG is an internationally recognized standard system of accessibility, so most of the accessibility analysis tools support the WCAG standard. WCAG altogether released two versions of guidelines, the latest version is WCAG 2.0 which was in 2008, so it's been more than 11 years, so by this time almost all of the accessibility analysis tools support both versions of WCAG guidelines. Some of the popular accessibility tools are Total validator, CynthiaSays, TAW, AChecker, WAVE, Readability Analysis Tools by Webfx and Readable, Color Contrast Analyzer (CCA), Keyboard Accessibility, etc.

Total Validator can check the website to help ensure that it is accessible, uses valid HTML and CSS, has no broken links, and is free from spelling mistakes. Cynthia says identifies errors in Web content related to Section 508 standards and/or the WCAG guidelines for Web accessibility. TAW is an automatic online tool for analyzing website accessibility based on W3C accessibility guidelines WCAG 2.0.

AChecker is used to evaluate HTML content for accessibility problems by entering the location of a web page, uploading an HTML file, or by pasting the complete HTML source code from a Web page.

AChecker identifies 3 types of problems:
  A. **Known problems**: Problems are already identified with accessibility barriers. Must modify the page to fix these problems.
  B. **Likely problems**: Some problems have high probabilities to be accessibility barriers, that needs human check to make decision.
  C. **Potential problems**: Some problems AChecker can't identify that needs human checks to make decision.

WAVE is developed by WebAIM to check the Accessibility for free. It was established in 2001 and it has been used to evaluate millions of web pages. WAVE identifies accessibility problems under six groups, such as Errors, Alerts, Features, Structural Elements, HTML 5 & ARIA and Contrast Errors. It's not only identified the problems but also shows the location of the problems which helps users to make the corrections.

The Readability Test Tool takes the text from a web page and gives a score based on most used readability indicators such as Flesch Kincaid Reading Ease, Flesch Kincaid Grade Level, Gunning Fog Score, Coleman Liau Index, Automated Readability Index (ARI) and SMOG Index[i]. It identifies the problems of different ages and grade levels.

The Color Contrast Analyzer is primarily a tool for checking foreground & background color combinations to determine if they provide good color visibility. It also contains functionality to create simulations of certain visual conditions such as color blindness.

Keyboard Accessibility function is very important for many people like motor disable person who can't use mouse or blind people. Keyboard accessibility normally identifies based on how a website can be operated by keyboard like focus indicator, logical navigation, skip link capabilities, widget navigation, select any available link by keyboard, etc.

WAI-ARIA, the Accessible Rich Internet Applications Suite, defines a way to make Web content and Web applications more accessible to people with disabilities. It especially helps with dynamic content and advanced user interface controls developed with Ajax, HTML, JavaScript, and related technologies WAI-ARIA describes navigation way and mark elements like menus, primary content, secondary content, banner information, and other types of Web elements.

V. RESEARCH METHODS

We have found there are 58 ministries and divisions are available in the Bangladesh National Portal, and almost all of the websites followed by similar theme and design. We randomly selected 20 government websites from the list. We used the homepage of every government website for our analysis. In the analysis part, we used different automated tools along with a manual testing system based on WCAG 2.0 Guidelines, in all cases, we considered WCAG 2.0 AA level as a standard level because AAA is too high standard to achieve and medium level of standard is also widely accepted. All tests have been performed in the first week of September 2019. We used total 7 online tools and applications for this research, we have used Total validator to identify the HTML and CSS errors, we used Total Validator Test 14.1.0 application for Mac, we used HTML validation option "Auto Detect" and Accessibility Validations option as "WCAG 2.0 AA".

TAW is another web accessibility testing tool, to use TAW just need to put the website link into the search box and it checks 4 design principles such as perceivable, operable, understandable and robust and give the result in three groups like as problems, warnings and not reviewed.

To use AChecker and CynthiaSays automatic accessibility testing tools we just need to open their websites and put the link, in both case we need to select compliance mode WCAG 2.0 (AA) as standard, AChecker gives the result in three main categories like as known problems, likely problems, and potential problems. On the other hand, CynthiaSays gives test results based on Compliance Level A and Compliance Level AA.

To check the errors of the website, ARIA, Color Contrast and many more we used WAVE plugins for the Mozilla Firefox browser. For color contrast, we have used Color Contrast Analyzer (CCA) application for Mac too. We test the readability with two different online tools that give readability scores based on users' age, grade level and the level of difficulties. Finally, we test manually keyboard accessibility, by pressing the tab button from keyboard we activated the keyboard operation function and then we test focus indicators, navigation, skip link, widget navigation and any available link selection by keyboard. We opened the sample websites one by one and tested the homepage based on WCAG 2.0 guidelines. On each homepage, we used a keyboard and press different buttons 150 times to see the keyboard operability.
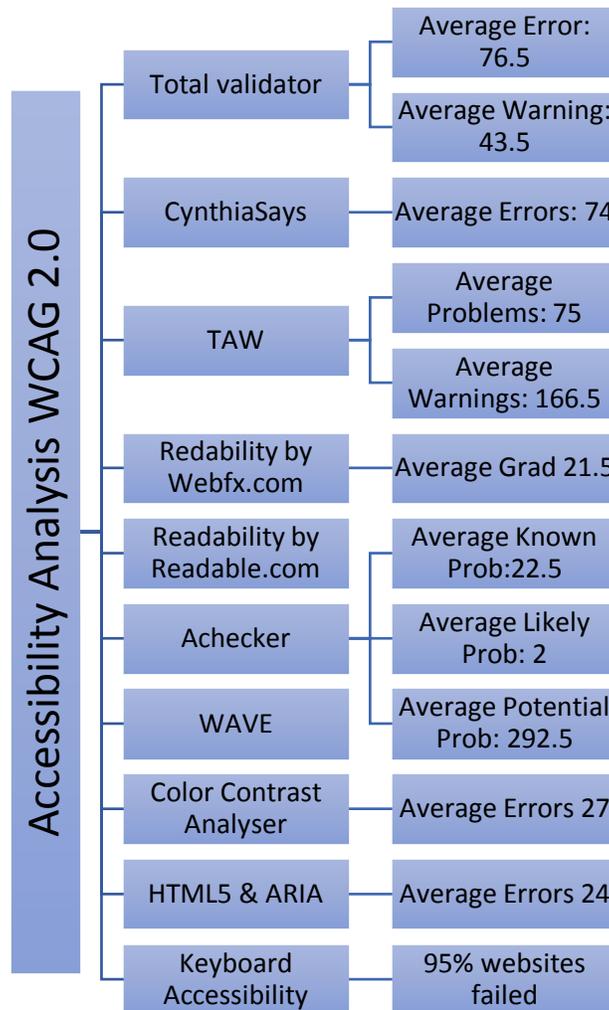

Fig 2. Web Accessibility analysis methods and results

VI. RESULTS AND ANALYSIS OF ACCESSIBILITY

After analyzing all sample websites, we have seen that there are many accessibility errors have been found, even though we have used WCAG 2.0 (Level - AA) almost all of the government websites failed to pass the test. We used different tools to become over sure and more confident about our result, all of the tools give pretty much the same results, all results are available in table-2 in the down below.

After doing our study with Total Validator and TAW we found that there are on average 76.5 and 75 errors or problems found accordingly which are pretty similar. Although the average waring found from the Total validator is 43.5 which is quite lower than the average warning found by TAW. Based on the analysis of TAW the total average warning is 166.5, which is very high.

AChecker also gives us pretty interesting result, according to AChecker average known problem is 22.5, but the average likely problem is quite low (2) which is a very positive sign, but it gives very high average of potential problems which is 592.5, so human checkup is needed in this regard. Based on the analysis of CynthiaSays the average error is 74 which is quite similar to the average errors of Total validator (76.5) and TAW (75).

WAVE is also one of the most popular tools to analyze the web accessibility, based on the result coming from WAVE the average error is 24 and the average alert is 114. WAVE also gives the result of HTML5, ARIA and Color Contrast test, average HTML5 and ARIA problem score is 24 and the average color contrast error is 27. It would be very difficult for navigation following the logical order and the people who got color blindness problem they will also face difficulties.

For keyboard accessibility test we manfully checked the website operability by keyboard, we divided keyboard accessibility into 5 main categories, which are Focus Indicators, Logical navigation, Skip link, Widget navigation, Any link selection. Only the website of the Ministry of Health and Family passed 4 keyboard accessibility tests among 5.

Focus Indicator: For the focus indicator we found very low contrast mild color has been used for most of the cases and in some websites, it's even very hard to find out the focus point, after doing this study we found only 5% websites passed the focus indicator test.

Logical navigation: Then we used keyboard buttons to test the logical navigation order, but in this case, we got a similar result as the previous test, only 5% of websites passed the logical navigation test. At the beginning we found the navigation was logical till the main menu bar, then we completely lost the navigation and focus point.

Skip Link: To avoid long navigation website should have skip links option at the beginning, in this part we got very positive result which is almost 95% websites got this skip links option, but in the skip link options we found "Accessibility Help" option as a first option, but there was not such a webpage exist in the websites. Although 95% of websites have skip links option but we found that the "Accessibility Help" page was missing on all websites.

Widget Navigation: Navigate the widget was also very difficult because the navigations weren't followed the right navigation order, focus indicator was also missing after some certain press on keyboard, so 95% government websites failed widget navigation test.

Any link Selection: Finally, we test all the websites for any link selection capabilities by keyboard, but we failed for 95% cases, only 5% of websites passed Any Link Selection by keyboard test.

TABLE 2
ACCESSIBILITY ANALYSIS RESULT BY DIFFERENT TOOLS

Websites	Total Validator		TAW		AChecker			Cynthia Says	WAVE				Keyboard Accessibility				
	Total Errors	Total Warnings	Problems (Needs corrections)	Warnings (Needs Human Review)	Known problems	Likely Problems	Potential Problems	Total Errors	Errors	Alerts	HTML5 & ARIA	Colour Contrast Errors	Focus Indicator	Logical Navigation	Skip Link	Widget navigation	Any Link Selection
President Office	50	33	69	132	9	3	445	60	24	77	23	27	N	N	Y	N	N
Prime Minister Office	41	29	67	120	9	1	443	90	20	74	21	28	N	N	Y	N	N
Ministry of Education	79	29	74	184	18	1	360	87	23	44	17	22	N	N	Y	N	N
Ministry of Public Adm.	90	40	65	163	21	0	662	89	21	143	9	35	N	N	Y	N	N
Ministry of Social Welfare	129	56	78	196	52	0	919	93	33	142	27	30	N	N	Y	N	N
Ministry of Health & Family	356	169	112	354	59	1	342	84	120	68	0	151	Y	Y	N	Y	Y
Ministry of Foreign Affairs	89	47	80	152	19	7	689	89	24	140	21	25	N	N	Y	N	N
Ministry of Wom. & Child	127	71	79	285	25	3	870	84	16	153	18	21	N	N	Y	N	N
Ministry of Finance	118	67	72	173	32	0	770	90	23	131	9	31	N	N	Y	N	N
Ministry of Information	73	31	72	145	17	0	542	87	26	99	19	33	N	N	Y	N	N
Ministry of Planning	42	32	77	122	9	5	339	87	22	49	19	25	N	N	Y	N	N
Ministry of Commerce	65	32	66	150	9	0	573	88	15	101	27	32	N	N	Y	N	N
Ministry of Road Trans.	109	65	74	180	34	10	794	89	26	160	18	31	N	N	Y	N	N
Ministry of Defence	54	44	65	145	13	0	503	88	18	97	15	29	N	N	Y	N	N
Ministry of Home Affairs	33	13	59	79	8	0	224	84	14	33	9	19	N	N	Y	N	N
Ministry of Industries	89	45	72	230	23	1	784	91	19	129	25	51	N	N	Y	N	N
Ministry of Sci. & Tec.	107	73	88	275	20	1	877	91	31	154	25	37	N	N	Y	N	N
Ministry of Railway	94	40	85	154	12	0	593	86	21	113	25	33	N	N	Y	N	N
ICT Division	95	57	72	225	28	1	781	90	37	144	25	36	N	N	Y	N	N
Ministry of labour & Emp.	103	54	81	201	36	1	740	88	24	151	25	27	N	N	Y	N	N
Average	**76.5**	**43.5**	**75**	**166.5**	**22.5**	**2**	**592.5**	**74**	**24**	**114**	**24**	**27**	**5%**	**5%**	**95%**	**5%**	**5%**

TABLE 3
READABILITY ANALYSIS RESULT BY DIFFERENT TOOLS

No.	Websites	Readability Analysis by Webfx.com Tools		Readability Analysis by Redable.com Tools
		Grade Level	Age level who can understand Easily (Years)	Grade Based on Readability level
01	President Office	14	19-20	B
02	Prime Minister Office	14	19-20	C
03	Ministry of Education	18	23-24	E
04	Ministry of Public Administration	25	Above 25	D
05	Ministry of Social Welfare	24	Above 25	C
06	Ministry of Health & Family Welfare	11	16-17	B
07	Ministry of Foreign Affairs	16	21-22	C
08	Ministry of Women & Children Affairs	28	Above 25	D
09	Ministry of Finance	18	23-24	C
10	Ministry of Information	12	17-18	D
11	Ministry of Planning	12	17-18	C
12	Ministry of Commerce	25	Above 25	D
13	Ministry of Road Transport & Highway	21	Above 25	C
14	Ministry of Defense	24	Above 25	D
15	Ministry of Home Affairs	17	22-23	C
16	Ministry of Industries	15	20-21	B
17	Ministry of Science & Technology	18	23-24	C
18	Ministry of Railway	19	Above 25	C
19	ICT Division	25	Above 25	D
20	Ministry of Labor and Employment	29	Above 25	C
	Descriptive Statistics	$\leq$ 15 **0** 15 to 20 **5** 20 to 25. **6** 25 to All **9** Average **21.5**	Age $\leq$15 **0** Age 15-20 **5** Age 20-25 **6** Age 25-all **9**	A Very Easy **0** B Easy **3** C Medium **10** D Hard **6** E Very Hard **1**

To check the readability, we used two different online tools, based on web content quality Webfx further divided into two categories, such as Grade level and Age level. In the grade level, we found that to understand the website content the visitors need higher education to understand all the information shared on the government websites. 25% of government websites need at least 15-20 grade level, 30% websites need the grade level 20-25, and rest 45% of other websites content is too difficult to understand and the required grade level is above 25. On average to understand the website content it is required to have the grade level is 21.5, which is quite difficult to understand for many users.

In Redable.com online readability analysis tools there are five grades, such as A, B, C, D, E. Based on website content quality and difficulties this tool automatically tells the website goes to which grade, the easiest grade is A and the most difficult grade is E. After doing our test we have found that there are no websites are into group A, there are only 3 websites are into Grade B that means only 15% websites goes into this grade. Then we have found almost 50% of websites are into Grade C, 30% of websites are into grade D and 5% websites are into most difficult Grade E.
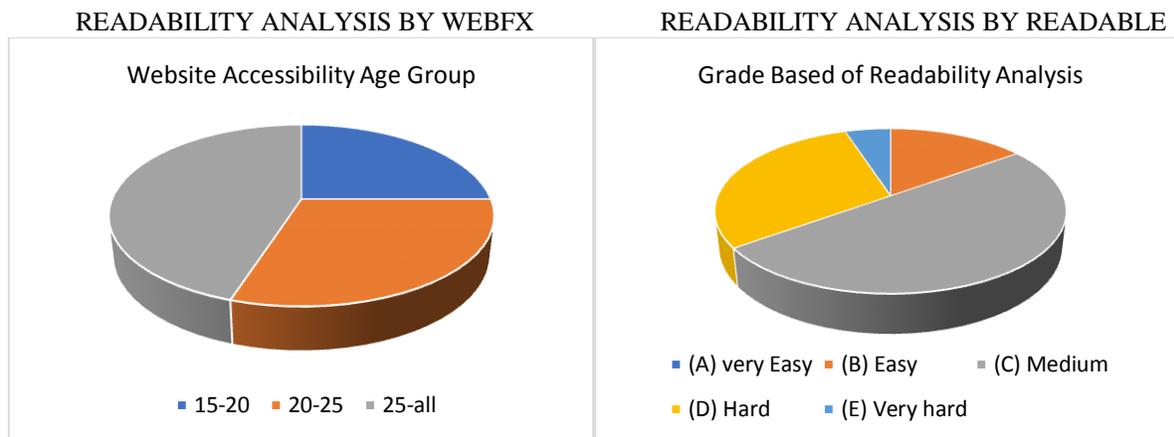
READABILITY ANALYSIS BY WEBFX   READABILITY ANALYSIS BY READABLE

Fig. 3 Readability Analysis Chart

VII.   LIMITATIONS AND FUTURE SCOPE

There are some limitations have been found in this research. First of all, in this research except the keyboard accessibility test, most of the tests were conducted through either online tools or applications, which can't be the substitute for real-life user tests. Another limitation of this study is we used only the homepage of the websites; different pages accessibility test results might vary based on different conditions. The researcher has been used all free and open-source tools to check the accessibility, some paid applications and online tools are also available which might give a more accurate result.

Moreover, this paper provides a strong foundation for future work to evaluate the accessibility of all other websites of government by using multiple automatic web accessibility testing tools and to involve the disable users to get more conclusive accessibility results. In future research, the real-life human test can be added this will give a more accurate and acceptable result. And also, some premium paid tools can be used to dig more deeply. Some other sectors of government websites can also be used as sample data to analyze the accessibility.

VIII.   CONCLUSION AND RECOMMENDATION

In this paper, we addressed 20 government websites of Bangladesh and tested the accessibility by using different online, offline and manual tests. Result showed that none of the government websites meets the minimum requirements of the accessibility based on the guidelines of WCAG 2.0. The results show that Government Websites of Bangladesh have a high rate of accessibility errors and it is very difficult for all kinds of people. We used different tools to analyze the accessibility of the websites to make our decision confidently, all accessibility testing tools give pretty much the same results. It is clear that, although the government of Bangladesh has done a great job to make all the information available online, neither web designer nor the government pays much attention to improve the accessibility of the websites.

The result of this paper is advancement in the existing knowledge to understand the current website accessibility status of Bangladesh government websites. These results will be helpful for researchers who will focus on accessibility research, web developers as well as policy makers in Bangladesh to recognize the current situation of website accessibility and the importance and need of improvement in accessibility for government websites.

As a recommendation we can suggest that web designers must pay attention to the accessibility issues, they need to know all the guidelines published by W3C to make the website more accessibility. Existing accessibility issues can easily be solved by doing some editing and moderation works on current websites based on W3C guidelines. So, the webmaster can use the available online tools to identify the existing problems, some online tools like WAVE shows where the problem located on the websites and how to solve the problem. For the readability issue, using more easier language can easily solve the problem, so increasing awareness is necessary. Define proper ARIA can solve the logical navigation problem. Other recommendations would be using the same theme for all government websites, which the Bangladesh government is currently doing. So, correcting one master theme perfectly based on the guidelines of WCAG 2.0 and using the same theme everywhere can solve the accessibility problems smartly.

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