

Exploring the accessibility of four university websites

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ABSTRACT

An important objective of the Digital Agenda for Europe is the web accessibility of the public sector. One of the most important goals of this strategy is to ensure equal access to education. To accomplish this goal, systematic evaluation and monitoring measures are needed. This paper aims to explore the accessibility of four university websites for visually impaired people. For each website, the home page and admission page have been analyzed. The approach is based on both automated accessibility validation by using an accessibility checking tool and manual evaluation by using the screen reader. The manual evaluation focused on four criteria: availability of an accessibility tool, zooming behavior, navigation, and contrast. The validation results show that all websites have accessibility errors. The manual evaluation confirmed the low accessibility since none of the websites meets all accessibility criteria.

Keywords

accessibility checking tools, web accessibility, WCAG2, university websites.

ACM Classification

D.2.2: Design tools and techniques. H5.2 User Interface.

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INTRODUCTION

Equal access to digital services and content for all citizens is the main goal of the European Disability Strategy [6]. One in six people in the European Union (EU) has mild to severe disability, and this ratio is likely to increase in the future since the population is aging [COM10].

A Web Accessibility Directive (WAD) of the European Parliament and Council has been issued that requires the accessibility of the public web by September 2020 [7]. In turn, this requires the identification and removal of barriers affecting their use by people with disabilities. Member states were supposed to transpose the WAD into national legislation by 23 September 2018.

The directive has been recently evaluated after three years of its application. [16]. An e-government benchmark report showed that only 16% of analyzed websites passed all stated accessibility criteria. Finally, the evaluation report concluded that it is important to raise public awareness since there is still little use of the feedback mechanism [16].

Poor web accessibility has negative effects as regards the inclusion of citizens in the provision of online services. In this respect, the accessibility of university websites should ensure fair access to education for all young people. In this study, the target users are people with visual impairment.

This work explores the accessibility of four university websites. Since providing equal access to higher education starts with accessible information regarding the admission exam, the evaluation includes both the university home page and the admission webpage.

The next section presents the web accessibility guidelines and some related work in the accessibility evaluation of university websites. Then, the accessibility evaluation results are presented for each case study. The paper ends with the discussion, conclusion, and intention of future work.

WEB ACCESSIBILITY

Web accessibility guidelines

The second version of web accessibility guidelines was published in 2008, and since then, it has been the reference for web accessibility. WCAG2 defined three levels of conformance (A - lowest, AA, and AAA - highest) [20]. According to the Web Accessibility Directive, the AA level of conformance is required for the public web in Europe.

The accessibility model of WCAG2 has a hierarchical structure that is based on four principles: perceivable, operable, understandable, and robust [20]. For each accessibility principle, several accessibility guidelines have been defined. For each guideline, several success criteria have been defined (lower-level accessibility guidelines).

Various techniques have been defined for each success criterion. The WCAG2 techniques guide developers and evaluators on how to meet the success criteria. There are three types of user guidance: enough techniques, advisory techniques, and failures.

Accessibility evaluation tools are software programs or online services that can automatically check the content against WCAG2 techniques. Evaluation tools differ in many respects: accessibility guidelines used, techniques tested, error classification and reporting, and supported technologies.

International and national regulations

Article 9 of the Convention on the Rights of Persons with Disabilities represents a starting point in international legislation on the recognition of the rights of persons with disabilities, which recognizes the right to have access to accessible information both in physical form and online. *"States Parties shall take appropriate measures to ensure to such person's access, on an equal basis with others, to the physical environment, transport, information and means of communication, including information and communication technologies and systems, and other*

facilities and services open or provided to the public, in both urban and rural areas."[18]

The European legislation described by Directive No. 2016/2102 extends the level of accessibility from websites to mobile applications developed by the public sector [7]. Web developers must consider the WAI (Web Accessibility Initiative) recommendations as a guide in creating page accessibility [19].

Since 2006, Law 448 on the protection of the rights of persons with disabilities states in Article 71 that public institutions must make their websites and public documents accessible. In 2008, the Ministry of Communications and Information Society published the first guide on Making web pages for central and local government in Romania, which includes a separate chapter on web accessibility.

In 2017 the Ministry of Public Consultations and Social Dialogue published the Guide for making accessible the web pages of public institutions in Romania [13]. The guide repeats the WCAG 2.0 recommendations and provides general recommendations on the three levels A, AA, and AAA, but it does not offer concrete, practical solutions, as developers should consult the WCAG (Web Content Accessibility Guidelines) developed by the W3C (World Wide Web Consortium). WCAG provides guidelines and basic principles for creating accessible web pages.

RELATED WORK

Gupta & Singh [8] analyzed the readability, accessibility, and web security of 27 university websites in Punjab. Their results showed that none of the websites meets the accessibility level required by WCAG2. Most frequently, errors were related to alternative text for images, form labels, titles, and link descriptions.

The study of Ahmi & Mohamad [1] evaluated the web accessibility of all Malaysian public university websites with AChecker and WAVE. Most errors were related to available functionality from the keyboard, navigation issues, and lack of text alternatives for non-text content.

Ismailova & Inal [10] analyzed the accessibility of university websites in four countries by using the automated assessment tool AChecker. The results showed that in all countries, most of the websites didn't pass the WCAG2 A accessibility level.

The study of Alim [4] explored the accessibility of the home pages of 66 research-intensive universities in the UK. Three automated tools have been used: WAVE, TAW, and EIII. The most common errors were related to contrast issues (level AA) and three WCAG2 success criteria: non-text content (1.1.1), info and relationships (1.3.1), and link purpose in context (2.4.4).

Recently, the study of Akram et al. [2] reported on the compliance of Arabic university websites with WCAG2. The accessibility of 33 websites has been analyzed by using TAW and aChecker automated tools. They found that more than half of websites do not provide an alternative text to non-text content.

Macakoglu & Peker [12] analyzed the web accessibility of 58 university hospitals in Turkey by using TAW and DeadLink Checker tools. The evaluation has been done

against WCAG2, and their results show that the most frequent errors are related to three success criteria: not-text content (1.1.1), info and relationships (1.3.1), and link purpose (2.4.4). They also found that most websites had five or more broken links.

Ismail & Kuppusamy [9] analyzed 44 college websites in India by using TAW and aXe-Easy checking tools. The most frequent violations of WCAG2 were related to a lack of text alternatives for non-text content, color contrast, and link text. Almost half of the reported issues are related to the first accessibility principle.

Laamanen et al. [11] tested 38 homepages of Finnish universities by using WAVE and Siteimprove accessibility checking tools. The results showed low accessibility, with an average of 65 errors per institution detected with WAVE, with a maximum of 1 and a maximum of 704. The most frequent errors were color contrast issues, link purpose issues, and lack of text alternatives.

A recent study [3] analyzed the accessibility of 58 Saudi university websites by using four tools: AChecker, WAVE, and SimilarwebPageSpeed Insights. The results showed that only 8% of these passed the WCAG2 accessibility level, and 95% performed poorly.

There are only two reports targeting the accessibility of Romanian university websites. In 2013, Cojocar & Guran [5] analyzed the accessibility of 12 Romanian university websites and found several errors, most websites having barriers for visually impaired users as regards the perceivability principle. All websites had errors related to the lack of alternative text for images and the lack of labels associated with controls.

A more recent study targeting 18 Romanian university websites showed that none of these meet the WCAG2 AA level of conformity [15]. The largest number of errors (49.8%) was related to the fourth accessibility principle (compatibility). The violations of the second accessibility principle (perceivability) accounted for 37.3% of the total number of errors, most of them (30.6%) being related to the lack of text alternatives for non-text content.

WebAIM report [21] showed that from the accessibility analysis of the first one million websites, about 50.8% of websites have errors on the home page. The number of complex elements on the front page has increased considerably by 10% compared to the previous year. Of the total number of pages analyzed, 96.3% of home pages had WCAG 2 failures. Among the most common errors identified were low contrast, missing or poor alternative text, missing links, missing form labels, unlabeled buttons, and lack of language localization of pages. The conclusion of the report shows that some sectors, such as public administration and education, have improved the accessibility of their websites. The number of educational pages analyzed was 53,415, with an average of 42.9 errors, 14.1 fewer than the previous year.

EVALUATION RESULTS

Method and tool

The analysis has been done on four universities that are members of the Universitaria Consortium: the University of

Bucharest, "Babeş-Bolyai" University of Cluj-Napoca, "Alexandru Ioan Cuza" the University of Iaşi, and the West University of Timișoara.

The web accessibility was analyzed in May-June 2023. For each case, the home page and the admission page have been evaluated for conformance against WCAG2.

In the first step, accessibility evaluation was done by using accessibility checking tools. Several checking tools are available, each one having strengths and weaknesses [14]. In this study, Total Validator has been selected that enables content validation against WCAG 2.0, HTML5 validation, parsing errors, link errors, and CSS 3 analysis. A reason to select this tool is to enable a comparison with previous data. Only WCAG 2A and WCAG 2AA levels of compliance have been considered. Additionally, the number of links and heading structure have been analyzed.

Then, the web pages have been manually examined using the screen reader. Four specific accessibility criteria have been used: availability of a dedicated accessibility tool, zooming behavior, navigation issues, and contrast.

The results are reported by each university and discussed by the accessibility principle and guideline/success criterion. The number of WCAG 2AA errors was mentioned (if any). Finally, the summary of the results is presented and discussed.

University of Bucharest (UB)

The automated evaluation resulted in 183 WCAG2 errors, out of which 137 (4 level AA) were on the home page and 46 on the admission page. The results are presented in Table 1.

Table 1. Validation errors

Categories	WCAG2	Parsing	Link	HTML
Home page	137	0	6	121
Admission page	46	0	3	72
TOTAL	183	0	9	193

The most frequent errors on the home page are related to the use of tags vs. CSS (64), text describing link purpose (24), text alternative (11), and table issues (10). The most frequent errors on the admission page are related to the text describing link purpose (21), improper heading ordering (14), and use of tags vs. CSS (5).

The website is accessible when browsing with a screen reader, but many different links have the same message. This is confusing when you want to browse through the list of links. The admissions files, bachelor and master level, are accessible when reading with a screen reader.

The contrast between text and background is relatively average (on a scale of 1 to 3 - ineffective, effective, and very effective), grey text with white background in the event area makes visual perception difficult. The text is small, and in the video gallery area, the text is positioned on the images.

The page has a logical and easy-to-follow structure. The links are easy to follow, and when increasing the text size to 200% and 300%, the elements on the page reorganize efficiently. Page elements do not mix and overlap. The cookie acceptor module positioned at the bottom of the

page remains permanently active, which reduces a little visibility or can become inconvenient.

On the admission page, the main menu is colored in shades of green - yellow, and the contrast with the white text makes the content harder to read in the yellow area. Some buttons have a very good contrast (white/yellow text on a black background) which makes the identification and visibility of items very good. In the news area, due to the blurring of images with a green tint, makes white text more difficult to read.

On the main page and the admission page, we did not identify any accessibility module. Increasing the size of elements to 200% and 300% made visual navigation poor. The banner and the main menu are not static, nor can they hide, which reduces the amount of information and the possibility of finding information on the page. Automated analysis and the number of errors reported are observed when browsing the web pages analyzed.

West University of Timisoara (UVT)

Automate evaluation resulted in 76 WCAG2 errors, out of which 30 (2 level AA) were on the home page and 46 (6 level AA) on the admission page. This is surprising, given the higher complexity of the home page. The results are presented in Table 2.

Table 2. Validation errors

Categories	WCAG2	Parsing	Link	HTML
Home page	30	1	9	51
Admission page	46	1	8	40
TOTAL	76	2	17	91

The most frequent errors on the home page are related to the text describing link purpose (21) and improper heading ordering (2). Most frequent errors on the admission page are related to the text describing link purpose (21) and form control issues (6).

When browsing with the screen reader, the first page is full of information and news, which creates discomfort in navigating the important information. The screen reader allowed the identification of buttons and graphics that are not defined, links with abbreviations, and the movement used as a shortcut to the titles with defined headings deficient. From a screen reader navigation perspective, the elements are inconsistently organized.

The UVT home page uses a specific add-on for accessibility, which can be enabled/disabled by shortcut testing (Ctrl+U). The facilities offered are not only specific to the low-vision user but also to other categories of users with disabilities. Some elements allow the site to be adapted visually for users with specific learning disabilities, such as dyslexia. Thus, they can adjust the spacing of text and lines, align text to the left, and use a specific font - easy to read.

There are elements dedicated to users with attention deficits by stopping animations or hiding images. In addition to these features, there are also elements to zoom in/out text, change cursor, change text/background contrast, reduce color saturation, highlight links, and change cursor size. This is a very useful add-on, and only this site has it.

The site retains the accessibility settings adjusted with the installed tool. When adjusting the size of text/page elements

in the tool, the page elements do not overlap each other, nor when using the zoom function of the browser.

However, we sometimes notice an ineffective contrast between the background and the text on the site (white background, grey text), which leads to poor readability of the text. The site is responsive and easy to follow. On the admissions page, the accessibility tool is no longer active, and the size adjustment in the browser causes the elements on the page to overlap the buttons. The contrast is effective.

Babes-Bolyai University (UBB)

The automated evaluation resulted in 51 WCAG2 errors, out of which 30 (2 level AA) were on the home page and 21 on the admission page. The results are presented in Table 3.

Table 3. Validation errors

Categories	WCAG2	Parsing	Link	HTML
Home page	30	3	4	25
Admission page	21	1	1	53
TOTAL	51	4	5	58

The most frequent errors on the home page are related to navigation issues (12), text describing link purpose (7), and labels of controls issues (3). The most frequent errors on the admission page are related to the text describing the link purpose (15) and text alternative (3).

The low number of errors analyzed also reflects a simple and intuitive navigation of the page. The contrast of the text with the background is effective, both on the page and within the main menu. The text is constructed, and the structure of the information is logical.

On the main page, we can identify a dedicated module for visually impaired visitors. The module allows increasing and decreasing font size, changing contrast, reversing colors, highlighting links, and adjusting text in uppercase. Increasing the text size makes images blur and elements on the page blur and overlap, making navigation very difficult. Resetting the mode and returning to its facilities makes navigation very difficult as the mode reverts to the initial settings before resetting.

Zoom navigation is much more browser efficient, even at 200% or 300%. Page elements adjust very efficiently, do not overlap each other, and allow very efficient navigation and interaction.

The accessibility module is not on the admission page, which has an efficient contrast with easy and intuitive navigation, easy-to-follow elements, and graphics. The browser size adjustment allows efficient navigation for the visually impaired user.

AI Cuza University of Iasi (UAIC)

The automated evaluation resulted in 44 WCAG2 errors, out of which 27 (6 level AA) were on the home page and 17 (1 level AA) on the admission page. The results are presented in Table 4.

Table 4. Validation errors

Categories	WCAG2	Parsing	Link	HTML
Home page	44	0	152	73
Admission page	27	0	6	36
TOTAL	17	0	158	109

The most frequent errors on the home page are related to text alternatives (6), text describing link purpose (6), and table issues (10). The most frequent errors on the admission page are related to navigation (6), heading text issues (4), and text describing link purpose (3).

When navigating on the first page, 2-3 unlabeled buttons can be identified in the search field area, and some labels are repeated.

On the admission page, we notice that the navigation mode is altered by the organization of the headings, which have an unorganized order, e.g., H2, followed by H1. The page is not localized for Romanian, and the screen reader renders both Romanian and English labels, as well as characters that are positioned without indicating or representing anything specifically.

The home page and admissions page do not have an integrated module for visitors with various disabilities. As shown by the number of automatically identified errors, in the navigation, there are a lot of images identified for different links. Adjusting the size and contrast makes navigation easy. The contrast between the background and text is very effective. The graphics do not mix but adjust to the browser size.

On the admission page, the text on the images is easy to read and shows a very effective contrast. In some areas, there is grey text on a grey-white background. The errors identified on the first page are also found on the admissions page through the existence of double-activated links. Some hover link images turn into an orange border, which covers the text in the image and thus hinders access. Image clarity is maintained at 200%-300% zoom.

Summary of results

A summary of validation results is presented in Table 5. The total number of WCAG2 errors varies from 21 to 137, with an average of 44.25 (SD=38.91). As regards the AA errors, it varies from 0 (two pages) to 6 with an average of 2.63 (SD=2.45).

Table 5. Summary of validation errors

Categories	WCAG2	Parsing	Link	HTML
Home page	224	4	171	270
Admission page	130	2	18	181
TOTAL	354	6	189	451

The number of parsing errors is small (M=0.75, SD=1.75). The number of link errors varies from 1 to 152, with an average of 23.63 (SD=51.94). The number of HTML varies from 25 to 121, with an average of 53.38 (SD=31.49).

A summary of errors by accessibility principle is presented in Table 6. Most errors are related to the first accessibility principle: making the web page perceivable by visually impaired users.

Table 6. Errors by accessibility guideline

Accessibility principle	No.	%
1. Perceivable	287	81.07
2. Operable	44	12.43
3. Understandable	11	3.11
4. Robust	12	3.39
TOTAL	354	100.00

The most frequent errors by accessibility guidelines are presented in Table 7.

Table 7. Errors by accessibility guideline

Categories	No	%
1.1.1 Text alternatives		
Text alternative for non-text content	21	5.93
Describing link purpose	118	33.33
Controls without labels	18	5.08
Use of tags instead of CSS	74	20.90
1.3.1 Info & relationships		
Table name issues	5	1.41
Improper heading ordering	27	7.63
2.4 Navigation issues		
Stuttering effect	22	6.21
Unique labels	20	5.65
Other guidelines	49	13.84
TOTAL	354	100.00

The most frequent errors are the lack of text describing the link purpose, the use of tags instead of CSS, and improper heading ordering. The number of errors related to the first accessibility guideline – 1.1.1 text alternatives – accounts for 65.25% of the total.

A summary of the manual evaluation results that have been analyzed in previous sections is presented in Table 8, where ok means an acceptable level of accessibility.

Table 8. Number of errors per web page

Accessibility issue	UB	UVT	UBB	UAIC
Accessibility tool	no	yes	yes	no
Zoom behavior	ok	ok	ok	ok
Navigation	poor	ok	poor	ok
Contrast	ok	poor	ok	ok

A positive aspect is the good Zoom behavior of all websites. Two of the websites have an accessibility tool. Although, in one case, the add-on is very effective, it is only available on the home page. Two of the websites have navigation issues, and another website has contrast issues.

Discussion

The results of the four case studies show that none of the eight web pages pass the WCAG2 criteria. The number of WCAG2 errors on the eight web pages is presented in Table 9. As regards the level AA errors, 14 were on the home pages and have been found on the home pages and 7 on the admission pages.

Table 9. Number of accessibility errors per web page

University	home	admission
University of Bucharest	137	46
Vest University of Timisoara	30	46
Babes-Bolyai University	30	21
AI Cuza University of Iasi	27	17
TOTAL	224	130

As could be noticed, the admission web page is more accessible in three case studies, and the number of errors is relatively low, varying between 17 and 46. However, in all cases, the admission webpage does not meet the WCAG2 requirements.

A comparison of the four home pages evaluated five years ago is presented in Table 10.

The total number of errors in 2023 is lower, but this is biased by the large number of errors on one webpage in

2018. The first university is less accessible, while the last two are preserving the accessibility of five years ago.

Table 10. Comparison with previous data

University	2018	2023
University of Bucharest	88	137
Vest University of Timisoara	543	30
Babes-Bolyai University	22	30
AI Cuza University of Iasi	36	27
TOTAL	678	224

As regards the manual accessibility evaluation, three of the websites have either navigation or contrast issues. Only two of the websites have a dedicated accessibility tool. Overall, the accessibility of the four websites is still low and should be improved.

CONCLUSION AND FUTURE WORK

Website accessibility is not only relevant to people with severe disabilities but web accessibility benefits all users, regardless of ability. For example, clear text and high contrast can be useful for people with low vision but also for users with mobile devices in bright light. Accessibility can also bring long-term benefits, such as increased readership and improved user experience. Accessibility is not just about adding textual alternatives to images but about creating information structures that are easy to navigate. There are many ways to create accessible websites that are aesthetically pleasing and engaging while maintaining functionality and usability for all users.

The errors identified represent violations of specific accessibility standards and may affect the ability of users, particularly those with disabilities, to access and navigate the site effectively.

We believe that the design of many pages can be improved by following WCAG2 recommendations. For accurate information, page dynamics are essential for promoting institutions but also essential for candidates and students with disabilities. It is necessary to comply with the web pages to WCAG2 standards and possibly to efficiently implement accessibility modules or adjust elements so that problems such as images not described, links not defined or wrongly defined, and text contrast are solved.

At the same time, web developers should take into account that users with disabilities often use applications that allow them to adjust pages by default (e.g., changing the contrast in the operating system, using special fonts within the browser, using a screen reader with the language already localized).

By fixing these bugs and achieving WCAG compliance, the website can provide a more inclusive experience for all users, improving usability and access and ensuring equal access to information and services. Conducting a comprehensive accessibility audit and seeking guidance from accessibility experts can help fix these errors and ensure a more accessible and inclusive web experience for all users.

Online accessibility includes not only the elements of page navigation but also the elements that make up the page. In the future, we plan to analyze the accessibility of online forms and files (e.g., accessibility of PDF, video, and audio files). In the academic year 2022/2023, according to the

Ministry of Education, 1101 students with different disabilities were reported in universities in Romania. Educational institutions, as well as public institutions, need to adapt their online information content alongside the physical content to increase the inclusion of students with disabilities at the university educational level.

This study is exploratory and is not without limitations. First of all, only four websites have been analyzed. Second, only one checking tool has been used. Third, the manual evaluation focused on only four criteria that are of interest to visually impaired users. Future work will extend the criteria used in the manual evaluation and will enlarge the sample to enable a comparison with previous data.

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