http://doi.org/10.35784/iapgos.4459 *received: 30.08.2023 | revised: 09.10.2023 | accepted: 01.12.2023 | available online: 20.12.2023*

AN ANALYSIS OF THE IMPLEMENTATION OF ACCESSIBILITY TOOLS ON WEBSITES

Marcin Cieśla, Mariusz Dzieńkowski
Lublin University of Technology, Department of Computer Science, Lublin, Poland

Abstract. *The websites of higher education institutions, due to the fact that they are addressed to multiple stakeholder groups, not only need to have an appropriately designed information structure but must also be useful. Additionally, in the case of public universities, their services are expected to be accessible to the widest possible audience, especially for people with disabilities. The accessibility tools used on websites should be quickly located, easily identifiable and user-friendly. So far, no standards have been developed regarding these issues, and therefore, there are various solutions on the web. The objective of this study is to analyze various implementations of accessibility tools on university websites in terms of their location, form of presentation and ways that enable access to them. A study was conducted in which web interfaces were evaluated with the participation of users. The experiment consisted of two parts: the first one used the eye tracking technique, whereas in the second one, a survey was conducted. The research material was prototypes of websites from four different universities. Each website had two versions differing in implementation of accessibility tools. In the study, 35 participants were divided into two groups of people. Each group was shown one of the two sets of website prototypes and the users were tasked with finding and activating a specific accessibility tool. After exploring the websites, each participant completed a questionnaire that pertained to their opinions regarding aspects such as appearance, placement and a way to access tools dedicated to people with disabilities. The obtained data, processed to the form of heatmaps and fixation maps, were subjected to a qualitative analysis. The survey results and eye tracking data were analyzed quantitatively. On the basis of performed analyzes it can be concluded that the following factors have an impact on the reduction in efficiency and productivity of users: placement of accessibility tools on university websites in a place other than the upper right corner, an indirect access to these tools or their non-standard appearance.*

Keywords: web accessibility, web usability, eye tracking, A/B tests

ANALIZA IMPLEMENTACJI NARZĘDZI DOSTĘPNOŚCI NA STRONACH WWW

Streszczenie. *Strony uczelni wyższych ze względu na fakt, że są skierowane do wielu grup interesariuszy, oprócz tego, że muszą mieć odpowiednio zaprojektowaną strukturę informacji, to muszą być także użyteczne. W przypadku publicznych uczelni wyższych oczekuje się, że ich serwisy będą dostępne dla jak największego grona odbiorców, w szczególności dla osób z niepełnosprawnościami. Stosowane w serwisach narzędzia dostępności powinny być szybko lokalizowane, łatwo identyfikowane i proste w użyciu. Jak dotąd nie opracowano standardów dotyczących tych kwestii i w związku z tym istnieje w sieci wiele rozwiązań. Celem pracy jest analiza różnych implementacji narzędzi dostępności w serwisach WWW szkół wyższych pod względem ich rozmieszczenia, formy prezentacji oraz sposobów, które umożliwiają do nich dostęp. Zrealizowano badania, w których dokonano oceny interfejsów webowych z udziałem użytkowników. Eksperyment składał się z dwóch części: w pierwszej wykorzystano technikę eyetrackingową, natomiast w drugiej ankietowanie. Materiał badawczy stanowiły prototypy stron internetowych czterech różnych uczelni wyższych. Każdą ze stron opracowano w dwóch wersjach różniących się implementacją narzędzi dostępności. W badaniu wzięło udział 35 osób podzielonych na dwie grupy i zastosowano testy A/B. Każdej grupie zaprezentowano jeden z dwóch zestawów prototypów stron, a użytkownicy musieli odnaleźć i wykorzystać konkretne narzędzia dostępności. Następnie badani wypełniali ankietę, która dotyczyła preferencji odnośnie sposobu prezentacji narzędzi dedykowanych osobom niepełnosprawnym, w tym aspektów dotyczących wyglądu, rozmieszczenia oraz sposobu dostępu do nich. Pozyskane dane przetworzone do postaci map cieplnych i map fiksacji poddano analizie jakościowej. Wyniki z ankiet oraz dane eyetrackingowe przeanalizowano w sposób ilościowy. Na podstawie przeprowadzonych analiz możliwe jest stwierdzenie, że następujące czynniki mają wpływ na spadek efektywności oraz produktywności użytkowników: rozmieszczenie narzędzi dostępności na stronach uczelni w miejscu innym niż prawy górny róg, pośredni dostęp do narzędzi, czy też niestandardowy wygląd.*

Słowa kluczowe: dostępność stron internetowych, użyteczność stron internetowych, eyetracking, testy A/B

Introduction

Accessibility of web applications is one of the frequently discussed topics in recent years. With the increasing number of people using online services, there is also a growing population of users with disabilities. An important aspect of application development is considering their implementation in terms of adapting functionality to the needs of users, particularly those who may have difficulties accessing information.

With the development and popularization of internet services, there has been increased awareness among programmers and interface designers about the need to provide solutions, that facilitate user access to information. A breakthrough step was the definition of Web Content Accessibility Guidelines (WCAG) [2] issued by the Web Accessibility Initiative in 1999. They are based on four principles: perceivability, functionality, understandability and robustness, which describe the goals and practices of presenting content on websites in an accessible manner to users.

Web developers implement solutions that make it easier for users to access website resources. Among these are elements referred to as accessibility tools. Thanks to their use, the accessibility of information is continuously expanded to an increasingly wider audience, including individuals with disabilities. In order to unify and ensure equal access do data, many documents were defined specifying the requirement to use tools, including to change font type, contrast, displaying tooltips and text-to-speech capabilities. In Poland, one of such documents is the applicable Act from 2019 on the accessibility of applications of public entities, which must comply with the WCAG 2.1 guidelines at level AA.

Websites of state universities belong to the group of services that are required to ensure accessibility. Most universities follow their own practices when creating applications, such as different designs or arrangement of accessibility tools. In addition to ensuring functionality, a crucial aspect of interface design is implementing it in a clear and understandable manner for the users. A common challenge for users is the inconsistent appearance of buttons that perform the same functions. The diverse approaches of web developers to ensure usability stem from the lack of clearly defined guidelines for designing user-friendly websites.

The usability of the interface can be achieved through the use of developed design methods. An approach gaining popularity is user-centric design described by Donald Norman and defined in 1999 as ISO 13407:1999. The software development process is based on the study of a group of people, who are end users, in terms of requirements, assessment and experience related to their experiences with the system, application or service. In the case of usability assessment, the most important of the four stages of the design process is the last one, namely testing. It is based on the collection and verification of the respondents' experiences of using the application according to the developed tasks.

The aim of the work was to analyze public websites of universities in terms of the impact of the implementation of accessibility tools on the effectiveness of user interaction. At the beginning, a review of existing solutions on 20 selected

university websites was carried out and the most commonly used approaches for presenting accessibility tools were identified. Afterwards, four page templates were prepared in two versions of the implementation of accessibility tools with regard to the arrangement, colors and applied graphic symbols of icons. A research scenario consisting of tasks concerning two versions of pages with different implementation of accessibility elements was developed. The scenario was used during the eye tracking study. Following that, participants of the experiment completed a questionnaire pertaining to their preferences regarding the presentation and implementation of accessibility tools. Based on the analyses, it turns out that a large number of websites have accessibility problems and do not meet the guidelines [13].

1. Literature review

Numerous studies have been conducted selected websites were evaluated according to defined accessibility recommendations. The authors of the paper [1] presented an empirical analysis of five selected government websites. A group of 25 visually impaired individuals was involved in the study. Each participant was tasked with completing the prepared instructions covering the issues of accessibility and assessing the difficulty of their performing on the basis of a five-point scale.

An important and growing group of people are elderly users. Some adults struggle with difficulties arising from, among other things, deterioration of vision, motor skills, and cognitive abilities [7]. Based on conducted studies [2, 9] regarding activities on educational websites and the activity of Internet creators, the need to provide solutions for easy navigation on the web has been justified. In addition to the issue of accessibility and the issue of usability is also emphasized. It mainly concerns the way content is presented and the implementation of functionality in such a way that it facilitates the use, navigation and retrieval of information by users [8]. The paper [6] discusses aspects of web application development based on a user-centered approach. The layout and content organization of the page template were analyzed in terms of navigation and content arrangement. The importance of two issues was emphasized: the consistency of the arrangement of elements and their intuitiveness. The significance of implementing data search functionality was also highlighted.

There are different views among researchers regarding the issues of accessibility and usability. According to some, accessibility derives from usability, as shown in the work [12]. In addition to defining and analyzing usability, a large portion of research focuses on methods of evaluating it. The most commonly used approaches are heuristic analysis and user testing [4]. Both approaches complement each other and allow to detect different problems. Unlike heuristics, checklists allow detection of accessibility errors such as visibility of elements or memorability through interaction with the application. The paper [5] presented the results of a review on the usage of evaluation methods and it was found that in as many as 69% of cases, manual methods such as surveys were employed.

One of the increasingly used methods of usability evaluation is the eye tracking technique. It involves recording eye movement and collecting data on how users focus their eyes on elements of the website's or application's content. To conduct the study, a research group is engaged with the task of carrying out designated instructions involving various activities, such as finding selected information [3, 11]. The results of the experiment are presented in the form of heat maps, which makes it easy to determine the most visited places within the site and verify the actions taken by the user. Unfortunately, there are also doubts about the accuracy of the data obtained [10]. The recorded activity does not always imply intentional behaviour, but only drawing attention to a particular functionality or interesting design.

Both accessibility and usability are increasingly discussed topics in the field of web applications. Currently, many interfaces of websites and web applications, as well as mobile applications, are analyzed for usability and compliance with the developed guidelines. Various methods are used for this purpose, often combining two methods to increase the credibility of the evaluation.

2. Methods

The usability study of accessibility tools was divided into three stages. The first one of them was the analysis of 20 selected websites of higher education institutions in terms of the diversity of presentation of those tools. Based on the identified approaches, interface prototypes were developed, taking into account the applied solutions. Then, tasks were prepared to be performed by users during the designed experiment using the eye tracking technique. In the last part, the respondents filled out a questionnaire, which concerned the evaluation of the implemented solutions and the ease of interaction with the prototypes of the pages into which these tools were embedded.

2.1. Review of existing solutions

The main criteria considered in the review of the applied solutions were the layout, color scheme and the way they were presented in the form of icons identifying the various tools and their functions. Some of the most common solutions were implementations of tools that allow users to change font size, contrast and content search. Less common ones included link highlighting, modifying word spacing, friendly text, reading guide or sign language interpreter (table 1).

Table 1. The number of university websites that include individual accessibility tools varies

Accessibility tool	The number of implementations
Contrast	18
Font size adjustment	19
Link highlighting	5
Adjusting letter spacing	4
Reading mask	3
Reading guide	3
Easy-to-read text (font type change)	6
Sign language interpreter	3

Grouping elements is one of the factors that can influence the effectiveness of their utilization. Tools are stored in a separate panel, which can be accessed via a button, thus increasing the free space on the page. This approach requires the creation of additional symbols – icons that give access to the menu with accessibility tools. The above solution has been implemented in 9 university websites, such as the University of Life Sciences in Poznan and Opole University of Technology. Such an approach was necessary due to the fact that the websites of these universities offer a wide range of accessibility tools – expanded panels have up to 10 different types of tools. However, some universities still limit themselves to only two accessibility elements, namely changing the size of the text and changing the contrast. An example of this could be the website of the University of Life Sciences in Wroclaw.

Intermediary buttons/icons that launch a drop-down menu or open a panel with accessibility tools usually include a graphic symbol representing a person in a wheelchair. Icons with the symbol of an eye or eyelid are also used, which are sometimes combined with the word Dostępność. The A+ symbol has been used on the websites of the University of Bialystok and the University of Life Sciences.

After analyzing the university's pages, it can be concluded that there is a wide variety of markings among the accessibility tools used. The font resizing element is dominated by the use of three, increasing letters A with optional additional characters, such as A+, A++, A-, A-- and A+, A-. Less commonly encountered designations include Ab- and Ab+. Similar in appearance markings are used for contrast change tools. The letter A symbol placed in squares with a background in one of three colors (black, yellow, white) and a circle divided into two

parts – dark and light – are the two most popular graphic forms used for this element.

Another considered issue regarding accessibility tools on websites was their placement. The problematic location of these tools can contribute to the difficulties that arise in finding them. Conducting a review of selected sites led to several findings (table 2). The typical location of these types of tools is the top part which is usually a section of the header. On the other hand, considering the horizontal location, it is usually the right side or, less frequently, the middle. The exception is the website of the University of Gdansk, where the accessibility panel is located on the left, just below the header, and the Gdynia Maritime University, where the tools are located in the footer.

Table 2. The arrangement of elements on university websites

Criterion	The number of implementations
Top right corner of page	14
Top left corner of page	2
Center of right edge of page	3
Bottom right corner of page	3
Bottom left corner of page	1

2.2. Research objects

The websites of four public universities were selected as the objects of the study: University of Life Sciences in Lublin, Poznan University of Technology, Wroclaw University and Karkonosze Academy of Applied Sciences. Their choice was dictated by the fact that they had a similar interface structure and that their information layer did not contain too much content. Their homepages, or rather their graphics, were used to develop prototypes of pages displayed using a specially developed application. The purpose of this application was to display the prototypes and measure task completion times. Research participants worked with one of two versions of the scenario, during which 4 prototypes of the university's pages were randomly displayed. Before presenting each page, a board with a short instruction containing the content of the braiding to be executed appeared. The two prepared versions (A and B) differed in the way of presenting the tools: the symbols used, the layout, the indirect or direct way of access. The application displayed the pages in a dynamic way, and participants were expected not only to find the required tool, but also, in some cases, to use the tool. The application responded to the user's actions – changing the font size or contrast.

The first prototype contained the same elements, but they were placed in different locations. Version A of the site provided users with tools in the upper right corner, while version B provided them in the lower central corner. The prototype of Site 2 in both versions (A and B) had the same location of the tools – the lower right corner, but different symbols were used in them. In the case of the next website, the tools were grouped together in both versions. n the A version of the site, access to them is direct, while in the B version it is indirect - when you press on a button/icon, a menu with accessibility items was expanded. A similar situation occurred in the last prototype: indirect (A) and direct (B) access. The pages differed in the location of the elements: top right for version B and top left for version A.

2.3. Research group

The research experiment involved 35 people who were Computer Science students of Lublin University of Technology, both at the undergraduate and graduate level, as well as students of a technical high school with a technical profile. The average age of the respondents was 22. There were 32 men among the participants. Due to the specifics of the experiment (A/B tests), the study group was divided into 2 parts: the first included 18 people, and the second 17.

2.4. Experiment

The task implementation involved performing by participants one of two scenarios, which consisted of 4 tasks. Prior to the experiment, each person was briefed on the purpose and conduct of the study and agreed to participate in it. After the study, the participants filled out a questionnaire in which they evaluated and expressed opinions in relation to the prototype sites and the ways in which accessibility tools were presented on these sites. Table 3 presents the instructions aimed at finding and using the appropriate tools. For both Scenarios A and B, the content of the tasks was identical. During the execution of each task, the time of its implementation was measured.

Table 3. Tasks to be performed by the respondents

Task number	The content of the task
1	Use the tool that sets the page background color to black and the font color to yellow
2	Increase the font size on the page
3	Adjust the page contrast to make the background dark
4	Increase the font size on the page

The experiment was carried out with a Gazepoint GP3 HD eye tracker (figure 1) recording the position of the research participants' point of view while interacting with the prototype sites. The iMotions 9.0 software was used to prepare and implement the experiment. It allowed designing the experiment, performing calibration, recording the course of each participant's research session - recording actions in the interface, and later analyzing the recordings.

Fig. 1. Experiment

After the eye tracking part of the experiment, the respondents completed a questionnaire consisting of eight questions/tasks (table 4). In the user opinion questions, the survey results were expressed on a five-point Likert scale. The gathered information from the participants allowed for the determination of preferences for using accessibility tools.

Table 4. Instructions and questions of the author's survey

No.	The content of the question
1	Determine the best placement of accessibility tools to change contrast and change font size on web pages.
2	Indicate the best font enlargement system on websites.
3	Indicate the best way to present accessibility tools on websites.
4	Indicate the graphic symbol that best represents the accessibility tools used on websites.
5	Will the use of a background containing the university's view make it more difficult to use accessibility tools?
6	Indicate the best way to present the search engine on the website.
7	Indicate the best location of the search engine on the web pages.
8	Indicate the best contrast change system on the website.

3. Results

After conducting the experiment, eye tracker data and survey results were obtained. The eye tracking data was processed in iMotions software. It allowed to generate heat maps and scanning paths and to obtain the values of eye tracking indicators determined in defined areas of interest.

3.1. Measurement of scenario execution times

One of the most commonly used metrics in interface usability studies is task completion time (figure 2). This indicator can be interpreted in such a way that the faster the commands were executed by the participants of the experiment, the higher the efficiency was, and thus the better the quality of the interface.

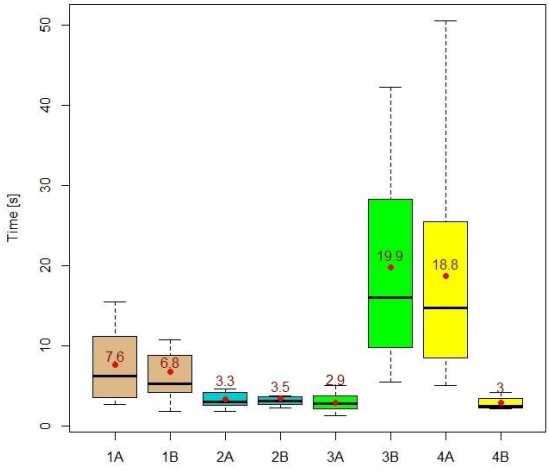


Fig. 2. Task completion times

For page 1, the average task completion times for the A and B versions of the page are comparable - the difference between them was small and amounted to 0.8 seconds. Reaching accessibility tools, normally located in the upper right corner, turned out to be slower than when they were located closer to the center of the page, below the large font text occupying a large area of the page.

For both versions of the second page, the times were almost the same. This was due to the fact that the elements searched for were located in the same place, i.e. in the lower right corner, and the tools differed only in the symbology used.

The execution times for the tasks in the two versions of the third page differed significantly. The difference was 17 seconds. Despite the same location (top right corner of the page), hiding the tool behind the icon and indirect access to the menu with accessibility items proved to be a major challenge for users.
A similar situation occurred in the case of the fourth page – here, too, a significant difference was observed in the execution times for versions A and B. Despite the same location of the tools (top left corner), the use of access via an icon, which, when clicked, expands a menu with tools resulted in a significant increase in the completion of this task. The reason for this can be attributed to the fact that there are additional actions that users need to perform during the execution of this task. These include moving the mouse cursor over the icon and then clicking on it with the mouse cursor.

3.2. Qualitative analysis

Qualitative analysis of the eye tracker results was conducted based on heat maps and scanning paths generated with the iMotions platform. Their preparation required time-consuming analysis of the recordings captured during the tests – marking in each recording the beginnings and ends of the display of successive stimuli. Heatmaps are graphical representations of fixation distribution superimposed on a static stimulus (page prototype). Scan paths, on the other hand, depict the individual activity of people watching or performing an assigned task on the displayed stimulus over time. Scanning paths take the form of different-sized circles representing fixations connected by lines, or saccades, and are superimposed on the displayed static image.

Figure 3 shows two heat maps – the result of visual scanning by the participants. In the case of version A of the site prototype, you can see the maximum concentration oriented in the upper right corner - where the accessibility tools are located. In version B, on the other hand, the hot spot is related to the location of accessibility icons positioned slightly lower from the center of the screen. In addition, the upper right corner of the page is also visibly greened, which is the place where respondents intuitively directed their attention first. This situation is illustrated by the example in figure 4, showing the scanning path for one research participant.

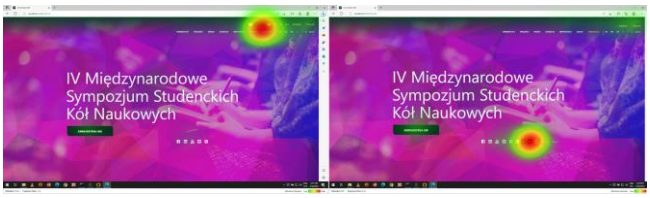


Fig. 3. Heat maps for the A and B versions of page 1

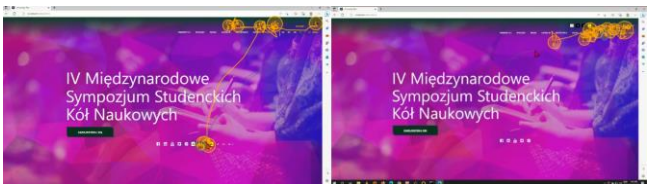


Fig. 4. Scan paths for the A and B versions of page 1

The second example (figure 5) relates to the fourth stimulus, in which the A version of the site includes an icon that allows access to accessibility tools by expanding the list. While the hot area clearly indicates the correct location, there are other places besides it that participants explored before making the final decision that behind the icon with the person in a wheelchair was an accessibility tool to enlarge the font. In the case of Scenario B, also visible is the hot area where respondents identified the target. However, in addition to this red-yellow-green circular area, only one warm green spot is visible - the upper left corner, to which the participants most likely intuitively and first directed their gaze. This conjecture is confirmed by the scanning paths presented in figure 6.

Fig. 5. Heat maps for the A and B versions of page 4

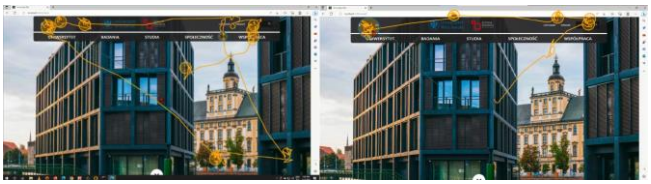


Fig. 6. Scan paths for the A and B versions of page 4

3.3. Quantitative analysis based on eye tracking indicators

The following eye tracking metrics were used for quantitative analysis: average time to first fixation, average number of fixations and average fixation duration. Each of the above metrics relates to a specially designated area of interest (AOI) covering the surroundings of a specific accessibility tool. Figure 7 summarizes the values of times to first fixation in the defined AOI.

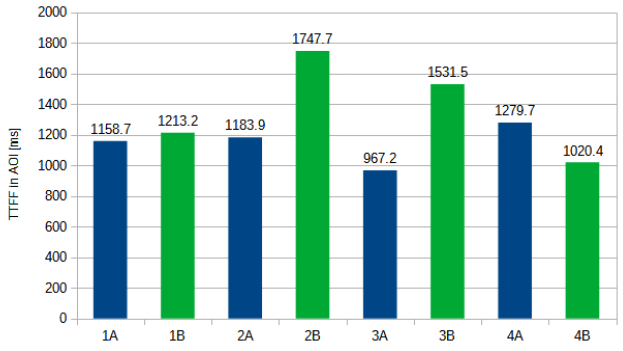


Fig. 7. Average time to first fixation in individual AOIs

Times to first fixation in areas of interest ranged from 967.2 ms to 1747.7 ms. For page 1 in both versions, the times were very similar because the icons searched for had the same distinctive appearance, but a different location. In version A, the accessibility icon was located in the upper right corner – the place where accessibility tools are most often located. The other icon was located in close proximity to the center of the page. In the case of page 2, the task completion times were clearly different, although the location of the tools was almost the same – the lower right corner. Additionally, the icons differed slightly in symbolism. The heat maps for the B version of the page show that the participants also observed other locations and elements of the page on their way to the target, such as the upper right corner and the icons for changing the language. This relatively large difference in average times to first fixation is puzzling in that the task completion times are similar. On page 3, the average time to first fixation was longer for version B, where the contrast change icon was accessed indirectly by pressing the icon with the wheelchair graphic, expanding the menu, and after selecting and clicking on the appropriate option. A similar situation occurred with prototype number 4. Here, too, the average time to first fixation was longer in the situation of indirect access to the target icon.

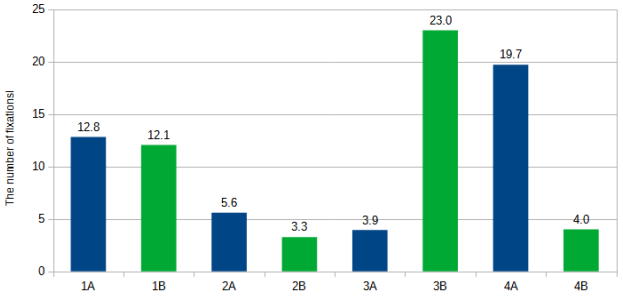


Fig. 8. Average number of fixations in individual AOIs

The next eye tracking indicator, the results of which are shown in figure 8, is the average number of fixations inside the areas of interest defined for each task and each version of the site prototype. The interpretation of this measure is that a higher average number of fixations takes place in those AOIs that include non-informative visual objects. For the prototypes of pages 1 and 2, the levels of this indicator for the A and B versions of the pages did not differ much. In the case of prototype 3, the high average number of fixations on the B version of the page was due to the fact that, on one side, the icon with the person in the wheelchair did not represent the contrast resizing tool but was used to expand the list with options, on which the contrast resizing tool was located. A similar situation occurred on page 4. A higher average number of fixations was encountered when the text resizing tool could be accessed by expanding the list. The higher value of this indicator may also have been influenced by the use of unusual symbolism in the form of tT letters.

The average fixation duration in AOI refers to one fixation (figure 9). This indicator may mean that the information in this area is particularly easy to read and understand, so participants do not need much time to process it. A long fixation time may indicate a high level of interest or task relevance in the context of the AOI.

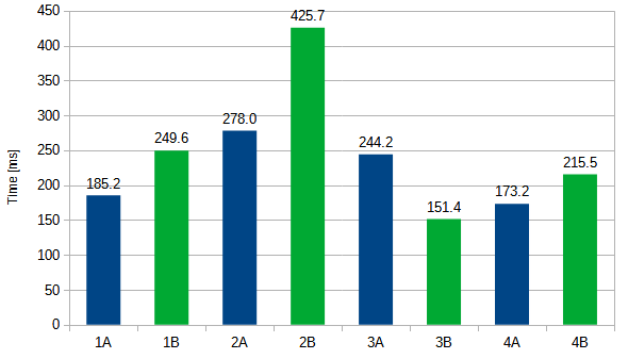


Fig. 9. Average fixation duration in AOI

For page 1, the B version of the prototype contained more icons per line, so participants needed more time to process the complex visual information. The A and B versions of the page 2 prototypes differed in their symbols. In the A version, the average fixation time was shorter because users intuitively chose the largest of the three A letters to reflect the enlarged text than it was in the B version, which used A-|A+ symbols. The longer average fixation duration for the A version of page 3 may indicate the greater relevance of this AOI. The white and black circle is a common symbol used to change contrast, while the wheelchair person icon is not used to change contrast. The results of this measure for the prototype of page 4 are analogous to those for page 3. Here, the same symbolism of a circle with a black and white background was also used, and therefore the average fixation time in this area was longer (version B) than on the tT icon in version A of the page.

3.4. Survey results

In the survey, respondents almost unanimously stated that the standard location for accessibility tools is the top-right corner of the page (figure 10).

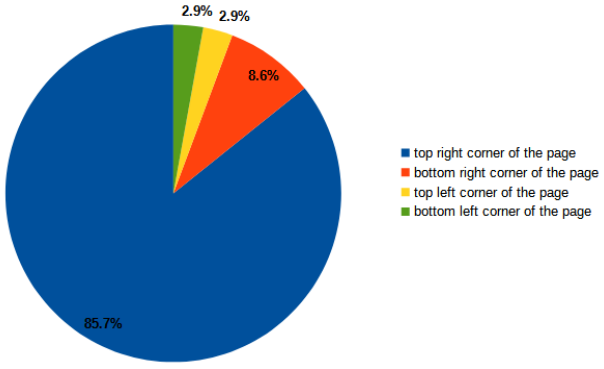


Fig. 10. Results regarding the location of accessibility tools

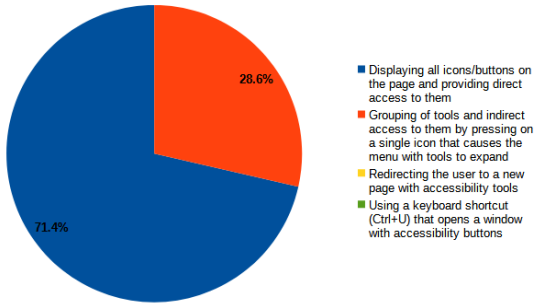


Fig. 11. Results regarding the method of accessing accessibility tools

According to the majority of respondents, when it comes to the method of accessing the elements, it should be direct – by displaying the appropriate graphic symbols in the page area (figure 11). In addition, 28.6% of respondents favored indirect access via a button/icon.

Figures 12 and 13 show the distribution of responses regarding the graphical presentation of accessibility tools. For contrast change items (figure 12), the most intuitive designation according to respondents is the letter A located in a yellow, black or white square. For changing the font size (figure 13), the options associated with combinations of the letter A combined with plus and minus signs were mostly selected. The button representing indirect access to accessibility elements, according to most respondents, should be combined with the word Dostępność in addition to the A+ or eye symbol.

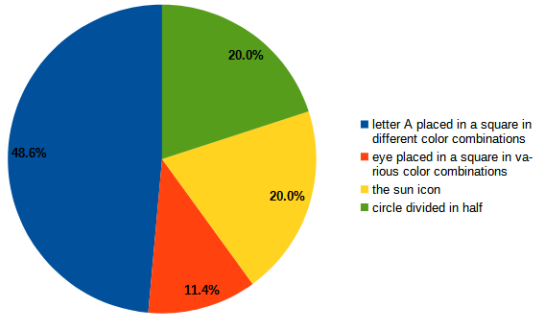


Fig. 12. Results of respondents' opinions regarding the choice of symbol for contrast change

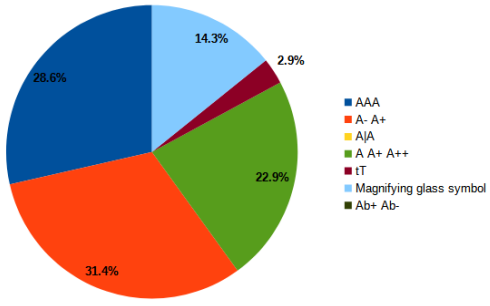


Fig. 13. Results of respondents' opinions regarding the choice of icon symbol for font size change

4. Conclusions

The purpose of the study was to verify the presentation of accessibility tools and its impact on the effectiveness of users working with these tools. On the basis of the collected data, from the experiment conducted using the eye tracking technique and the author's questionnaire, an analysis was carried out, which made it possible to formulate some conclusions and verify the research hypotheses. It turned out that various aspects of the graphical interface of websites, such a the placement of tools, the icon symbolism used and the way of accessing accessibility elements have an impact on the efficiency of people using them. Placing tools in an area of the site other than the top right corner increases the time it takes to locate them. When users enter a website, they first direct their gaze to this place, and only later search the other areas of the site. Another factor that increases the interaction time is the use of indirect access to tools. A single icon representing a button to a hidden panel or a drop-down list containing accessibility tools is more difficult to identify and find than when these tools are clearly located in one place close to each other. On the other hand, too many elements make the user have to look longer to reach a specific tool to find first and then recognize the symbol representing that tool. According to users, for changing the font size, the most intuitive solution is to use the letter A in combination with a plus or minus sign. However, the best way to reach the contrast change tool is to use an icon symbolizing a square with different background colors and the letter A placed inside it. On the other hand, the most effective form of search engine presentation according to respondents is a text field with the word Szukaj and a magnifying glass icon.

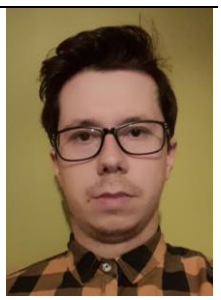
References

[1] Akram M., Bt Sulaiman R.: An Empirical Study to Evaluate the Accessibility of Arabic Websites by Low Vision Users. 8th International Conference on Information Technology and Multimedia (ICIMU), 2020, 206–211.
[2] Algül Y.: Web Accessibility of MOOCS for elderly students: the case of Turkey. Journal of life economics V(4), 2018.
[3] Ehmke C., Wilson S.: Identifying web usability problems from eye-tracking data. 21st British HCI Group Annual Conference on People and Computers: HCI...but not as we know it – Volume 1, 2007, 119–128.
[4] Esmeria G. J., Seva R. R.: Web Usability: A Literature Review. DLSU Research Congress, 2017.
[5] Insfran E., Fernandez A.: A Systematic Review of Usability Evaluation in Web Development. Web Information Systems Engineering – WISE 2008. Springer Berlin Heidelberg, 2008.
[6] Ma H., Zhao H.: Construction of High-Availability Teaching Website. International Conference on Management and Service Science, 2010, 1–4.
[7] Martin-Hammond A., Patil U., Tandukar B.: A Case for Making Web Accessibility Guidelines Accessible: Older Adult Content Creators and Web Accessibility Planning. 23rd International ACM SIGACCESS Conference on Computers and Accessibility, 2021, 1–6.
[8] Matera M., Rizzo F., Carughi G. T.: Web Usability: Principles and Evaluation Methods. Mendes E., Mosley N. (eds): Web Engineering. Springer, Berlin, Heidelberg, 2006, 143–180.
[9] Rodrigues S. S., Scuracchio P. E., de Mattos Fortes R. P.: A support to evaluate web accessibility and usability issues for older adults. 8th International Conference on Software Development and Technologies for Enhancing Accessibility and Fighting Info-exclusion, 2018, 97–103.
[10] Thoma V., Dodd J.: Web Usability and Eyetracking. Klein C., Ettinger U. (eds): Eye Movement Research. Studies in Neuroscience, Psychology and Behavioral Economics. Springer, Cham, 2019, 883–927.
[11] Țichindelean M. et al.: A Comparative Eye Tracking Study of Usability-Towards Sustainable Web Design. Sustainability 13, 2021, 10415 [http://doi.org/10.3390/su131810415].
[12] Vieritz H., Schilberg D., Jeschke S.: Merging Web Accessibility and Usability by Patterns. Computers Helping People with Special Needs. 12th International Conference ICCHP 2010. Procedings 12. Springer Berlin Heidelberg, 2010, 336–342.
[13] Web Content Accessibility Guidelines (WCAG) 2.1. https://www.w3.org/Translations/WCAG21-pl/ (available: 29.11.2022).

M.Sc. Marcin Cieśla
e-mail: marcin.ciesla@pollub.edu.pl

Graduate of the Lublin University of Technology in the field of Computer Science. His research interests include web development and, in particular, JavaScript-based technologies.

http://orcid.org/0009-0004-5736-5948



Ph.D. Mariusz Dzieńkowski
e-mail: m.dzienkowski@pollub.pl

Assistant professor in the Computer Science Department at the Faculty of Electrical Engineering and Computer Science at Lublin University of Technology. His scientific interests include human-computer interaction, eye tracking applications and web application development.

http://orcid.org/0000-0002-1932-297X