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Web Content Accessibility Analysis using the WCAG and ARIA Guidelines

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Abstract: The Web is an important medium for receiving information, providing information and interacting with society. Its importance is in its universality to be accessed by everyone. Accessibility is achieved by following guidelines and usage of different testing tools when designing web sites. The goal of this paper is to examine the compliance of a group of web sites to the WCAG and ARIA accessibility guidelines. To achieve that we are going to give overview of the WCAG and ARIA guidelines and define the requirements needed to achieve accessibility. We are going to use Tenon and Lighthouse automated tools as well as manual testing to test the accessibility of the most visited Macedonian web sites. To find out these sites we are going to use Alexa and SimilarWeb web traffic analytical tools. At the end we are going to discuss and compare the collected results.

Keywords: Web Accessibility, WCAG, ARIA, Accessibility Evaluation Tools, Lighthouse, Tenon

I. INTRODUCTION

People often talk of accessibility as if it meant only “designing for users with disabilities”. Disability is a conflict between someone’s functional capability and the world we have constructed [1]. In this social view of disability, it is the product that creates the barrier, not the person, just as design is at fault when a site has poor usability. This can be expressed as:

$$\text{Ability} + \text{Barrier} = \text{Disability} \qquad (1)$$

Most studies find that about one fifth (20%) of the population has some kind of disability [2]. The major categories of disability types are:

- Visual - Blindness, low vision, colour-blindness
- Hearing - Deafness and hard-of-hearing
- Motor - Inability to use a mouse, slow response time, limited fine motor control
- Cognitive - Learning disabilities, distractibility, inability to remember or focus on large amounts of information

Adopting a practice of accessibility is crucial to avoid creating barriers and thus maximize the accessibility. The W3C Web Accessibility Initiative (WAI) provides a set of guidelines [3-6] that are internationally recognized as the standard for web accessibility. These include:

- Web Content Accessibility Guidelines (WCAG)
- User Agent Accessibility Guidelines (UAAG)
- Authoring Tool Accessibility Guidelines (ATAG)
- Accessible Rich Internet Applications (ARIA)

WCAG and ARIA are most important standards when writing web content and web applications. WCAG [7] is a stable, referenceable technical standard which has 12 guidelines that are organized under 4 principles: Perceivable, Operable, Understandable, and Robust. ARIA [6] is web standard which helps with dynamic content and advanced user interface controls developed with Ajax, HTML, JavaScript, and related technologies. It contains three main features: Roles, Properties and States. Our goal is to examine the compliance of the most visited Macedonian web sites to the WCAG and ARIA standards with priority to the screen reader dependent user group. To achieve this, we are going to start with an overview of the results from screen reader survey and explore more the WCAG and ARIA guidelines. Then we are going to use web analytical sites Alexa and SimilarWeb [9-11] to find out which sites are most visited and what kind of content they serve. We will give overview of Tenon and Lighthouse [12, 13] automated testing tools and use them to test these sites. At the end we will compare the results and discuss them.

II. OVERVIEW

People are all so accustomed to seeing other people wear glasses or contact lenses that they do not think of poor vision as a disability. In the other hand, total lack of vision represents the extreme end of the scale of a condition that is called blindness. Similarly, screen readers are assistive technology which helps to people who have blindness or low vision to

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use information technology with the same level of independence and privacy as anyone else. Web AIM has done seven surveys [14-20] regarding the usage of screen readers. Most of the responders are from North America and Europe. On average more than 92 percent reported that have disability. In Table 1 is displayed summarized data of Web AIM's last two surveys classified by the type of disability. These surveys were done in October 2017 and July 2015 with total number of responders 1792 and 2515 respectively. Not all the respondents have provided answer for all questions. Most of the respondents reported blindness and low vision as major disability. Also, around 10% reported multiple disabilities from which 4% reported being both deaf and blind.

Table I. Disability types

Survey Number	**7**	**6**	**Average**
Year	2017	2015	
Blindness	1358 (75.8%)	1610 (64%)	1484 (70%)
Low Vision	366 (20.4%)	973 (38.7%)	670 (29.6%)
Cognitive	39 (2.2%)	44 (1.7%)	42 (1.9%)
Deafness / Hard of hearing	90 (5%)	157 (6.2%)	124 (5.6%)
Motor	33 (1.8%)	60 (2.4%)	47 (2.1%)
Other	41 (2.3%)	65 (2.6%)	53 (2.8%)

Table II. Primary screen reader

Survey Number	**7**	**6**	**Average**
Year	**2017**	**2015**	
JAWS	811 (46.6%)	743 (30.2%)	782 (44%)
NVDA	555 (31.9%)	360 (14.6%)	355 (19.7%)
Voice Over	204 (11.7%)	188 (7.6%)	175 (9.7%)
Window Eyes	27 (1.5%)	508 (20.7%)	212 (10.3%)
Other	145 (8.2%)	661 (26.9%)	321 (16.25%)

In Table 2 are summarized the results referring to the primary choice of a screen reader. In these two samples of data, JAWS is mostly used before NVDA and Voice over. In the others column are summed the results for ZoomText, System Access/SA To Go, ChromeVox, Narrator, Orca, SuperNova and Speakup. This confirms that the responders mostly use Windows and MacOS as operating systems which are commercial.

A. WCAG and ARIA: Web Content Accessibility Guidelines (WCAG) is developed through the W3C process in cooperation with individuals and organizations around the world. The goal of WCAG is providing a single shared standard for web content accessibility that meets the needs of individuals, organizations, and governments internationally. Current version WCAG 2.0 is a stable, referenceable technical standard also approved as an ISO standard ISO/IEC 40500:2012 [21]. It has 12 guidelines [22] organized in 4 principles:

1. Perceivable
1.1. Provide text alternatives for non-text content.
1.2. Provide captions and other alternatives for multimedia.
1.3. Create content that can be presented in different ways, including by assistive technologies, without losing meaning.
1.4. Make it easier for users to see and hear content.
2. Operable
2.1. Make all functionality available from a keyboard.
2.2. Give users enough time to read and use content.
2.3. Do not use content that causes seizures.
2.4. Help users navigate and find content.
3. Understandable
3.1. Make text readable and understandable.
3.2. Make content appear and operate in predictable ways.
3.3. Help users avoid and correct mistakes.
4. Robust
4.1. Maximize compatibility with current and future user tools.

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There are five requirements that must be met in order for web content to be classified as 'conforming' to WCAG 2.0:

- Conformance level - can be Level A (the minimum level of conformance), Level AA or Level AAA. It basically says that all information on a page conforms or has a conforming alternate version that is available from the page. The requirement also explains that no conformance is possible without at least satisfying all of the Level A Success Criteria.
- Full pages - Conformance (and conformance level) are for full web page(s) only and cannot be achieved if part of a web page is excluded.
- Complete processes - When a web page is one of a series of web pages presenting a process (i.e., a sequence of steps that need to be completed in order to accomplish an activity), all web pages in the process conform at the specified level or better. Example: An online store has a series of pages that are used to select and purchase products. All pages in the series from start to finish (checkout) conform in order for any page that is part of the process to conform.
- Only Accessibility-Supported Ways of Using Technologies - Only accessibility-supported ways of using technologies are relied upon to satisfy the success criteria. Any information or functionality that is provided in a way that is not accessibility supported is also available in a way that is accessibility supported. Example: A picture that is supposed to be clicked on to go to a topic would not be accessible to a person who was blind unless text alternatives for the picture were provided in a way that user agents including assistive technologies can find and display them. The key here is that the text alternative must be included in a way that user agents including assistive technologies can understand and use – in a way that is "Accessibility Supported".
- Non-Interference - technologies that are not accessibility supported can be used, as long as all the information is also available using technologies that are accessibility supported and as long as the non-accessibility-supported material does not interfere. Example: A web page incorporates a new interactive graphic technology called "ZAP". Although ZAP is accessibility-supported, the information that is presented in ZAP is also presented on the page in HTML, so ZAP is not relied upon. So, this page would pass conformance requirement #1. However, if the user tries to tab through the ZAP content, the focus drops into the ZAP object and gets stuck there. Once inside, there is nothing the user can do to get the focus back out. Conformance requirement #5 prevents situations like these from being possible on a conforming page.

Unlike WCAG which defines guidelines to make the web content more accessible, ARIA defines additional set of properties to explain the state and role of complex interface controls. Simple example is tree control or a navigation menu with nested submenus. Another example of an accessibility barrier is drag-and-drop functionality that is not available to users who use a keyboard only and cannot use a mouse. Many web applications developed with Ajax (also known as AJAX) and other technologies pose additional accessibility challenges. For example, if the content of a web page changes in response to user actions or time or event-based updates, that new content may not be available to some people, such as people who are blind or people with cognitive disabilities who use a screen reader. WAI-ARIA addresses these accessibility challenges by defining how information about this functionality can be provided to assistive technology. It provides web authors with:

- Roles to describe the type of widget presented, such as “menu”, “treeitem”, “slider”, and “progressmeter”
- Roles to describe the structure of the web page, such as headings, regions, and tables (grids)
- Properties to describe the state widgets are in, such as “checked” for a check box, or “haspopup” for a menu.
- Properties to define live regions of a page that are likely to get updates (such as stock quotes), as well as an interruption policy for those updates - for example, critical updates may be presented in an alert dialog box, and incidental updates occur within the page
- Properties for drag-and-drop that describe drag sources and drop targets
- A way to provide keyboard navigation for the web objects and events, such as those mentioned above

The current version of WAI-ARIA (1.1) is working draft and extends WAI-ARIA 1.0 to provide a small number of features to complete the HTML + ARIA accessibility model. It has couple of working draft documents [29] from witch the WAI-ARIA technical specification [30] and WAI-ARIA Authoring Practices [31] are crucial for web developers and content writers.

B. Accessibility evaluation tools: Web accessibility evaluation tools are software programs or online services that help determine if web content meets accessibility guidelines. They can be used through all phases of the web design and development process to assist in achieving accessibility. Web Accessibility Initiative, which develops the WCAG 2.0 standards, has compiled a searchable Web Accessibility Evaluation Tools List [8] to make it easier to pinpoint which tools might best meet developer’s needs. We cannot check all accessibility aspects automatically. Human judgement is required. Simple example of human involvement is whether a block of alternative text accurately describes an image or not. On the other hand, accessibility testing tools are known for their false positives and false negatives – they report barriers where there are none, or they ignore existing barriers [23]. Recent study done by United Kingdom’s Government Digital Service [24] introduced 142 accessibility barriers to a page of content and ran them through 13 automated tools. The results were presented in percentage in two categories:

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(1) Percentage of barriers that each tool fully detected on a “pass” or “fail” basis
(2) Potential barriers that tools noticed, but needed a human being to check, like whether alt text descriptions were accurate.

The best performing tool in the first category founded 40% of the deliberate mistakes that has been introduced whereas the worst performing tool only picked up 13%. The best performing tool in the second category picked up 50% of the deliberate mistakes. From [24] the accessibility tool Tenon has founded 34% of the introduced deliberate mistakes where in contrast the Web Accessibility Toolbar by Google only 17%. Because there are no results for the Lighthouse evaluation tool (and it is also developed by Google) we will use it and compare with Tenon on real web sites and examine the reported results.

III. ANALYSIS

As testing target we have chosen the most visited Macedonian web sites. To select them we needed to use some traffic analysis tools. In [25] are listed 10 free web analytical tools which purpose is to measure web traffic but can be used as a tool for business and market research. Analyses of the accuracy of the measured results for some of these tools (Alexa, Compete, DoubleClick and Google Trends) are listed in [26, 27]. The conclusion is that these tools are not 100% accurate [28] but they offer some good data that can be used to compare traffic, learn more about their usage of keywords and see related sites. We used Alexa and SimilarWeb from [25] to choose best ranked Macedonian web sites. In Table 3 and Table 4 are displayed the results for the last three months expressed in format “rank/visits in millions/estimated or verified”.

Table III. Best ranked macedonian websites by alexa

Rank	Site	February 2018	March 2018	April 2018
3 / V	reklama5.mk	0.13M	0.14M	0.14M
4 / V	time.mk	0.13M	0.14M	0.14M
43/E	pazar3.mk	0.76M	0.29M	0.29M
6 / V	femina.mk	0.23M	0.25M	0.24M
7 / V	motika.com.mk	0.22M	0.25M	0.23M
8 / V	crnobelo.com	0.22M	0.25M	0.24M

The rank by country is calculated using a combination of average daily visitors and pageviews from users from Macedonia over the past month. The site with the highest combination of visitors and pageviews is ranked with smallest number.

Table IV. Best ranked macedonian websites by similarweb

Rank	Site	February 2018	March 2018	April 2018
5 / E	reklama5.mk	2.05M	2.05M	1.85M
10 / E	time.mk	3.90M	4.35M	4.05M
15 / V	pazar3.mk	1.54M	1.61M	1.43M
16 / E	femina.mk	1.20M	1.30M	1.15M
20 / E	motika.com.mk	1.15M	1.15M	1.15M
24 / E	crnobelo.com	1.00M	1.10M	1.05M

From the table most of the sites are verified[1] and use Alexa to measure data traffic and visits except for pazar3.com.mk which results are measured using Google Analytics. Both Alexa and SimilarWeb reported similar order of the most visited web sites although most of the results for SimilarWeb are estimated. In terms of the content that is served, these sites belong to three different groups: Trading (reklama5.mk and pazar3.mk), News (time.mk) and Arts and Entertainment (femina.mk, motika.com.mk and crnobelo.com).

C. Accessibility evaluation results: The accessibility evaluation results were collected from the landing page for the sites listed in Table 3 and Table 4. We used the web tool Tenon [12] which accepts link from the page that needs to be evaluated and can evaluate against WCAG 2.0, Section 508 and US federal procurement standard. Also, we used Lighthouse [13] tool from ChromeDev tools which can run different kind of audits (Performance, Progressive Web App, Best Practices, Accessibility, SEO) with web throttling and desktop/mobile emulation. For our analyses we used Accessibility audit with desktop emulation without throttling for both tools (Tenon and Lighthouse). The results from these tools are displayed in Figure 1 and Figure 2.

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Issues	Level	Sites					
		reklama5.mk	time.mk	pazar3.mk	femina.mk	motika.com.mk	crnobelo.com
1.1.1	A	35	5	31	21	8	65
1.1.1, 1.3.1, 3.3.2, 4.1.2	A, A, A, A	0	4	0	1	0	1
1.3.1	A	0	5	1	0	0	1
1.3.1, 2.4.10, 4.1.2	A, AAA, A	0	0	0	1	0	0
2.1.1, 4.1.2	A	2	2	12	8	8	0
2.1.1, 2.1.3	A, AAA	60	1	0	1	0	0
2.4.1	A	5	2	4	2	3	0
2.4.6	AA	0	0	4	0	0	0
2.4.4, 2.4.9	A, AAA	33	127	2	27	12	22
3.1.1	A	1	1	0	1	1	0
4.1.1	A	0	28	0	0	73	0
4.1.2	A	30	0	1	0	1	0
Total		166	175	55	62	106	89

Figure1. Accessibility evaluation results Tenon

Issues	Level	Sites					
		reklama5.mk	time.mk	pazar3.mk	femina.mk	motika.com.mk	crnobelo.com
1.1.1	A	5	5	0	21	5	1
1.1.1, 4.1.2	A, A	2	56	1	2	8	7
1.3.1, 3.3.2	A, A	0	4	0	1	0	1
1.4.3	AA	0	44	35	5	10	55
1.4.4	AA	0	0	0	0	1	0
2.2.1, 2.2.4, 3.2.5	A, AAA, AAA	0	1	0	0	0	0
3.1.1	A	1	1	0	1	1	0
4.1.1	A	0	14	0	0	25	0
4.1.2	A	0	2	1	1	1	1
Total		8	127	37	31	51	65
Passed		5	6	11	7	6	8
Not Applicable		27	20	21	22	22	22
Manual check		10	10	10	10	10	10

Figure2. Accessibility evaluation results Lighthouse

From Figure 1 and Figure 2 it's clear that the totals that each accessibility evaluation tool reported differ also, the number of WCAG vulnerabilities that were identified is different: 12 vulnerabilities identified Tenon, 9 vulnerabilities identified Lighthouse. Both tools have reported that time.mk has highest total number of vulnerabilities but the number of issues per WCAG rule differs. Specifically, for this site vast issues that Tenon reported refer to the purpose of the link when the link has/has not descriptive text or the entered text is ambiguous (2.4.4 and 2.4.9). Also, most of the issues that Lighthouse reported for time.mk refer to link text (and alternate text for images, when used as links) that must be discernible by a screen reader, must not have a duplicate label, and must be focusable (1.1.1, 4.1.2). For each site Lighthouse reported more than 30 rules (10 manually checked and 20 not applicable) that need human involvement.

D. Manual testing results: To manually test these sites, we used latest Mozilla Firefox browser on Windows 7 operating system along with NVDA screen reader. The manual checks that were performed are:

1. The page has logical tab order
2. Interactive controls are keyboard focusable
3. The user's focus is directed to new content added to the page
4. User focus is not accidentally trapped in a region
5. Custom controls have associated labels
6. Custom controls have ARIA roles
7. Visual order on the page follows DOM order
8. Offscreen content is hidden from assistive technology
9. Headings don't skip levels
10. HTML5 landmark elements are used to improve navigation

The results of the manual checks are displayed in Figure 3 in format T (True), F (False) and N/A (Not Available). All the sites were using standard/native html elements, mostly links, paragraphs and headings which were in correct tab order and focusable accordingly. Only motika.com.mk was having custom menu in shape of a dropdown and wasn't using according ARIA tags. Focus traps were identified on reklama5.mk and pazar3.mk because both sites were displaying image map and the focus was disappearing inside area elements of the image map. None of the sites was having offscreen/hidden content and HTML landmark elements.

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Manual Check	Sites					
	reklama5.mk	time.mk	pazar3.mk	femina.mk	motika.com.mk	crnobelo.com
1	T	T	T	T	T	T
2	T	T	T	T	T	T
3	N/A	N/A	N/A	N/A	N/A	N/A
4	F	T	F	T	T	T
5	N/A	N/A	N/A	N/A	F	N/A
6	N/A	N/A	N/A	N/A	F	N/A
7	T	F	F	T	T	T
8	N/A	N/A	N/A	N/A	N/A	N/A
9	N/A	T	N/A	F	F	F
10	F	F	F	F	F	F

Figure3. Manual testing results

CONCLUSION

In this paper we examined the different types of disabilities and the current standards and automated tools available which can help in making the web content more accessible. We used the Tenon and Lighthouse evaluation tools to check the conformance of the most visited Macedonian web sites to the WCAG standard. These tools have reported different number of issues for each site. The Tenon tool has reported more types of issues and more total number of issues than Lighthouse. On the other hand, Lighthouse has reported issues that were manually tested. Overall experience of the manual testing is that the sites are poorly accessible, they don't fully confirm to any accessibility level and there is a room to be improved the navigation. This improvement can be achieved by adding custom navigation elements, landmarks and usage of ARIA state, roles and properties.

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