

# Accessibility Requirements for Blind and Visually Impaired in a Regional Context: An Exploratory Study

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**Abstract**—At the time when we are debating the Internet as a human right, an access to basic online information is a challenge for blind and visually impaired community. Steps taken for their digital inclusion, such as, the Web Content Accessibility Guidelines (WCAG) are often insufficient. In this paper we present initial requirements gathered during three workshops organized with various stakeholders coming from three different countries. Initial results suggest that the context of use and the cultural dimension play a crucial role in making digital content accessible for this community. Additionally, a one-solution-fits-all model is inadequate without considering levels of visual impairment when providing customized web and mobile experience. Finally, we lay out challenges that with comprehensive requirements gathering in the future, could address various problems that blind and visually impaired face.

**Index Terms**—Blind and visually impaired, accessibility, requirements gathering, web and mobile

## I. INTRODUCTION AND BACKGROUND

The increased portability and wide adoption of diverse internet resources and mobile technologies have resulted in the fact that computers are not anymore perceived as distinct technological objects but more as integrated tools to support our everyday activities [12]. The ubiquity of these environments creates the possibilities for people to communicate across multiple computational devices at the same time. These trends provided the opportunities for the evolvement of the web toward a fully-fledged software platform [13]. The main idea behind this view is the fact that people are actively engaged by contributing with digital content on the Internet through the use of different web and mobile applications and platforms across diverse devices [1].

All these developments result in new ways for people to create, share, manage everyday life, as well as communicate with their friends and family. The different levels of accessibility of these solutions directly affect their use by diverse user groups. Primarily this creates challenges for user groups with special needs. One such user group is the community of blind and visually impaired (BVI) people in Macedonia that are highly marginalized. Some of their challenges include lack of proper access to the different Internet resources that could ease their everyday activities. These access challenges in the majority of cases are addressed

by complying with the Web Content Accessibility Guidelines (WCAG). Research shows that the application of the WCAG is often insufficient because of the overlooked factors particularly in terms of efficiency, errors or satisfaction [9]. Similarly, there are efforts to improve the web and mobile accessibility experience by adapting and personalizing the software to user preferences and device characteristics [5].

Usability and in particular accessibility issues are common reasons why software deployment fails to meet user needs, especially for the BVI users. The efforts focusing only on addressing functional requirements and ignoring to also elicit usability and accessibility requirements, bring a higher cost and require more development time [3].

Motivated by these challenges and research trends, in this paper we report our efforts on domain analysis for the actual needs of BVI community in Macedonia from the accessibility perspective. The main effort is to understand the key requirements towards identifying the most accessible interfaces that could be utilized for providing access to Internet resources for this marginalized group. To this end, we provide the initial exploratory insights on the accessibility requirements identified through three workshops held in Macedonia and Sweden.

In the following sections of this paper we present our research approach followed with an overview of the accessibility requirements identified in this process. At the end we discuss initial findings and provide some challenges for future efforts.

## II. RESEARCH APPROACH

Advances in web and mobile technologies provide greater flexibility and opportunities to support BVI [14]. In order to utilize these advances, a proper domain requirement analysis is essential [8]. This type of analysis is defined as a process that acquires, classifies and analyzes the total requirement of domain stakeholders [10].

The BVI community in Macedonia and the surrounding region is a diverse group scattered across different locations and has various requirements. In these settings we have utilized a need-driven approach based on active participation in order to identify the needs in this domain.

Another motivation for choosing a need-driven and user-oriented approach was the need to reduce the risk of over engineering as well as avoiding defective requirements [2].

Motivated from this and trying to get the best grasp of the domain analysis, we organized three workshops with different stakeholders from various ethnic, cultural, professional and socio-demographic backgrounds. The aim of the first workshop held in Macedonia was to enable an in depth understanding of local perspectives and behaviors regarding the needs of the BVI community. Whereas, the aim of the second and third workshop held in Sweden was to bring the Swedish experience to the aspects identified in the first workshop.

#### A. Workshop Settings and Participants

The first workshop was held at South East European University in Tetovo, Macedonia and gathered various participants starting from research community, BVI people, and non-governmental organizations (NGO's) working especially with BVI. The workshop hosted a total of 21 participants (12-researchers and students from the web and mobile technologies and Human-Computer Interaction (HCI) fields; 4-representatives of educational establishments; 2-NGO representatives; and 3-BVI students).

The second workshop was held in Kalmar at Linnaeus University, Sweden. The added value of this workshop was the inclusion of additional stakeholders from the fields such as eHealth and Optometry. In total it gathered 11 participants (3-eHealth; 1-optometrist researcher; 1-visually impaired; and 6-researchers from various fields of web and mobile technologies and HCI).

The third workshop took place at Blekinge Institute of Technology in Karlskrona, Sweden. This workshop included additional stakeholders coming from the fields of Applied Health Technologies, Interaction Design and Caring Sciences. In total it gathered eight participants (3-health technologies; 1-Informatics; and 4-from various fields of Computer Science).

All these workshops were carried out in an open discussion forum with presentations and demonstrations. These discussions provided us with a better understanding of the needs of the BVI community. Furthermore, it allowed us to build up knowledge about different accessibility approaches used in different countries when dealing with BVI needs. This approach helped us to tackle the *digital outcast* barrier in relation to the web and mobile accessibility and introduced the importance of interdisciplinary cooperation [13]. The outcome of the workshops expanded substantially the ecosystem model by inclusion of various stakeholders. The ecosystem view finally became a confluence between educators, researchers, community support agents and most importantly, the end users, i.e., the BVI. The complete scheme of the stakeholders' ecosystem is depicted in Fig. 1.

### III. ACCESSIBILITY REQUIREMENTS

The discussion with stakeholders during the three workshops provided a good empirical base to understand the main challenges that keeps the BVI as a marginalized community in Macedonia and the surrounding region. The research efforts led to the identification of accessibility requirements that we grouped into two main categories (in more details shown in Table 1):

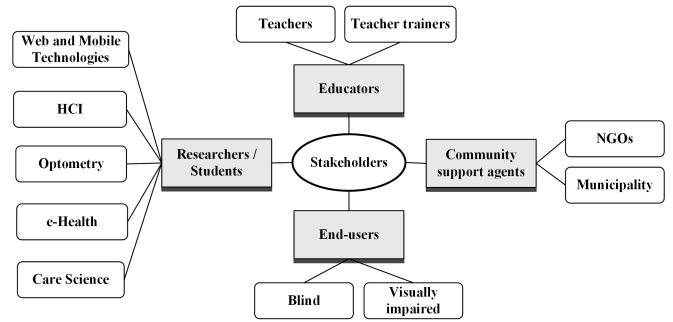


Fig. 1. Ecosystem view of the stakeholders.

#### A. Personalized Experience

Poorly designed or inexistent solutions force users to adapt to the closest best option available. Adaptation typically enables users reach limited usability and bad user experience. To depict one such situation, during the workshop, a blind participant, a computer science major student from Kosova, wrote a sentence in his laptop and instructed the screen reader to read it aloud for the audience to hear it and try to understand it. Only the blind people from the audience understood the sentence, others remained clueless. The issue was that although the sentence was written in the Albanian language, the JAWS (Job Access With Speech) screen reader was reading it using the English speech synthesizer (JAWS still lacks Albanian speech synthesizer).

Because of lack of a screen reader in the Albanian language, the blind people have adapted to understand Albanian content speaking with an English accent synthesizer. Although, there is freely available software named NVDA (NonVisual Desktop Access), which has the speech synthesizer in Albanian, its poor text-to-speech reading quality makes it a less appealing choice than using JAWS with an English synthesizer. This challenge presents an obstacle for the BVI community to gain quality information access to education resources, entertainment and social engagement.

#### B. Mobility and Community Support

A blind person in Macedonia (or neighboring countries such as Albania and Kosova) always requires an escort. This lack of ability to independently navigate outdoors (e.g., home to school, or even around the school campus) is due to two reasons. First, the organizational structures and facilities (e.g., buildings, roads) do not have the required accessibility level that will enable a blind person to navigate freely without running into obstacles.

Table 1. Blind and visually impaired community needs.

Personalized Experience	Mobility	Community support
<ul style="list-style-type: none"> <li>• Learning</li> <li>• Entertainment</li> <li>• Social engagement</li> </ul>	<ul style="list-style-type: none"> <li>• Navigation</li> <li>• Monitoring</li> </ul>	<ul style="list-style-type: none"> <li>• Organizational structures</li> <li>• Special schools</li> <li>• Special training programs</li> <li>• Sensibility</li> </ul>

Second, the schools where BVI students get educated, do not provide training classes for navigation, for instance, learning to use the white cane or a specially trained dog. Teachers who participated in the workshop stated that infrastructure lacks basic accessibility, thus it is in vain to train students about navigation, as they will not be able to make use of such knowledge. The issue of navigation makes it difficult for the BVI to go to school, or even just going to class when they live on the campus dormitories.

The current approach the schools in the region have adopted is the concept of “mobile teachers”. These teachers visit BVI students at their homes and try to provide education typically on weekly bases. This brings a heavy load on the schools particularly when having limited human resources. Furthermore, this does not provide satisfactory education that makes BVI students ready to be fully integrated with the rest of the society. For example, the only specialized school for BVI people in Albanian language in the region currently has 15 blind and 43 visually impaired, of which only three continued with university education since its establishment in 1982. The reason for such low number of university level enrollment is manifold, but the abovementioned issues take a substantial share.

#### IV. LESSONS LEARNED

The analysis of the data gathered during the workshops, helped us identify two important aspects that inform the process of interface requirements for the BVI community in Macedonia and surrounding region. These aspects are related to contextual factors and adaptive levels of accessibility for BVI people, which we elaborate in the following sections.

##### A. Contextual Factors to Ensure Accessibility

Web and mobile applications have increased in importance due to the relevance of the user context (i.e., profile, activities, and location) which greatly influence the quality perspective [6]. Table 2 highlights different contextual factors motivated particularly for (a) the importance due to the user context that plays nowadays, (b) the end-user satisfaction, (c) and the significant impact on the quality of the overall user experience, particularly BVI people. For instance, a particular website could be accessible on Windows, but not on OS X or diverse mobile platforms, because of a lack of sophisticated screen reader. Or following the WCAG guidelines does not guarantee that all blind people will gain the satisfactory level access to digital information. A website could pass all WCAG validations, but still be unusable due to a lack of screen readers available for a particular language, such as in our case Albanian.

The cultural dimension as a contextual factor goes in line with our previous efforts in using non-speech sounds to deliver content to BVI users. In a previous research, we have successfully developed and evaluated *audemes* as a novel non-speech sounds to deliver educational content in experiments conducted with K12 students in a BVI school in U.S. [4]. Audemes are brief non-speech sounds created of music and sound effect sound snippets referring to natural, artificial or

abstract sounds, even popular music. Considering the different culture and language of Albanian users in Macedonia with respect to the U.S. culture for which audemes were conceptualized and evaluated, the socio-cultural dimension of audeme design becomes a crucial issue. This will be further discussed in the next section.

##### B. Designing for Various Levels of Visual Impairment

An interesting insight from one of the workshops was the necessity to “teach” visually impaired (not blind) how to make the best use of their remained sight. An optometrist present at the workshop argued that many visually impaired people could pass the legally blind threshold by learning techniques of using peripheral vision [7]. Designing interfaces for visually impaired users familiar with such techniques would require understanding their specific needs, rather than treating them as homogenous group.

While various web and mobile adaptation techniques could be used to deliver usable content to visually impaired users, the one-size-fits-all model, however, does not provide satisfactory solution. Hence a specific user requirement should be gathered to apply the specific adaptation technique suitable for the user. Based on user’s level of impairment, a particular solution should be suggested. For instance, various content could be adaptively presented based on user’s distance from the screen using zooming or inverted fisheye techniques. Typical interface solutions offered for the BVI users are shown on Fig 2. The highlighted acoustic and visual branches represent our main requirement gathering approach for BVI users respectively.

#### V. DISCUSSIONS AND FUTURE WORK

In this paper we presented requirements gathered from three workshops held with different stakeholders to identify the needs of BVI users for a particular regional context. The novelty of this study is the identification of two important factors relevant when addressing the needs of BVI. The first factor identified was the context of use, which influences the accessibility of digital content for the BVI. The second factor is the need to evaluate user’s level of visual impairment before applying any adaptation technique. Inspired from these factors we see three main lines of action that could contribute toward reducing the digital outcast gap for the BVI.

Table 2. Contextual factors.

Factors	Description	Testing activities
Day/time of use	The impact of natural light and time of day in user’s activities	Functionality testing
Location	User activity influenced by his location (indoor, outdoor, in a car, train, etc.)	Mobility testing
Device/Platform	The impact of device type, size and platform in user’s activities	Interoperability and/or compatibility
User profile	The level of user disability	Optometric testing/ Survey testing
Accessibility	An overarching factor that ensures achievement of all previous factors	Heuristics/ Usability/field testing

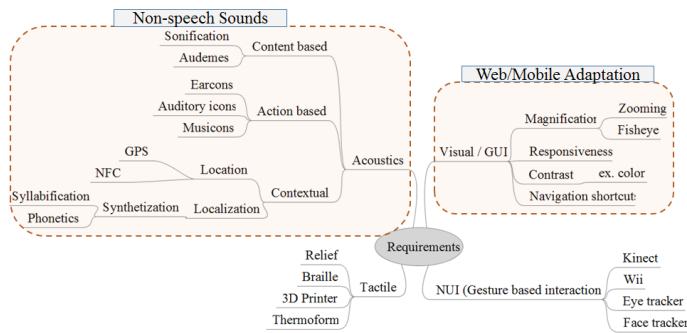


Fig 2. Requirements identified.

- Considering the importance of location, language and socio-cultural aspects, there is a need to understand how these dimensions could impact the audeme design. Audemes could be leveraged to accommodate for the different cultures when providing accessible content. For instance, the sound of a *barking dog* could have different meaning for the listener in U.S., where dogs are typically used as pets versus those in Macedonia where they are used as property protectors. To investigate these factors of sounds used to create audemes, we are currently conducting an experiment in parallel with participants in U.S. and Macedonia to establish the requirements for cross-cultural design of audemes.
- Accessible Massive Open Online Course (MOOC) approach is being considered as a means to provide quality education to BVI people [11]. This can be an important step toward eliminating the need of BVI to get to school. Future efforts need to gather requirements for building accessible MOOCs and the skills required for the users to have in order to be able to access online content.
- To increase content accessibility, new adaptation approaches could be possible by leveraging open data and standards together with emerging web technologies. This would provide contextual adaptability for specific preferences of BVI. In addition, this would enable architectural solutions that are capable to deal with dynamic requirements and heterogenous environments in web and mobile technologies [15].

These three lines of action represent important future research challenges, as we believe that they are key aspects to influence accessibility needs and emerging technologies in general, and in particular of the BVI community in Macedonia and surrounding region.

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