MOBILE APPS ACCESSIBILITY FOR PEOPLE WITH DISABILITIES

Abstract. The article focuses on the features of mobile applications and their accessibility for people with disabilities. The study aims to highlight the stages, processes, and specifics of developing mobile applications for individuals with disabilities in the context of ensuring their accessibility. General scientific methods of cognition were used in the research, such as literature analysis, comparison, data systematization, and expert evaluations. The results show that integrating accessibility into mobile technologies is becoming an urgent need given their growing popularity. The increasing use of smartphones and tablets among people with disabilities emphasizes the importance of making these devices accessible. As noted by representatives of Accessibility Partners, mobile devices and applications are becoming increasingly accessible, making them indispensable tools for accessing information and services for people with disabilities. This includes: adding alternative text to images; captions for audio and video; clear labeling of forms and input fields; proper formatting of tables with clearly marked row and column headers; testing applications using assistive technologies to identify potential accessibility issues; involving users with disabilities in the app testing process. This approach ensures that applications are usable by a wide audience, including people with various disabilities, thus enhancing their universality and promoting social inclusion. A comparative analysis of the accessibility of mobile operating systems Android and iOS shows significant support and adaptation for different categories of users, including those with visual, auditory, physical, and cognitive impairments. Android offers features such as TalkBack, BrailleBack, and Live Transcribe, while iOS includes VoiceOver, Magnifier, Live Listen, and more. Both systems are constantly evolving, adding new features and improving existing accessibility tools,
making them competitive in meeting the needs of users with disabilities. The practical significance of the study lies in providing recommendations for developing mobile applications that consider the needs of people with disabilities, thereby contributing to their integration into modern society.

Keywords: accessibility, mobile applications, people with disabilities, inclusive technologies.

Problem statement. In developed societies, the pursuit of equality for all segments of the population, including people with physical disabilities, is a fundamental principle. Accessibility and inclusiveness are becoming key aspects of modern policy and social integration. Ensuring equal access to resources and technologies helps create conditions in which every citizen can fully participate in society, contributing to overall progress. Mobile applications play a crucial role in this process, becoming tools that allow the blind to "see" and the hearing-impaired to communicate. For example, applications that convert text to speech or provide visual alerts transform everyday life and enable users with disabilities to interact with the world more independently.

The significance of mobile applications is determined not only by their social importance but also by their economic potential. Many companies invest significant resources in developing inclusive technologies, understanding that accessibility can open up broad markets and ensure sustainable revenues.

For consumers, it is essential to understand which applications are available on the market and which best meet their needs. On the other hand, it is critical for developers to create products that are not only technically accessible but genuinely useful for end-users. This means involving people with disabilities in testing and evaluating new applications during the development process to ensure the final product meets the real needs and expectations of this audience. Such an approach helps create inclusive technologies that truly improve lives.

Analysis of recent scientific research and publications. The issue of mobile app accessibility for people with disabilities is well-researched in foreign scientific literature. Significant contributions to the development of the topic have been made by authors such as I. Apori [2], who explores comparative aspects of mobile web application accessibility on Android and iOS platforms, providing insight into the features and problems of accessibility on both platforms. M. Halpin [7] provides a comprehensive guide to mobile accessibility, emphasizing the need to consider various aspects of accessibility when developing mobile applications. T. Chuiasova [5] in her work details successful accessibility testing strategies, which are essential for ensuring high-quality applications for users with disabilities. K. Casey [3] highlights six main aspects to consider when developing mobile applications for people with disabilities, emphasizing the importance of universal design and interactivity. AFB’s research [1] compares accessibility features and screen enhancements in Google Android Lollipop 5.0 and Apple iOS 8.1.1 for people with low vision, helping
understand how these platforms meet the needs of visually impaired users. Chaitali Tannirwar [4] focuses on usability testing involving people with disabilities, identifying specific problems and improving the user experience. A. Cyr [6] offers nine ways to improve digital experiences for people with disabilities, including adapting interfaces and app features to ensure maximum accessibility. Expert literature, including publications in modern internet editions such as Recite [7], Luxe Quality [5], and Wishdesk [9], highlights contemporary aspects of the topic. Despite a sufficient amount of literature on this topic, there is a lack of systematic material on the subject of the study. Therefore, various scientific cognition methods were used to analyze, group, and systematize the information and present it in light of the research topic.

The article aims to highlight the stages, processes, and specifics of developing mobile applications for people with disabilities.

Research results

Key factors influencing mobile app accessibility

In today's world, the importance of mobile applications for people with disabilities cannot be overstated, as the number of this demographic group in the US reaches approximately 60 million people. This segment of the population, the largest minority in the country, can increase at any moment, often unexpectedly, especially considering the aging baby boomer generation. Integrating accessibility into mobile technologies becomes an urgent need given their growing popularity [5].

The increasing use of smartphones and tablets among people with disabilities underscores the importance of making these devices accessible. As noted by representatives of Accessibility Partners, mobile devices and applications are becoming increasingly accessible, making them indispensable tools for accessing information and services for people with disabilities. This highlights the need to consider inclusive technologies in mobile device development [5].

The economic aspect of integrating accessibility is also significant, as people with disabilities have a combined discretionary income of $220 billion. Ignoring their needs can negatively impact the economic performance of companies that do not consider inclusivity in their products. Furthermore, companies working with the federal government are required to meet the accessibility standards outlined in Section 508 of the Rehabilitation Act of 1973 [5].

To ensure accessibility, Accessibility Partners representatives highlight several key areas. These include: adding alternative text to images; captions for audio and video; clear labeling of forms and input fields; proper formatting of tables with clearly marked row and column headers; testing applications using assistive technologies to identify potential accessibility issues [5]; involving users with disabilities in the app testing process. This approach ensures that applications are usable by a wide audience, including people with various disabilities, thus enhancing their universality and promoting social inclusion [5].
Ensuring the accessibility of mobile applications for people with physical disabilities requires considering a wide range of factors that can affect their use. The approach to developing such applications should be inclusive and focused on the needs of all users, including those with disabilities. Ensuring accessibility means not only meeting technical standards but also creating a convenient and intuitive interface that can be easily used without additional assistance. Analyzing materials from internet editions and expert publications [3,6,9,7], key aspects to consider when developing mobile applications to ensure their accessibility for people with physical disabilities can be highlighted.

**Color contrast:** ensuring sufficient contrast between foreground and background colors is critical for people with visual impairments. High contrast helps visually impaired users distinguish text and icons on the screen more easily, aiding better navigation and understanding of information [3,9,7].

**Text readability and adaptive font:** implementing features such as dynamic font type and automatic scaling allows users to adjust the font size to their needs. This is especially important for people with visual impairments, as they may require larger or clearer fonts for comfortable reading [9,7]. Navigation and interface logic: clear and consistent navigation options are crucial for accessibility. People using screen reading technologies must be able to easily navigate between sections and find the necessary information without undue stress [3,6].

**Alternative text descriptions:** including alternative text descriptions for images and media allows people with visual impairments to understand what is displayed on the screen. Well-formulated alternative text is essential for ensuring the accessibility of non-text content and promoting better content understanding [3,7].

**Sizes and placement of interactive elements:** the sizes and placement of interactive elements, such as buttons and links, should be adapted so they can be easily pressed without the risk of incorrect selection. This is especially important for people with limited motor skills or those who have difficulty with touch accuracy [7,9].

Each of these factors directly impacts the convenience and accessibility of mobile applications for people with physical disabilities, as illustrated in Fig. 1.
Features of apps on Android vs iOS for people with disabilities

The study examined internet publications and expert sources that contain a comparative analysis of the accessibility options of mobile operating systems Android and iOS for people with disabilities. The literature review concludes that both platforms offer substantial support and adaptation for different categories of users, including those with visual, auditory, physical, and cognitive impairments. However, it is important to consider the specific properties of each system that may influence the choice of smartphone and applications for users with different accessibility needs (Table 1).

Table 1

<table>
<thead>
<tr>
<th>Accessibility category</th>
<th>Android features</th>
<th>iOS features</th>
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<tbody>
<tr>
<td><strong>Visual accessibility</strong></td>
<td>TalkBack (screen reader) [2], BrailleBack (Braille display connectivity) [2], color settings [2]</td>
<td>VoiceOver (screen reader) [2], Magnifier (magnifying glass) [2], Speak Screen (screen reading) [2]</td>
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<tr>
<td><strong>Auditory accessibility</strong></td>
<td>Live Transcribe (real-time transcription) [2], Sound Amplifier (sound amplifier) [8]</td>
<td>Live Listen (environmental sound listening) [2], MFi hearing devices (MFi hearing devices) [2]</td>
</tr>
<tr>
<td><strong>Physical accessibility</strong></td>
<td>Switch Access (switch control) [2], Voice Access (voice control) [2]</td>
<td>AssistiveTouch (assistive touch) [2], Switch Control (switch control) [2]</td>
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<tr>
<td><strong>Cognitive accessibility</strong></td>
<td>Action Blocks (simplified commands) [2], Simplified Interface (simplified interface) [2]</td>
<td>Guided Access (restricted access) [2], Siri Suggestions (Siri suggestions) [2]</td>
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<tr>
<td><strong>New features in 2024</strong></td>
<td>Lock screen personalization, Health Connect (centralized health data access) [8]</td>
<td>Live Speech (real-time speech transcription) [1], Personal Voice (personalized voice) [1]</td>
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Overall, both systems are constantly evolving, adding new features and improving existing accessibility tools. The choice between Android and iOS should be based on the specific needs of the user and personal preferences regarding interface and ease of use.

Usability testing with people with disabilities (PWD)

Accessibility testing is defined as the process of evaluating the features and functionality of software to ensure effective interaction with users, regardless of their physical abilities [5]. This type of testing is a subset of general usability testing and assesses how well software applications are accessible to people with disabilities, such as visual, auditory, color blindness, or other cognitive challenges [5]. Such testing is important as it not only meets ethical standards of inclusivity but is also a legal requirement in many countries. It is not enough to simply create a software
product; it is essential to ensure it is accessible to a broad audience, including people with disabilities.

Specifically, the Web Content Accessibility Guidelines (WCAG) require websites to be accessible to all users [5].

![Fig. 2. Accessibility testing process for people with disabilities](image)

The process of testing applications for people with disabilities should include several critical steps to ensure a comprehensive evaluation of the product [10, 4]. It is important to ensure diversity among participants with various types of disabilities. This helps identify a broader range of potential accessibility issues. Individuals with different visual, auditory, motor impairments, or cognitive challenges should be included in the testing [10].

Conducting testing in a convenient location for participants is key. If testing is not conducted in a laboratory, it is important to ensure the chosen location is accessible to people with different disabilities [10, 4]. Additionally, allowing participants to use their own equipment and software can reduce setup time and increase comfort [10]. During the testing itself, it is important to consider the specifics of the participants, such as setting reading speed on screen readers or adapting the interface for visually impaired users [10]. It is crucial to analyze collected data, identify accessibility issues, and work on resolving them. Involving developers, designers, and other stakeholders in the review and modification process is critical for success [4] (Table 2).

### Table 2

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Description</th>
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<tbody>
<tr>
<td>Expanding user base</td>
<td>Accessibility increases the potential audience of the product as more people can use it regardless of their physical limitations.</td>
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<tr>
<td>Improving code quality</td>
<td>Testing reveals code errors that may affect accessibility, helping to create a more reliable and high-quality product.</td>
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<tr>
<td>Ensuring legal compliance</td>
<td>Compliance with accessibility standards such as ADA (Americans with Disabilities Act) and WCAG reduces the risk of legal issues.</td>
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<tr>
<td>Enhancing SEO</td>
<td>Websites with good accessibility are more easily indexed by search engines, improving SEO and attracting more visitors.</td>
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<tr>
<td>Improving overall user experience</td>
<td>Ensuring inclusivity and accessibility improves the user experience for everyone, including people with and without disabilities.</td>
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Accessibility testing involves integrating various specialized methods and tools to ensure that software products are accessible and user-friendly for people with disabilities.

Let's consider some main types of testing that address the specific needs of different user groups.

Testing for visually impaired individuals focuses on verifying the correct operation of programs with screen readers, which help people with vision impairments. Key efforts are directed toward validating the reading order of content and the accessibility of all interactive elements, as well as checking the presence of correct descriptions for graphic elements. It is also important to check color contrast and the ability to enlarge text without disrupting interface functionality [10].

For hearing-impaired individuals, the presence of alternative text descriptions for audio and video content is critical. Ensuring that visual notifications adequately replace audio signals is also an important component of this type of testing. This helps ensure that important messages are accessible without the need to hear sound [10]. Accessibility testing for colorblind individuals includes ensuring that information is not conveyed solely through color. Products should be designed so that information is understandable without the need to distinguish colors, which may include using text labels or symbols to identify color elements such as buttons or links [10].

Special attention in accessibility testing should be given to people with cognitive disabilities. Interface simplicity, intuitive clarity, and minimizing distractions are key aspects that help this category of users effectively interact with software products. Consistent navigation and logical content structure are also important to support users with memory and orientation challenges [10].

Additionally, for people with motor impairments, it is necessary to ensure that all interactive elements are accessible through keyboard commands and that the interface is adapted for voice control. This ensures the possibility of using products for individuals who cannot effectively use standard inputs due to physical limitations [10].

Understanding these aspects and integrating them into the accessibility testing process is fundamental to creating inclusive products that meet the needs of a wide range of users.

Conclusions. Implementing mobile accessibility is critically important for ensuring inclusivity and independence for people with disabilities, which are essential for social integration and economic activity. The development of mobile applications should encompass factors such as high color contrast, adaptive fonts, logical navigation, alternative text descriptions, and optimization of interactive elements to ensure convenience and accessibility for a wide range of users. This will allow companies to meet accessibility legislation requirements and expand their target audience by attracting a significant segment of the population with discretionary income, as well as promoting social inclusion of people with disabilities. The comparative analysis of accessibility options in mobile operating
systems Android and iOS shows that both systems provide extensive and specific tools to meet the needs of people with different types of disabilities. However, the specifics of each system can influence user choice depending on their individual accessibility requirements and personal preferences. Features such as color settings in Android versus more detailed text settings options in iOS highlight these differences, which are significant for people with visual and cognitive impairments. Accessibility testing involving people with disabilities includes critical stages: selecting participants with diverse disabilities to identify a wide range of potential accessibility issues; conducting testing in convenient locations with the possibility for participants to use their own equipment; setting specific parameters to ensure participant comfort; analyzing collected data to identify and address accessibility issues. This process is important not only for meeting legal requirements but also for creating inclusive and accessible products that enhance the experience for all users.

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