Global Mobile App Accessibility: A Comparative Study of WCAG Compliance Across 12 Countries

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Abstract

This study assesses the accessibility of mobile applications across twelve countries, including the USA, Vietnam, Turkey, Ireland, and South Korea. Our evaluation of 60 popular apps reveals a widespread failure to meet the Web Content Accessibility Guidelines (WCAG), with Vietnam exhibiting the highest average of 41.2 violations per app. These violations were particularly prevalent in essential areas such as touch target size and color contrast, critical for users with visual and motor impairments. Despite robust accessibility laws such as the Americans with Disabilities Act (ADA) in the USA and the European Accessibility Act (EAA) in the EU, our findings indicate a significant gap between these legal frameworks and their practical application. Our study highlights the urgent need for a multifaceted approach that includes strict enforcement, enhanced developer education with a focus on cross-cultural accessibility, and international cooperation. This research underscores the importance of integrating accessibility as a core component of digital infrastructure development to ensure mobile applications are truly accessible to all users.

Keywords: mobile applications, accessibility, WCAG compliance, digital inclusion, visual impairments, motor impairments, international legislation, developer education, user experience, global accessibility standards.

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Introduction

Mobile applications are essential in daily life, spanning communication, education, health care, and leisure. Despite their widespread use, ensuring these applications are accessible to all users, including those with disabilities, presents significant challenges. Accessibility is both an ethical imperative and a legal requirement in many jurisdictions, governed by the Web Content Accessibility Guidelines (WCAG) (World Wide Web Consortium (W3C), 2018).

Research highlights the critical role of adhering to these guidelines to ensure inclusivity for users with disabilities (Acosta-Vargas et al., 2021). However, substantial gaps in awareness and implementation among developers and designers persist (De Almeida & Gama, 2021), leading to common accessibility barriers such as missing labels, undersized elements, and inadequate color contrast (Alshayban et al., 2020; Mateus et al., 2020). These issues underscore the urgent need for more inclusive design practices.

While previous research has often been limited to specific regions, languages, or app categories, the dynamic nature of mobile technologies, coupled with the diverse needs of users with various disabilities, continues to challenge developers and researchers. This study conducts a comprehensive accessibility evaluation of mobile applications from Vietnam, Turkey, Australia, the United States, Israel, India, Ireland, Malaysia, Nepal, Oman, Pakistan, and South Korea.

The objectives of this research are to:

- Examine the prevalence of accessibility barriers in widely used mobile applications across these countries, identifying those most critical for users with disabilities.
- Evaluate mobile app compliance with WCAG, investigating how geographic context influences implementation and highlighting areas of non-compliance.
- Offer targeted recommendations for developers, policymakers, and other stakeholders to enhance mobile app accessibility, emphasizing the integration of accessibility into the development lifecycle and the importance of enforcement and education.

This study aims to contribute significantly to the field of digital accessibility by highlighting common challenges and best practices in mobile app accessibility, ensuring that users with disabilities enjoy the same level of access and participation as their non-disabled counterparts, thereby fostering a more inclusive digital world.

Methodology

Selection of Mobile Applications

Applications were selected based on their popularity, as determined by their rankings in the Google Play Store across a diverse set of countries, including Vietnam, Ireland, South Korea, Oman, Turkey, Malaysia,

Nepal, Israel, Pakistan, India, Australia, and the United States. To ensure broad geographical representation and address accessibility barriers related to language and region-specific constraints, the top 5 apps from each country, offering English-language options or not requiring local mobile number logins, were chosen. A wide range of app categories was included to cover various aspects of societal participation and daily life, ensuring the study's findings would be relevant across different user needs and experiences.

Accessibility Testing

The axe DevTool mobile app was utilized for its comprehensive testing capabilities against WCAG criteria (bin Ahsan, 2024). An API key was obtained to enable full functionality within the mobile testing environment. After installing the selected apps, 3-5 key screens per app were chosen for evaluation, focusing on areas critical to the app's functionality and user interaction. Automated scans conducted with the axe DevTool mobile app identified a range of accessibility issues, which were then reviewed and compiled using the tool's web dashboard for detailed analysis.

Data Compilation and Analysis

Test results were systematically organized in Google Sheets to facilitate a comparative analysis across apps and countries. This approach allowed for the identification of common accessibility barriers and the assessment of WCAG compliance levels.

Ethical Considerations

Anonymity and Confidentiality

In line with ethical research practices, the names of the apps and their developers will not be disclosed in any publications or presentations resulting from this study. This decision respects the privacy and intellectual property of the app developers while focusing the study's outcomes on improving accessibility practices broadly rather than critiquing individual apps.

Data Handling and Security

All data collected and analyzed in this study are handled with strict confidentiality. Access to the compiled data in Google Sheets is restricted to the research team, and all findings are reported in aggregate form to prevent the identification of specific apps or developers.

Limitations

While automated testing with axe DevTools provides a broad overview of accessibility issues, it may not capture all nuances of user experience, necessitating complementary methods such as manual testing and user feedback where possible. Additionally, testing a limited number of screens per app might not fully represent the app's overall accessibility, indicating the need for a broader evaluation in future studies.

Findings

General Observations

Our analysis of 60 mobile applications across 12 countries identified 4,079 accessibility violations, highlighting significant barriers that prevent full utilization by users with disabilities. Vietnam reported the highest number with 728 violations, while South Korea had the lowest at 174. This variation underscores the global challenge of ensuring digital accessibility, particularly in areas such as touch target size, color contrast, and navigational structures.

Key Challenges Across Countries

- Touch Target Size and Spacing: Particularly severe in Vietnam, where the average of 41.2 violations per app indicates a widespread issue affecting navigation and interaction for users with motor impairments, contravening WCAG criterion 2.5.5.
- Color Contrast: Apps in Turkey averaged 31.4 violations, highlighting a critical gap in visual accessibility that could render content indecipherable for those with visual impairments, in violation of WCAG criterion 1.4.3.
- Labeling and Navigational Structures: The United States and Australia reported significant challenges, with averages of 18.8 and 14.4 violations per app respectively. These issues complicate the use of assistive technologies, affecting compliance with WCAG criteria 2.4.1 and 2.4.7.

These findings highlight the urgent need for inclusive design and strict adherence to WCAG standards. Developers must prioritize accessibility at the design phase, conduct thorough usability testing with diverse user groups, and commit to ongoing accessibility education within the developer community.

Country-Specific Analysis

- Vietnam: Severe issues with both touch target size and color contrast significantly hinder users with motor and visual impairments.
- Turkey: Faces a visual accessibility crisis, limiting usability for users with visual impairments due to poor color contrast.
- Australia: Struggles with complex app structures, notably with nested interactive elements that complicate navigation for users using assistive technology.
- United States: Notable for focusable text issues, impacting users who rely on keyboard navigation and screen readers.
- Other Countries (Israel, India, Ireland, Malaysia, Nepal, Oman, Pakistan, and South Korea): Present a mix of touch target and labeling issues, affecting functional accessibility for users with visual and motor impairments.

Data Synthesis and Strategic Insights

This analysis emphasizes the critical need for targeted improvements in mobile app design to meet WCAG standards and enhance user experience across diverse user bases. Addressing these issues not only aids in legal compliance but also significantly enhances the functional usability of apps, fostering a more inclusive digital environment.

Tables of Accessibility Violations by Country

Two comprehensive tables detail the total number of accessibility violations identified, categorized by the most prevalent type of violation observed in each country, and align these violations with relevant WCAG criteria. This layout provides clear insights into specific areas of non-compliance and highlights areas requiring urgent attention.

Table 1: Overview of Accessibility Violations by Country with WCAG Criteria

This table encapsulates the total number of accessibility violations identified, categorizing them by the most prevalent type of violation observed in each country. It aligns these violations with the relevant WCAG criteria to highlight specific areas of non-compliance.

Country	Total Violations	Category with Most Violations	Avg. Violations per App	WCAG Criterion	Notes
Vietnam	728	Touch Target Size	145.6	WCAG 2.5.5	Highest number of violations, indicating a significant need for design improvements.
Turkey	445	Color Contrast	89.0	WCAG 1.4.3	Color contrast issues are especially prominent, suggesting a need for better visual design standards.
Australia	434	Nested Element Navigation	86.8	WCAG 2.4.1	Nested elements highlight complex app structures, potentially challenging for assistive technology users.
United States	398	Focusable Text	79.6	WCAG 2.4.7	Focusable text violations suggest issues with keyboard and screen reader accessibility.
Israel	369	Touch Target Size	73.8	WCAG 2.5.5	Touch targets and labeling issues indicate a broad range of accessibility concerns.
India	343	Touch Target Size	68.6	WCAG 2.5.5	Touch target size is a notable problem area, impacting user interaction with apps.
Ireland	340	Touch Target Size	68.0	WCAG 2.5.5	Touch target sizes are a concern, but overall violations are moderate compared to other countries.
Malaysia	263	Touch Target Size	52.6	WCAG 2.5.5	Consistent issues with touch targets, indicating possible design oversights.
Nepal	219	Touch Target Size	43.8	WCAG 2.5.5	Fewer violations overall, but touch target size remains an area needing attention.

Oman	189	Label in Name	37.8	WCAG 4.1.2	Labeling stands out as a primary issue, affecting screen reader navigation.
Pakistan	177	Touch Target Size	35.4	WCAG 2.5.5	Relatively fewer violations, with an emphasis on improving touch target size and labeling for accessibility.
South Korea	174	Touch Target Size	34.8	WCAG 2.5.5	Lowest total violations, with touch targets and labels as focus areas for improvement.

Table 2: Comparative Analysis of Average Accessibility Violations across Countries with WCAG Criteria

This table offers a metric for assessing mobile app compliance with WCAG standards across different countries, categorized by issues with Interactive Elements, Visual Presentation, and Structure & Labeling. It provides a succinct comparison of average accessibility violations per app, highlighting notable patterns and specific concerns.

Country	No. of Apps	Interactive Elements (Avg. Violations)	WCAG Criteria IE	Visual Presentation (Avg. Violations)	WCAG Criteria VP	Structure & Labeling (Avg. Violations)	WCAG Criteria SL	Notable Trends or Limitations
Vietnam	5	62.2	WCAG 2.5.5	41.2	WCAG 1.4.3	27.6	WCAG 2.4.1	High violations across all categories
Turkey	5	16	WCAG 2.5.5	31.4	WCAG 1.4.3	2	WCAG 2.4.1	Color contrast stands out as a major issue
Australia	5	13.8	WCAG 2.5.5	3	WCAG 1.4.3	37.75	WCAG 2.4.1	Nested elements and labeling notably problematic
United States	5	20.6	WCAG 2.5.5	8.2	WCAG 1.4.3	18.8	WCAG 2.4.1	High focusable text violations highlight need for screen reader accessibility
Israel	5	30.2	WCAG 2.5.5	5.8	WCAG 1.4.3	9.6	WCAG 2.4.1	Touch target and labeling require improvement
India	5	24.6	WCAG 2.5.5	9.2	WCAG 1.4.3	5.6	WCAG 2.4.1	Moderate violations, touch targets a concern
Ireland	5	22	WCAG 2.5.5	13.2	WCAG 1.4.3	4.6	WCAG 2.4.1	Moderate violations with

								touch targets as a key area
Malaysia	5	21.2	WCAG 2.5.5	8	WCAG 1.4.3	3.8	WCAG 2.4.1	Touch target size remains a significant issue
Nepal	5	16.4	WCAG 2.5.5	4.8	WCAG 1.4.3	6.2	WCAG 2.4.1	Fewer violations overall, yet notable in structure & labeling
Oman	5	9.2	WCAG 2.5.5	6.6	WCAG 1.4.3	21	WCAG 2.4.1	Relatively fewer violations but significant issues with labeling
Pakistan	5	11.6	WCAG 2.5.5	6.2	WCAG 1.4.3	3	WCAG 2.4.1	Fewer violations with emphasis on improving labeling
South Korea	5	14.8	WCAG 2.5.5	2.4	WCAG 1.4.3	5.6	WCAG 2.4.1	Lower violations, with touch targets and labels as focus areas

Note: The 'WCAG Criteria IE' (Interactive Elements), 'WCAG Criteria VP' (Visual Presentation), and 'WCAG Criteria SL' (Structure & Labeling) columns align specific violations with corresponding WCAG criteria, providing insights into which standards are most frequently breached and which aspects of app design require the most attention for compliance.

These findings necessitate stronger enforcement mechanisms, incentivizing accessibility for businesses, and promoting continuous accessibility education and audits for developers. The goal is to bridge the gap between existing legal frameworks and practical implementation, ensuring mobile apps uphold the rights of users with disabilities.

Discussion

This study corroborates existing research on the pervasive barriers to mobile app accessibility, particularly highlighting non-compliance with critical WCAG standards like touch target size (WCAG 2.5.5) and color contrast (WCAG 1.4.3). Notably, many apps from the USA do not meet touch target size guidelines, mirroring global accessibility challenges.

Despite stringent accessibility laws such as the ADA[1] and Section 508[2] in the United States, and the EAA[3] in the European Union, a significant gap persists between legal frameworks and their practical implementation. This gap underscores the limitations of a purely legalistic approach to accessibility, highlighting the necessity for a multifaceted strategy:

- Empowering Developers: Enhancing developer capabilities through comprehensive training and access to design resources is crucial. Our analysis suggests that integrating both manual and automated testing methods can significantly improve the detection and rectification of accessibility issues, reinforcing the need for tools that adapt to evolving technological landscapes.
- Strengthening Enforcement: Persistent non-compliance across various regions indicates that without rigorous monitoring and tangible penalties, legislation remains largely ineffective. This study supports the establishment of stronger enforcement mechanisms that ensure accountability and consistent application of accessibility standards.
- Incentivizing Accessibility: Encouraging digital inclusivity through incentives such as tax benefits, recognition programs, and preferential government procurement policies could motivate developers and organizations to prioritize accessibility. These incentives can drive a proactive commitment to inclusive design from the earliest stages of app development.

Persistent challenges with labeling and navigation, especially in well-regulated countries, further emphasize the need for practical developer education and proactive design practices. To foster a truly inclusive digital environment, stakeholders in technology, policy, and academia must collaborate to enhance enforcement mechanisms, equip developers with essential knowledge on accessible design, and drive ongoing research to address emerging accessibility challenges.

Conclusion

Our research systematically identifies significant accessibility barriers within mobile applications across various countries, highlighting widespread non-compliance with essential WCAG standards such as touch target size and color contrast. The pervasive issues in these apps, including many US-based applications failing to meet touch target size guidelines, underscore a stark gap between legislative frameworks and the practical accessibility of digital applications.

To cultivate a truly inclusive digital environment, intensive collaboration among stakeholders across the technology, policy, and academic sectors is crucial. This collaboration should aim to enhance enforcement

[1] Americans with Disabilities Act of 1990, accessed 2024, https://www.ada.gov/

[2] Section 508 of the Rehabilitation Act (29 U.S.C. 794d), accessed 2024, https://www.section508.gov/

[3] European Accessibility Act (Directive (EU) 2019/882), accessed 2024, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019L0882

mechanisms, empower developers with comprehensive accessibility training, and promote ongoing research to address emerging challenges in app accessibility.

As mobile applications increasingly shape our daily interactions, our commitment to inclusivity must be unwavering. Achieving this goal requires a concerted, multi-pronged approach that emphasizes not only proactive design and stringent enforcement but also a robust understanding of accessibility as a foundational element of technological advancement.

These revisions aim to tighten the language, provide clearer action steps, and ensure the tone is consistently academic throughout the discussion and conclusion sections.

Limitations and Future Research Directions

This study has identified several key limitations that underscore the need for further exploration to advance the field of mobile app accessibility:

- Automated Testing Scope: While automated tools provide efficiency in initial evaluations, they do not fully capture the nuanced experiences of users with disabilities. Incorporating methods that include direct user feedback is essential for more accurate assessments.
- Evaluation Depth: Analyzing only a limited number of app screens may not comprehensively represent the overall accessibility of the applications, which could impact the depth of our findings.
- Integration of Diverse Testing Methods: Future research should integrate automated tools with manual testing and direct user feedback to provide a more holistic view of app accessibility.
- Technological Evolution: Given the rapid evolution of mobile technologies, continuous updates and longitudinal studies are imperative to ensure that accessibility evaluations remain relevant and effective.

Addressing these areas will enhance our methodologies and contribute significantly to fostering a more inclusive digital environment.

Declaration of Interest

The authors declare no conflict of interest related to this study.

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