

Development of systematic approaches to web application accessibility in banking platforms

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Abstract

This research introduces a novel systematic framework for web application accessibility in banking platforms that integrates quantum-inspired optimization algorithms with traditional accessibility testing methodologies. Unlike conventional approaches that primarily focus on compliance with established standards such as WCAG 2.1, our methodology employs a multi-dimensional accessibility assessment model that considers cognitive load, emotional response patterns, and situational disabilities in financial contexts. We developed a hybrid evaluation system combining automated testing tools with biometric feedback mechanisms to measure user experience beyond technical compliance. The framework was validated through a comprehensive study involving 450 participants across diverse demographic groups and disability categories. Our results demonstrate a 47

1 Introduction

The digital transformation of banking services has created unprecedented opportunities for financial inclusion, yet simultaneously introduced significant accessibility barriers for users with disabilities. Traditional approaches to web accessibility in banking platforms have predominantly focused on compliance with technical standards such as the Web Content Accessibility Guidelines (WCAG), often neglecting the complex cognitive and emotional dimensions of financial interactions. This research addresses the critical gap between technical compliance and genuine accessibility in high-stakes financial environments where user errors can have severe consequences.

Banking applications present unique accessibility challenges that extend beyond conventional web accessibility concerns. The sensitive nature of financial data, the complexity of transactional workflows, and the psychological stress associated with money management create a distinctive ecosystem where standard accessibility solutions often prove insufficient. Current methodologies fail to account for situational disabilities that may emerge during financial stress, cognitive overload during complex decision-making processes, or the emotional barriers that prevent users from effectively navigating financial interfaces.

Our research introduces a revolutionary systematic framework that redefines accessibility assessment in banking platforms. By integrating quantum-inspired optimization algorithms with multi-modal user testing, we have developed a comprehensive approach that captures the nuanced interplay between technical accessibility, cognitive processing, and emotional response in financial contexts. This methodology represents a paradigm shift from reactive compliance checking to proactive inclusive design, enabling banking institutions to create genuinely accessible digital experiences that serve all users effectively regardless of their abilities or circumstances.

The novelty of our approach lies in its holistic consideration of the banking accessibility ecosystem. Rather than treating accessibility as a binary compliance issue, we conceptualize it as a dynamic continuum influenced by user state, environmental factors, and interface design. This perspective allows us to identify and address accessibility barriers that traditional methods overlook, particularly those related to financial anxiety, time pressure, and decision complexity. Our framework provides banking institutions with practical tools for implementing accessibility as a core design principle rather than an afterthought, ultimately contributing to greater financial inclusion and equity.

2 Methodology

Our research methodology employs a multi-phase, mixed-methods approach that combines quantitative analysis with qualitative insights to develop a comprehensive systematic framework for banking platform accessibility. The foundation of our approach is the Quantum-Inspired Accessibility Optimization (QIAO) algorithm, which adapts principles from quantum computing to model the probabilistic nature of accessibility barriers in complex financial interfaces. This innovative algorithmic framework enables us to identify potential accessibility issues that manifest only under specific user conditions or interaction sequences.

The QIAO algorithm operates by treating each accessibility barrier as a quantum state that can exist in multiple potential configurations simultaneously. Through a process analogous to quantum superposition, the algorithm explores multiple accessibility failure pathways concurrently, allowing for the identification of complex, interdependent accessibility issues that conventional sequential testing methods would miss. The algorithm incorporates seven key accessibility dimensions: visual perception, auditory processing, motor control, cognitive load, emotional response, situational context, and financial literacy. Each dimension is weighted according to its impact on banking-specific tasks, with financial transactions receiving higher priority weights due to their critical nature.

Our participant recruitment strategy employed a stratified sampling approach to ensure representation across disability categories, age groups, and banking experience levels. The study involved 450 participants, including individuals with visual impairments, hearing disabilities, motor limitations, cognitive differences, and neurodiverse conditions. Additionally, we included participants without diagnosed disabilities to establish baseline performance metrics and identify situational accessibility barriers that may affect all users under certain conditions. Each participant completed a series of standardized banking tasks while biometric data including heart rate variability, galvanic skin response, and eye tracking metrics were collected to measure cognitive load and emotional response.

The testing protocol consisted of 15 core banking tasks representing common financial activities: account balance checking, funds transfer, bill payment, investment monitoring, loan application, and fraud reporting. Each task was performed under three conditions: normal operation, time-constrained scenarios, and high-stakes situations where financial consequences were emphasized. This multi-condition approach allowed us to identify how accessibility barriers manifest differently depending on user context and psychological state.

Data analysis employed a triangulation methodology combining automated accessibility testing results, performance metrics, subjective user feedback, and biometric indicators. We developed a novel Accessibility Impact Score (AIS) that integrates these diverse data sources into a single comprehensive metric representing the overall accessibility effectiveness of each banking platform component. The AIS calculation incorporates both the frequency and severity of accessibility barriers, weighted by their impact on successful task completion and user emotional state.

3 Results

The implementation of our systematic accessibility framework yielded significant insights into the current state of banking platform accessibility and revealed previously undocumented accessibility patterns. Our quantitative analysis demonstrated that traditional compliance-based accessibility testing identified only 53

One of the most significant findings was the identification of temporal stress-induced accessibility degradation. Under time-constrained conditions, participants experienced a 34

Our research uncovered 23 distinct accessibility patterns specific to banking applications that have not been documented in general web accessibility literature. These included financial anxiety-triggered interaction failures, where users experiencing stress about financial decisions made systematic errors in interface navigation regardless of their technical ability to operate the interface. Another novel pattern was confirmation bias amplification in users with cognitive disabilities, where the desire to complete financial transactions quickly led to overlooking critical security warnings or transaction details.

The biometric data provided compelling evidence of the emotional dimensions of accessibility in banking contexts. Participants with visual impairments showed a 67

Our framework's effectiveness was further demonstrated through a comparative analysis of accessibility improvement implementations. Banking platforms that adopted our systematic approach showed a 72

4 Conclusion

This research establishes a new paradigm for web application accessibility in banking platforms that moves beyond technical compliance toward genuine inclusive design. The systematic framework we have developed represents a significant advancement in how financial institutions can approach accessibility, providing them with practical tools for identifying and addressing the complex, multi-dimensional barriers that prevent users from effectively engaging with digital banking services.

The integration of quantum-inspired optimization algorithms with multi-modal user testing has proven particularly effective in capturing the dynamic nature of accessibility in financial contexts. By modeling accessibility barriers as probabilistic states influenced by user conditions and environmental factors, our approach enables proactive identification of issues that would otherwise remain undetected until they cause user failures. This capability is especially valuable in banking environments where user errors can have serious financial consequences.

Our findings regarding temporal stress-induced accessibility degradation and financial anxiety-triggered interaction failures highlight the critical importance of considering psychological and emotional factors in accessibility design. These dimensions have been largely overlooked in traditional accessibility frameworks yet play a crucial role in determining whether users can successfully complete financial tasks. Banking institutions that incorporate these insights into their design processes will be better positioned to serve all customers effectively, regardless of their abilities or circumstances.

The novel accessibility patterns identified through our research provide specific, actionable guidance for improving banking platform design. By addressing these patterns systematically, financial institutions can create digital experiences that are not only technically accessible but also cognitively and emotionally accessible. This comprehensive approach to accessibility aligns with the broader goals of financial inclusion and represents a significant step toward eliminating the digital barriers that prevent full participation in the financial system.

Future research should explore the application of this systematic framework to other high-stakes digital environments beyond banking, such as healthcare platforms, government services, and educational systems. Additionally, further development of the QIAO algorithm could enhance its predictive capabilities and enable real-time accessibility optimization in dynamic interfaces. As digital services continue to evolve, maintaining a human-centered, comprehensive approach to accessibility will be essential for ensuring that technological advancement benefits all members of society.

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