Comprehensive study of human-computer interaction principles in designing accessible banking applications

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1 Introduction

The evolution of digital banking has transformed financial services, yet accessibility remains a persistent challenge for diverse user populations. Human-computer interaction principles have traditionally focused on general usability, often overlooking the specific needs of individuals with varying cognitive, physical, and sensory abilities when interacting with financial applications. This research addresses this critical gap by developing and validating a novel HCI framework specifically designed for accessible banking applications. The increasing reliance on digital financial services necessitates interfaces that accommodate neurodiverse users, including those with autism spectrum conditions, attention deficits, motor impairments, and visual challenges. Traditional banking interfaces often create barriers through complex navigation,

overwhelming visual stimuli, and cognitive overload, particularly for users who may experience anxiety or sensory sensitivities in financial contexts.

Our study builds upon the foundational work of Khan, Williams, and Brown (2019), who demonstrated the effectiveness of hybrid approaches in recognizing behavioral patterns, extending these concepts to interface design for financial applications. The research questions guiding this investigation include: How can HCI principles be adapted to address the unique challenges faced by neurodiverse users in banking contexts? What design patterns most effectively reduce cognitive load while maintaining security and functionality? How do adaptive interface components impact user trust and engagement across different ability spectrums?

This research makes several original contributions to the field of accessible financial technology. First, we introduce a neurodiversity-informed HCI framework that integrates spatial, temporal, and cognitive considerations specifically for banking applications. Second, we develop novel adaptive interface components that dynamically adjust to user behavior and environmental context. Third, we establish empirical evidence for the effectiveness of these approaches through comprehensive user testing across diverse populations. The findings have significant implications for financial inclusion, regulatory compliance, and the ethical design of technology that serves all members of society.

2 Methodology

Our research employed a multi-phase mixed-methods approach to develop and validate the accessible banking HCI framework. The methodology integrated quantitative usability testing with qualitative phenomenological analysis to capture both objective performance metrics and subjective user experiences. The study was conducted over an 18-month period and involved 347 participants recruited through disability advocacy organizations, neurodiversity communities, and financial institutions serving diverse populations.

Participants represented a broad spectrum of abilities, including individuals with visual impairments (n=87), motor disabilities (n=73), autism spectrum conditions (n=92), attention deficit disorders (n=59), and age-related cognitive changes (n=36). The sample included both experienced and novice banking application users, with ages ranging from 18 to 78 years. Ethical considerations were paramount throughout the research process, with particular attention to informed consent procedures adapted for different cognitive styles and communication preferences.

The framework development began with an extensive literature review and expert consultations across HCI, accessibility, behavioral finance, and neurodiversity studies. We identified critical gaps in existing design guidelines and developed prototype interfaces incorporating novel interaction patterns. These included progressive information disclosure mechanisms, customizable sensory profiles, context-aware assistance, and multi-modal feed-

back systems. The prototypes were implemented using a modular architecture that allowed for dynamic adaptation based on user behavior, environmental context, and task complexity.

Usability testing employed a within-subjects design where participants interacted with both conventional banking interfaces and our adaptive prototypes. Quantitative measures included task completion rates, time-on-task, error frequencies, cognitive load assessments using NASA-TLX, and physiological indicators of stress. Qualitative data collection involved semi-structured interviews, think-aloud protocols, and experience sampling methods to capture real-time user reactions and longitudinal engagement patterns.

Data analysis integrated statistical methods for quantitative measures with thematic analysis for qualitative insights. We employed multivariate analysis of variance to examine interface effects across different user groups and used grounded theory approaches to identify emergent themes in user experiences. The iterative design process involved three major refinement cycles based on user feedback and performance data.

3 Results

The implementation of our neurodiversity-informed HCI framework demonstrated significant improvements across multiple dimensions of accessibility and usability. Quantitative analysis revealed that participants using the adaptive interfaces completed banking tasks with 43

Cognitive load measurements using the NASA-TLX scale indicated a substantial 58

Qualitative analysis revealed several emergent themes that provided deeper insights into the user experience. Participants consistently reported increased confidence in managing their finances through digital platforms, with many describing the adaptive interfaces as "intuitive" and "respectful" of their cognitive styles. Users with sensory sensitivities particularly appreciated the customizable visual and auditory profiles, which allowed them to reduce overwhelming stimuli while maintaining necessary information.

The progressive information disclosure mechanism, which presented complex financial information in manageable chunks based on user pace and demonstrated comprehension, received overwhelmingly positive feedback. Users reported that this approach reduced anxiety associated with financial decision-making and improved their understanding of banking processes. The context-aware assistance features, which provided targeted help based on user behavior patterns and task context, were especially valued by participants with attention-related challenges.

Longitudinal engagement data collected over six months showed that users of the adaptive interfaces maintained higher usage frequency and completed a broader range of financial operations compared to their experiences with conventional banking applications. Trust metrics, measured through both explicit surveys and behavioral indicators, indicated that the transparent and predictable nature of the adaptive interfaces fostered greater confi-

dence in digital banking security.

4 Conclusion

This research establishes a new paradigm for accessible banking application design through the development and validation of a neurodiversity-informed HCI framework. The findings demonstrate that conventional HCI principles require significant adaptation to effectively serve diverse user populations in financial contexts. Our framework addresses this need by integrating spatial, temporal, and cognitive considerations specifically tailored for banking applications serving users with varying abilities.

The substantial improvements in task completion rates, cognitive load reduction, and user engagement provide compelling evidence for the effectiveness of our approach. The 67

The original contributions of this research include the development of novel interaction patterns specifically designed for financial applications serving neurodiverse populations, the establishment of empirical evidence for their effectiveness across multiple ability spectrums, and the creation of a comprehensive framework that can guide future accessible financial technology development. The methodology employed in this study, which integrates quantitative performance metrics with rich qualitative insights, provides a model for future research in inclusive technology design.

Several limitations warrant consideration in interpreting these findings.

The participant sample, while diverse, may not represent all potential user groups, and cultural factors influencing financial behavior were not extensively explored. Future research should examine the cross-cultural applicability of the framework and investigate longitudinal effects on financial literacy and independence.

The implications of this research extend beyond banking applications to other domains where complex information and high-stakes decisions intersect with diverse user needs. Healthcare systems, educational platforms, and government services could benefit from similar neurodiversity-informed HCI approaches. As digital technologies become increasingly central to daily life, the ethical imperative to design inclusively grows correspondingly more urgent.

This study demonstrates that through thoughtful application of adapted HCI principles, financial technology can become truly accessible to all users, regardless of their cognitive, physical, or sensory characteristics. The framework developed here provides both theoretical foundations and practical guidelines for achieving this vision of inclusive digital finance.

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