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Challenges and Strategies of Financial Inclusion in an Aging Society: An Analysis of Internet Banking and Anti-Fraud Practices

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ABSTRACT

In the context of an aging society and the rapid digitalization of financial services, this study investigates the challenges faced by older adults in using internet banking and mobile biometric technologies. It highlights the usability and security barriers encountered by individuals aged 65 and above, particularly in digital interfaces, multi-factor authentication procedures, and fraud risks. Drawing on literature analysis and case-based insights, the research proposes a layered risk management mechanism combining system alerts, manual verification, and law enforcement collaboration to prevent financial fraud. The study also explores the potential of integrating voice recognition and facial recognition technologies to enhance accessibility, while emphasizing the need for user-friendly interface design and human-centered assistance protocols. It calls for cross-sectoral cooperation, data privacy safeguards, and gradual policy experimentation to ensure that FinTech development remains inclusive, secure, and responsive to the needs of vulnerable populations. This research contributes to building a framework that promotes equitable access to financial technologies for older users, advancing the goal of inclusive finance in the digital age.

INTRODUCTION

Within the context of contemporary developed societies, the phenomena of population aging and declining birth rates have increasingly evolved beyond their characterization as mere demographic indicators (Gamber *et al.*, 2024). These demographic transformations have emerged as critical variables shaping the structural reorganization of socioeconomic systems and the reorientation of public policy frameworks (Smith *et al.*, 2024). Declining fertility rates, coupled with extended life expectancy, have accelerated increases in median age, generating profound effects on labor market configurations, intensifying fiscal pressures on public finance, and producing escalating demands for social care infrastructures. These shifts have also exerted considerable influence on financial systems, particularly within the context of the global expansion of financial inclusion as a normative and operational priority. Ensuring equitable access to financial services for aging populations and addressing their capacity to adapt to technological innovations have accordingly become significant subjects of scholarly and policy-oriented inquiry (Sharif *et al.*, 2024).

Financial inclusion, conceived as a development strategy grounded in the principles of fairness, accessibility, and social equity, aspires to eliminate conditions of financial marginalization by enabling individuals across age cohorts, socioeconomic strata, and geographic locations to access and utilize essential financial services securely. Within this framework, the widespread diffusion of digital technologies has been positioned as a central mechanism for advancing financial inclusion objectives. Non-physical financial institutions, including internet banking platforms, leverage technological infrastructures to enhance scalability and operational efficiency while simultaneously reducing transactional costs. These dynamics facilitate the extension of services to previously underserved populations constrained by geographic isolation or resource scarcity. Nonetheless, the acceleration of financial digitalization reveals specific vulnerabilities and persistent barriers for older adults, who frequently demonstrate delayed adoption of technological products. Their levels of adaptability, operational proficiency, and risk recognition within increasingly complex digital financial environments remain constrained (Nwosu & Ilori, 2024).

Operationally, internet banking services accessed through mobile devices or personal computers provide enhanced convenience in performing account inquiries, transfers, and investment activities. These services have the potential to alleviate the barriers that elderly individuals encounter in accessing physical banking facilities due to declining mobility or deteriorating physical function. However, user interface design, procedural complexity, and semantic frameworks often fail to accommodate the cognitive and perceptual needs of older users. Such design limitations may engender psychological burden and learning obstacles that collectively diminish usage willingness. The rapid pace of technological change and the growing sophistication of financial products further compound difficulties in risk comprehension, fraud detection, and resolution of unforeseen technical contingencies. These cumulative factors place older populations at elevated risk of digital financial exclusion (Mpofu, 2024).

From a security perspective, the expansion of digital financial usage has coincided with increasing exposure to fraud risks, particularly among elderly users. There has

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been a marked rise in the incidence of fraud cases and a corresponding escalation in financial losses affecting this demographic segment. Fraud perpetrators employ diverse tactics, including counterfeit banking SMS messages, deceptive websites, and voice phishing operations, to manipulate older adults into disclosing sensitive information or authorizing unauthorized transactions (Kamuangu, 2024). This phenomenon highlights persistent inadequacies in the design and responsiveness of current anti-fraud mechanisms, especially regarding their suitability and accessibility for older users. When financial institutions predominantly rely on digital alerts and individual vigilance to prevent fraud, older adults with slower response times and limited risk awareness are disproportionately affected. This increases the likelihood of significant financial harm and undermines institutional credibility.

The accessibility, clarity, and cognitive demands associated with reporting, appealing, or seeking assistance after fraud incidents further determine the effectiveness of financial inclusion initiatives targeting older populations. If financial institutions do not demonstrate procedural responsiveness and sensitivity to the specific needs of elderly users, the emotional and economic repercussions of fraud may be intensified. Such failures can erode public trust in digital finance and weaken confidence in inclusive policy frameworks. Therefore, the development of dedicated fraud prevention protocols and protective mechanisms designed explicitly for older users, supported by interdisciplinary cooperation spanning information engineering, financial regulation, social work, and gerontological education, is necessary to systematically strengthen financial literacy and digital resilience within this demographic cohort.

Beyond considerations of individual behavioral risk and user experience, the effectiveness of financial inclusion in aging societies is contingent upon macro-level policy coordination and robust institutional design. Existing legal frameworks and technological safeguards frequently neglect to incorporate the behavioral characteristics and cognitive patterns of older adults. As a consequence, detection systems and response mechanisms may misclassify or fail to identify high-risk scenarios accurately. The paucity of systematic quantitative and qualitative data documenting fraud experiences among elderly users further constrains evidence-based policymaking and the development of user-centric service architectures. Expanded empirical research focusing explicitly on elderly populations is essential to identify patterns of vulnerability, diagnose barriers to effective system engagement, and illuminate mechanisms for fostering digital trust.

In sum, within the intersecting trajectories of demographic aging and accelerated digitalization, the realization of financial inclusion objectives requires a paradigmatic shift that transcends technological proliferation and transactional expansion. Policy and institutional frameworks must respond to the differentiated needs and vulnerabilities inherent in specific user groups. The difficulties experienced by older users in adapting to digital banking systems and the heightened fraud risks they encounter necessitate integrated approaches that combine interdisciplinary perspectives, institutional innovation, and robust empirical foundations. Strengthening accessibility while safeguarding the dignity, security, and agency of older adults within digital financial systems remains indispensable to the fulfillment of the foundational principle of financial inclusion, which aspires to ensure that no segment of society is left behind.

LITERATURE REVIEW

In recent years, concurrent with the global momentum surrounding financial inclusion and the proliferation of digital finance, the enhancement of accessibility and usability of financial services has emerged as a central concern among scholars and policymakers, particularly in relation to vulnerable and marginalized groups. The seminal study conducted by Ozili (2020) established a foundational framework for theorizing financial inclusion as an integrated policy and research agenda. This research identifies the core of financial inclusion as the capacity to enable all individuals, irrespective of socioeconomic status, to access and effectively utilize basic financial services in an equitable manner. Recognizing the substantial cross-national variations in financial inclusion practices, the study employs conceptual analysis to propose a series of explanatory theories intended to consolidate the underlying principles and perspectives accounting for these differences. Ozili argues that a systematic and comprehensive theory of financial inclusion remains absent within both policy discourse and academic literature, contending that this theoretical contribution addresses the existing lacuna and supports ongoing international dialogues on inclusive finance.

Building on this initial inquiry, Ozili (2022) further reexamines digital financial inclusion as an expansive international development agenda. Through conceptual discourse, the study delineates the definition, objectives, structural components, provider typologies, instruments, associated risks, and regulatory challenges that collectively shape digital financial inclusion ecosystems. The analysis underscores that while the expansion of digital financial services has significant potential to enhance outreach and efficiency, it may simultaneously reinforce digital divides and perpetuate information asymmetries, particularly disadvantaging older adults and individuals with lower levels of education. The study highlights the necessity of addressing these structural barriers through innovative institutional design and robust risk governance in order to cultivate a digital financial environment that equitably benefits all societal segments.

Expanding the empirical foundation of this field, Dar and Ahmed (2021) focus on India as a case study to examine the determinants and barriers of financial inclusion. Drawing upon data from the 2017 Global Findex and utilizing a Probit model, the study demonstrates that

gender, age, educational attainment, and income exert significant influence on formal account ownership, saving and borrowing behaviors, and debit card utilization. The findings reveal that women and individuals with lower income and education levels encounter disproportionate obstacles to accessing formal financial services. Accordingly, the study advocates the development of targeted educational and economic policies designed to improve the financial inclusion of these underserved groups. Additionally, by incorporating informal saving and borrowing practices into the analytical framework, the research offers a more comprehensive assessment than is typically afforded by conventional financial inclusion indicators.

From the perspective of user experience, Jahan *et al.* (2020) investigate the determinants of customer satisfaction with internet banking services in Bangladesh. The study identifies service quality, security, and ease of use as key positive factors shaping user satisfaction. Despite the growing adoption of internet banking, a substantial segment of users continues to report dissatisfaction, contributing to persistent reluctance in embracing digital financial services. The study recommends that financial institutions reevaluate their system design and service delivery processes from a user-centric perspective in order to improve overall user experience and expand their client base.

In addition to access and usability, financial literacy has been identified as a critical determinant of digital financial service adoption. Andreou and Anyfantaki (2021) found a positive correlation between financial knowledge and the frequency of digital financial service utilization in their study of financial literacy and internet banking usage among Cypriot adults. Conversely, individuals exhibiting low financial literacy report higher levels of distrust in online banking and a lack of confidence in their digital and financial competencies, thereby discouraging adoption. The findings underscore the importance of enhancing both financial and digital literacy to mitigate digital exclusion and foster a more inclusive financial environment.

Beyond issues of service accessibility and literacy, the escalation of financial fraud risk has emerged as an unavoidable concern in the context of digital financial development. Wang (2021) observes that as financial technology has become more pervasive, fraudulent activities have evolved to become increasingly organized, professionalized, and geographically dispersed. This transformation presents severe challenges to traditional anti-fraud mechanisms. In response, the study proposes a behavior-based anti-fraud engineering framework that advocates the utilization of behavioral data modeling to construct non-intrusive, continuous verification systems as a supplementary line of defense. This approach prioritizes preventative strategies and real-time detection capacities, thereby enhancing the responsiveness of security systems to potential threats without compromising user experience.

In a complementary domain of financial risk management, Zhu *et al.* (2021) apply imbalanced data classification methodologies to develop predictive models for credit fraud detection. Using historical loan data, the study compares the performance of random forest, decision tree, and regression algorithms, concluding that the random forest model achieves superior predictive accuracy. The model effectively identifies key variables influencing credit risk, offering a robust algorithmic foundation and data-driven decision support for financial institutions engaged in pre-loan risk assessment and resource allocation.

Taken together, the reviewed literature spanning theoretical development (Ozili, 2020, 2022), empirical validation (Dar & Ahmed, 2021), user experience research (Jahan *et al.*, 2020), studies on financial and digital literacy (Andreou & Anyfantaki, 2021), and investigations of risk governance through fraud detection (Wang, 2021; Zhu *et al.*, 2021), converges on a shared recognition of the critical tension inherent in the advancement of financial technology and digital finance. This tension lies in balancing inclusive outreach with considerations of accessibility, security, and user trust. Collectively, these studies provide a robust theoretical and empirical foundation for the design, regulation, and implementation of digital financial systems in aging societies, highlighting the necessity of integrative approaches that combine technological innovation with inclusive policy design.

Research Objectives

This study aims to examine the implementation and challenges of financial inclusion within the context of an aging society, offering empirically grounded observations and strategic considerations designed to strengthen both the social function and institutional resilience of financial inclusion amid structural demographic transitions. As the proportion of older adults in the population increases, the financial system faces not only a reconfiguration of the age composition of its user base but also the imperative to address the adaptive design of financial technologies, the risk management of financial security, and broader issues of social equity and digital justice in the distribution of resources and services. Within this context, selecting internet banking as the primary focus of analysis provides a robust foundation for investigating the behavioral patterns, needs, and risk exposures characteristic of older users in digital financial environments. Such inquiry facilitates the systematic identification of specific barriers and threats that older adults may encounter during the digitalization of finance, while enabling the development of strategic responses encompassing institutional reform, technological innovation, and educational initiatives.

The study further concentrates on the distinctive patterns of fraud risk to which older users are particularly vulnerable, with a specific focus on incidents occurring within internet banking activities. These include data breaches, the proliferation of fraudulent platforms, and social engineering attacks. In recent years, fraudulent

activities have demonstrated increasing degrees of organization, digital sophistication, and transnational coordination. Such operations often exploit older adults' unfamiliarity with technological interfaces, limited understanding of specialized financial terminology, and elevated trust in communications perceived to be authoritative. Through early-stage identification and behavioral modeling of these risk mechanisms, the research seeks to inform the design of targeted anti-fraud technologies and to contribute to the establishment of user-friendly, accessible, and clearly signaled digital financial environments that address the needs of older populations.

An additional objective of this research lies in constructing a forward-looking framework for inclusive finance that integrates technological advancement with principles of social care and distributive justice. As digital financial services achieve pervasive diffusion and as artificial intelligence and big data analytics become progressively embedded within financial supervision systems and service interfaces, positioning older users as central participants rather than passive recipients emerges as a critical design imperative. Such an approach has the potential to guide the development of financial technology in ways that foster inclusiveness, enhance risk awareness, and promote ethical accountability. Accordingly, this study not only engages with the design of fraud prevention and response mechanisms but also addresses deeper institutional questions concerning how to reconstruct service logics within financial systems to simultaneously uphold accessibility, security, and dignity amid demographic aging and technological transformation.

Methodologically, the study adopts a multi-method approach comprising literature analysis, policy mapping, and case study examination. This framework is utilized to identify and assess the types of services, interface designs, risk management strategies, and educational support mechanisms currently available to older users within internet banking platforms. The research further interrogates the existence of design gaps, policy lags, and behavioral mismatches that may undermine the effectiveness and legitimacy of service delivery. The analysis explores the cognitive characteristics, operational barriers, and subjective risk perceptions exhibited by older adults in their interactions with digital financial services and leverages these user experience insights to inform the optimization of service design and financial education strategies. The overarching goal is to develop policy and practical recommendations that are both operationally feasible and scalable, grounded in a comprehensive cross-level analysis.

At the theoretical level, the study aims to critically examine the ethical and governance challenges inherent in implementing inclusive values within technology-driven finance. Current trajectories in FinTech development are predominantly shaped by imperatives of efficiency and innovation. However, the failure to integrate systematic risk assessment protocols and institutional safeguards for vulnerable users may inadvertently exacerbate the digital divide and entrench patterns of financial exclusion. This dynamic risks deviating from the foundational principles of financial inclusion. By taking fraud risk prevention among older adults as a point of departure, the study seeks to reconsider prevailing models of FinTech governance and to reconfigure the underlying value systems that guide institutional development. This approach aspires to address existing institutional gaps and to offer an informed reference for future policy design in the domain of smart finance.

In conclusion, the purpose of this study is to conduct a systematic and multidimensional analysis of the risks associated with internet banking usage in the context of an aging society. The findings aim to enhance the responsiveness, adaptability, and foresight of inclusive financial policy. By proposing actionable anti-fraud strategies and age-responsive design principles, the research intends to establish a dynamic adjustment mechanism capable of aligning technological progress with evolving social needs. The vision of financial technology development articulated in this study entails not only the pursuit of efficiency and innovation but also the commitment to addressing the societal challenges posed by demographic transformation. This commitment is essential for achieving a genuinely inclusive and sustainable financial future.

MATERIALS AND METHODS

This study adopts a multi-method research design incorporating literature analysis and case study investigation to examine the challenges encountered by individuals aged 65 and above in using internet banking services within digital financial environments. The primary objective is to develop feasible institutional recommendations and interface optimization strategies capable of enhancing accessibility and security. The literature analysis synthesizes relevant research conducted over the past decade regarding older adults' engagement with digital financial tools, with a particular focus on internet banking. This synthesis identifies limitations and obstacles related to usage behaviors, information processing capacity, risk perception, and trust in digital systems. The case study component selects representative financial institutions and specific user groups to explore discrepancies between actual user experiences and prevailing system design, thereby bridging the gap between institutional intentions and practical outcomes through empirical insights.

Preliminary findings derived from these methodological approaches indicate that individuals aged 65 and above experience substantial cognitive and operational barriers in internet banking environments. A frequently identified challenge involves interface designs that insufficiently account for the visual capabilities and interaction habits of older users (Omotayo, 2020). Although current systems often emphasize simplicity and low information

density, design choices concerning font size, color contrast, spatial layout, and button placement frequently do not correspond with the visual decline and reduced attention span commonly observed in this demographic. When procedures require multiple sequential steps, such as executing fund transfers, applying for financial services, or configuring authentication passwords, the lack of clear visual cues and precise instructions may generate user errors, elevate cognitive load, and induce anxiety.

In addition to interface-related cognitive demands, the implementation of multi-factor authentication protocols constitutes a major obstacle to digital financial access for older adults. In response to the rising prevalence of cyber fraud, internet banking systems have introduced layered verification mechanisms, including one-time passwords, device registration procedures, CAPTCHA tests, facial recognition, and fingerprint identification. While these measures enhance systemic security, they simultaneously create usability challenges for individuals accustomed to in-person banking or lacking familiarity with digital interfaces. Excessive security procedures may not necessarily produce a heightened sense of safety but instead function as technological and psychological barriers to the adoption of new financial practices (Iqbal *et al.*, 2020). This tension between security and accessibility is particularly pronounced among older adults and has emerged as a pressing concern within the digital transformation of financial services (Hansson, 2021).

Furthermore, analysis of fraud prevention literature indicates that internet banking users are increasingly exposed to a diverse range of cybersecurity threats, with targeted and manipulative tactics frequently directed at older adults. These schemes often exploit limited familiarity with specialized financial terminology, difficulty recognizing suspicious communications, and a general overreliance on the credibility of institutional messages. Fraud techniques such as impersonation of customer service agents, phishing websites, and fabricated claims of authority are commonly employed to extract confidential information or induce unauthorized transactions. In this context, the development of layered and adaptive verification mechanisms is imperative. Biometric authentication methods, including facial and fingerprint recognition, have demonstrated significant preventive efficacy due to their uniqueness and non-replicability (Fang *et al.*, 2021).

However, despite their technical strengths, biometric technologies may introduce unintended exclusionary effects for older users. Physiological characteristics such as blurred fingerprints, facial wrinkles, and diminished motor dexterity can result in repeated verification failures, generating frustration and reinforcing reluctance to engage with digital banking services. Moreover, biometric authentication typically requires access to smartphones or tablets, which remain unfamiliar or inaccessible to many older individuals. These obstacles contribute to apprehension toward internet banking and undermine broader trust in digital financial systems.

It is essential to recognize that current anti-fraud systems largely adopt technology-centric approaches that insufficiently account for variations in user experience and risk perception among older adults. In the absence of adequate development of digital and financial literacy, and without efforts to cultivate familiarity with relevant platforms, purely technological interventions are unlikely to achieve comprehensive mitigation of fraud exposure. A more balanced strategy entails the implementation of educational programs tailored to older users, encompassing FinTech literacy training, foundational risk awareness, and instruction on appropriate response strategies. Institutional designs should also incorporate supportive user interfaces and responsive customer assistance protocols to promote both protection and inclusion (Sohn, 2006).

Through the integrated analysis of literature and case study data, this study demonstrates that the obstacles faced by older adults in digital banking environments are not isolated phenomena but rather constitute a complex intersection of cognitive, psychological, technological, and institutional challenges. As internet banking consolidates its role as a principal platform for digital financial services, systems must transcend the implicit assumption that young, technologically proficient users are the default reference group. The design and governance of these systems must instead prioritize the unique needs and circumstances of older users. Achieving substantive financial inclusion requires the intentional integration of accessible interface design, flexible authentication processes, multi-layered fraud detection, and sustained educational support. Addressing these interrelated dimensions holistically is essential for ensuring that digital financial services advance equity, reinforce institutional resilience, and contribute to the long-term sustainability of inclusive financial ecosystems.

RESULTS AND DISCUSSION

Originating from the concept of inclusive finance, the core objective of this paradigm lies in ensuring that all members of society possess the capacity to access and effectively utilize a comprehensive range of financial services, irrespective of socioeconomic status, age, educational attainment, geographic location, or technological proficiency. Inclusive finance transcends its function as a framework for the design of financial systems and operates simultaneously as a policy practice rooted in the values of social justice and distributive equity. The principles of universality and accessibility emphasize the imperative to avoid systemic exclusion during financial development, thereby ensuring that financial services are not monopolized by elites or technologically literate segments but are instead positioned as public resources available to the entire population (Fernández-Olit *et al.*, 2020). Within this normative foundation, financial technology has emerged as a pivotal enabler of inclusive finance. Tools such as internet banking, mobile payments, and remote verification technologies are widely recognized

as essential instruments for expanding financial inclusion. Nonetheless, the accelerated pace of technological advancement raises critical questions concerning whether older adults, who constitute a relatively vulnerable group with higher adaptation thresholds, are genuinely able to derive benefits from these innovations.

In societies undergoing simultaneous demographic aging and pervasive digital transformation, the removal of technological barriers that hinder older adults from accessing financial systems has become an inescapable challenge for financial institutions and system designers. These barriers extend beyond operational difficulties to encompass structural information asymmetries (Bessler *et al.*, 2011), deficits in digital literacy (Zaimovic *et al.*, 2024), and psychological aversion rooted in distrust of technology. For instance, during interactions with internet banking interfaces, older users frequently encounter anxiety and uncertainty resulting from small font sizes, ambiguous commands, and complex procedural workflows. These factors negatively affect both their willingness to engage and the accuracy of their transactions. Additionally, when biometric authentication methods such as fingerprint or facial recognition are deployed as primary verification mechanisms, and when such systems fail to account for age-related physiological constraints, older adults may experience further exclusion from digital financial ecosystems.

This contradiction illustrates the inherent tension between financial inclusion and digital security. Prioritizing ease of use and accessibility without adequate security safeguards may produce serious vulnerabilities, especially in an environment characterized by increasingly sophisticated fraud tactics. Conversely, the imposition of overly stringent verification procedures may create prohibitive usage thresholds and generate psychological stress among older adults and other disadvantaged populations. Consequently, achieving a dynamic equilibrium between security and accessibility in the provision of financial services represents a persistent dilemma that financial institutions and policymakers must proactively address. In particular, as digital fraud becomes more advanced, efforts to streamline procedures or weaken authentication protocols in the name of usability risk exposing older users to heightened levels of exploitation. Such vulnerabilities not only endanger individual financial well-being but also erode institutional trust in the financial system as a whole.

In response to these challenges, this study proposes preliminary recommendations derived from the aforementioned literature and empirical evidence, with the intention of informing future policy development and research agendas. First, internet banking platforms and related technological infrastructures should incorporate accessibility and age-friendly design principles. Recommended measures include adjustments to font size, customizable contrast settings, streamlined interface logic, integrated voice guidance functions, and real-time assistance options to enhance engagement and usability among older users. Second, biometric authentication systems should be complemented by fallback mechanisms such as traditional passwords or physical security tokens, thereby preventing exclusion in cases where primary authentication methods prove unreliable. Third, policy frameworks should support the implementation of digital financial education programs targeted at older populations. These initiatives could be delivered through community centers, libraries, or eldercare institutions, enabling users to develop familiarity with FinTech applications and fundamental operations in low-pressure environments and thereby strengthening their risk awareness and digital competencies.

Beyond technological and financial considerations, this issue requires the integration of interdisciplinary perspectives spanning sociology, education, information engineering, and aging policy to develop comprehensive and responsive solutions. Future research may adopt a user-centered approach employing qualitative interviews or focus group methodologies to explore the psychological responses, cognitive challenges, and experiential barriers encountered by older adults during their engagement with internet banking services. These insights can serve as a basis for the redesign of user interfaces and the recalibration of regulatory frameworks. Moreover, empirical analysis of the feasibility, effectiveness, and user acceptance of existing fraud prevention mechanisms among older populations is essential to support institutional refinement and evidence-based policy adjustments.

In summary, the challenges confronting inclusive finance in an era of accelerated aging and digitalization cannot be adequately resolved through isolated technological innovations or singular institutional reforms. Rather, these challenges necessitate a holistic reassessment that encompasses structural system design, risk assessment practices, educational interventions, and ethical governance principles. The preliminary observations and recommendations articulated in this study are intended to contribute to ongoing academic inquiry and policymaking by offering a balanced perspective that simultaneously upholds security, accessibility, and fairness. By advancing this agenda, inclusive finance can more effectively realize its foundational commitment to leaving no individual behind. Accordingly, this study proposes the following recommendations for future action.

Develop Age-Friendly Online Banking Interfaces

In the context of the accelerated proliferation of digital lifestyles, mobile devices such as smartphones have emerged as critical platforms for delivering a wide spectrum of financial services. Internet banking, in particular, has increasingly supplanted traditional in-person banking by enabling users to conduct account inquiries, execute fund transfers, and perform investment transactions through dedicated mobile applications. However, for many older adults, the use of smartphones introduces considerable and, in some cases, insurmountable challenges. These difficulties are especially pronounced in tasks requiring

text input and command confirmation. Age-related physiological and psychological factors, including declining visual acuity, reduced finger dexterity, memory deterioration, and heightened cognitive load, frequently constrain user experience and contribute to avoidance or withdrawal from digital financial services. Among the most commonly cited obstacles are the illegibility of small on-screen fonts, the compact configuration of interface elements, and the high sensitivity of virtual keyboards. These factors collectively generate frequent input errors, diminish operational efficiency, and erode user confidence.

In response to these challenges, the adaptive redesign of internet banking interfaces to align with the physical capacities and usage habits of older adults represents a critical intervention. Transforming conventional visually dependent and manual input modalities into voice-guided interaction formats offers a pathway to substantially enhance both accessibility and usability of digital financial services for this demographic. Voice input, as a progressively mature technology within the domain of human-computer interaction, has already achieved widespread application across virtual assistants, translation platforms, and accessibility-focused applications. By employing advanced voice recognition engines capable of translating spoken language into text-based commands or direct actions, voice interfaces can markedly lower operational thresholds. This modality is particularly advantageous for older adults, individuals with visual impairments, and users experiencing limitations in fine motor skills.

Integrating voice input within internet banking systems would enable users to issue commands such as "check account balance," "transfer NT$5,000 to my child's account," or "set ATM PIN," thereby obviating the need for manual entry and complex navigation sequences. Such integration can streamline operational workflows, improve accuracy, and reduce the cognitive demands associated with digital financial transactions. Furthermore, the incorporation of multilingual recognition capabilities, dialect support, and training datasets reflecting the commonly used vocabulary and speech patterns of older users can enhance recognition precision and the naturalness of interaction, while minimizing semantic ambiguities and procedural errors. In contexts where handwriting is impractical, voice input can serve as a direct substitute, especially for populating critical fields such as account numbers, recipient names, or transaction amounts. Additionally, voice input can be utilized to confirm commands or supplement password verification through spoken authentication sequences.

Voice-assisted systems can also be effectively integrated with existing biometric authentication technologies, wherein the issuance of a voice command automatically triggers a secondary verification process involving facial or fingerprint recognition. This combination offers a balanced approach that reconciles usability considerations with stringent security requirements. The successful implementation of voice-directed interfaces further necessitates the design of simplified visual displays and the integration of clear, responsive voice feedback mechanisms. For instance, upon completing a voice command, the system should provide immediate spoken confirmation, such as "Your account balance is NT$53,000" or "You are about to transfer NT$5,000 to your child's account; please confirm if this is correct." Such real-time auditory feedback enhances procedural predictability, reduces uncertainty, and lowers the risk of operational errors. This process is likely to strengthen user trust and foster sustained engagement with digital financial platforms among older adults.

In summary, the incorporation of voice input as an alternative to handwriting or touch-based interaction within internet banking systems and the systematic alignment of this functionality with the operational characteristics and needs of older users has the potential to significantly improve their access to essential financial services. These adaptations exemplify the core tenets of inclusive finance by explicitly recognizing and accommodating the diverse requirements of users across age cohorts and functional capacities. The development of voice-guided interfaces should be conceptualized not as an ancillary feature but as a fundamental component of financial service system architecture. This design philosophy represents an essential step in reconciling digital transformation with human-centered technological development in societies characterized by progressive demographic aging.

Replace Certain Verification Procedures with Manual Checks

To effectively mitigate the fraud risks that older adults may encounter when conducting fund transfers via internet banking platforms, it is imperative to establish a verification mechanism that integrates risk alerts with real-time response capabilities. Specifically, when a user initiates multiple transfers within a brief time interval or attempts a transaction that exceeds a pre-determined monetary threshold, the system should automatically trigger an anomaly detection protocol. Such transactions should be immediately flagged as potentially high-risk and subjected to further manual review and verification procedures. This risk management logic is grounded in patterns consistently observed in prior fraud cases, which frequently involve either high-frequency, small-amount transfers designed to avoid automated detection or sudden, large-value transactions that diverge significantly from the user's established financial behavior. In the absence of timely detection mechanisms, fraudulent actors can rapidly withdraw funds, rendering recovery efforts ineffective and precipitating significant financial losses for the victim.

Upon identifying suspicious activity, financial institutions should promptly activate a structured manual review procedure. This process should include the assignment of dedicated personnel to contact the account holder through telephone, video conferencing, or other secure channels to conduct secondary identity verification and confirm

the authenticity and purpose of the transaction. The entire communication process must be comprehensively recorded and securely archived as supporting evidence for subsequent investigation or legal proceedings. These audio records serve dual purposes: they provide traceable documentation of the verification process and offer essential reference materials in dispute resolution or fraud reporting. Such records are instrumental in determining whether the transaction was genuinely authorized by the account holder and whether informed consent was granted with adequate comprehension of the associated risks. All recordings must adhere strictly to applicable data protection regulations, including statutory requirements concerning retention duration, access controls, and confidentiality obligations, to ensure lawful and proportionate use of personal data.

If, during the manual verification process, the account holder displays signs of confusion, communicative difficulty, emotional distress, or visible indications of coercion, the financial institution should immediately initiate collaboration with law enforcement agencies by notifying local authorities to enable timely intervention. The establishment of such cross-agency cooperation requires the development of clearly delineated reporting protocols and the maintenance of real-time communication channels. This infrastructure enables financial institutions to rapidly mobilize expert resources and safeguard the property and personal rights of individuals deemed at elevated risk. These measures are particularly critical in cases involving scams perpetrated by individuals impersonating government officials, fraudulent requests purporting to originate from family members, or fabricated investment schemes, contexts in which older adults frequently encounter difficulty discerning deception and where frontline customer service representatives or automated systems alone may prove insufficient for effective detection.

In addition, banks can leverage historical transaction data and behavioral analytics to construct individualized risk profiles for each user. This approach facilitates the dynamic adjustment of fraud detection thresholds and the refinement of verification protocols. For example, if a customer typically engages in low-value, routine transfers and abruptly initiates a large transaction directed to an unfamiliar recipient or adds multiple new payees within a compressed timeframe, the system should classify such behavior as high-risk, suspend transaction processing, and activate the alert and verification sequence. For older users, supplementary protective measures can be implemented, including the establishment of daily or monthly transfer ceilings and the incorporation of high-value transaction authorizations requiring confirmation by pre-designated family members. These interventions collectively provide a more flexible and human-centered model of fraud prevention.

This integrated three-tiered framework, which combines technological monitoring, manual review, and coordinated police support, can effectively address the limitations inherent in contemporary internet banking systems with respect to the timely identification and resolution of high-risk transactions. Moreover, it has the potential to substantially enhance both the trust and perceived safety experienced by older users within digital financial environments. To maintain effectiveness, these institutional mechanisms should be subjected to regular evaluation and iterative refinement in response to the continuous evolution of fraud tactics and operational modalities. Such vigilance ensures that financial technology remains aligned with its foundational commitment to equity, security, and inclusion in societies characterized by progressive demographic aging.

Telecommunication Providers to Assist in Setting Up Facial Recognition

With the rapid advancement of contemporary mobile technologies, most smartphones have incorporated biometric identification as a principal method of user authentication. Among these modalities, facial recognition systems have increasingly emerged as the default or preferred unlocking mechanism (Granados & Garcia-Bedoya, 2021). Compared to traditional password-based or pattern-based authentication methods, facial recognition offers multiple advantages, including resistance to replication, reduced likelihood of being forgotten, and greater operational speed. Collectively, these characteristics effectively alleviate the burden associated with repeated password entry and improve overall user experience. For older adults in particular, whose vision, memory capacity, and finger dexterity frequently decline as a function of aging, the process of inputting complex passwords often generates psychological stress, operational frustration, and diminished confidence. Consequently, within the context of demographic aging, enabling and familiarizing older users with facial recognition functionality constitutes a pragmatic and effective approach for simplifying mobile device operations and improving digital accessibility.

Given these considerations, the establishment of a systematic support process is essential to assist older adults in activating and configuring facial recognition features during new device purchases or technical repairs. This assistance should encompass not only basic feature explanations and procedural guidance but also detailed instructions regarding optimal lighting conditions, face positioning, and troubleshooting procedures. Even for individuals with limited familiarity with digital technologies, a structured and supportive process can facilitate successful configuration and mitigate apprehension. As the frontline providers of devices and associated services, telecommunications operators bear a social responsibility to contribute to technological inclusion for older populations. By offering age-friendly instructions, visually guided step-by-step materials, and in-person assistance, the resistance that older adults may express toward adopting unfamiliar technologies can be reduced, thereby increasing willingness to engage.

As a biometric application, facial recognition technology also introduces several potential risks and ethical concerns, including personal privacy protection, data leakage, recognition errors, and technological limitations. In the specific context of older users, age-related physiological changes, such as facial wrinkles, skin laxity, and facial hair growth, can compromise recognition accuracy and impede smooth system interaction. In circumstances where identification failures occur, older adults may experience heightened anxiety and frustration, potentially discouraging continued use. Therefore, while promoting facial recognition as the primary unlocking mechanism, it is essential to retain alternative authentication options, including simplified password entry and voice-based unlocking methods, to ensure that older users can access essential functions across diverse scenarios.

From an implementation perspective, clear procedural safeguards must be established to ensure that telecommunications providers and service personnel do not engage in unauthorized data access or privacy intrusions during the configuration process. All support activities must comply with relevant personal data protection legislation, including requirements pertaining to data minimization, consent acquisition, and secure data handling practices, to safeguard user rights and maintain institutional accountability. Government agencies and financial regulatory bodies may consider developing a standardized "Protocol for Technology Assistance for Older Adults," which would outline consistent support procedures adapted to the characteristics and needs of specific age groups. Telecommunications providers and device manufacturers should be obligated to allocate the requisite resources and training to operationalize these protocols, thereby promoting cross-sector collaboration and systematically strengthening digital adaptability among older populations.

It is recognized that any technological innovation or institutional initiative will entail certain risks and implementation challenges, and the intended benefits may not be immediately realized. The challenges associated with demographic aging are multidimensional, encompassing healthcare access, information literacy, financial security, and social support. Against the backdrop of escalating fraud risks and the expansion of the digital divide, present-day strategies should prioritize the formulation of concrete and operationally feasible solutions within existing technological and institutional frameworks, while maintaining flexibility to accommodate future revisions and incremental optimization. Policy implementation should not be premised on expectations of an immediate or comprehensive resolution but should instead proceed through a gradual, iterative adjustment process guided by pilot programs, outcome evaluation, and structured feedback mechanisms. This approach is more likely to advance the foundational principles of inclusiveness, accessibility, and equity that underpin financial inclusion.

This study contends that promoting facial recognition as the primary unlocking mechanism for older users should be conceptualized as a phased strategy designed to respond to immediate operational challenges and fraud prevention requirements encountered by older adults. The objective is not to comprehensively resolve all associated challenges but to provide a practical, actionable measure that addresses current needs in a targeted manner. In the future, this approach can be progressively integrated with other digital financial applications, including voice-based transaction prompts, real-time audio feedback during transaction processes, and remote family supervision functionalities. Through such integration, it will be possible to develop a robust FinTech support system that balances considerations of usability and risk management for older populations. This vision ultimately embodies a genuinely human-centered model of inclusive technological development.

CONCLUSION

In conclusion, this study underscores the urgent need to tailor internet banking and biometric authentication systems to the capabilities and concerns of adults aged 65 and above by implementing a multi-layered risk management framework that combines automated system alerts, targeted manual verification, and coordinated law enforcement partnerships. By integrating voice and facial recognition technologies with intuitive, accessible interface designs and robust privacy safeguards, financial institutions can reduce usability hurdles and strengthen fraud prevention for vulnerable users. Cross-sector collaboration and incremental policy pilots will be essential to refine these solutions in real-world settings. Ultimately, fostering an inclusive FinTech ecosystem that prioritizes older adults' security and autonomy not only advances equitable access but also supports broader societal goals of financial resilience and digital inclusion.

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