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Article

Examining the Digital Products and Technologies Currently Being Used by Commercial Banks in Resource-Constrained Environments: A Case of Uganda

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Abstract: Electronic banking was introduced to commercial banking in Uganda in 1997. However, adoption of digital products and technologies remains low, with only 39% of the banking population actively using them. This study examines the current digital products and technologies offered by banks in low-resource settings, using Uganda as a case study, to inform strategies that can enhance adoption. The study employed quantitative and qualitative approaches, including observations, an online survey of 14 Bank IT Managers, and questionnaires to 1,512 customers from three randomly selected banks. Expert opinions were compared with customer insights to refine conclusions. Findings show that most banks offer similar digital products and technologies, such as mobile wallets, web banking, and debit/credit card platforms, limiting consumer choice and reducing satisfaction. A mismatch exists between the digital products and technologies offered and customer expectations, creating adoption barriers. Quantitative analysis highlighted usage trends, while qualitative data provided insights into challenges and perceived benefits, enabling the derivation of user-centred requirements. The results are relevant to commercial banks, central banks, policymakers, financial planners, and fintech companies. The study contributes to the body of knowledge through the application of the Diffusion of Innovation process—covering knowledge, persuasion, decision-making, implementation, and confirmation stages—as applied to digital products banking. Furthermore, the market-share-based sampling approach ensures regional representation and allows exploration of digital divide issues across Uganda.

Keywords: Digital Products and Technologies, Bank Digital Platforms, I-Banking, M-Banking, E-Banking, V-Banking, Digital Banking, Online Banking

1. Introduction

Commercial banks have increasingly adopted digital products and technologies to enhance service delivery and customer experience. These include online banking, internet banking, e-banking, mobile and virtual banking, as well as digital service points such as agency banking, e-branches, Point of Sale (POS) systems, and mobile applications. These platforms enable customers to access a wide range of financial services, including account opening, deposits and withdrawals, bill payments, money transfers, and access to credit and other financial

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instruments. By introducing such innovations, banks aim to extend services to remote areas, provide new service channels, and reduce reliance on physical branches [1], [2].

Despite these efforts, the utilization of digital banking technologies remains below expectations in many contexts, including Uganda [3] . While digital platforms were intended to improve convenience, reduce costs, and expand outreach, their full benefits have not been realized. Confusion among customers due to overlapping terms—such as online banking, internet banking, and virtual banking—further complicates adoption. In addition, the mismatch between technology deployment and customer needs highlights the importance of reassessing whether current digital tools align with their original objectives of financial inclusion and efficiency [4], [5]. Digital products and technologies were originally deployed for several reasons: to provide services in remote areas without physical branches, to differentiate banks from competitors, and to reduce operational costs [6], [7], [8]). However, these intended benefits have not been fully realized in many digital banking contexts, making it crucial to reassess whether current technologies align with their original purpose. In Uganda, despite efforts by banks to digitize systems and introduce various online banking platforms, the utilization of these technologies remains suboptimal [9].

In Uganda, commercial banks continue to digitize their systems and roll out various platforms to improve service delivery. However, the uptake of these technologies remains limited, often due to barriers such as low digital literacy, lack of trust, and limited consumer protection. To improve adoption, banks must not only provide reliable digital products but also ensure that these platforms are user-friendly, well-communicated, and responsive to customer challenges. Identifying the enablers and barriers of adoption is therefore essential for strengthening customer engagement and ensuring that digital technologies fulfill their intended role in driving financial access and inclusion. Therefore, the aim of this study was to examine the digital products and technologies currently utilized by commercial banks in resource-constrained environments focusing on Uganda. The study sought to identify the barriers and enablers of digital banking adoption. The central research questions that guided the investigation were: *(1) What digital products and technologies are currently in use by commercial banks in Uganda? (2) What are the main barriers and facilitators affecting the adoption of bank digital products and technologies? (3) How can the identified barriers to the adoption of bank digital products and technologies be addressed?*

2. Literature Review

In Uganda, electronic banking was introduced into commercial banking in 1997. Despite its early adoption, the uptake remains low: only 39 percent of the banking population engages in digital banking services [10]. Several studies have attempted to explore the institutional, legal, and behavioral factors influencing the adoption of digital banking in Uganda. Regulatory challenges have been highlighted in the assessment of the legal and institutional framework for electronic banking in Uganda[11]. Ebong and George [12] explored the potential of Digital Financial Services (DFS) to enhance financial inclusion, emphasizing the need for banks to innovate through digital products. Another study by Baganzi [13] explored the integration of Task-Technology Fit (TTF), Unified Theory of Acceptance and Use of Technology (UTAUT), and Initial Trust Model (ITM) frameworks. Their findings underscored the significance of both technology and task characteristics in influencing user adoption of the Bank of Uganda's internet banking system. Ssonko [14] using the Socialization, Externalization, Combination and Internalization (SECI) knowledge management model, revealed that financial managers in Uganda perceived knowledge

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creation processes (SECI) as key to competitiveness, productivity, and sustainability in the financial sector. Despite these insights, there remains a critical gap in examining the specific digital products and technologies deployed by commercial banks and how well they align with customer needs and expectations [15].

Furthermore, Ssonko and Kawooya [16] noted the low uptake of value-added services such as utility payments, Bank-to-Wallet (B2W) and Wallet-to-Bank (W2B) transfers, insurance, and credit access because of low digital banking adoption. Digital Financial Literacy (DFL) has been proposed as a critical intervention to bridge the knowledge and skill gaps in using digital platforms [3]. However, Kaawaase and Nalukwago [17] and Kagoya and Yapkoreny [18] observed that digital transformation in Uganda's banking sector remains largely ineffective without aligning technologies to customer needs and ensuring their usability and accessibility. At a broader regional level, Kyewaalabye et al. [19] highlighted the mixed results of financial sector innovations on economic growth in East Africa. Wamalwa et al. [20] emphasized the persistent gender gap in accessing digital financial services, particularly among women in rural areas, low-income groups, and those with limited education groups that form a significant part of East Africa's population. These findings stress the need to design digital banking solutions that are inclusive, user-friendly, and contextually relevant.

Haule [21] found that in Tanzania, perceived usefulness of mobile financial services strongly predicts their adoption, even when users have moderate risk concerns. Similarly, in Rwanda, Umutoni [22] demonstrated that internet banking, mobile banking, and card services contribute up to 87.2% to commercial banks' financial performance, further advocating for intuitive and user-friendly digital interfaces.

Across Africa, digital banking is emerging as a transformative force, improving accessibility and financial inclusion. However, challenges remain, including inadequate infrastructure in rural areas, cybersecurity threats, and the digital divide [23]. In Zambia, informal business owners continue to face difficulties using digital products effectively due to limited digital literacy and poor infrastructure [24]. Global perspectives also offer useful insights. In the UK, Mbama and Ezepue [25] identified several attributes that shape digital banking experiences, including service quality, usability, customization, and perceived risk. In the UAE, Bocanet and Webb [26] noted that innovations such as AI, machine learning, and blockchain are reshaping financial services by improving transparency and inclusivity, though they also require balanced regulation. The synergy between these technologies and sustainable development is further explored in E-Financial Strategies for Advancing Sustainable Development [27] which argues that digital finance plays a pivotal role in achieving a poverty-free world.

These regional and global insights underscore the importance of benchmarking successful practices in digitally advanced contexts and adapting them to low-resource environments like Uganda. However, without first examining the specific digital products and technologies currently in use, and assessing how they align with the local context, banks risk widening rather than closing the gaps in financial inclusion and service delivery. In global, African, and Ugandan contexts, digital products and technologies are reshaping banking ecosystems. However, resource-constrained environments like Uganda continue to face challenges related to infrastructure, digital literacy, and trust. While various studies have explored individual aspects of digital banking, a comprehensive examination of the specific products and technologies used by commercial banks in such environments remains absent. Addressing this gap is crucial for designing inclusive, effective, and sustainable digital banking solutions.

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2.1 Theoretical Framework: Diffusion of Innovation Process

The Diffusion of Innovation Decision Process (DIDP) by Rogers [28] provides a useful lens for understanding the adoption of digital banking products and technologies such as online banking, mobile banking, agency banking, Point of Sale (POS) systems, and virtual banking platforms by focusing on the Diffusion of Innovation Decision Process (DIDP) of the Diffusion of Innovation Theory. According to the five-stage innovation-decision process, customers first gain knowledge of these products, then move to persuasion, where early adopters influence attitudes toward their use. The decision stage is critical, as individuals choose whether to adopt or reject banking technologies, followed by implementation, where usability and effectiveness are tested in real financial transactions. Finally, in the confirmation stage, customers evaluate whether these products meet their needs, continuing use if expectations are met or abandoning them if barriers persist. This framework helps explain how Ugandan banks' digital products and technologies spread among customers and provides insight into identifying and addressing barriers that limit adoption as shown below.

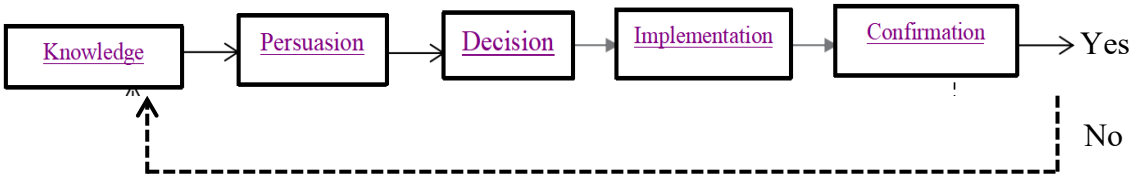


Figure 1. Diffusion of Innovation Decision Process (Rogers, 1995)

Figure 1 shows that if the digital products and technologies meet customer needs, their use continues; however, if they do not, barriers to adoption become evident. The feedback loop allows the identification of these barriers, which can then be addressed to enhance the adoption process. The process highlights a key feature: the innovation-decision of most individuals is influenced by the decisions of others within their social system [28]. This makes the confirmation stage critical because it determines whether the digital products and technologies fulfill customer needs. This process also guided the development of research tools, namely the survey guide for bank IT managers and the questionnaire guide for customers, which explored how digital banking products are perceived and used along the five themes of the study.

2.2 Summary of Other Theoretical Frameworks Reviewed

A noticeable gap exists in the literature regarding frameworks that specifically address the impediments to examining bank digital products and technologies. A review of existing theoretical frameworks reveals that while models such as TAM, TAM2, TAM3, UTAUT, ITM, and Systems-based approaches provide insights into technology adoption, they have limitations in addressing barriers specific to digital banking products and technologies. For instance, TAM emphasizes ease of use but neglects broader adoption dynamics, while TAM3 and UTAUT, though comprehensive, adds complexity or remain untested in many areas [29]. The DOI theory stands out through its five stage Diffusion of Innovation Decision Process (DIDP) as it addresses post-implementation through its confirmation construct, enabling the identification of barriers and facilitators affecting customer adoption of digital products such as mobile banking, online platforms, and agency banking. This makes DIDP particularly relevant in Uganda, where customer feedback is crucial in refining digital banking services to bridge the digital divide, enhance financial inclusion, and ensure that banking innovations

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align with customer needs in resource-constrained settings. Indeed, TAM2 considers external and social influences that are important for this study but has post implementation concerns because it does not go beyond implementation [30]. As a result, other reviewed theories were not adopted. Hence, DIDP was adopted to handle the post implementation issues through its confirmation construct, which is critical in understanding whether the digital products and technologies meet customer needs. There is hardly any literature using the DIDP of DOI theory that was found to examine the bank digital products and technologies in Uganda as a low resourced country.

3. Method

The study adopted both quantitative and qualitative methods. Observations**,** questionnaires, and an online survey were employed to investigate digital products and technologies used by commercial banks in Uganda. The document review drew from diverse sources such as regulatory reports, audited financials**,** academic papers**,** and international benchmarks, enriching the study's background and offering insights into the evolution of digital banking in Uganda and other countries.

Table 1 shows a summary of participant demographics.

Table 1: Study Population

Category of Respondents	**Number of Respondents**	**Method used to collect Data**	**Data being Sought**
Customers	1512	Questionnaire	Themes, patterns, trends, correlations, and opinions
IT Bank managers	14	Online Survey	Themes, patterns, trends, correlations, opinions, and insights.
TOTAL	1526		

The study examined 48 bank branches that constitute 10 percent of Uganda's 480 branches to assess the customer utilization of digital platforms**.** The branch sample size was based on Moro and Soumahoro's [31] sample size recommendation. An online survey targeting IT managers from 14 banks was also conducted using random sampling based on the technical expertise and preference for digital communication [32]. This dual approach ensured the collection of relevant and expert-driven data on the functionality, adoption, and impact of digital banking technologies.

The sample size of 1,512 customers was calculated using Yamane's probability sampling formula, based on a population of 15,120,000 bank customers [10] and a margin of error of 2.57% (e = 0.025716). Three banks—Centenary Bank**,** Post Bank**,** and National Commercial Bank of Africa (NCBA) Bank—were selected through random sampling (10% of 20 banks). The market-share method, based on 2022 published financial statements from individual audited book of accounts by certified credible auditors, was used to proportionally allocate the sample size across the three banks.

Based on 2022 market share data, Centenary Bank (19.55%), NCBA Bank (1.78%), and Post Bank (1.19%) collectively represented 22.52% of the commercial banking sector. To allocate the total sample of 1,512 customers**,** each bank's share was proportionally calculated. Thus,

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the study selected 1,312 customers from Centenary Bank, 119 customers from NCBA Bank**,** and 81 customers Post Bank. This market share-based sampling ensured that the study accurately reflected the distribution of digital banking customers across the three participating banks. This method, would be more accepted by the banks, who are the major owners of digital banking.

To ensure regional representation, each bank's customer sample was evenly divided across Uganda's four regions: North, Central, East, and West. Using the market-share method**,** the 48 selected bank branches were proportionally allocated among the three case study banks as follows: Centenary Bank: 41 branches, Post Bank: 4 branches, NCBA Bank: 3 branches

This approach ensured proportional regional coverage based on each bank's market share within the total sample. Based on the number of selected branches per region for each case study bank, the customer interviews were proportionally allocated**:** Centenary Bank**:** 32 customers per branch (1312 ÷ 41), NCBA Bank: 40 customers per branch (119 ÷ 3), Post Bank**:** 20 customers per branch (81 ÷ 4).

Questionnaires were administered randomly by research assistants as customers entered the branches, ensuring an unbiased and representative sample. More women were deliberately selected than men.

3.1 IT Managers Participation

IT Managers were selected using random sampling of those who responded to a survey that was sent via email to all the Bank IT Managers. Due to regulatory changes, three banks were downgraded, reducing the number of Tier 1 banks from 23 to 20 and yielding a 70 percent response rate (14 IT Managers). These managers were included because of their daily interaction with digital banking systems and customer concerns**,** offering valuable insights that supported and enriched customer data. Given their tight schedules, online surveys proved more effective than face-to-face interviews. Most responses came during non-working hours, especially during the weekend and at night), and follow-ups were conducted via phone where responses required further clarification.

3.2 Customer Sampling

Customers were interviewed by Research assistants at bank branches as they randomly came in to do transactions, choosing more women than men. This method improved representation and inclusivity**,** aligning well with the study's mixed-method approach. A sample of 1512 were selected.

3.3 Data Analysis

The study analyzed data from 1,526 respondents using Partial Least Squares Structural Equation Modelling (PLS-SEM), chosen for its ability to handle complex datasets with both continuous and categorical variables and latent constructs. PLS-SEM is robust even when standard statistical assumptions are not met and has been increasingly applied in digital banking research and other advanced methodologies [33]. Pearson Product Correlation (R) was used to assess the strength of relationships among factors, and the model examined both direct and indirect effects on digital banking adoption in resource-constrained environments. The analysis included five latent constructs composed of reflective and formative variables,

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retaining only statistically significant factors after validity testing. The model was estimated using SmartPLS 4, with fit evaluated via the Standardized Root Mean Square Residual (SRMR). Of the eight initially proposed hypotheses, those related to perceived ease of use were dropped due to low reliability. Additionally, thematic analysis was conducted to code challenges reported in questionnaires by customers, highlighting barriers to adoption and areas for improvement in digital banking services.

3.4 Validity and Reliability measures

Validity was established using the Content Validity Index (CVI) $\frac{VT + R}{} = \frac{4+3}{}$

$$VR+R+SR+NR \quad 4+3+2+1 = 0.7 \text{ or } 70\%$$

Conventional research wisdom requires that good research should be greater or equal to 70% [34]. It means that the individual questions posed are relevant and valid to the study variables. To determine if sections in the instrument were consistent Cronbach alpha coefficient was calculated. The alpha score was greater than 0.75 which is recommendable for social science research [35] as shown below;

Table 2 Showing the validity and reliability measures

	Scale (Section/Variable)	**Cronbach alpha**
1	Knowledge	0.826
2	Persuasion	0.884
3	Decision	0.883
4	Implementation	0.861
5	Confirmation	0.868
	Average	0.864

From the above table 2, the instrument was commendable to measure the constructs of the study. The average score of 0.864 is recommended to measure the constructs of study.

4. Findings

The quantitative data was analysed using PLS-SEM while the qualitative data was subjected to thematic analysis based on the constructs of the Diffusion of Innovation Decision Process (DIDP), namely knowledge, persuasion, decision, implementation and confirmation. The stages of DIDP from the DOI theory were developed into themes through which to present findings.

Table 3 provides an overview of the demographic characteristics of the customers involved in the data collection process. The results from the study are arranged according to the demographic details of the respondents to ascertain their appropriateness for the study.

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Table 3. Demographic characteristics of customers

Variable	Category	Frequency	Percentage
Gender	Female	666	44
	Male	844	56
Age	Below 21years	40	3
	21-30years	487	32
	31-40years	648	43
	41-50years	248	16
	Above 50 Years	86	6
Education	No Education	41	3
	Primary	83	6
	O' Level	154	10
	A' Level	234	16
	Tertiary	998	66
Employment	Not Employed	91	6
	Self Employed	531	35
	Employed	886	59
Experience with Digital Banking	Less than 5 years	691	46
	5 - 10 years	424	28
	10 - 15 years	121	8
	Above 15 years	33	2
	Never	241	16
Marital status	Single	409	27
	Married	1030	69
	Divorced	33	2
	Widowed	30	2
Disabilities	Yes	86	6
	No	1417	94
Income level	Less than 100k	111	7
	100k-1m	559	38
	1.1m-2m	485	33
	2.1m-5m	241	16
	Above 5m	86	6
Frequency of using digital banking solutions	Not at all	259	18
	Very Rarely	63	4
	Rarely	211	14
	Not Sure	66	4
	Often	640	43
	Very Often	246	17
Demographics of IT Managers			
Gender	Female	3	21%
	Male	11	79%
Age range	20 – 25 years	1	7%
	26 – 30 years	2	14%
	31 – 40 years	7	50%
	41 – 50 years	2	14%
	Above 50 years	2	14%

Table 3 shows how the study included 44% women respondents in the study, because they are more affected by the problem of study. More respondents (75%) are between the age of 21 to 40 years, which is adaptable to digital banking. Most of the respondents (97%) attended some form of education, a factor key in digital adoption. The findings lay a foundation for analysis as to why more women, youths and yet educated respondents are affected by the problem of study. Only 6% of the respondents are not employed and 16% do not have any

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experience with digital banking. Findings also show that 69% are married, bringing the question of confidentiality and security into light. Also 6% of the respondents have disabilities yet no bank of study caters for their needs. Only 6% of respondents earn above 5 million shillings, bringing the effects of digital bank charges, costs and focus into play. Furthermore, only 43% of the respondents use digital banking often. While more IT Managers (79%) are male confirming the male dominance in the field. The majority of IT Managers (64%) are between the ages of 26 to 40years nearly corresponding to the age divide of the customer respondents. Interestingly, the above stated factors favour the use of Digital banking yet its use remains low. The above findings made a good fit of the respondents to participate in the current study, setting pace for further data analysis according to the set themes in the DID Process.

4.1 Results on Digital Products and Technologies

The study revealed that customers became aware of digital banking products such as mobile apps, internet banking, and USSD services mainly through bank promotions and peer influence. Attitudes toward these technologies were shaped by their perceived convenience, security, and cost-effectiveness, with mobile banking apps viewed as more innovative but also more complex compared to USSD. Decisions to adopt digital products were strongly influenced by transaction costs, ease of access, and the reliability of network connectivity. In practice, customers used these technologies primarily for balance inquiries, transfers, and bill payments, with limited uptake of more advanced features like online loan applications or investment services. While many customers confirmed that digital products improved convenience and accessibility, challenges such as system downtimes, high transaction charges, and limited customer support reduced overall satisfaction and hindered sustained adoption.

4.2 Knowledge Construct

This analysis examined how both bank customers and IT bank managers perceived the benefits and challenges of digital banking technologies, which ultimately influenced adoption decisions. These perceptions shaped customer attitudes and behaviors, highlighting the importance of trust, convenience, cost, and reliability in driving uptake. Figure 2 presents the main challenges identified in the study, showing the factors that either encourage or hinder the effective use of digital products and services. These findings point to areas requiring improvement such as system reliability, transaction charges, and customer support to enhance satisfaction and strengthen adoption rates, ensuring that digital banking solutions meet user needs effectively.

4.2.1 Challenges of Using Digital Banking Solutions

By use of PLS-SEM the data was analysed and compared with the outcome in figure 2 below. This study summarizes the challenges faced by users in adopting digital banking solutions. The data is categorized by the level of severity: Not a Challenge, Slight Challenge, Moderate Challenge, and Significant Challenge. This refers to factors that hinder the adoption and

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effective use of digital banking services. Customers gave their opinions separately as well as IT Managers that gave their views separately. Below are the separate results for each sub-theme of results. The chart below visualizes the distribution of responses across 12 identified challenges.

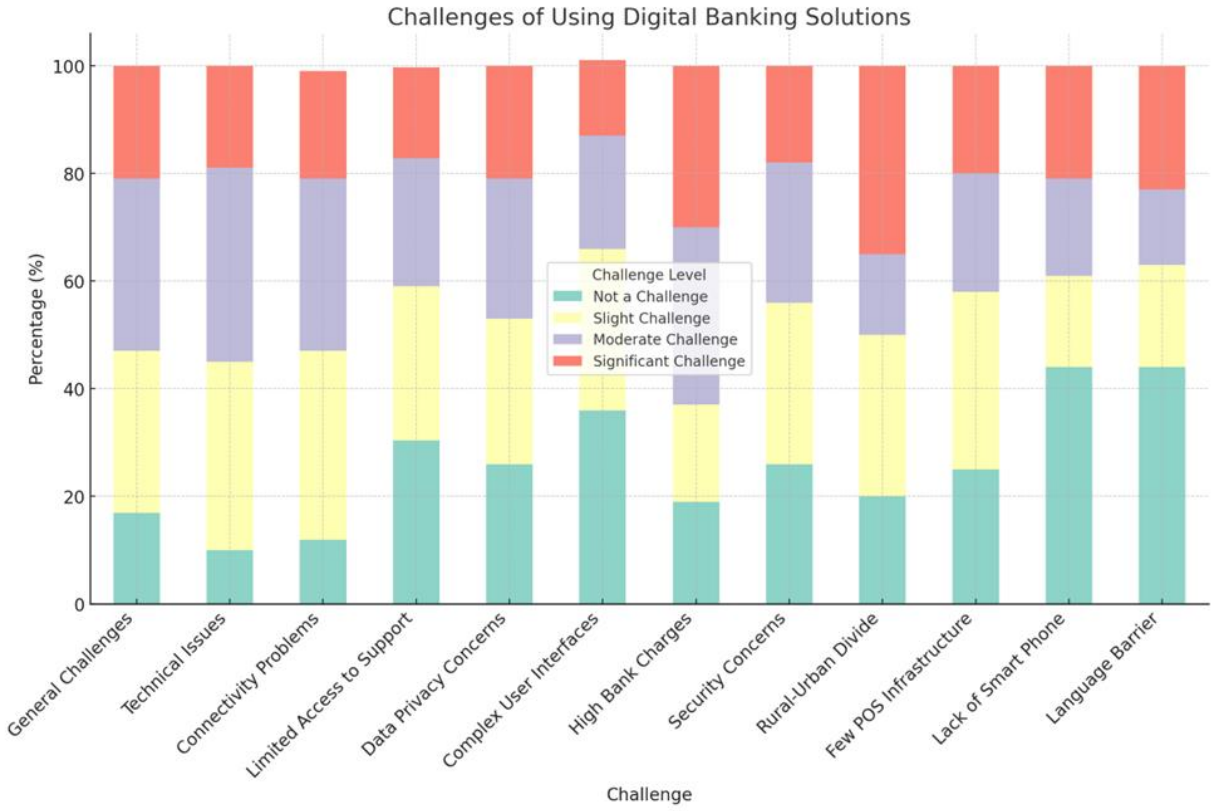


Figure 2. Challenges of digital banking

In figure 2, it is evident that the most significant challenges include; rural-urban Internet divide, high digital bank charges, language barriers, and technical issues. Conversely, issues such as complex user interfaces, and lack of smartphone also had a significant number of respondents who marked them as 'Not a Challenge' making them not to be a challenge, indicating a diverse experience among users. These were analysed as top, moderate and not a challenge.

Regarding top moderate challenges**, t**hese had the highest "Moderate Challenge" ratings:

Challenge	**% Moderate Challenge**
Technical Issues	36%
Connectivity Problems	32%
High Digital Bank Charges	33%
Limited Access to Support	23.8%
Data Privacy Concerns	26%

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Challenge	% Moderate Challenge
Security Concerns	26%

While most frequently not a challenge had the highest "Not a Challenge" response:

Challenge	% Not a Challenge
Lack of Smart Phone	44%
Language Barrier	44%
Complex User Interfaces	36%
Data Privacy Concerns	26%
Security Concerns	26%

And the notable observations had these observations:

Rural-Urban divide is a major barrier (35% significant challenge), highlighting infrastructure gaps.

Cost (digital bank charges) and **technical/connectivity issues** are dominant moderate-to-significant concerns.

Language and smartphone access are divisive—while 44% say they are not a challenge, over 20% still rate them as significant challenges.

Complex user interfaces appear to be less of a problem (only 14% significant challenge, 36% not a challenge).

Figure 2 further highlights the key challenges of digital banking adoption, showing disparities between customer and IT manager perspectives. Security concerns, high transaction charges, and technical issues emerged as the most significant barriers, creating a divide that limits the effective use and full potential of digital products and technologies. According to respondents of the study, these challenges are hinderances for adoption of bank digital adoption, thus helping to inform the study what needed to be worked on.

4.2.2 Benefits of Products and Technologies for Customers

Customers reported that digital banking technologies provided major benefits, particularly convenience (93%) and time savings (92%). Other technology-related advantages included improved customer service (86%), streamlined digital transactions (77%), cost savings (68%), enhanced security (67%), better financial management (56%), and 24/7 access (39%). These benefits demonstrate why customers adopt digital products and highlight their potential for wider diffusion. These benefits helped to inform the study about the major attractions for customer to adopt digital banking.

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4.2.3 Benefits of Products and Technologies for IT managers

IT managers reported that digital banking technologies offered key benefits, including convenience and accessibility (86%), time savings (92%), enhanced security (69%), 24/7 availability (85%), cost savings (93%), better financial management (57%), streamlined transactions (83%), and improved customer service (86%). IT Managers ranked cost saving as key for adoption yet customers felt that convenience was the most important factor for adoption of digital banking. Both customers and IT Managers equally ranked Time Saving as the second most important factor for digital banking adoption. They also equally ranked customer service as the third most important factor for digital banking adoption though the IT Managers had an equal rank for Convenience, which they ranked the same as customer service. The customers did not seem to agree with this position because they ranked Convenience in the number one position. Much as the IT Managers ranked 24/7 Access in the fifth position, the customers felt this factor of 24/7 Access ranked last in position number eight. Another factor of Streamlined digital transaction was ranked in position six by IT Managers, yet the customers ranked it in a better position number four. Enhanced security was ranked as number seven by IT Bank Managers, while the customers ranked it in the sixth position. Better financial management was ranked last by IT Managers in the eighth position, while the customers also ranked it lower in the seventh position. The divergence of ranks between IT Managers on the banking supply side and the customers on the demand side cause a mismatch in the projection of digital bank adoption. What the customers would like to be supplied is not what the studied banks are putting on the market. These results align with the Diffusion of process, highlighting how knowledge, persuasion, and adoption stages influence the uptake of digital banking.

4.2.4 Challenges of Products and Technologies by IT Managers

Figure 3 shows that IT managers identified connectivity issues (53%), security concerns (43%), technical problems (42%), limited support access (30%), complex user interfaces (29%), and data privacy concerns (15%) as the main barriers to effective use of digital banking. Unlike customers, managers did not see language barriers or smartphone access as significant, highlighting differences in perceptions of digital product challenges by the bank and customers.

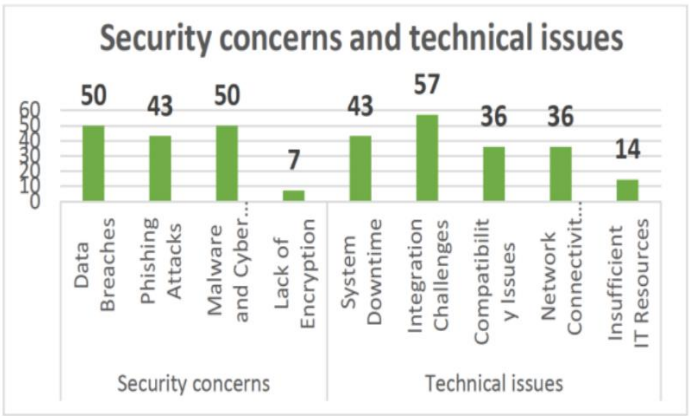


Figure 3. The different aspects of Security and Technical issues

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Figure 3 also shows that IT managers identified key security concerns in digital banking, including data breaches (50%), malware and cyber threats (50%), phishing attacks (43%), and lack of encryption (7%). Technical challenges included system integration (57%), downtime (43%), compatibility (36%), network connectivity (36%), and limited IT resources (14%).

Banks supported implementation through online training (79%), media campaigns (64%), training sessions (57%), phone alerts (57%), emails (43%), and sales representatives (43%). Most studied banks offered online and mobile banking services with functionalities such as statements, transfers, standing orders, salary and bill payments. Managers' perceptions of these products and technologies influenced adoption by identifying where most effort is put by the bank, implementation, and sustained use of the digital banking.

4.3 Persuasion Construct

In the Diffusion of Innovation Decision Process (DIDP), the persuasion stage involves users forming positive or negative attitudes towards digital products and technologies. Communication, peer influence, and perceived benefits or risks determine whether users are willing to adopt these innovations. The construct was important to evaluate both the demand and supply side.

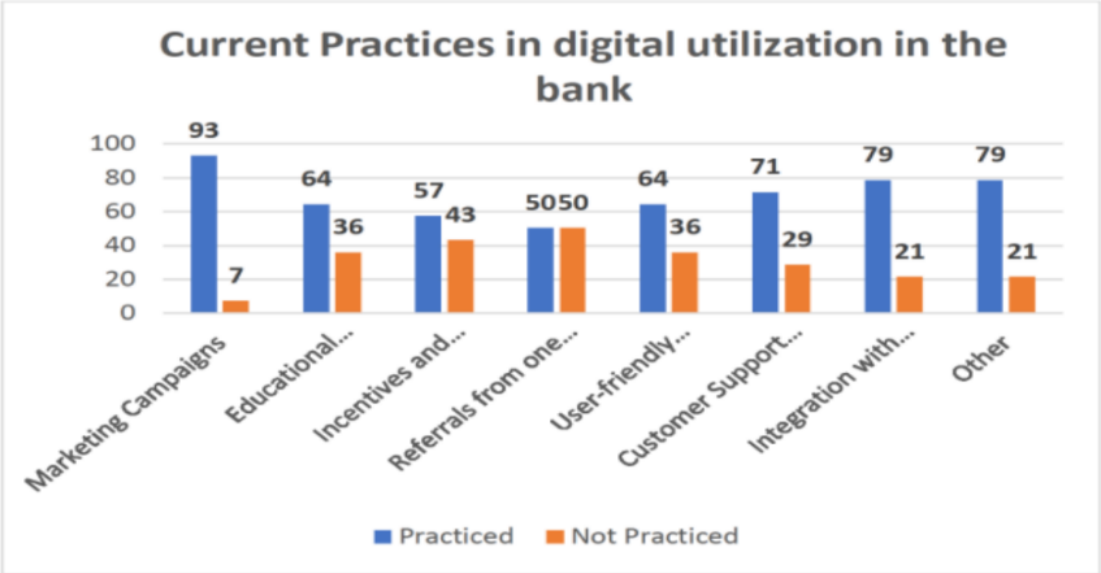


Figure 4. Current Practices of Digital Banking

Figure 4 shows that banks promote digital banking technologies using marketing campaigns (93%), integration with other services (79%), customer support (71%), educational workshops (64%), user-friendly services (64%), incentives and rewards (57%), and customer referrals (50%). Other strategies were reported by 79% of managers. Adoption rates varied, with most customers (50%) using digital solutions between 26% and 50%, while smaller proportions used them more or less frequently. Banks gathered feedback through customer service (79%), social media monitoring (64%), and online reviews (50%). These strategies reflect the persuasion stage of the DID process, demonstrating how banks encourage adoption of digital products and technologies. From the above analysis, marketing campaigning carry the majority of the expenditure on marketing for digital banking but the study shows that

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there are other strategies to rally for adoption that could be employed.

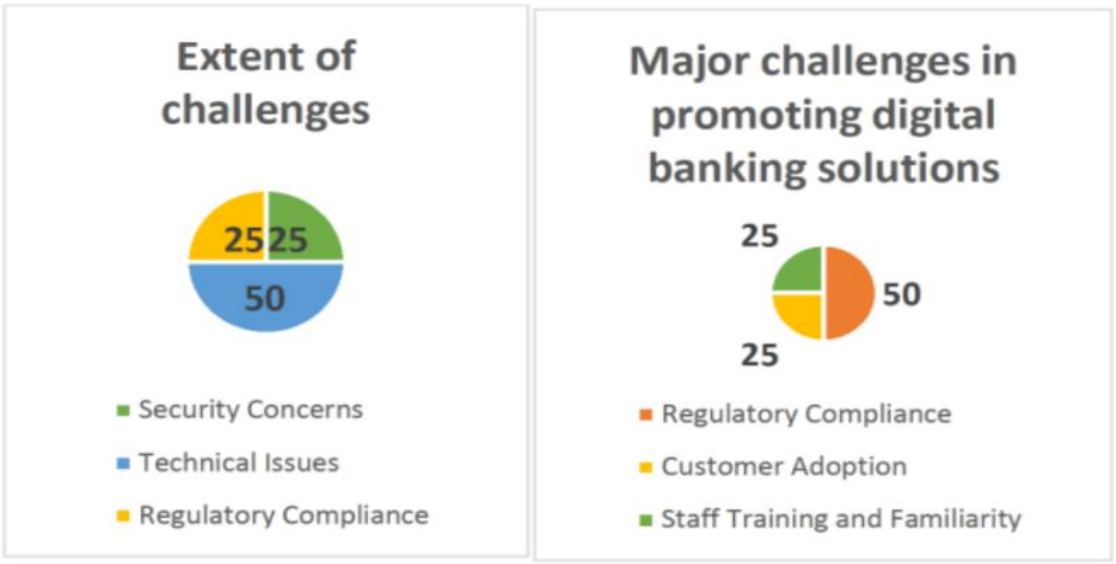


Figure 5. Comparison of the extent of challenges

Figure 5 shows that major challenges in promoting digital banking included regulatory compliance (50%), customer adoption (25%), staff training and familiarity (25%), technical issues (25%), and security challenges (25%). Addressing these barriers, especially regulatory and technical issues, is critical for increasing adoption of digital products and technologies. Regulators, policy makers and other stakeholder need to urgently focus on the enabling laws to enhance digital banking.

4.4 The Decision Construct

The study found that banks primarily offered mobile banking apps and internet banking (93%), followed by digital payment platforms (71%), e-banking security measures (50%), online account management (43%), and digital wallets (36%), while cryptocurrency services were not provided. IT managers reported high satisfaction with these technologies in terms of turnaround time, ease of use, usefulness (79%), availability (71%), and robustness (57%). Usability was rated very easy or easy by 77% of managers. Expertise levels varied, but overall, 93% of managers enjoyed using the technologies. Customer knowledge was high for mobile banking apps (64%) and digital payment platforms (62%), moderate for e-banking security measures (50%), and low for cryptocurrency services (15%). These findings reflect how customers' decisions to adopt digital banking are influenced by the benefits and usability of digital banking technologies. Customers decisions need to be enhanced by the knowledge construct of DID process in order to influence adoption of digital banking

4.5 Implementation Construct

Digital banking platforms have been implemented through technological infrastructure, including core banking systems, internet and mobile platforms, security measures, and integration with payment systems. Customer-facing platforms and regulatory support also play a key role. The study identified challenges in these digital products and technologies

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through thematic analysis of customer questionnaires, with specific themes and codes highlighting barriers to adoption and usage by taking advantage of the qualitative part of the study.

Table 4. Summary of Challenges to Digital Banking from Customers

Code		Challenge (s)
C1		Lack of knowledge about digital banking
C2		High cost of mobile money
C3		Cultural barriers
C4		High infrastructure costs to set up a banking infrastructure
C5		Language barrier
C6		Limited internet infrastructure
C7		Low digital literacy
C8		Mismanagement of the income
C9		Lack of trained personnel to support digital banking
C10		Regulatory challenges
C11		Unreliable internet connection
C12		Security and privacy issues
C13		Social-economic factors like poverty
C14		Intermittent electricity supply
C15		Limited smartphone penetration

Table 5. Summary of Recommendations as presented by IT Managers

Code	Solution/Recommendation to the challenges
S1	Partnership with NGOs to foster community engagement
S2	Continuous mass training on technology advancements
S3	Conduct target marketing campaigns
S4	Implement cyber security measure
S5	Decentralize businesses all over the country
S6	Align digital literacy programs for communities
S7	Avail power solutions
S8	Adopt the use of USSD and voice-based commands
S9	Invest in the latest technology
S10	Implement robust cybersecurity measures
S11	Provide a 24/7 service monitoring system
S12	Provide proactive monitoring tools
S13	Conduct regular system updates
S14	Provide escalation procedures
S15	Provide mobile app push notifications
S16	Collaboration of the customer support team with IT teams
S17	Provide online digital banking resources

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S18	Monitor social media platforms for mentions of technical issues related to digital banking
S19	Provide feedback mechanisms for users to report digital banking issues
S20	Integrate known platforms like mobile money with digital banking
S21	More research into user needs
S22	Institute awareness mechanisms
S23	Lower the cost of digital banking charges
S24	Pilot programs before deployment
S23	Develop reliable and user-friendly platforms
S24	Provide security measures and communicate them effectively to build trust
S25	Provide digital banking services in local languages
S26	Provide affordable and easily accessible digital banking services to individuals
S27	Improve the advertisement

The study identified key challenges to digital banking technologies, including lack of knowledge, high costs, infrastructure limitations, and security concerns. Recommended solutions included improving cybersecurity, adopting accessible technologies such as USSD and voice commands, integrating mobile money platforms, and enhancing customer support. These measures aim to make digital products and technologies more secure, accessible, and user-friendly, fostering higher adoption and financial inclusion. The above findings from the qualitative study also align with the findings from the quantitative findings of this study.

4.6 Confirmation Construct of DIDP-Derived Requirements from Recommendations

The study identified key challenges to digital banking technologies, including lack of knowledge, high costs, infrastructure limitations, and security concerns. Recommended solutions included improving cybersecurity, adopting accessible technologies such as USSD and voice commands, integrating mobile money platforms, and enhancing customer support. These measures aim to make digital products and technologies more secure, accessible, and user-friendly, fostering higher adoption and financial inclusion.

Table 6. Derived requirements

Code	**Challenge (s)**	**Code**	**Derived requirement (DD)**
C1	Lack of knowledge about digital banking	DR1.1	Continuous mass training on technology
		DR1.2	Conduct target marketing campaigns
		DR1.3	Provide online digital banking resources
		DR1.4	Align digital banking programs with communities

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		DR1.5	Improve the advertisement
C2	High cost of mobile money	DR2.1	Lower the costs of digital banking charges
		DR2.2	Provide affordable and easily accessible digital banking services to individuals
C3	Cultural barriers	DR1.1	Continuous mass training on technology
		DR3.1	Pilot programs before deployment
		DR3.2	Partner with NGOs to foster community engagement
		DR3.3	Foster collaboration between the customer support team with IT teams
C4	High infrastructure costs to set up a banking infrastructure	DR4	Allocate a dedicated budget for digital banking investment and shared resources.
C5	Language barrier	DR5	Provide digital banking services in local languages
C6	Limited internet infrastructure	DR6	Integrate known platforms like mobile money with digital banking
C7	Low digital literacy	DR1.1	Continuous mass training on technology
		DR7.1	Institute awareness mechanisms
		DR7.2	Provide mobile app push notifications
C8	Mismanagement of the income	DR8	Conduct regular audits to check on the mismanagement of the office
C9	Lack of trained personnel to support digital banking	DR1.1	Continuous mass training on technology
		DR9	Recruit IT experts in digital banking
C10	Regulatory challenges	DR10	Provide proactive monitoring tools
C11	Unreliable internet connection	DR11.1	There is a need to provide a 24/7 service monitoring system
		DR11.2	There is a need to provide feedback mechanisms for users to report digital banking issues

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		DR11.3	There is a need to monitor social media platforms for mentions of technical issues related to digital banking
C12	Security and privacy issues	DR12	Provide security measures and communicate them effectively to build trust
C13	Social-economic factors like poverty	DR13	Adopt the use of USSD and voice-based commands
C14	Intermittent electricity supply	DR14	Provide alternative power sources, like solar systems
C15	Limited smartphone penetration	DR15	Adopt the use of USSD and voice-based commands

The study revealed a gap between digital banking products supplied and their actual use by bank customers of the studied banks. Customer usage of digital products varied: mobile banking apps were used often by 62%, internet banking by 38%, digital payment platforms by 50%, e-banking security measures by 57%, digital wallets by 36%, and online account management by 25%. Cryptocurrency services were rarely used. These results highlight a disparity between the intended supply of bank digital products and technologies and their real adoption by customers.

5. Discussion of Results

The study revealed a significant digital knowledge gap affecting the adoption of digital banking products and technologies. Despite high smartphone ownership (92.7%), 76.7% of respondents had limited experience with digital platforms, 78.9% were unaware of digital banking products, and overall usage was low (34.5%). Ease of use (75.7%) strongly influences adoption, while 91% identified lack of knowledge as the main barrier, highlighting the urgent need for targeted digital literacy and awareness initiatives to improve uptake of digital products and technologies.

5.1 Knowledge

The study emphasizes that lack of knowledge limits the adoption of digital banking products and technologies, even among educated customers with smartphones. Banks can improve adoption by providing comprehensive training through physical sessions, online platforms, media, SMS, community programs, conferences, and TV/radio campaigns. Adoption was higher among employed individuals, suggesting workplace-targeted training could further promote the use of digital products and technologies. Knowledge management processes also enhance the reputation and trust in digital banking technologies [3].

5.2 Need to cater for the physically challenged

The study found that no digital banking products were specifically designed for physically challenged individuals, despite this group representing 6% of respondents. This highlights a market opportunity for banks to develop accessible digital products and technologies for the

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blind, deaf, lame, and other disabled users. Targeting this segment could increase adoption and market share, especially among middle-aged (31–40) and young adult (21–30) customers, who show higher uptake rates. Regulatory support may be needed to encourage banks to serve this underserved population [36], [37], [38].

5.3 Impact of income levels on adoption

Income influences the adoption of digital banking products and technologies, with customers earning between UGX 100,000–1,000,000 and UGX 1,100,000–2,000,000 being the most likely users. Banks can target these groups by offering affordable digital services and premium options for higher-income earners. Incentive programs, such as rewards for referrals, cashback, reduced bank charges, or membership in privileged groups, could further encourage adoption of digital products and technologies, leveraging the higher technological literacy of salaried employees played a significant role in the adoption of digital banking products.

5.4 Benefits of digital banking

Respondents identified the primary benefits of digital banking products and technologies as time-saving (45%), convenience and accessibility (39%), 24/7 availability (36%), and improved customer service. Banks should focus on reducing transaction times, ensuring fast turnaround, and minimizing downtime to boost adoption.

These benefits can be leveraged to promote digital products and technologies and strengthen their appeal to the target market [35], [39], [40]. There is a gap in benefits between what the studied banks offer or supply as portrayed by the Bank IT Managers and what the customers need. Banks need to align what products and services they supply on the market to the customers' needs. The foregoing conclusion emanates from the fact that for customers to take on a product or service, they are buying the benefits of that product or service [41]. As a result, banks need to evaluate and make use of this principle when designing bank digital products for the market.

5.5 Challenges of digital banking

Digital banking products and technologies face challenges such as high costs, technical issues, and complex user interfaces. Sixteen percent of respondents cited expense as a major concern, while many highlighted technical problems as barriers to adoption. To improve uptake, banks should reduce costs, simplify interfaces, make services more accessible, and collaborate with private sector partners or NGOs to provide infrastructure. Resource sharing among banks, such as co-financing leased Internet lines, can also lower costs and enhance accessibility of digital products and technologies. Banks need to collaborate with other service providers and fellow banks not offering similar services in areas of digital infrastructure in order to lower their costs of operation. The measure will help banks to pass on the lowered cost to customer thus encouraging bank digital adoption.

5.6 Divergent views between Managers and Customers

The study revealed gaps between IT managers' and customers' perspectives on digital banking products and technologies. Managers emphasized ease of use and usefulness (71%),

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while customers prioritized turnaround time (45%), highlighting misaligned expectations. Only 29% of managers were experts, and knowledge gaps existed across services: high knowledge of mobile apps (64%), internet banking (38%), digital payment platforms (62%), online account management (31%), digital security (50%), and none for cryptocurrencies.

Customers' actual usage was lower than managers' perceptions, with 38% using internet banking and 36% using digital wallets. To improve adoption, banks should enhance manager training [42], [43], align services with customer needs, streamline operations, reduce costs, and implement targeted education and communication strategies for digital products and technologies [7], [44].

5.7 Misguided Persuasion

The study found that banks emphasized mass marketing (93%) over more effective strategies for promoting digital products and technologies, such as educational workshops (64%) and incentives/rewards (57%). The above imbalance contributed to low customer referrals (50%) and slowed diffusion, especially among late adopters. Shifting focus to targeted marketing, incentivizing existing customers to promote digital products, and reducing general advertising could improve adoption, enhance cost-effectiveness, and potentially lower digital service charges for customers [45].

5.8 Decision-Enhancing User Experience through Customization

IT managers observed that digital banking products and technologies were not user-friendly. To improve usability, banks should customize apps to reflect local needs, including personalized greetings, local languages, and removal of irrelevant form requirements like ZIP codes. Streamlining repeated identification for existing customers and strengthening both online and in-person customer support can facilitate smoother adoption of digital products and technologies [46], [47].

5.9 Infrastructure gaps in POS implementation

While half of IT managers believed their banks had sufficient infrastructure for digital products and technologies, many customers disagreed, particularly regarding point-of-sale (POS) systems. To improve adoption, banks should install more POS machines across key locations, ensure compatibility with major payment systems (Visa, MasterCard, loyalty programs), and leverage public-private partnerships to enhance accessibility and convenience of digital financial services. [48], [49], [50].

5.10 Lack of Product Differentiation across Banks

Most Ugandan banks provide similar digital products and technologies, with 93% offering mobile apps and internet banking and 71% offering digital payment platforms, limiting differentiation and slowing adoption. To increase uptake, banks should diversify offerings with innovative services such as digital wallets (36% availability), mobile check deposits, cryptocurrencies, and drive-through banking. While core technologies like Electronic Funds Transfer (EFT) and Real Time Gross Settlement (RTGS) are widely used, introducing innovative digital products is essential to meet evolving customer needs, ever changing technology and setting in of new advanced core systems to boost adoption [7], [51]

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5.11 Implementation and confirmation- Future Initiatives to ease of use

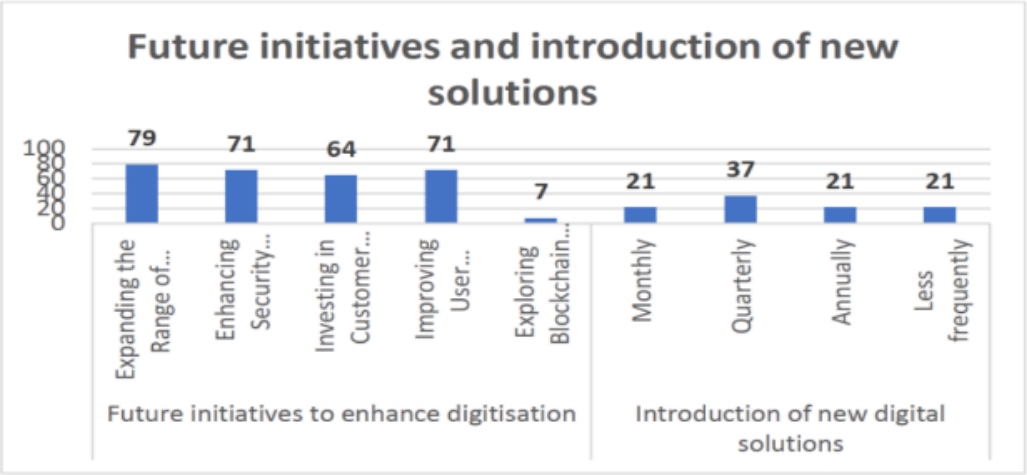


Figure 5. Future Bank Initiatives and Solutions

IT bank managers reported plans to enhance digital banking products and technologies, with priorities including expanding offerings (79%), strengthening security (71%), improving user experience (71%), and investing in customer education (64%). Only 7% focused on blockchain or cryptocurrency services. Updates to digital solutions occurred monthly (21%), quarterly (37%), annually (21%), or less frequently (21%). Aligning new digital products with customer expectations is essential to increase adoption and ensure long-term success of digital banking innovations. [39], [52], [53].

6. Limitations of the study

The study's cross-sectional design limited its ability to track changes in digital banking products and technologies over time, though a larger sample size partially mitigated this limitation. Data access was constrained by banks' confidentiality and competitive concerns, limiting insight into the broader landscape. Resource limitations due to lack of funding further restricted the study's scope and duration. Additionally, changes in the banking sector during the study, including one bank closure and three downgrades from Tier 1 to Tier 2, affected sampling and data collection for assessing digital banking adoption.

7. Conclusion

The study emphasizes the need for banks to innovate and diversify digital products and technologies rather than replicate competitors. Localizing applications with cultural and linguistic elements can improve understanding and adoption. Misalignment between managers' and customers' perspectives on product relevance must be addressed to enhance implementation, confirmation, and sustained use. Barriers include regulatory challenges (50%), customer resistance (25%), training needs (25%), and security concerns. Banks should invest in training, strengthen cybersecurity, ensure quick resolution of technical failures, and make platforms inclusive for physically challenged users. Targeted, segment-specific marketing and customer-focused innovations can enhance persuasion, reduce costs,

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and increase adoption. Contributions of the study included; Theoretical contributions, where the DIOP stages reveal adoption barriers and facilitators in low resource contexts. Practical contributions involved the need for digital product differentiation, localized services and improved digital product literacy. The methodological contributions included the use of the market-share sampling as a replicable approach and the use of the DIO Process to examine bank digital products and technologies in other low-resource settings.

8. Future Research

Future research should examine the impact of artificial intelligence (AI) and big data analytics on digital banking products and technologies. Investigating an inclusive Bank of Uganda (BOU) app that integrates all regulated bank apps could enhance supervision and customer trust. Comparative studies between resource-constrained and well-resourced environments, as well as longitudinal research designs, are recommended to provide deeper insights into the development, effectiveness, and adoption of digital banking technologies.

Conflict of Interest: The authors declare that there is no conflict of interest in this paper.

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