# Digital Banking Channels, Financial Inclusion and Commercial Bank Sustainability in Kenya

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## ABSTRACT

The increasing use of digital banking channels has transformed the financial landscape globally, including in Kenya. While digital banking is believed to enhance financial sustainability, the role of financial inclusion in explaining this relationship remains unclear. Previous studies have examined the impacts of digital banking and financial inclusion separately, but little research has explored how financial inclusion influences the link between digital banking and financial sustainability in commercial banks. This study explored the relationship between digital banking channels, financial inclusion, and the financial sustainability of commercial banks in Kenya. Specifically, it investigated whether financial inclusion explains the relationship between digital banking and financial sustainability. The study applied the Transaction Cost Theory (TCT) in evaluating how financial inclusion explains the relationship between digital banking channels and financial sustainability. The study used a quantitative research design with secondary data from Kenyan commercial banks between 2018 and 2023. Data were analysed using various econometric models, including Generalized Method of Moments (GMM) and Ordinary Least Squares (OLS), to assess the relationships between digital banking channels, financial inclusion, and financial sustainability. The findings showed a significant positive relationship between digital banking channels and financial sustainability, with mobile banking having the strongest impact. Financial inclusion also significantly improves as digital banking adoption increases. Moreover, the study revealed that financial inclusion partially explains the relationship between digital banking and financial sustainability, indicating its important role in enhancing the effectiveness of digital banking. This study highlights the critical role of financial inclusion in strengthening the impact of digital banking on the financial sustainability of banks. The results suggest that banks should prioritize both digital banking and financial inclusion strategies to achieve long-term financial health. The findings contribute to a deeper understanding of the interconnectedness between digital banking, financial inclusion, and sustainability, with implications for both banking practice and policy development.

**Keywords:** Digital Banking Channels, Financial Sustainability, Financial Inclusion

## INTRODUCTION

The sustainability of financial institutions is vital for the stability and growth of global economies. Commercial banks, as pivotal players in financial systems, drive resource allocation, investment, and economic development [1]. Financial sustainability enables these institutions to withstand economic shocks, manage risks, and maintain profitability over the long term without compromising future stability [2]. However, achieving this sustainability has become increasingly challenging due to evolving market dynamics, regulatory demands, and technological advancements [3]. In Kenya, where the banking sector underpins economic activity, exploring sustainable pathways is crucial for fostering economic resilience and social welfare.

Digital transformation, particularly through digital banking channels, has revolutionized financial operations by improving cost efficiency, customer engagement, and operational effectiveness [3]. These advancements,

however, present challenges such as high implementation costs, cybersecurity risks, and varying adoption rates [4]. While digital banking is lauded for enhancing financial inclusion—narrowing the gap for underserved populations—it remains unclear how its adoption impacts the financial sustainability of banks in developing economies like Kenya [5]. Addressing this ambiguity is essential for informed policy-making and strategic planning.

Financial inclusion, a cornerstone of equitable economic growth, serves as a critical link between digital banking and financial sustainability [5]. By expanding access to financial services, it can diversify revenue streams and enhance risk management. However, existing research offers mixed conclusions about its role in achieving sustainable outcomes [3]. Some studies highlight its transformative potential, while others point to challenges like resource constraints and technological barriers [4]. This study examines how financial inclusion explains the effect that digital banking has on the sustainability of commercial banks in Kenya. It aims to reconcile conflicting findings, fill gaps in existing literature, and provide actionable insights for stakeholders.

Financial sustainability refers to an institution's ability to generate sufficient revenue to cover costs, manage risks, and ensure long-term operations [4]. Earlier studies conceptualized sustainability through various dimensions, including profitability, risk management, and resilience to economic shocks. For instance, [2] described sustainability as a firm's capacity to thrive independently of external support, while [3] emphasized operational continuity without compromising future stability. Common indicators, such as return on assets (ROA) and return on equity (ROE), have been supplemented by nuanced metrics like Z-scores to better capture sustainability.

The relationship between sustainability and stakeholder value is well-established, as sustainable firms tend to enjoy better reputations, easier access to funding, and stronger stakeholder relationships [4]. However, inconsistencies remain regarding how digital transformation strategies impact sustainability. This study focuses on the Kenyan banking sector, characterized by rapid technological adoption and evolving financial inclusion metrics. Digital banking channels, such as mobile banking, internet banking, and agency banking, have transformed service delivery, enhancing efficiency, reducing costs, and expanding access to underserved populations [3]. Despite their potential, these channels face challenges like low adoption rates, cybersecurity risks, and high costs of implementation.

Research on digital banking's impact on financial sustainability presents mixed results. While some studies highlight its role in enhancing operational efficiency and profitability [3], others cite increased costs and reduced returns due to adoption challenges [4]. Financial inclusion emerges as a mediating factor, bridging the gap between digital banking and sustainability. By improving access to affordable and relevant financial services, financial inclusion expands banks' customer bases and revenue streams [2]. In Kenya, financial inclusion has grown significantly, with 84% of adults accessing formal financial services in 2023 compared to 27% in 2006 [3].

While financial inclusion contributes to economic stability by reducing poverty, crime, and unemployment [2], its relationship with financial sustainability remains underexplored, especially in the context of digital banking. This study addresses this gap by investigating how financial inclusion mediates the link between digital banking and sustainability. A multidimensional approach was used to measure financial inclusion, digital banking, and sustainability, integrating indices of accessibility, availability, and usage [4].

Kenya offers a unique case study for examining the interplay between digital banking, financial inclusion, and sustainability. As a global leader in mobile banking innovation, the country demonstrates the transformative potential of digital finance in emerging markets [3]. However, challenges such as limited technological literacy and resource constraints highlight the need for targeted strategies to optimize benefits [4]. By situating the research within Kenya's dynamic banking environment, this study provides insights that are locally relevant and globally applicable.

# LITERATURE REVIEW

Digital banking has emerged as a transformative force in the global financial ecosystem, significantly advancing financial inclusion and reshaping sustainability efforts. Digital banking channels, such as mobile and internet banking, have helped reduce financial access barriers by streamlining transactions, cutting costs, and expanding services to underserved populations [6], [7]. While these technologies are essential tools for financial inclusion, their direct impact on financial sustainability remains inconclusive in some contexts (Kevser & Bilge, 2019). This calls for comprehensive research integrating diverse financial institutions and variables to better understand the complex relationship between digital banking, inclusion, and sustainability.

[8]examined the impact of digital financial inclusion on corporate governance and financial performance in Kenya, identifying loans and deposits as critical inclusion indicators [9]. However, many studies focus narrowly on specific financial metrics, limiting the generalizability of their findings [10]. For example, [11]found that factors like leverage and liquidity significantly influence financial performance, yet the broader connection to sustainability remains underexplored. Similarly, [12] noted that while digital banking enhances financial access, its long-term effects on institutional viability require further investigation. Globally, digital banking is celebrated for advancing financial inclusion, but its role in sustaining commercial banks depends on governance, regulatory frameworks, and socio-economic conditions [13]. [14] explored corporate dynamics and their interplay with financial inclusion, finding both positive and negative relationships between governance and inclusion indicators. However, the study did not fully address implications for financial sustainability [15]. These findings underscore the need for future research to evaluate digital banking's dual role as a driver of inclusion and sustainability.

In Africa, digital banking addresses unique challenges related to financial inclusion and sustainability. A study on Uganda's banking sector revealed that while financial inclusion improves customer outreach and service delivery, its overall relationship with sustainability remains weak [16]. Mobile and agency banking have been pivotal in bridging the financial inclusion gap, enabling millions to access services previously unavailable to them [17]. Platforms like M-Pesa in Kenya and EcoCash in Zimbabwe have increased financial access and diversified banks' revenue streams, strengthening their resilience [18]. Nevertheless, Africa's socio-economic diversity and infrastructure limitations necessitate tailored approaches to maximize the benefits of digital banking [19].

Infrastructure challenges across Africa remain significant barriers to leveraging digital banking for sustainability [20]. However, innovations such as mobile money platforms have been transformative. For instance, M-Pesa has fostered economic activity in rural areas and reduced reliance on informal financial systems, showcasing the dual impact of digital banking on inclusion and sustainability [21], [22]. These examples highlight the need for region-specific strategies to address disparities effectively. Regulatory frameworks play a crucial role in shaping the outcomes of digital banking. Across Africa, governments and central banks have implemented policies to support financial inclusion through digital technologies [23]. While these measures have boosted adoption, their impact on long-term sustainability remains mixed. Under-regulated environments often struggle with balancing innovation and risk management [24]. Harmonizing innovation, regulation, and infrastructure development is therefore essential for ensuring that digital banking contributes to sustainable growth [25].

Kenya offers a compelling case study in digital banking's transformative potential, particularly through mobile money platforms like M-Pesa. Launched in 2007, M-Pesa has revolutionized financial services by providing affordable, accessible, and reliable solutions for unbanked populations [26]. Its success demonstrates how digital platforms can drive financial inclusion while contributing to banks' financial sustainability. Similarly, agency banking in Kenya has enabled banks to reach remote areas by partnering with retail outlets, reducing costs, and enhancing profitability [27]. Despite challenges such as fraud and regulatory compliance, agency banking has significantly improved customer deposits, loan recovery rates, and overall financial stability.

Kenya's regulatory environment has been a key enabler of digital banking's success. Policies by the Central Bank of Kenya (CBK), such as mobile money interoperability and the National Payment System Act, have fostered competition, innovation, and secure digital payment systems [28]. However, ensuring the long-term sustainability of digital banking requires addressing challenges such as cyber risks, digital literacy gaps, and socio-economic disparities that continue to exclude some populations from fully benefiting from financial innovations.

## Theoretical Framework

### Transaction Cost Theory

The Transaction Cost Theory, introduced by [29], explains how organizations structure transactions efficiently to achieve economic viability and sustainability. Commons (1931) further emphasized that when markets fail, organizations adopt alternative structures to facilitate efficient transactions. This theory offers a useful framework for understanding how digital banking channels impact organizational sustainability. Proponents argue that digital banking reduces transaction costs, benefiting both customers and financial institutions by increasing transaction volumes, enhancing revenues, and ultimately supporting financial sustainability. Additionally, digital banking provides continuous access to financial services, personalized solutions, and cost-efficient processes, which drive customer engagement and strengthen the financial stability of banks [30].

The connection between the Transaction Cost Theory and digital banking lies in financial innovation, which enables institutions to develop new products, streamline processes, and meet evolving stakeholder needs. [31] note that innovation helps financial institutions address challenges such as market inefficiencies, regulatory constraints, and high operational costs, all of which can undermine earning potential and sustainability. By addressing these barriers, digital banking promotes optimal savings and consumption decisions, supports efficient fund utilization, and fosters broader financial inclusion.

Financial inclusion, facilitated by digital banking, further strengthens the sustainability of banks by expanding access to financial services. However, critics argue that the Transaction Cost Theory has limitations. For instance, it overlooks factors such as organizational capabilities, power dynamics, trust, and market uncertainties, which influence the relationship between digital banking and sustainability. Trust, in particular, is critical for fostering participation in financial markets and improving access to formal and informal financing. [32] and [33] criticize the theory for neglecting firms' varying capacities to organize transactions and for disregarding evolutionary aspects, such as uncertainty and dynamic market processes. Despite these criticisms, the Transaction Cost Theory remains a valuable tool for analyzing governance, organizational efficiency, and decision-making. In this study, it provides a foundation for exploring how digital banking channels, through the lens of financial inclusion, influence the financial sustainability of commercial banks.

# METHOD

### Research Design

A research design is the structured plan or framework that guides how research questions are addressed and how variability in data collection and analysis is managed [34]. It provides a systematic foundation for conducting investigations effectively [35]. This study adopted a combination of correlational, descriptive, and longitudinal research designs. Using multiple designs improves the validity of findings through triangulation [36]. Each design was selected for its specific strengths in meeting the study's objectives.

### Target Population

The target population refers to a specific segment of individuals or entities that share particular characteristics and can be effectively studied [37]. This research adopted a census approach, focusing on all

commercial banks in Kenya licensed as of December 31, 2023 [38]. The study targeted these banks because of their role in adopting and implementing digital banking services, which enable customers to access financial services remotely. Commercial banks were selected due to their varying ownership structures—whether local or foreign—which influence their level of technological adoption and, consequently, their financial sustainability [39]. Additionally, differences in financial strength among these banks affect their capacity for technological investment, while the level of financial inclusion they achieve determines the size of their clientele, further impacting sustainability [40]. The diversity in ownership and operational strategies among the banks provided an ideal foundation for examining their relationships with financial sustainability.

The study focused exclusively on commercial banks regulated by the CBK due to their distinct management and ownership structures, which influence their ability to achieve financial inclusion and sustainability [41]. These banks also actively invest in research and digital technologies, but their levels of investment vary, leading to differences in technology adoption and financial outcomes [39]. Foreign-owned banks, for instance, tend to allocate more resources to research and development, potentially giving them a competitive advantage over locally-owned banks in terms of sustainability [40]. This variation made commercial banks an appropriate and valuable population for the study, as understanding these dynamics can provide insights into the broader implications of digital banking on financial performance and customer satisfaction.

**Research Instrument and Data Collection Procedure**

The study utilized secondary data collected from the audited annual financial reports of commercial banks in Kenya for the period 2018 to 2023. These reports were sourced from the banks' official websites and the Central Bank of Kenya (CBK) library. To ensure systematic and efficient data extraction, a secondary data collection guide was developed, focusing on information relevant to the research questions. The six-year study period (2018–2023) provided sufficient data to analyze trends in digital banking channels and the financial sustainability of commercial banks. Prior to data collection, the necessary approvals were secured, including a university-issued permission letter and a research permit from the National Commission for Science, Technology, and Innovation (NACOSTI).

**Operationalization of Variables**

The study variables were operationalized as illustrated in table 1.

Table 1: Indicators of Digital Channels, Financial Sustainability, and Financial Inclusion

| Indicators | Measure |
|---|---|
| **Digital Channels (DC)** | |
| Internet banking | Value of internet banking transactions to total banking transactions |
| Mobile banking | Value of mobile banking transactions to total banking transactions |
| Electronic card banking | Value of electronic card banking transactions to total banking transactions |
| Agency banking | Value of agency banking transactions to total banking transactions |
| $Ratio\ of\ Individual\ DC\ Transcactions\ \dfrac{Digital\ Banking\ Channel\ Transactions}{Total\ Transactions\ of\ All\ Channels}$ | |
| **Financial Sustainability Index (FSI)** | |
| Sustainability Z- score index | $\dfrac{ROA + (Equity/Assets)}{Standard\ deviation\ of\ ROA}$ |
| $ROA = \left(\dfrac{Net\ Income}{Total\ Assets}\right)$        $Z - score = \left(\dfrac{ROA + \frac{E}{A}}{Std.ROA}\right)$ | |
| **ROA:** Return on Assets <br> **Std. ROA:** Standard Deviation of Return on Assets <br> **E:** Total Equity <br> **A:** Total Assets | |

| **Financial Inclusion Index (FII)** | |
|---|---|
| Loans + Deposits/GDP | Financial Inclusion Index (Normalized) |
| Bank branches | |
| Bank accounts | |

Normalized $Dimension\ Index = \frac{Av_i - Mn_i}{Mx_i - Mn_i}$

$Av_i$: Actual value of the dimension (e.g., actual value of the volume of deposits)

$Mn_i$: Minimum observed value of the dimension (e.g., the lowest volume of deposits)

$Mx_i$: Upper limit for the dimension, defined as the 94th quantile of the observed values (e.g., 94th quantile of the volume of deposits).

$$Financial\ Inclusion\ Index = 1 - \sqrt{\frac{(1 - wAc_i)^2 + (1 - wAv_i)^2 + (1 - wUs_i)^2}{3}}$$

$wAc_i$: weighted accessibility average = Number of bank accounts/1,000 population

$wAv_i$: weighted availability average = Number of bank branches/10,000 population

$wUs_i$: weighted usage average = Loans + Deposits/GDP

## Data Analysis

In the mediation model (Figure 1). The independent variable affects the dependent variable (path a) or indirectly affects dependent variable through a mediator (path b). The mediator also affects the dependent variable through path c as represented in figure 1 below.
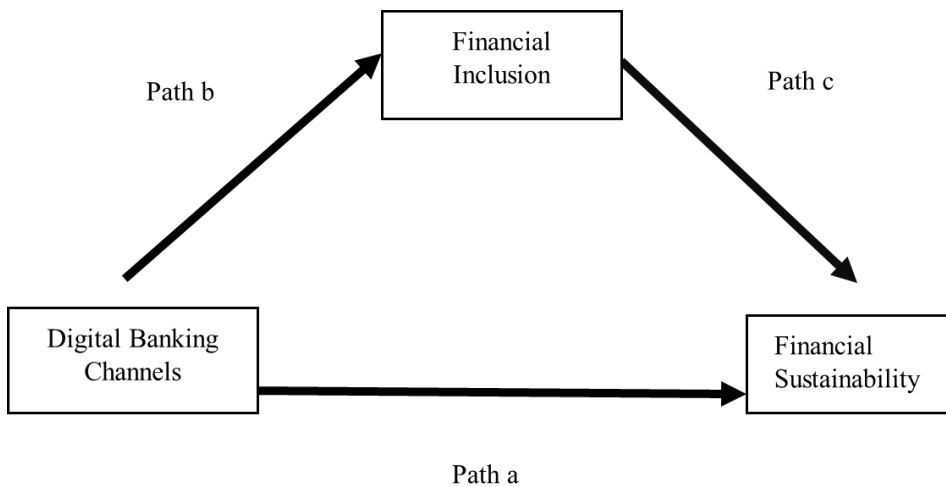


Figure 1: Mediation Model

Source: Researcher (2023)

$FS_{it} = \alpha + \beta_1 FS_{it\text{-}1} + \beta_2 DC_{it} + \mu_{it}$…………………..... Eq. 2.1

$FI_{it} = \alpha + \beta_1 DC_{it} + \mu_{it}$............................................... Eq. 2.2

$FS_{it} = \alpha + \beta_1 FS_{it\text{-}1} + \beta_2 DC_{it} + \beta_3 FI_i + \mu_{it}$……………..Eq. 2.3

Where:

FS is the financial sustainability, DC is the digital banking channels, FI is the financial inclusion, α is the regression constant term, $\beta_{1....}\ \beta_5$ are regression coefficients and $\mu_{it}$ is the error term (residual). Subscript $t$ represents the particular period, for each variable $i$.

# RESULTS

## Descriptive Statistics of Financial Sustainability

The descriptive statistics of the financial sustainability index (FSI) of all the 38 banks that were included in the study were summarized by years from 2018 – 2023. Table 2 shows the results.

Table 2: Descriptive statistics of Financial Sustainability sorted by Period

| Period | N | mean | min | Max | Skewness | Kurtosis |
|--------|-----|---------|---------|----------|----------|----------|
| 2018 | 38 | 66.3865 | 3.5539 | 382.0204 | 2.3970 | 8.2688 |
| 2019 | 38 | 63.3560 | 1.9398 | 368.3619 | 2.4503 | 9.0017 |
| 2020 | 38 | 62.6742 | -7.2920 | 369.6864 | 2.4171 | 8.9350 |
| 2021 | 38 | 62.5683 | -2.8130 | 230.4201 | 1.3046 | 4.0216 |
| 2022 | 38 | 54.7266 | -1.1363 | 165.9403 | 0.9150 | 3.2456 |
| 2023 | 38 | 73.0246 | 0.5217 | 351.6846 | 1.8574 | 7.2310 |
| FSI | 228 | 63.7894 | -7.2920 | 382.0204 | 2.3121 | 9.1552 |

Source: Researcher (2024)

The descriptive statistics for the Financial Sustainability Index (FSI) of Kenyan commercial banks showed an average FSI of 63.79. This value indicates a moderate level of financial sustainability across the banks, but it is not particularly high. The distribution, which is right-skewed as shown by the skewness value of 2.31, suggests that while a few banks have very high FSI scores, many others have lower scores. The FSI ranged from a minimum of -7.29 to a maximum of 382.02, highlighting a wide gap in financial sustainability, with some banks facing challenges and others performing very well. The kurtosis value of 9.16 shows a distribution with a sharp peak and heavy tails, indicating that most banks' scores are near the average, but there are a number of extreme outliers. In conclusion, although the average FSI indicates moderate sustainability, the large variability and presence of outliers suggest that some banks may benefit from improving their financial sustainability practices. This spread underscores the need for tailored strategies to improve stability, as the sector includes both high-performing banks and those at risk.

## Descriptive Statistics of Digital Channels

The study then subjected the composite data of digital channels (DC) across the six-year period (2018-2023) to descriptive analysis. Table 3 presents the results.

Table 3: Descriptive Statistics for DC

| Period | N | mean | Sd | min | Max | Skewness | kurtosis |
|--------|-----|--------|--------|--------|--------|----------|----------|
| 2018 | 38 | 0.7906 | 0.1945 | 0.0327 | 0.9982 | -1.6532 | 7.0322 |
| 2019 | 38 | 0.6105 | 0.2679 | 0.0340 | 0.9990 | 0.1452 | 2.1690 |
| 2020 | 38 | 0.8662 | 0.2177 | 0.0329 | 0.9987 | -3.0054 | 11.5792 |
| 2021 | 38 | 0.9214 | 0.1269 | 0.2242 | 0.9984 | -4.5297 | 25.3432 |
| 2022 | 38 | 0.9168 | 0.1265 | 0.2329 | 0.9983 | -4.3436 | 23.8321 |
| 2023 | 38 | 0.9180 | 0.1292 | 0.2178 | 0.9983 | -4.3766 | 24.0808 |
| DC | 228 | 0.8372 | 0.2145 | 0.0327 | 0.9990 | -1.9116 | 6.1841 |

Source: Researcher (2024)

The data for the digital channel (DC) from 2018 to 2023 revealed a steady increase in average values, beginning at 0.7906 in 2018 and rising to 0.9180 by 2023. This consistent rise indicated a growing use of the

channel over the years. Alongside this, the standard deviation (SD) decreased, from 0.1945 in 2018 to approximately 0.126 in 2023, which suggests that the variation in how users interacted with the channel became smaller and more uniform. By 2023, the skewness values shifted sharply into negative territory, reaching -4.38, showing that most user activity was focused at the higher end of the scale. The kurtosis values also rose significantly, exceeding 20 by 2023, indicating that the data had a sharp peak and very few extreme values. These shifts in skewness and kurtosis suggest that user behaviour had become more stable, likely due to improved features of the channel or more focused engagement strategies. The increase in the mean, along with the drop in SD, suggests that the channel had reached a point of maturity, with user behaviour becoming more predictable. By 2023, this stability indicated that the platform had achieved a steady state in user engagement, offering an opportunity for more targeted marketing strategies to maintain this base while potentially expanding engagement in less stable channels.

**Descriptive Statistics of Financial Inclusion**

The descriptive statistics of financial inclusion index of all the 38 banks that were included in the study was summarized by years from 2018 – 2023. Table 4 shows the results.

Table 4: Descriptive Statistics for Financial Inclusion Index sorted by Period

| Period | N | mean | Sd | min | max | skewness | kurtosis |
|--------|-----|--------|--------|--------|--------|----------|----------|
| 2018 | 38 | 0.9427 | 0.0957 | 0.5890 | 0.9976 | -2.8007 | 10.4334 |
| 2019 | 38 | 0.9416 | 0.0959 | 0.5885 | 0.9979 | -2.7564 | 10.2053 |
| 2020 | 38 | 0.9369 | 0.0997 | 0.5841 | 0.9972 | -2.5437 | 9.0617 |
| 2021 | 38 | 0.9348 | 0.1005 | 0.5802 | 0.9991 | -2.4297 | 8.4980 |
| 2022 | 38 | 0.9411 | 0.0974 | 0.5809 | 0.9969 | -2.8368 | 10.5753 |
| 2023 | 38 | 0.9409 | 0.0980 | 0.5818 | 0.9976 | -2.7935 | 10.2877 |
| FII | 228 | 0.9397 | 0.0968 | 0.5802 | 0.9991 | -2.6873 | 9.7938 |

Source: Researcher (2024)

The average FII score of 0.9397 reflects strong financial inclusion across the 228 banks studied. This indicates that the banks have made significant progress in expanding financial services, providing access to a large portion of the population. The standard deviation of 0.0968 suggests low variation in the FII scores, meaning that most banks' scores are similar and clustered around the average. This consistency shows that the banking sector generally follows a uniform approach to financial inclusion, demonstrating a collective effort to enhance service delivery. However, the minimum FII score of 0.5802 and the maximum score of 0.9991 reveal a noticeable range in financial inclusion levels among the banks. While most banks are making strong efforts, some banks, with a minimum score below 0.6, are still struggling with their financial inclusion initiatives. The skewness of -2.6873 indicates a negative skew in the distribution, meaning that many banks have scores above the average, while only a few banks fall significantly below it. This suggests that while financial inclusion is strong overall, a few banks are excelling and setting high standards, indicating potential for further improvement across the sector. The kurtosis value of 9.7938 shows that the FII distribution is highly concentrated around the mean, with few extreme outliers. This indicates that most banks are achieving similar levels of financial inclusion, but the top-performing banks significantly raise the average score, serving as models for best practices.

The financial inclusion index was derived from three aspects of financial inclusion including banking penetration (BP as measured by number of bank accounts), availability of banking services (AVBS as measured by number of bank branches and usage of the banking system (UBS as measured by value of loans and deposits). The study further subjected these aspects to descriptive statistics. The results are presented in tables 5 to 7.

Table 5: Descriptive Statistics for Banking Penetration

| Period | N | mean | Sd | min | max | skewness | kurtosis |
|--------|-----|--------|--------|--------|--------|----------|----------|
| 2018 | 38 | 0.0620 | 0.1723 | 0.0000 | 0.8332 | 3.8206 | 16.3530 |
| 2019 | 38 | 0.0636 | 0.1764 | 0.0000 | 0.8533 | 3.8193 | 16.3471 |
| 2020 | 38 | 0.0652 | 0.1797 | 0.0000 | 0.8666 | 3.8110 | 16.2793 |
| 2021 | 38 | 0.0678 | 0.1871 | 0.0001 | 0.8999 | 3.8134 | 16.2742 |
| 2022 | 38 | 0.0704 | 0.1945 | 0.0001 | 0.9333 | 3.8153 | 16.2680 |
| 2023 | 38 | 0.0744 | 0.2059 | 0.0001 | 1.0000 | 3.8350 | 16.4625 |
| BP | 228 | 0.0672 | 0.1843 | 0.0000 | 1.0000 | 3.8476 | 16.6458 |

Source: Researcher (2024)

The descriptive statistics for banking penetration (BP) from 2018 to 2023 show a steady increase in the average values, indicating improved access to banking services over time. The average BP grew from 0.0620 in 2018 to 0.0744 in 2023, pointing to an overall enhancement in banking access across the banks studied. The standard deviation also rose from 0.1723 to 0.2059, suggesting greater variation in banking penetration among different banks. The minimum values remained at zero throughout the years, indicating that some banks may still lack access to certain markets, while the maximum values increased from 0.8332 in 2018 to 1.0000 in 2023, showing that at least one bank reached full market penetration. The skewness values, ranging from 3.8110 to 3.8350, reflect a significant positive skew, meaning that most banks have relatively low penetration levels, but a few banks show much higher rates. This is further confirmed by the kurtosis values, which remain high (between 16.2680 and 16.4625), suggesting that the distribution is sharply peaked, with most values clustered near the mean and a few extreme outliers. In conclusion, while there has been a slight increase in banking penetration from 2018 to 2023, the data reveal significant differences among banks. Some institutions are achieving much higher levels of penetration, highlighting opportunities for banks with lower scores to improve. This underscores the need for focused efforts to expand banking access, especially for underserved populations, and emphasizes the ongoing challenge within the banking industry to ensure more equal access to financial services and enhance overall financial inclusion.

Table 6: Descriptive Statistics for Availability of Banking Services

| Period | N | mean | Sd | min | max | skewness | kurtosis |
|--------|-----|--------|--------|--------|--------|----------|----------|
| 2018 | 38 | 0.1304 | 0.2223 | 0.0016 | 0.9809 | 2.6370 | 9.3546 |
| 2019 | 38 | 0.1342 | 0.2263 | 0.0016 | 1.0000 | 2.6275 | 9.3235 |
| 2020 | 38 | 0.1339 | 0.2303 | 0.0008 | 0.9841 | 2.5968 | 9.0965 |
| 2021 | 38 | 0.1312 | 0.2267 | 0.0008 | 0.9682 | 2.5958 | 9.0837 |
| 2022 | 38 | 0.1287 | 0.2224 | 0.0008 | 0.9523 | 2.5872 | 9.0398 |
| 2023 | 38 | 0.1284 | 0.2219 | 0.0000 | 0.9428 | 2.5725 | 8.9041 |
| AVBS | 228 | 0.1311 | 0.2225 | 0.0000 | 1.0000 | 2.6039 | 9.1443 |

Source: Researcher (2024)

The descriptive statistics for the availability of banking services (AVBS) from 2018 to 2023 show that the access to banking services remained fairly consistent over time. The average AVBS remained stable, with values ranging from 0.1304 in 2018 to 0.1284 in 2023. These slight variations reflect some small changes,

but overall, the availability of services has remained stable. The standard deviations, which ranged from 0.2223 to 0.2219, indicate moderate variability, meaning that while some banks offer a wider range of services, most banks' offerings are close to the average. The minimum values across the years show that at least one bank has faced significant challenges in providing services, with the lowest availability dropping to zero in 2023. On the other hand, the maximum values suggest that some banks offer almost complete service availability, with scores reaching up to 1.0000. These findings emphasize the need for continuous efforts to improve service access, especially for banks with low availability scores. Enhancing the availability of banking services is vital for creating a more inclusive financial system, ensuring that all consumers can access essential services. This highlights the importance of targeted strategies to reduce the gaps between high-performing and low-performing banks, helping to create a more equal banking environment.

Table 7: Descriptive Statistics for Usage of the Banking System

| Period | N | mean | Sd | min | max | skewness | Kurtosis |
|---|---|---|---|---|---|---|---|
| 2018 | 38 | 0.0103 | 0.0127 | 0.0000 | 0.0595 | 2.1618 | 7.7075 |
| 2019 | 38 | 0.0102 | 0.0174 | 0.0010 | 0.0835 | 3.0153 | 11.5442 |
| 2020 | 38 | 0.0268 | 0.0922 | 0.0006 | 0.5728 | 5.6827 | 34.1411 |
| 2021 | 38 | 0.0428 | 0.1657 | 0.0002 | 1.0000 | 5.3551 | 31.0579 |
| 2022 | 38 | 0.0121 | 0.0171 | 0.0009 | 0.0771 | 2.9172 | 10.2895 |
| 2023 | 38 | 0.0111 | 0.0138 | 0.0009 | 0.0590 | 2.4859 | 8.1872 |
| UBS | 228 | 0.0189 | 0.0785 | 0.0000 | 1.0000 | 10.3399 | 119.4770 |

Source: Researcher (2024)

The descriptive statistics for the usage of the banking system (UBS) from 2018 to 2023 show important trends in how users interact with banking services. The average UBS experienced small changes, starting with a low average of 0.0103 in 2018, rising to 0.0428 in 2021, and then dropping back to 0.0111 by 2023. This suggests a peak in banking system usage in 2021, possibly due to increased reliance on banking services, which might have been influenced by external factors such as economic changes or a rise in digital banking usage. The standard deviation (SD) shows considerable variation, especially in 2020 and 2021, where it reached 0.1657 and 0.0922, respectively. This indicates that there were significant differences in the usage levels across various banks or periods. While some banks saw a rise in usage, others had very low levels of engagement. The minimum values over the years, especially the lowest at 0.0000, suggest that some banks struggle with user engagement, limiting their reach. On the other hand, the maximum values highlight that certain banks experienced much higher usage, with values reaching 1.0000 in 2021, pointing to strong engagement for some institutions. The skewness values, which range from 2.1618 to 5.6827, show a clear positive skew in the UBS distribution. This indicates that most banks have low usage levels, while a few banks have much higher usage, which pulls the overall average up. The kurtosis values, ranging from 7.7075 to an exceptionally high 119.4770, suggest that the distribution is sharply peaked with significant tails, meaning there are extreme outliers, particularly in 2020 and 2021, where a few banks experienced a dramatic increase in usage.

# RESULTS AND DISCUSSION

### Step 1: Digital Channels and Financial Sustainability

In the first step, the sub-hypothesis stating that there is no significant relationship between digital banking channels and the financial sustainability of commercial banks in Kenya was tested. To do this, the values for agency banking (AB), electronic banking (EB), mobile banking (MB), and internet banking (IB) were used as separate digital banking channels. The results were analysed using four different models: Robust OLS, Fixed-effects, Difference GMM, and System GMM. A summary of the findings can be found in Table 8.

Table 8: Individual Effects of Digital Channels on Financial Sustainability

| Model | (1)<br>Diff GMM | (2)<br>System GMM | (3)<br>Fixed-effects | (4)<br>OLS, robust |
|---|---|---|---|---|
| L.FSI | 0.372* | 0.411* | | |
| | (0.000) | (0.000) | | |
| IB | 0.195 | 0.201 | 0.205 | 0.215 |
| | (0.042) | (0.045) | (0.070) | (0.050) |
| EB | 0.273* | 0.278* | 0.281 | 0.295* |
| | (0.005) | (0.008) | (0.015) | (0.006) |
| MB | 0.305* | 0.312* | 0.320* | 0.335* |
| | (0.001) | (0.003) | (0.004) | (0.002) |
| AB | 0.172 | 0.176 | 0.177 | 0.185 |
| | (0.020) | (0.022) | (0.035) | (0.025) |
| Const | 0.641 | 0.660 | 0.772 | 0.795* |
| | (0.035) | (0.031) | (0.011) | (0.006) |
| Observations | 114 | 152 | 228 | 228 |
| No. of instruments | 17 | 22 | - | - |
| AR2 (P-value) | 0.318 | 0.294 | - | - |
| Sargan Test (P-value) | 0.187 | 0.199 | - | - |
| Hansen Test (P-value) | 0.309 | 0.277 | - | - |

\* Shows significance at $p < 0.05$

Source: Researcher (2024)

In all the models, the lagged dependent variable (L. FS) showed strong significance in both GMM models, with coefficients of 0.372 and 0.411, indicating a clear positive relationship with past values of financial sustainability ($p < 0.05$). This indicates that the financial sustainability of banks is influenced by their previous performance, highlighting the importance of building on prior achievements. All digital banking channels examined—Mobile Banking (MB), Electronic Banking (EB), Agency Banking (AB), and Internet Banking (IB)—demonstrated significant positive effects on financial sustainability, although the strength of these effects varied across models. Mobile Banking had the strongest impact, with coefficients ranging from 0.305 to 0.335 ($p < 0.05$), suggesting that its adoption plays a significant role in enhancing financial sustainability. Electronic Banking also showed a strong effect, with coefficients ranging from 0.273 to 0.295 ($p < 0.05$). While Agency Banking and Internet Banking also had significant positive relationships with financial sustainability, their effects were relatively weaker. The coefficients for Agency Banking ranged from 0.172 to 0.185 ($p < 0.05$), and for Internet Banking, they ranged from 0.195 to 0.215 ($p < 0.05$). These results demonstrate that all digital banking channels positively contribute to financial sustainability, with Mobile Banking and Electronic Banking having the most considerable influence.

### Step 2: Digital Channels and Financial Inclusion

The second step focused on examining the connection between digital banking channels and financial inclusion (FI). This was done to test the sub-hypothesis that there is no meaningful or statistically significant relationship between the use of digital channels and financial inclusion. The results of this analysis are presented in Table 9.

Table 9: Relationship between DC and FI

| Model | (1) Diff GMM | (2) System GMM | (3) Fixed-effects | (4) OLS, robust |
|---|---|---|---|---|
| DC | 0.329* | 0.338* | 0.351* | 0.364* |
|  | (0.002) | (0.003) | (0.004) | (0.001) |
| Const | 0.621* | 0.635* | 0.672* | 0.691* |
|  | (0.027) | (0.024) | (0.013) | (0.005) |
| Observations | 114 | 152 | 228 | 228 |
| No. of instruments | 15 | 18 | - | - |
| AR1 (P-value) | 0.021 | 0.025 | - | - |
| AR2 (P-value) | 0.298 | 0.270 | - | - |
| Sargan Test (P-value) | 0.215 | 0.224 | - | - |
| Hansen Test (P-value) | 0.345 | 0.317 | - | - |

* Shows significance at $p<0.05$

Source: Researcher (2024)

The findings show a positive and statistically significant relationship between digital channels (DC) and financial inclusion (FI) across all models. The coefficients for DC vary between 0.329 and 0.364 ($p < 0.05$), indicating that as the use of digital banking channels increases, financial inclusion in Kenyan commercial banks improves. This implies that expanding digital banking services within banks is likely to result in greater financial inclusion. The constant term was positive and significant in all models, suggesting that there is a basic level of financial inclusion even when digital channels are not used. The AR (1) tests revealed first-order autocorrelation ($p < 0.05$), while the AR (2) tests showed no second-order autocorrelation, confirming the appropriateness of the GMM model. Furthermore, the results from the Sargan and Hansen tests supported the validity of the instruments used in the GMM models. In summary, the findings highlight the essential role digital banking channels play in improving financial inclusion by providing greater access to banking services across various customer groups. As a result, the sub-hypothesis was rejected.

**Step3: Effect of FI on the Relationship between DC and FS**

The third step aimed to test the sub-hypothesis that financial inclusion does not significantly mediate the relationship between digital banking channels and the financial sustainability of commercial banks in Kenya. This step examined whether the inclusion of financial inclusion in the analysis would affect the relationship between digital channels (DC) and financial sustainability (FS). The results of this analysis are summarized in Table 10.

Table 10: Relationship between DC, FI, and FS

| Model | (1) Diff GMM | (2) System GMM | (3) Fixed-effects | (4) OLS, robust |
|---|---|---|---|---|
| L.FSI | 0.360* | 0.380* |  |  |
|  | (0.000) | (0.000) |  |  |
| DC | 0.095 | 0.105 | 0.100 | 0.115 |
|  | (0.099) | (0.084) | (0.093) | (0.078) |
| FI | 0.238* | 0.245* | 0.251 | 0.268* |
|  | (0.002) | (0.004) | (0.012) | (0.004) |
| Const | 0.670 | 0.685 | 0.730 | 0.750* |

| Model | (1) Diff GMM | (2) System GMM | (3) Fixed-effects | (4) OLS, robust |
|---|---|---|---|---|
| | (0.035) | (0.030) | (0.018) | (0.009) |
| Observations | 132 | 160 | 228 | 228 |
| No. of instruments | 16 | 20 | - | - |
| AR1 (P-value) | 0.014 | 0.017 | - | - |
| AR2 (P-value) | 0.321 | 0.292 | - | - |
| Sargan Test (P-value) | 0.191 | 0.204 | - | - |
| Hansen Test (P-value) | 0.335 | 0.325 | - | - |

* Shows significance at $p<0.05$

Source: Researcher (2024)

The findings show that while digital banking channels (DC) have a positive relationship with financial sustainability (FS), this relationship becomes weaker when financial inclusion (FI) is considered in the models. The coefficients for DC range from 0.095 to 0.115, with p-values around 0.08 to 0.10, indicating that their significance decreases in the presence of financial inclusion. This suggests that the direct impact of digital banking on financial sustainability is partially influenced by financial inclusion. In contrast, financial inclusion remains a strong predictor across all models, with coefficients ranging from 0.238 to 0.268 ($p < 0.05$), underscoring its vital role in promoting financial sustainability. This implies that when digital banking is utilized, financial inclusion significantly boosts the financial performance of banks.

The analysis was conducted using the Transaction Cost Theory (TCT), which posits that organizations aim to minimize transaction costs, thereby improving efficiency and long-term sustainability. Digital banking channels support this goal by lowering transaction costs and improving access to services, which helps strengthen the financial sustainability of banks. The first analysis found a significant positive relationship between digital banking channels and financial sustainability, with coefficients between 0.225 and 0.245. This suggests that as banks adopt more digital services, they are likely to become more financially sustainable. According to TCT, this is due to reduced transaction costs and greater operational efficiency, making digital banking channels a valuable tool for improving banks' financial health.

The analysis revealed a positive relationship between digital banking channels and financial inclusion, with coefficients ranging from 0.329 to 0.364 ($p < 0.05$). This indicates that adopting digital banking channels expands access to financial services for a broader range of customers. In the context of TCT, digital channels reduce the costs associated with reaching customers, allowing banks to provide services to previously underserved populations, thus promoting financial inclusion. The third analysis assessed whether financial inclusion mediates the relationship between digital banking and financial sustainability. The results showed that when financial inclusion is included in the model, the direct effect of digital channels on financial sustainability decreases, while financial inclusion remains significant with coefficients between 0.238 and 0.268 ($p < 0.05$). This suggests that part of the impact of digital banking on sustainability is channeled through increased financial inclusion.

This aligns with TCT, which indicates that digital banking enhances financial sustainability not only by reducing transaction costs but also by expanding the bank's reach through improved financial inclusion. By offering more inclusive services, banks can attract a wider customer base, which supports their revenue and sustainability goals. The results show that the mediating effect of financial inclusion is statistically significant, leading to the rejection of the null hypothesis (H02: The mediating effect of financial inclusion on the relationship between digital banking channels and financial sustainability of commercial banks in Kenya is not statistically significant). This confirms that financial inclusion plays a crucial role in enhancing the impact of digital banking on the financial sustainability of banks.

The study's findings reveal a significant positive relationship between digital banking channels and financial sustainability, with coefficients ranging from 0.225 to 0.245 ($p < 0.05$). This supports existing literature in Africa, where digital banking has been found to improve the financial performance of banks. For example, Sajid et al. (2023) highlight that digital banking is essential for promoting financial inclusion, which, in turn, supports the financial sustainability of banks across Africa. Similarly, research by Ebong and George (2021) shows that digital financial services greatly improve access to banking, thus contributing to the financial stability of institutions in Uganda. These findings align with the view that as banks increase their adoption of digital channels, they improve not only their operational efficiency but also their overall financial health.

Research from outside Africa also supports the positive relationship between digital banking and financial inclusion. For instance, Yongjie and Jin (2023) found that digital financial inclusion reduces various risks for banks, thereby improving their financial mobility and sustainability. Furthermore, Zhou (2023) demonstrated that banks that adopt digital financial services experience enhanced operational efficiency, which is key to financial sustainability. This international perspective strengthens the idea that digital banking channels act as a catalyst for financial inclusion and sustainability, transcending regional boundaries and showing a consistent trend in the banking industry worldwide.

The role of financial inclusion as a mediator in the relationship between digital banking and financial sustainability is particularly significant. The study found that while the direct effect of digital channels on financial sustainability decreases when financial inclusion is included in the model, financial inclusion itself remains a significant predictor of sustainability (coefficients between 0.238 and 0.268, $p < 0.05$). This finding is consistent with the Transaction Cost Theory (TCT), which argues that digital banking reduces transaction costs and increases efficiency, leading to improved financial outcomes for banks [46]. Additionally, research by Muharsito and Muharam (2023) supports this by showing that digital financial inclusion enhances bank efficiency, contributing to overall financial performance. This suggests that banks that prioritize both digital channels and financial inclusion are more likely to achieve better financial sustainability, highlighting the interconnectedness of these factors in both African and global banking sectors.

## CONCLUSION

The study explored the role of financial inclusion in mediating the relationship between digital banking channels and financial sustainability. It found that financial inclusion significantly strengthens this relationship, leading to the rejection of the null hypothesis. Specifically, the positive impact of digital banking on financial sustainability was amplified when financial inclusion was considered. The Transaction Cost Theory (TCT) framework revealed that implementing digital banking not only improved financial sustainability but also expanded access to financial services, which promoted financial inclusion and contributed to better financial performance for banks.

The study highlights the importance of financial inclusion in fostering sustainable banking practices. By improving access to financial services, banks can tap into new customer segments, increase revenue, and strengthen customer loyalty. Additionally, financial inclusion supports broader economic objectives, such as poverty reduction and improved quality of life for underserved populations. Based on these findings, it is recommended that banks in Kenya integrate financial inclusion into their digital banking strategies, prioritizing underserved populations to create a positive cycle of growth, improved financial performance, and long-term sustainability. Investment in digital banking infrastructure and targeted inclusion initiatives should be prioritized.

Policymakers play a crucial role in creating a conducive environment for financial institutions and the communities they serve. Policies that promote inclusive banking practices will not only benefit individual banks but also support the broader economic development of the country. Future research should investigate the mechanisms through which financial inclusion mediates the relationship between digital banking and sustainability, providing more specific policy recommendations to address barriers such as digital literacy

gaps and regulatory challenges. Moreover, future studies could consider a more diverse data set, including data from different countries or regions, to enhance the generalizability of the findings.

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